WATER INFORMATION BULLETIN No. 1

SUMMARY OF GROUND-WATER CONDITIONS IN IDAHO, 1966

by

W. L. Burnham, and others

United States Geological Survey

PREPARED BY THE UNITED STATES GEOLOGICAL SURVEY

IN COOPERATION WITH

THE IDAHO DEPARTMENT OF RECLAMATION

Published by

Idaho Department of Reclamation

R. Keith Higginson

State Reclamation Engineer

DECEMBER 1966

ERRATA

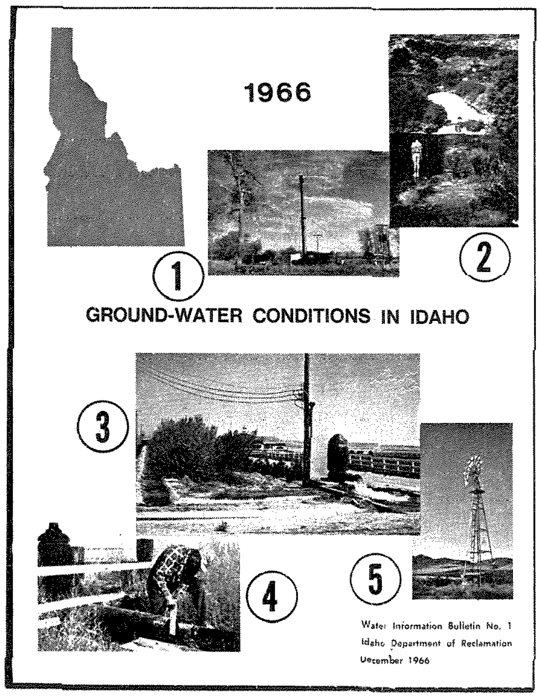
a. Photograph No. 1 is of a well being drilled for Rex *Ward* instead of Rex Wood as indicated on page 2.

b. Figure 10. The caption under the figure should identify the second well as being located at 4N - *26*E - 26cdl instead of 4N - 25E - 26cdl.

c. Figure 17 does not show the contour lines as described in the caption as these blue lines were lost in the printing process.

d. Figure 29. The location of the well should be 7*S* - 5E - 18bcl instead of 7N - 5E - 18bcl.

e. Figure 33. The interpretation of the location of the contours in T. 12 S., R. 23 E. and the east half of T. 12 S., R. 22 E. has been revised since the printing of the illustration.



The Cover Photos

1. Well being drilled for Rex Wood in Cassia County near Malta.
2. Niagara Springs near the Snake River in Gooding County. Photo courtesy of U.S. Geological Survey.
3. Irrigation well owned by R. L. Craner in Cassia County. Photo courtesy of Idaho Power Co.
4. Discharge of an irrigation well owned by Raft River Cattle Co. in the Raft River Valley being measured by H. G. Haight of the Idaho State Department of Reclamation. Photo courtesy of U.S. Geological Survey.
5. Windmill on a well for stock water on a hill northwest of Albion.

CONTENTS

CONTENTS (Continued)

ILLUSTRATIONS

TABLES

TABLE 1

Areas in which ground water is being developed extensively

1	Rathdrum Prairie
2	Moscow Basin
3	Payette Valley
4	Big Lost River Basin
5	Little Lost River Basin
6	Boise Valley
7	Big Wood-Silver Creek Area
8	Snake River Plain
9	Lower Teton Area
10	Bruneau-Grand View Area
11	Salmon Falls Tract
12	Rock Creek-Goose Creek Area
13	Albion Basin
14	Raft River Valley
15	Michaud Flats
16	Malad Valley

TABLE 2

Areas of ground-water potential that have not been developed extensively

17	Kootenai River Valley, Priest River Valley, Bonners Ferry-Sandpoint-Hoodoo Valley Area
18	Benewah County
19	Palouse River-Potlatch River Area
20	Lewiston Area
21	Craigmont-Cottonwood Area
22	North Fork Payette River Valley
23	Weiser River Basin
24	Garden Valley Area
25	Stanley Basin
26	Challis-Round Valley Area
27	Pahsimeroi River Valley
28	Lemhi River Valley
29	Birch Creek Basin
30	Homedale-Murphy Area
31	Mountain Home Plateau
32	Camas Prairie
33	Upper Teton Basin
34	Owyhee Uplands
35	Sailor Creek Area
36	Rockland Valley
37	Arbon Valley
38	Portneuf River Valley
39	Willow Creek Highlands
40	Gem-Gentile Valleys
41	Curlew-Pocatello Valleys
42	Cache Valley
43	Bear Lake Area

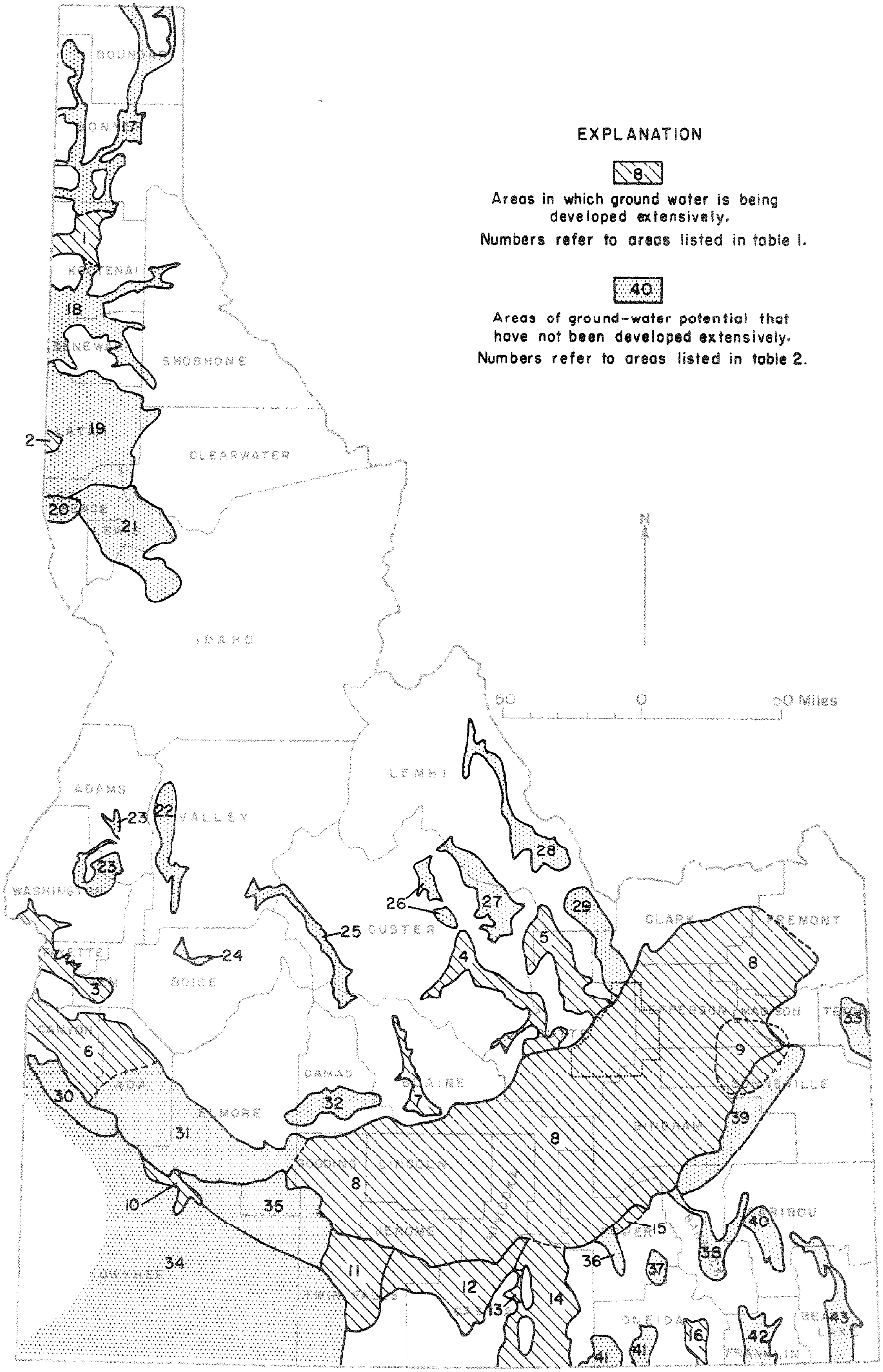


Figure 1. Map showing areas of extensive and potential ground-water development.

INTRODUCTION

This report begins a series of water information bulletins which will describe the many aspects of the water resource in Idaho. This first volume of the series summarizes the occurrence of ground water within the principle geographical and geological subdivisions of the State, as of the Spring of 1966, and discusses briefly, conditions related to development of this resource. It was prepared as a part of the cooperative program of the Water Resources Division of the U. S. Geological Survey and the Idaho Department of Reclamation. The report is designed to present current data and to summarize interpretive information from many published sources which may be of interest to persons concerned with conservation and development of the ground-water resource of the State. For detailed discussion of individual areas, the reader is referred to the list of selected references listed at the end of this volume and to the numerous published reports to be found in most principle libraries.

The data used in preparation of this report were compiled from the files of the Geological Survey. Many of these data were collected as a part of the continuing program with the Idaho Department of Reclamation. Only selected data are included on the illustrations and in the discussions that follow. The current observation wells are shown on the maps, but the water-level contours and change maps are based on large numbers of other observation and measuring points, which are not shown.

WELL-NUMBERING SYSTEM

The well-numbering system used in Idaho by the Geological Survey indicates the location of wells within the official rectangular subdivisions of the public lands, with reference to the Boise base line and meridian. The first two segments of the number designate the township and range; the third segment gives the section number. The section number's followed by two letters and a numeral which indicate the quarter section, the 40-acre tract, and the serial number of the well within the tract. Quarter sections are lettered a, b, c, and d in counter-clockwise order, beginning with the northeast quarter of each section. Within the quarter sections, 40-acre tracts are lettered in the same manner. Thus, well 8S-16E-12bcl near Jerome is in the SW¼NW¼ sec. 12, T. 8 S., R. 16 E., and is the first well visited in that tract.

GROUND WATER IN IDAHO

About 3 million acre-feet of water is withdrawn from the ground-water reservoirs of Idaho each year to irrigate approximately 1 million acres. In addition, nearly all municipal, industrial, domestic, and livestock water requirements are met from the ground-water resource. The ground-water supply is continuously drawn upon by rivers and streams, by native and cultivated vegetation, by evaporation, and by the many demands of man. It is replenished by the rain and melting snow within the drainage basins tributary to and within the State. Because the demands on the resource are nearly constant, and replenishment is seasonal and somewhat cyclical, the availability of ground water tends to vary throughout the year and from one year to another. Small quantities of ground water can be obtained from wells and springs throughout most of the State in nearly all years. Only in specific areas, however, can large quantities of water of suitable chemical quality for general irrigation, public supply, or industrial use be obtained within presently economical limits. These areas are mainly in the southern part of the State and along the western boundary.

Most areas of the State wherein large quantities of ground water are known to occur are being developed extensively by the construction of numerous wells. These areas are shown on figure 1 and are listed in table 1. Areas with potential for development of large supplies of ground water, but which have not been developed extensively, are also shown on figure 1 and are listed in table 2. There are many other smaller areas where individual wells or small numbers of wells yield large quantities of ground water for short periods or during certain times of the year. It is not known whether these wells tap extensive aquifers or isolated bodies of ground water.

Most ground-water development has been for irrigation and the distribution of wells in Idaho is related both to areas of availability of ground water and to the distribution of areas suitable for agriculture. Suitably long growing season, large tracts of arable land, and the need for ground water to supplement diversions from streamflow has caused the majority of irrigation wells to be drilled in the southern and southwestern part of the State. Water is obtained from both consolidated and unconsolidated rocks, and in a given area most wells draw from either one or the other. A few wells obtain water from both types of rocks. Basalt and older silicic volcanic rocks form the principal aquifers of the consolidated rocks. Some water is obtained from older sediments and from extensive deposits of ash, tuff, and associated fine-textured sediments, but the principal supplies of ground water to be obtained from unconsolidated rocks occur in the geologically young alluvial fans and valley-fill deposits, or along the major stream channels.

The location and distribution of wells in which the Geological Survey makes periodic measurements of water level to keep track of changes in the amount of water stored in the ground is shown in figure 2.

Throughout the Snake River Plain and in many areas southeast, south, and southwest of the Snake River, the majority of wells obtain their principal supply of water from consolidated rocks—principally basalt. Wells in the Moscow, Lewiston, Palouse River-Potlatch River, and Craigmont-Cottonwood areas also obtain water from basaltic lavas.

In the large intermontane valleys and basins, and in the stream valleys of the major drainages, most wells draw water from the coarser parts of the unconsolidated alluvial materials that have been brought in from adjacent mountainous areas. These deposits are mostly poorly sorted mixtures of gravel, sand, and silt or clay; they are usually better sorted and most permeable in the central parts of the valleys.

Sedimentary deposits interlayered with basaltic lava flows yield water to wells in some localities. In general, however, these deposits are fine textured and serve to restrict vertical water movement through the basalt. Such relationships are noted briefly in the following discussions of the conditions of ground-water occurrence in the areas of major development in the State.

AREAS IN WHICH GROUND WATER IS BEING DEVELOPED EXTENSIVELY

RATHDRUM PRAIRIE, by E. G. Crosthwaite

Rathdrum Prairie, a roughly triangular lowland, is in the northern part of Kootenai County in northern Idaho. The prairie overlies a basin gouged out by glaciers and then partly filled with coarse sediments deposited by large streams as the glaciers receded. Around the border of the prairie are depressions with no surface outlet, occupied by lakes which drain by seepage to the water table. No streams flow across the prairie, and only the Spokane River along the extreme southern edge of the prairie can maintain a perennial flow.

Ground water occurs under water-table conditions in the sand and gravel deposits which underlie the prairie. These deposits are extremely permeable and form one of the most copious water-bearing formations in Idaho. Remnants of basalt and lake beds that were not scoured out by the glaciers may contain very small amounts of water. Granitic and metamorphic rocks form the basement beneath the prairie and are not regarded as important water-bearing formations.

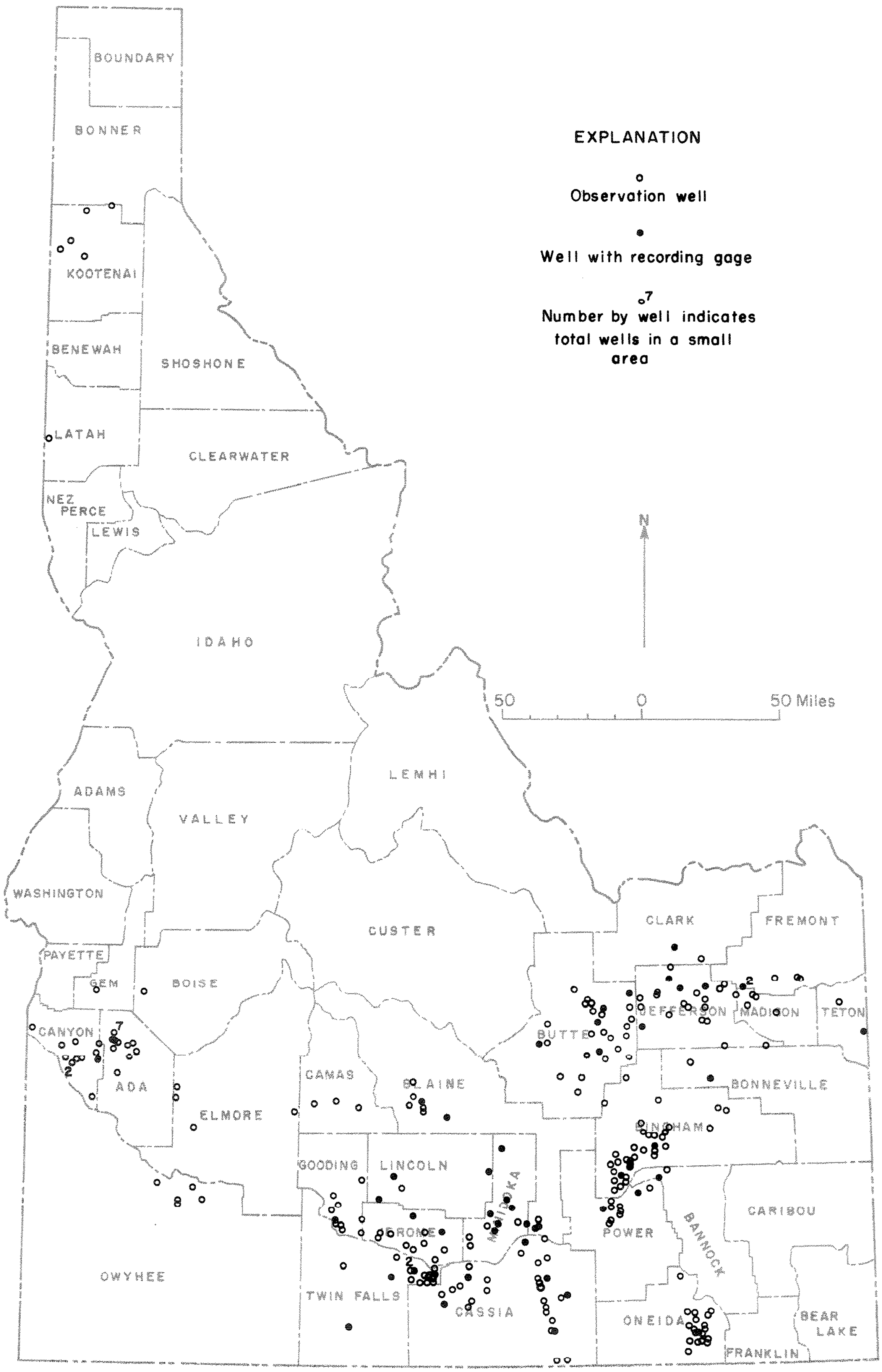


Figure 2. Map showing location of observation wells.

Ground water is recharged by infiltration of rain and melted snow on the prairie, seepage from the marginal lakes and several small streams which drain onto the prairie, and by percolation of irrigation water diverted from the Spokane River, Hayden Lake, and Twin Lakes. Depth to water ranges from 125 feet at the Washington State line to 500 feet near the northern edge of Kootenai County.

The ground water moves generally southwestward through the pervious fill of alluvial and glacial deposits as shown by the water-level contour map (fig. 3) and discharges to the Spokane River beyond the State line in Washington. An estimated 500,000 acre-feet of ground water originating in Idaho is discharged annually to the Spokane River.

Ground water is withdrawn for irrigation, municipal, industrial, domestic, and stock use. It is estimated that ground water serves about half the population. Several irrigation wells are in use and yields range from 1,000 to 3,000 gallons per minute.

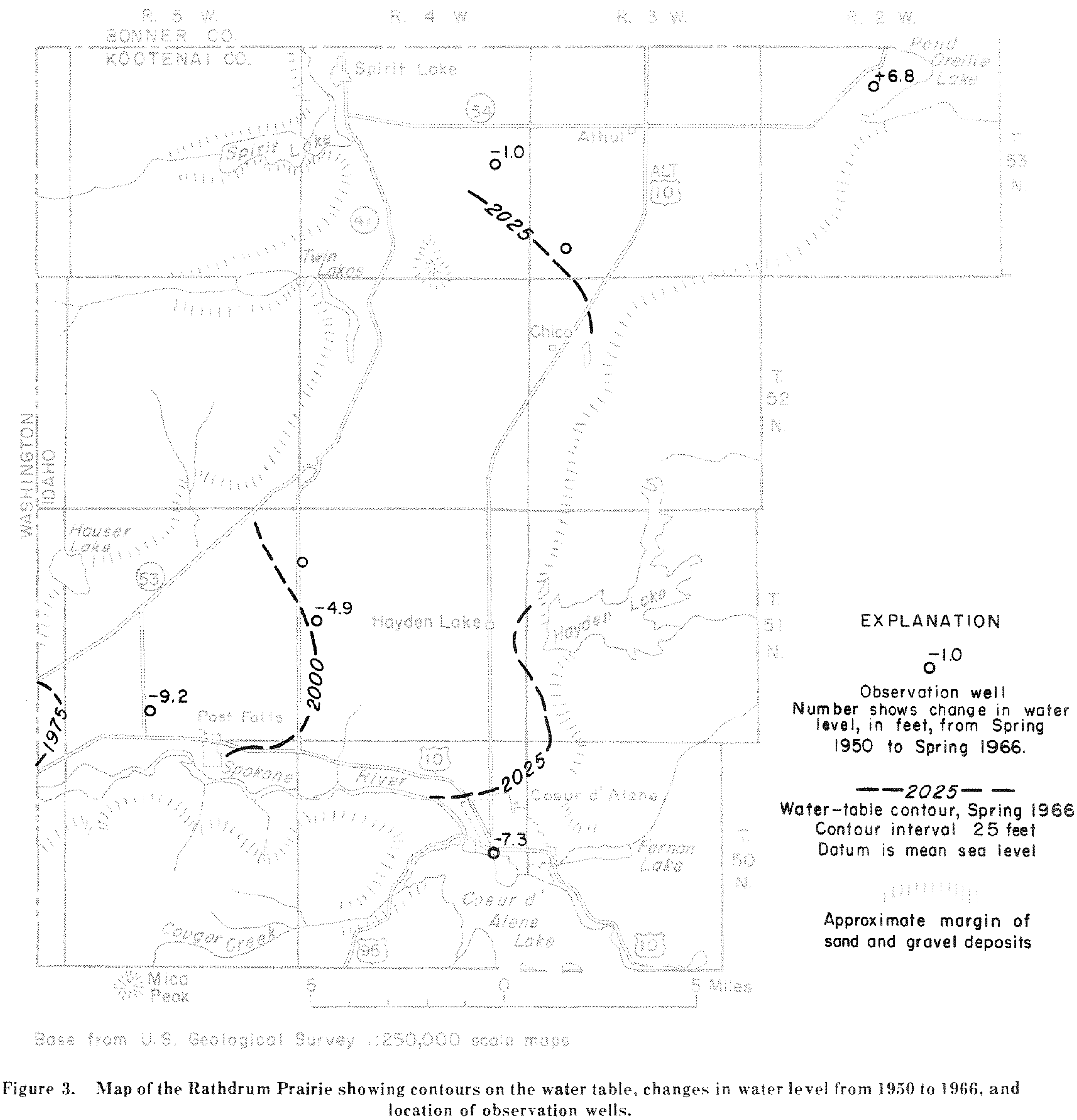


Figure 3. Map of the Rathdrum Prairie showing contours on the water table, changes in water level from 1950 to 1966, and location of observation wells.

Water levels in wells are usually the lowest in late winter and highest in midsummer, reflecting the influence of local recharge on the water table. Figure 4 shows the annual and long term fluctuations in well 53N-4W-24bbl and the cumulative departure from average precipitation at Coeur d'Alene Ranger Station for the period 1931-66. These graphs show that trends in precipitation can be correlated with the trends in water-level fluctuation.

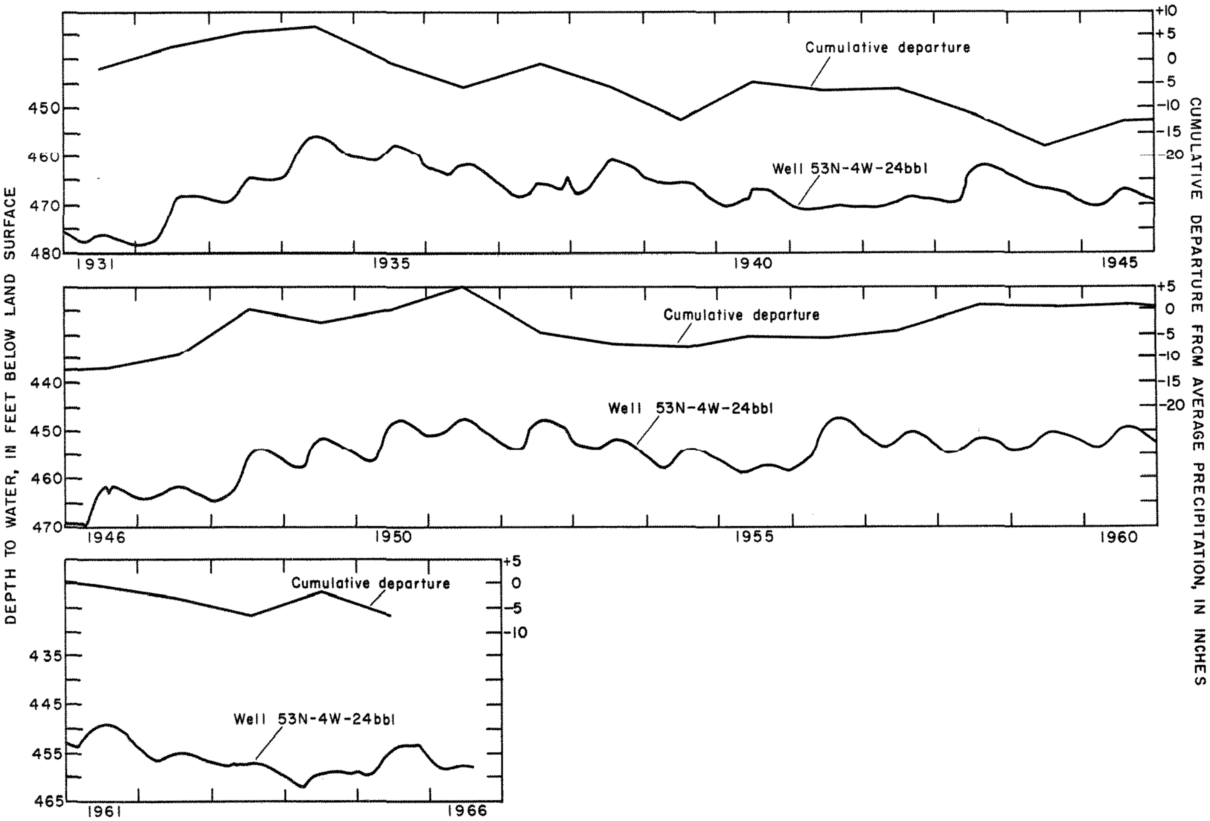


Figure 4. Hydrograph of well 53N-4W-24bbl, Kootenai County, and the cumulative departure from average precipitation at Coeur d'Alene Ranger Station.

MOSCOW BASIN, by E. G. Crosthwaite

The Moscow Basin is an area of 60 square miles in western Latah County adjacent to the Washington State line. The Palouse Range forms the northern drainage divide, Tomer Butte and the adjacent highlands form the eastern boundary, and Paradise Ridge forms the southern (fig. 5). The basin is drained by the South Fork Palouse River and Paradise and Missouri Creeks which flow westward out of the area. Altitudes range from 2,520 to 4,980 feet above sea level. Much of the basin has rolling hills typical of the "Palouse Hills" of eastern Washington and northwestern Idaho.

The source of water is precipitation falling on the basin. Annual precipitation at Moscow is 21.7 inches and is estimated to average 24 inches on the higher terrain.

Ground water occurs under water-table conditions in granitic rock, in the "Palouse soil", and in alluvium. It also occurs under artesian pressure in basalt and interbedded sedimentary deposits which underlie the alluvial deposits and the Palouse soil in the central part of the basin. The water-table aquifers are recharged by infiltration of precipitation that falls on the basin and by seepage from streams. The artesian aquifers are recharged by percolation from the water-table aquifers around the periphery of the basin. Ground water tends to move toward the center of the basin but the major direction of flow is westward out of the Idaho part of the Moscow basin. Some water is discharged from the water-table aquifers by small springs, some of which are intermittent.

The water-table aquifers yield meager to moderate supplies to domestic and stock wells. The artesian aquifers yield as much as 1,500 gallons per minute to wells but the average yield is less than half the maximum yield. The University of Idaho and the City of Moscow obtain their supplies from the artesian aquifers.

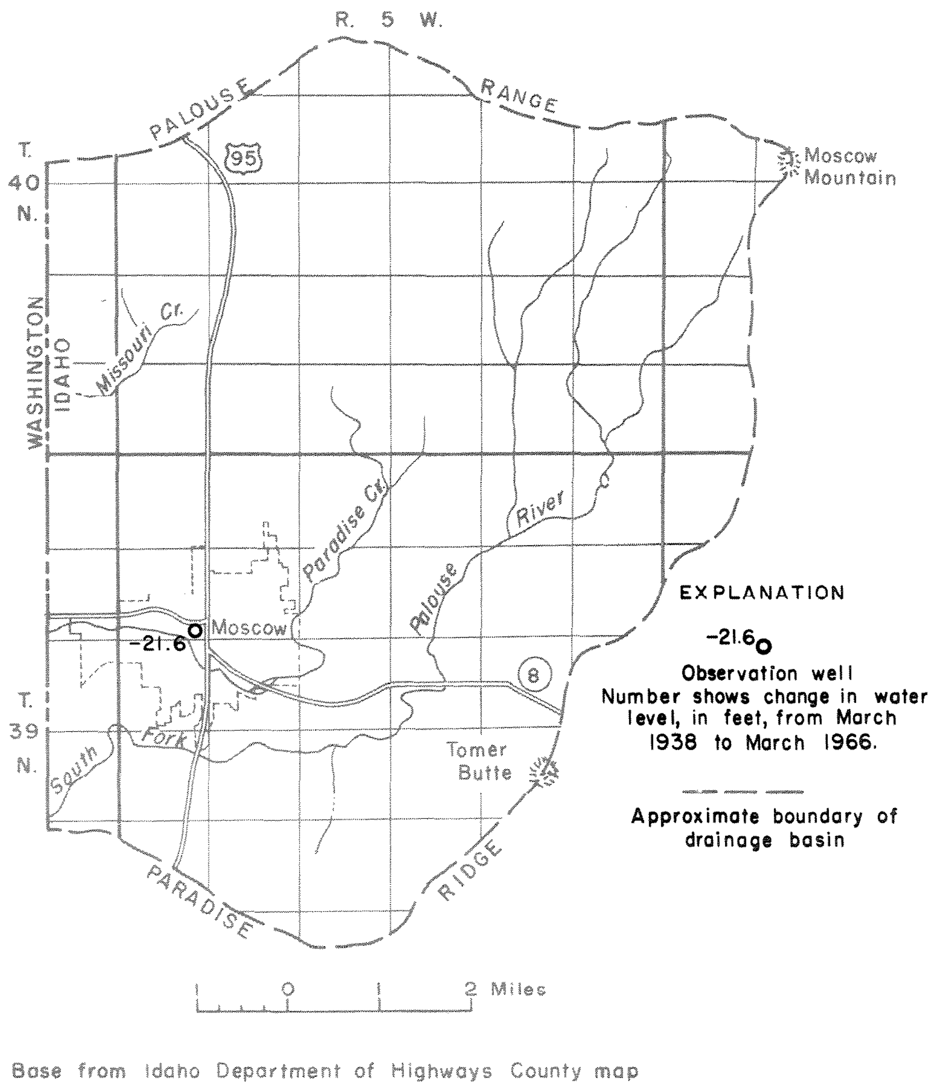


Figure 5. Map of the Moscow basin showing location of observation wells.

In general, the water levels in both the artesian and water-table aquifers are highest in the spring, decline during the summer, and reach their low point in late fall. Ground-water withdrawals by the City and University have altered this pattern of fluctuation in the artesian aquifers in the vicinity of Moscow (fig. 6). When wells were first drilled into the artesian aquifers before 1900, the pressure was sufficient for wells to flow. As development continued, artesian pressures decreased and the water level now is many feet below the land surface. Figure 6 shows the water-level fluctuations in the upper artesian aquifer for the periods 1937-40 and 1950-66. The reversal in the downward trend in 1960 and 1965-66 was caused by discontinuance of pumping from the upper artesian aquifer during those periods. The net decline from 1937 to 1966 has been about 22 feet.

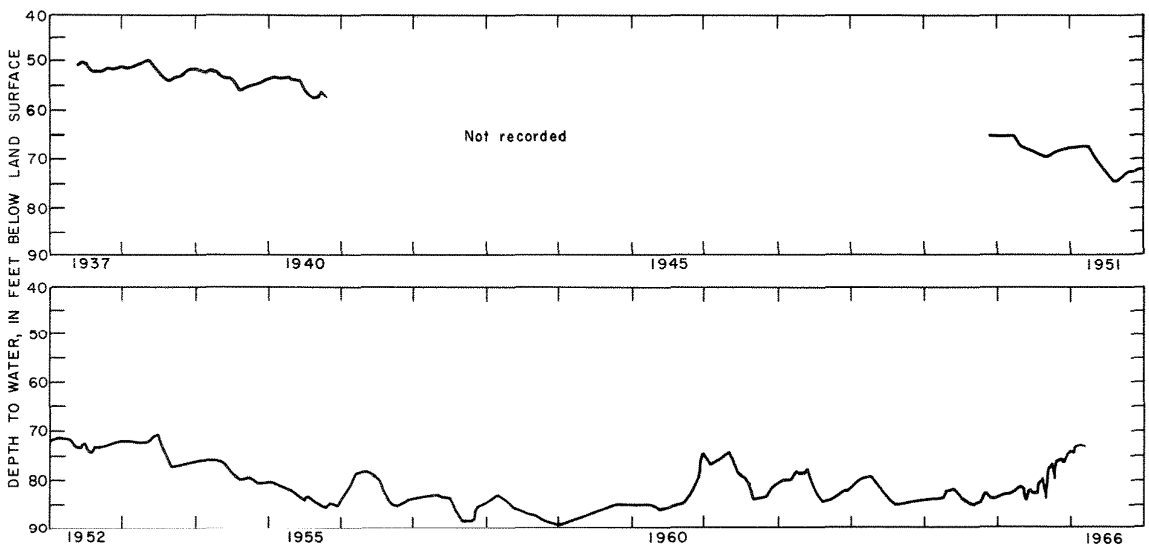


Figure 6. Hydrograph of well 39N-5W-7ddl, Latah County.

PAYETTE VALLEY, by R. F. Norvitch

The Payette Valley, in Payette, Gem, and Boise Counties, extends along more than 40 river miles, westward and northwestward, from the Horseshoe Bend area to near Fruitland (fig.7). The main broad part of the valley, downstream from Black Canyon Dam, is of moderately low relief and is floored with a succession of stream terraces rising steplike from the river floodplain and extending to the valley walls.

The main source of water to the valley is runoff from precipitation in the surrounding mountains. Precipitation on the valley lowlands is small, ranging annually from about 11 inches at Payette to 12.4 inches at Emmett. More than 100,000 acres are irrigated with water diverted from the river northeast of Emmett.

Ground water occurs in the surficial alluvial valley-fill deposits, in underlying unconsolidated sediments, and in older sedimentary and volcanic rocks. The unconsolidated sediments and the older rocks yield small to large amounts of artesian water to wells. Beds of sand and gravel between confining layers of silt and clay in the unconsolidated sediments are the best aquifers.

Sand and gravel in the surficial valley fill are the chief sources of unconfined water.

The ground water moves from sources of recharge along the valley walls toward the center of the valley, and then down gradient in the direction of streamflow. The artesian aquifers are recharged by precipitation on the outcrop areas and by infiltration of stream-flow and irrigation water in the lowlands. The nonartesian aquifers are recharged directly by percolating mountain runoff, streamflow, and irrigation water. It is doubtful that much recharge comes from direct precipitation on the lowlands.

Aquifers in some parts of the valley are nearly full and water logging occurs. Large volumes of ground water are discharged by evapotranspiration at these places. Also, large volumes of ground water are discharged from the valley as underflow into the Snake River valley. Volumes of water withdrawn through wells are small in comparison to the natural discharge from the ground-water reservoir.

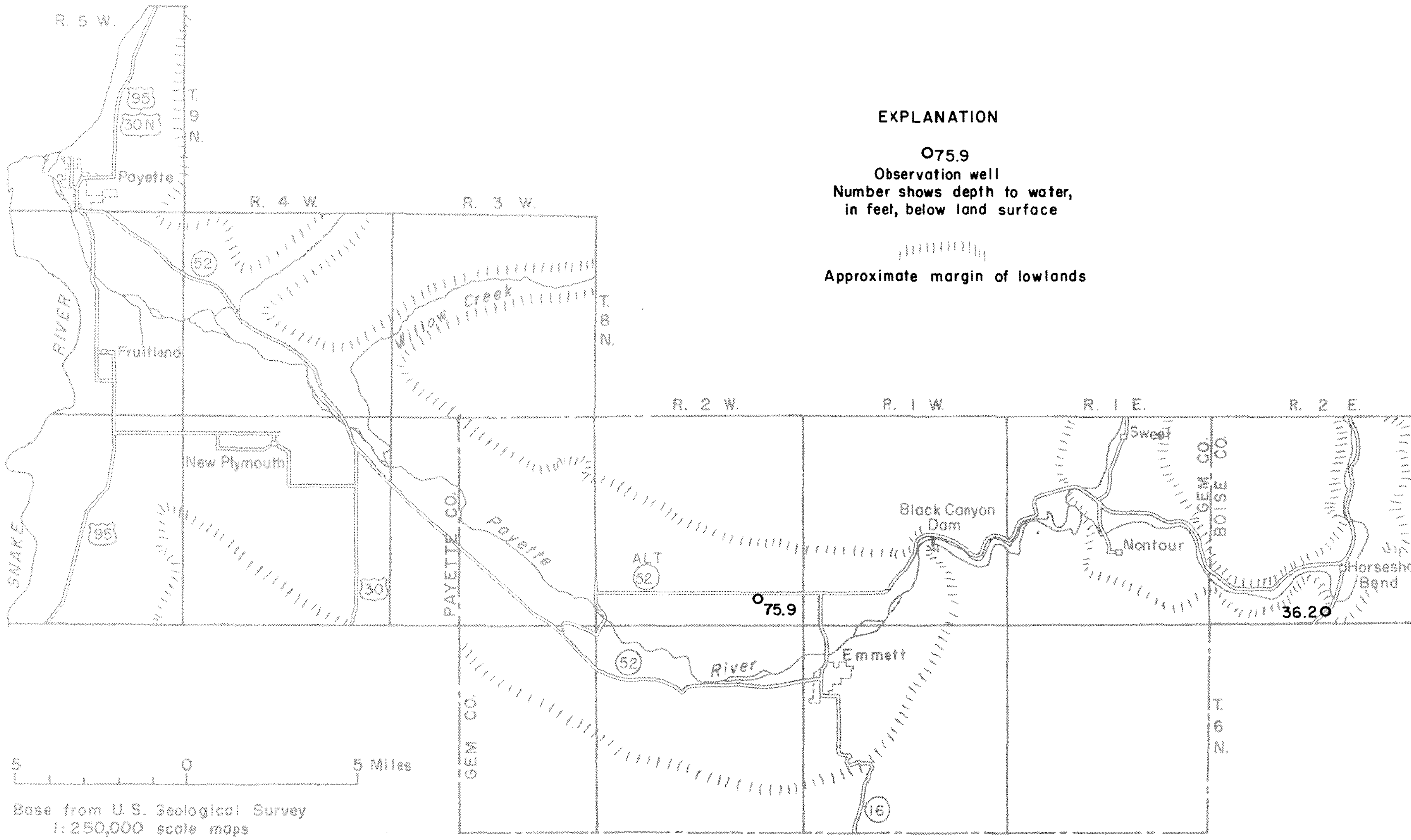


Figure 7. Map of the Payette Valley showing location of observation wells and depth to water, March 1966.

Wells in the valley are used for domestic, stock, municipal, industrial, and irrigation supplies. The amount of ground water used for irrigation is not known but it probably does not exceed several hundred acre-feet annually because of the large available source of surface water. The ground-water reservoir has not been developed to its full potential.

The hydrographs of water-levels in 2 wells (fig. 8) show water-level changes in the valley. Well 7N-2E-34cal, located near the edge of the upper part of the valley, shows little significant change during the period of record. Seasonal changes in recharge and discharge are reflected and climatic cycles probably account for the long-term trends.

Well 7N-2W-35abl shows seasonal fluctuations of about 4 to 11 feet, apparently governed by the application of surface water during the irrigation season. The long-term trend probably follows climatic cycles as witnessed by the rise in water level in 1965, a year of unusually high runoff.

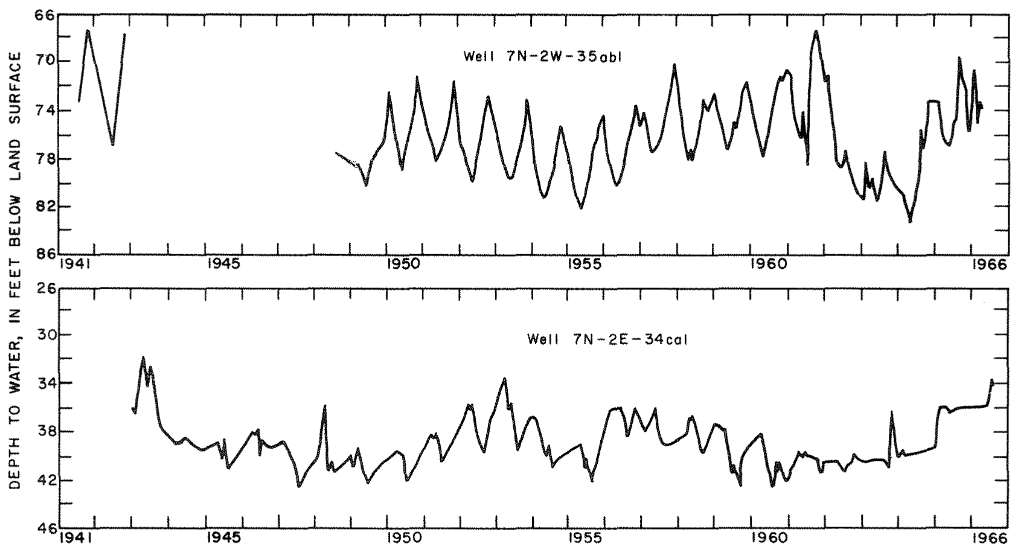


Figure 8. Hydrographs of wells 7N-2W-35abl, Gem County, and 7N-2E-34cal, Boise County.

BIG LOST RIVER BASIN, by E. G. Crosthwaite

The Big Lost River basin (fig. 9) is an area of 1,500 square miles in Butte and Custer Counties on the northwest side of the Snake River Plain. Included in the basin are parts of the Lost River Range on the east side of the basin and parts of the Sawtooth and Pioneer Mountains on the west. The White Knob Mountains are entirely within the basin.

The Big Lost River is the principal stream. It discharges to the Snake River Plain where its flow is lost by seepage to the Snake Plain aquifer and by evaporation.

The source of water for the lowland is runoff of precipitation from the surrounding mountains. Precipitation on the valley floor averages from 8 to 10 inches and adds little to the surface or ground water supplies. Annual precipitation on the mountains, occuring mostly as snow, exceeds 40 inches.

Fluvioglacial, alluvial fan, and alluvial valley-fill deposits form the floor of the lowland from Chilly to Arco. Basaltic lava flows at the mouth of the valley near Arco interfinger with the alluvial deposits. Ground water occurs under water-table conditions in the alluvial deposits and in the basalt, but local silt and clay deposits may cause weak artesian pressures in some places.

The alluvial deposits contain and transmit large quantities of ground water. The Big Lost River is a losing stream in the lowland upstream from Chilly and in the vicinity of Darlington, and all tributaries to the valley lose a large part of or all their flow before reaching the main stem of the river. Percolation of water diverted for irrigation also recharges the alluvial deposits. Depth to water ranges from less than 5 feet to as much as 250 feet below land surface. The ground water moves down the valley and discharges to the aquifer that underlies the Snake River Plain. The discharge is estimated to be in excess of 300,000 acre-feet annually.

Ground water from about 180 irrigation wells supplements the surface-water supply in normal and dry years and provides a full supply for some lands. Most irrigation wells were drilled between 1959 and 1963 and yield from 300 to 3,000 gpm. Ground water is also used for most municipal, domestic, and stock supplies.

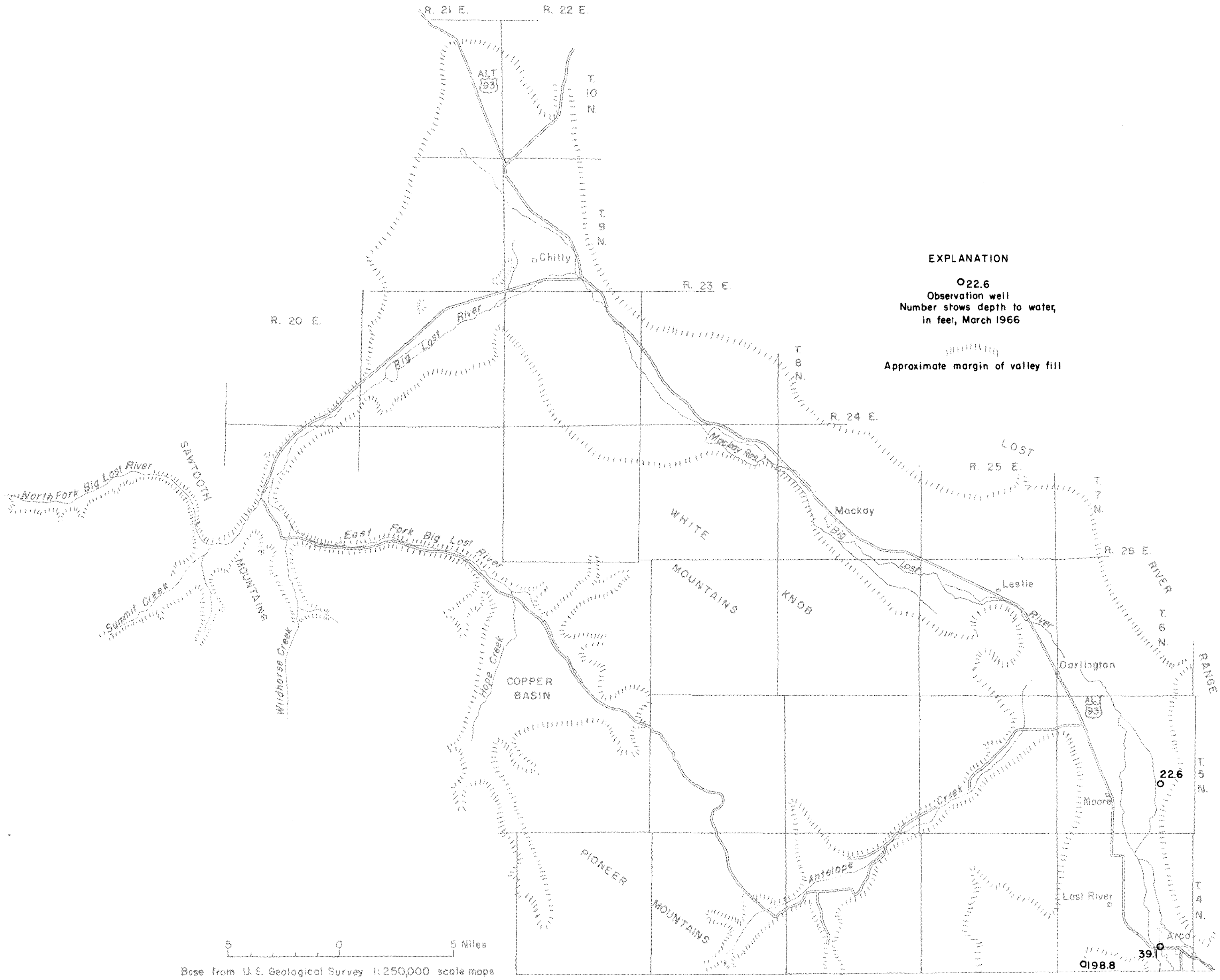


Figure 9. Map of the Big Lost River basin showing location of observation wells and depth to water.

The water table fluctuates in response to irrigation and to recharge from Spring runoff. In most wells the water level begins to rise in the Spring, reaches a peak in July or August, and declines the rest of the year as shown by the hydrographs in figure 10. The hydrographs also show a water-level decline during the dry years of 1959-61, a recovery during 1962-65, and then a downward trend caused by the very dry winter and spring of 1966. Trends in precipitation as reflected by runoff at the Howell Ranch surface-water gage correlate with the water levels.

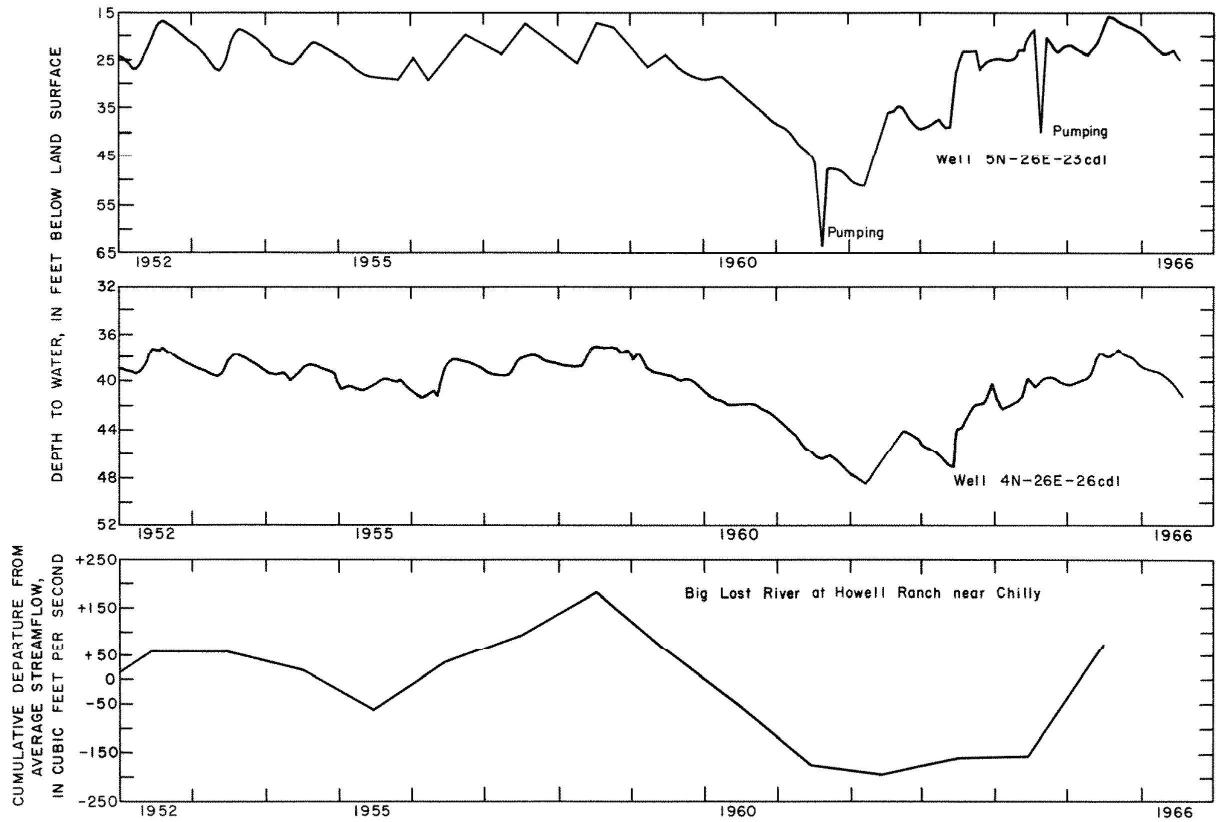


Figure 10. Hydrographs of wells 5N-26E-23cdl and 4N-25E-26cdl, Butte County, and cumulative departure from average streamflow of Big Lost River at Howell Ranch.

LITTLE LOST RIVER BASIN, by H. A. Waite

The Little Lost River basin (fig. 11) is one in a series of southeastward-trending basins tributary to the Snake River Plain along its northwestern flank. The basin, more than 50 miles long and about 20 miles wide, is flanked by the Lost River Range on the west and the Lemhi Range on the east, both of which receive moderately large amounts of rain and snow. Much of the runoff percolates into the permeable alluvium that underlies the valley floor. Surface water and ground water are closely interrelated in the valley and constitute a single resource.

Little Lost River valley is apparently a down-faulted structural trough partly filled with alluvium from the flanking mountain ranges which are formed chiefly of limestone, quartzite, and shale. At some places, andesitic or silicic volcanic rocks constitute a major part of these mountains.

Precipitation averages less than 10 inches annually at Howe, the only station in the valley, but on some of the higher peaks it probably exceeds 30 inches annually.

The most important aquifer in the valley is alluvium containing sand, gravel, and boulders, possibly originating in part as glacial outwash. Except for a few wells near the mouth of the valley that obtain water from basalt, all wells derive water from the alluvium.

Near the mouth of Little Lost River valley, in the vicinity of Howe, basalt flows are interbedded in the alluvium. Basalt is exposed at the surface east and southeast of Howe as the valley merges with the Snake River Plain.

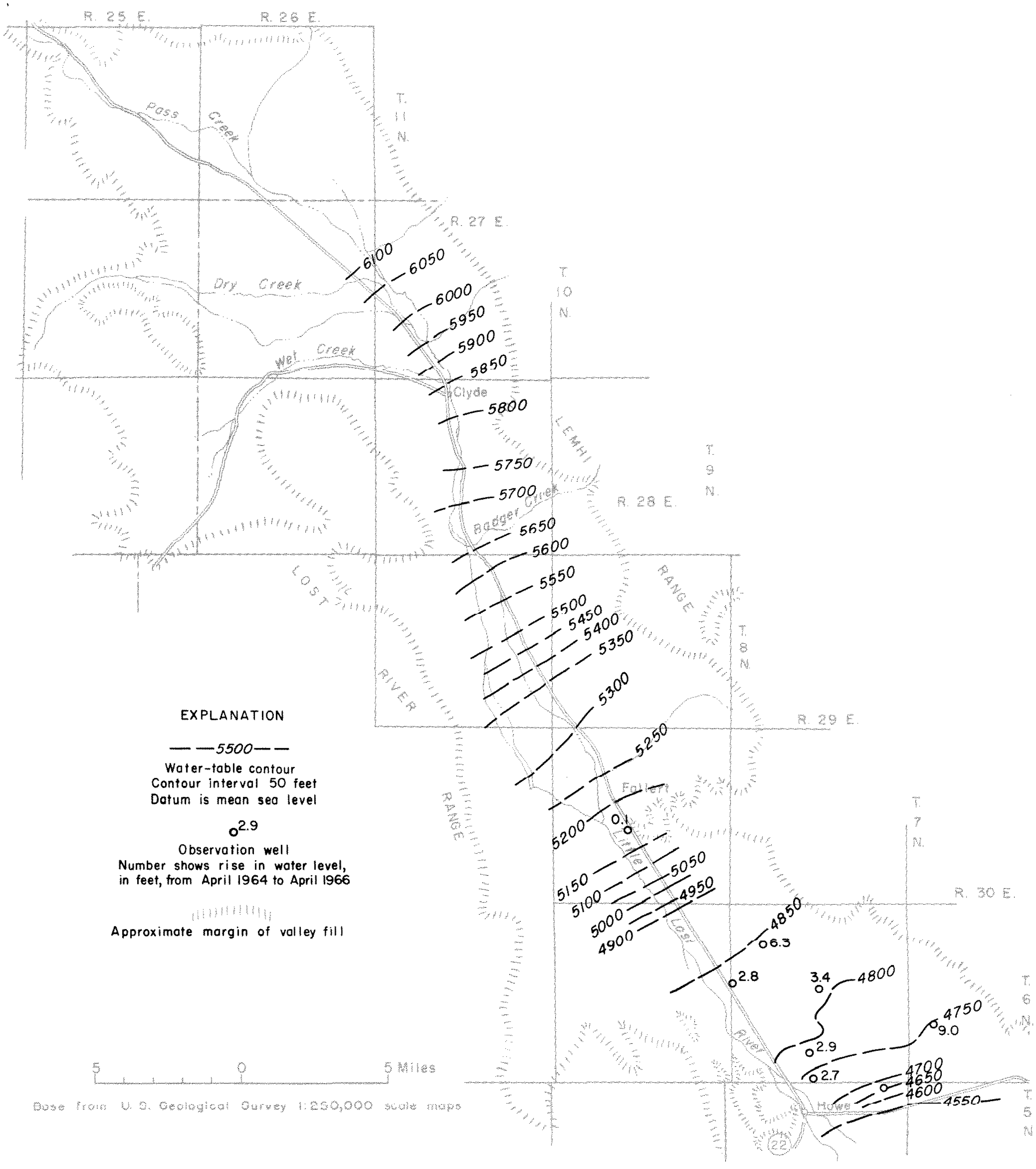


Figure 11. **Map of the Little Lost River basin showing contours on the water table, April 1966, and location of observation wells.**

Ground water in the alluvium is unconfined, that is, it is under water-table conditions. The water-table contours (fig. 11), show the downvalley gradient of the water table to be relatively uniform, averaging about 43 feet per mile, north of a bedrock ridge that constricts the aquifer in secs. 21, 22, 23, and 24, T. 7 N., R. 28 E. The water table declines steeply from this point, dropping about 200 feet in less than 2 miles.

The aquifer widens downvalley from the bedrock barrier, and the water-table gradient in the vicinity of Howe ranges generally from 15 to 20 feet per mile. The water table in most of this area is about 40 to 100 feet below the surface. The water level in the basalt of the Snake River Plain, only a mile or so to the south, is nearly 200 feet lower. The configuration of the contours in the southern half of T. 6 N., R. 29 E., reflects the influence of heavy pumping from wells for irrigation.

The ground-water reservoir is recharged chiefly by percolation from stream channels that cross alluvial fans. Most of the tributary streams flow throughout the year, but Spring snowmelt contributes additional increments of recharge.

About 100 wells were used for irrigation in 1966 in the valley; many are less than 100 feet deep and few are more than 150 feet. Several hundred domestic and stock wells have been dug or drilled in the valley, but the quantity of water pumped from them is small compared to that pumped for irrigation.

The number of irrigation wells used and estimated quantities pumped in the Little Lost River basin during the period 1959-65 is as follows:

Year	Wells Used	Amount Pumped (acre-feet)
1959	63	38,000
1960	69	47,500
1961	87	50,000
1962	82	40,000
1963	86	39,500
1964	86	33,000
1965	85	26,000

Water levels in wells reflect above-normal or below-normal precipitation and the impact of such climatic variations on the quantity of water pumped each irrigation season. These water-level fluctautions and trends in the basin are shown in figure 12 by the hydrographs of two selected wells. Water-level measurements beginning in 1952 in well 6N-29E-33dcl, about 2 miles north of Howe, show a progressive net decline from the beginning of record until about the middle of 1964. From that time until the present, the water level continued to rise in response to above-normal precipitation and resultant lesser pumping for irrigation. The hydrograph for well 5N-29E-23cdl, about 3 miles southeast of Howe, showed a somewhat similar downward trend until about April 1964, and showed a net rise from then until July 1966.

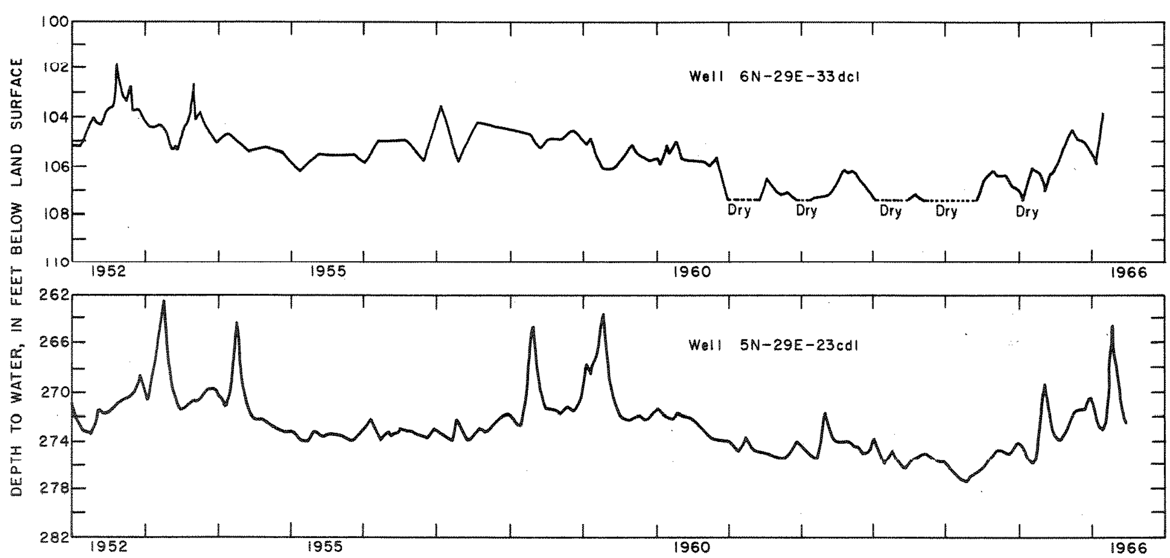


Figure 12. Hydrographs of wells 6N-29E-33dcl and 5N-29E-23cdl, Butte County.

BOISE VALLEY, by E. H. Walker

The Boise Valley area (fig. 13) includes the bottomlands and low terraces along the Boise River, and the much larger tracts of rolling plain that extend southward to the Snake River and are irrigated with water diverted from the Boise River. About 370,000 acres are irrigated. The area is bounded on the north by foothills, which rise behind Boise, to mountains about 7,000 feet high. The Boise River emerges from the mountains about 10 miles east of Boise and takes a course westward to join the Snake River about 45 miles from Boise. Numerous valleys drain to the Boise Valley from the northern foothills and mountains, but the stream channels carry water as far as the Boise River only in the Spring season of snowmelt.

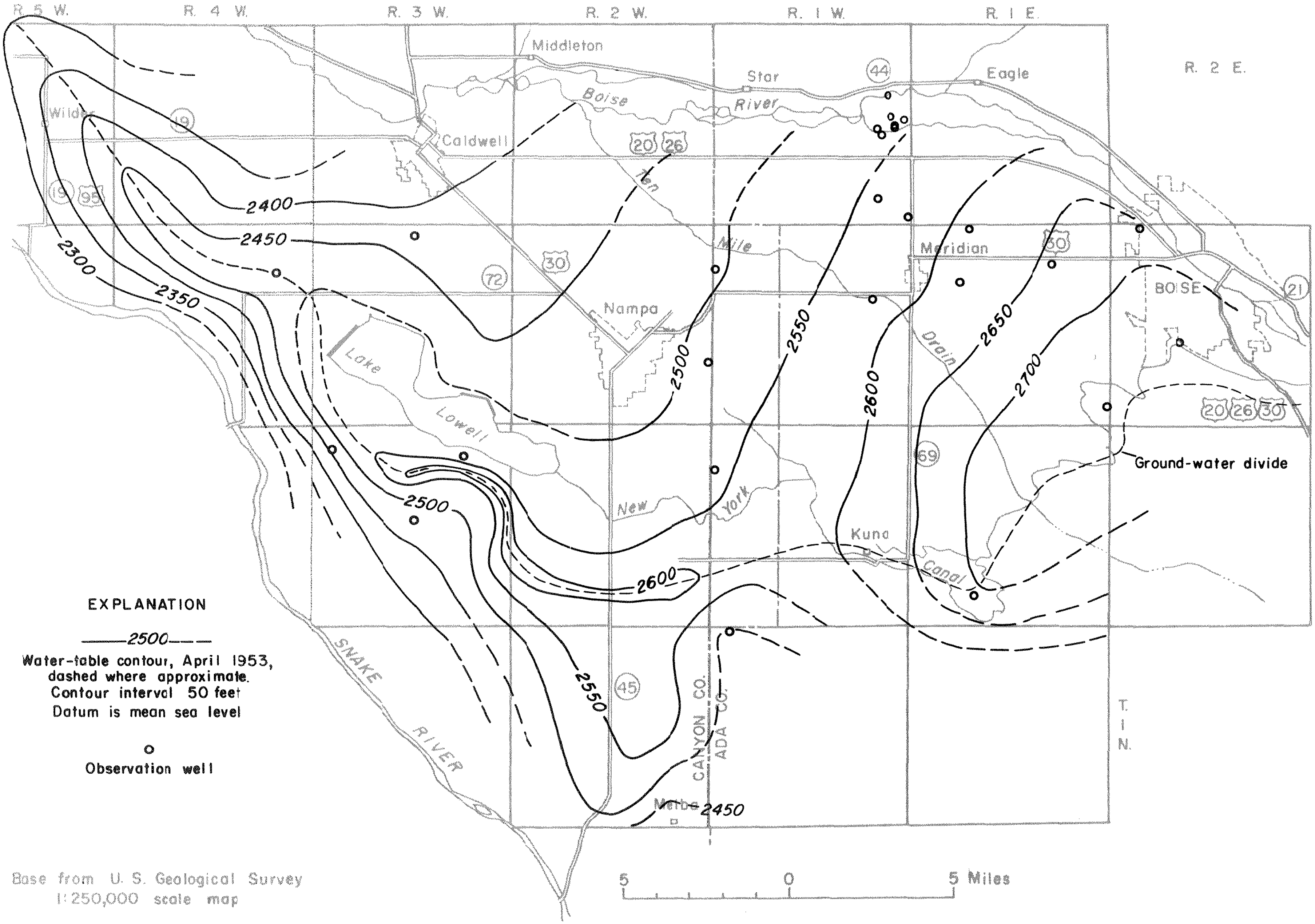


Figure 13. Map of the Boise Valley showing contours on the water table and location of observation wells.

Ground water occurs in the river gravel along the Boise River and under the river terraces, and in beds of sand and gravel and lava flows in the thick lake and stream deposits that underlie the entire area. Water occurs unconfined at many places in the shallower aquifers and more or less confied in both the shallow and deeper ones, at many places under sufficient pressure to flow at the surface. Flows of artesian hot water have been developed from the deeper water-bearing zones close to and beneath the foothills.

The water-bearing formations under the Boise Valley can yield sufficient water for irrigation in most places, and ground water has been developed in tracts of considerable size, especially to the south of the lands served with water from canals.

The principal source of water is runoff in the Boise River, which drains about 2,600 square miles of mountainous country. Drainage from the hills and mountains immediately north of the Boise Valley adds a smaller but still significant amount of water.

Little recharge originally occurred on the upland plain south of the river where precipitation averages only about 10 inches a year, but now more than 300,000 acre-feet of recharge occurs yearly by drainage from irrigation of the former sagebrush desert with surface water.

The recharge from irrigated lands now determines the pattern of ground-water movement, at least in the shallow water-bearing zones. Ground water moves generally westward except west of Kuna where a ground-water ridge occurs beneath the New York Canal and Lake Lowell. From this ridge water locally moves to the north and to the southwest.

Most of the ground water moving beneath the Boise Valley is ultimately discharged by seepage into drainage canals and the Boise River, and thence into the Snake River.

In the early 1950's it was estimated that about 150,000 acre-feet of ground water was being pumped in the Boise Valley for all purposes, and that about 70,000 acre-feet of this was consumed by evaporation and transpiration. Pumpage and consumption have increased significantly since that time. Also, it is estimated that about 160,000 acre-feet of ground water per year is being consumed by such water-loving vegetation as willows and cattails growing on about 40,000 acres where ground water is close to the surface or forms marshes and ponds.

Water levels rose noticeably in the Boise Valley after completion of the first large irrigation projects in the early 1900's. The water level in well 2N-1W-4ddl (fig. 14), about 5 miles southwest of Nampa, shows the general rise of about 70 feet that occurred here by the early 1950's, after which the water level more or less stabilized. Water levels rose as much as 140 feet in some of the area around Lake Lowell. Owing to these rises, a great deal more water is in storage in the aquifers that in pre-irrigation days. The rise of water level has caused water-logging and drainage problems in many low areas where extensive systems of drainage ditches and drainage wells have only partially remedied the problems.

The hydrograph of well 4N-1W-35aal (fig. 14,), located about 3 miles northwest of Meridian, shows typical annual fluctuations of water level beneath irrigated lands. Water levels begin to rise abruptly at the end of April after the first applications of irrigation water, and crest late in August or early in September at the end of the irrigation season. Water levels then decline until next Spring. Water-level fluctuations beneath irrigated lands range from about 3 to 10 feet.

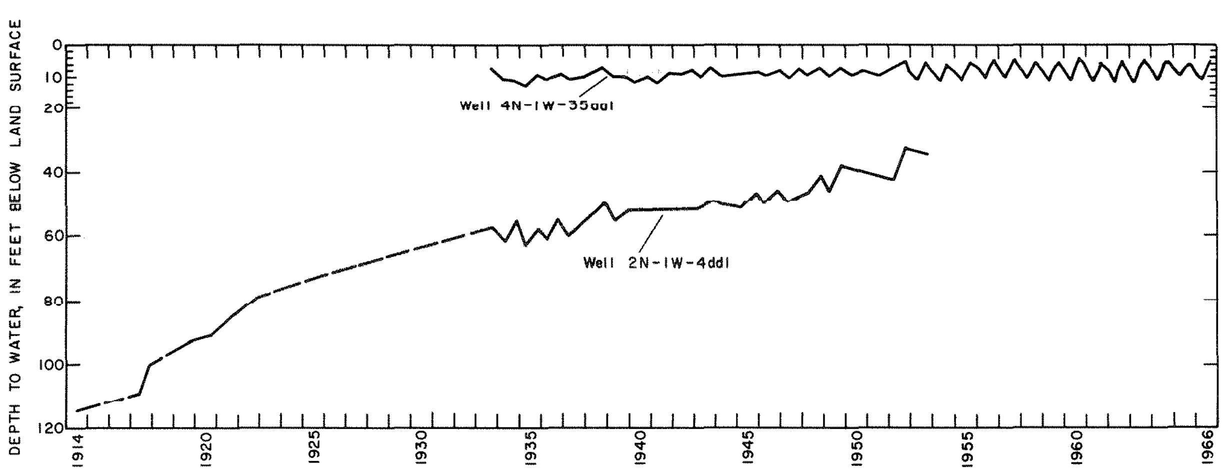


Figure 14. Hydrographs of wells 4N-1W-35aal and 2N-1W-4ddl, Ada County.

BIG WOOD RIVER-SILVER CREEK AREA, by E. H. Walker

The Big Wood River-Silver Creek area (fig. 15), located in the central part of Blaine County, is a wedge-shaped embayment in the mountains on the north side of the Snake River Plain. The lowlands, covering about 50,000 acres, broaden to the south where hills of bedrock separate them from the Snake River Plain. The Big Wood River heads in the mountainous area to the north were many peaks rise to altitudes of about 10,000 feet, and flows southward through the valley and then westward through a gap in the southern hills.

Water for the valley is wholly derived from precipitation, mainly the snow upon the uplands and mountains to the east, north, and west. Only about 3 inches of precipitation occurs on the valley floor during the growing season.

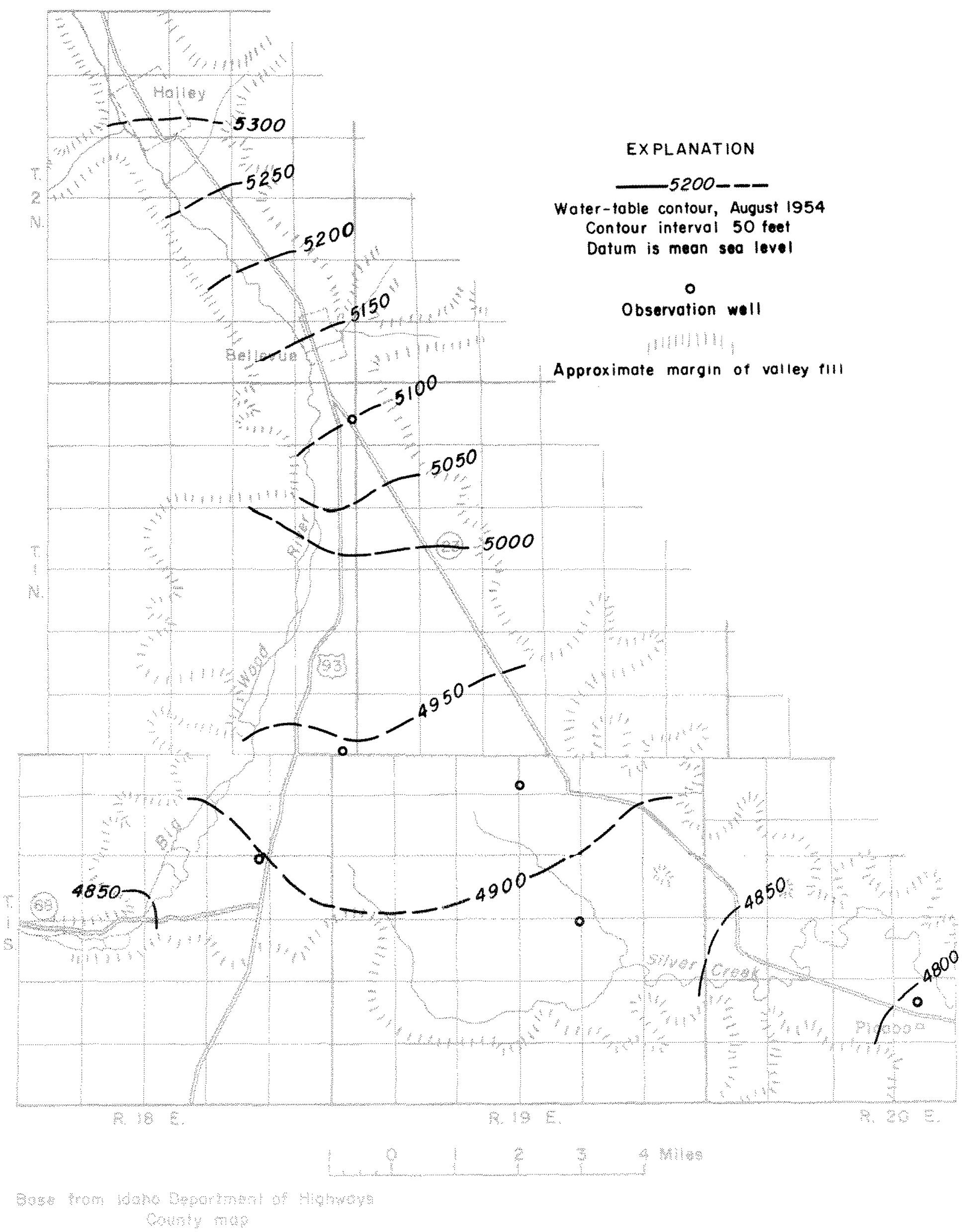


Figure 15. Map of the Big Wood-Silver Creek area showing contours on the water table and location of observation wells.

Most of the ground water occurs in valley-filling deposits of sand and gravel that range in thickness from more than 300 feet to a feather edge at the margins of the valley. Basalt lavas form an excellent aquifer where they occur beneath the surface in the south-eastern part of the area near Picabo. Water occurs unconfined under water-table conditions throughout the valley, and there is an extensive area of artesian confinement and flowing wells in the southern part of the valley where a sheet of gravel occurs at depth below a wedge of silt and clay formed in an old lake.

The sand and gravel aquifer receives recharge mainly by infiltration from the Big Wood River and minor streams during the Spring season of snowmelt and high runoff. Percolation from the irrigated lands through the coarse-textured and permeable soils, also contributes much recharge to the ground-water bodies.

The ground water moves generally southward (fig. 15) and then toward the gaps in the southeast and southwest parts of the valley. It is discharged from the basin by natural vegetation and crops, by spring flow that contributes to outflowing streams, and by underflow. Consumption of ground water by native vegetation has been estimated at about 50,000 acre-feet per year.

Ground water withdrawal from wells in the area increased from about 2,500 acre-feet in 1946 to about 8,000 acre-feet in 1954 when about 30 irrigation wells were in operation. More irrigation wells have been drilled since that time and pumpage may exceed 10,000 acre-feet a year at present. It is estimated that less than half the pumped water is consumed by plants or evaporated; the remainder seeps back to the ground water.

Geologic conditions in the southern end of the lowlands cause much ground water to emerge at the surface as springs and seeps, and to escape from the valley as surface flow in the Big Wood River and Silver Creek.

Seepage to the Big Wood River from ground water has been estimated at 100 cfs (cubic feet per second), or 72,000 acre-feet per year, or about 35 percent of the average flow of 203,000 acre-feet per year of the Big Wood River where it leaves the basin.

The entire flow of Silver Creek out of the valley past Picabo, averaging around 116,000 acre-feet a year, comes from ground water that emerges at the surface in the southeast part of the valley. An additional 38,000 acre-feet of water per year is estimated to move through permeable formations under this gap, giving a total ground-water discharge that may average about 155,000 acre-feet per year. The total outflow of ground water from the area, as surface flow and as underflow, is therefore believed to total around 225,000 acre-feet per year.

The hydrographs of 3 selected wells (fig. 16) show representative changes in water level in the Big Wood-Silver Creek basin. These show that water levels throughout the area begin to rise early in the Spring and come to a peak in June or July, after which water levels decline through late Summer, Autumn, and Winter, until the next Spring when runoff from snowmelt and drainage from irrigated areas recharges ground water.

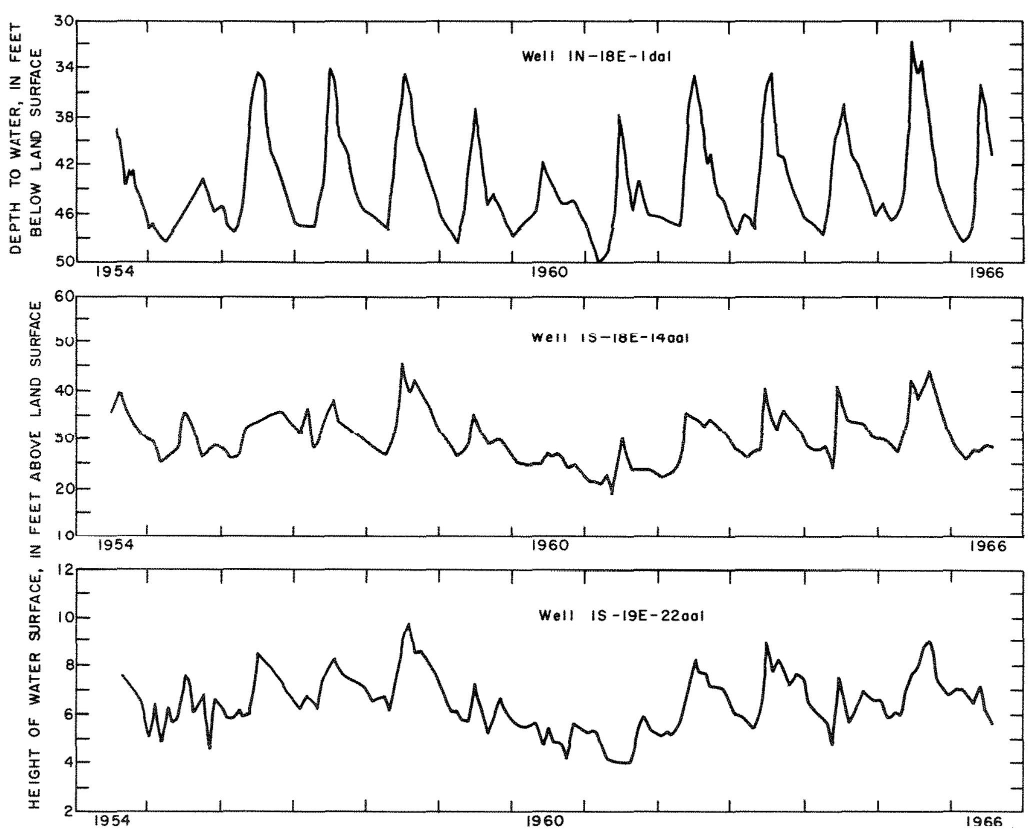


Figure 16. Hydrographs of wells 1N-18E-1dal, 1S-18E-14aal and 1S-19E-22aal, Blaine County.

Water levels in all three wells show a similar long-term pattern from 1954, when records began. Water levels rose in the late 1950's, began to decline in 1959, reached lows in 1960 and 1961, and then rose again in the following years. Present water levels, including those in two flowing observation wells in the southern part of the basin, are close to those in 1954, showing that pumping has not caused any significant net depletion or decline in artesian pressure during the period of record.

SNAKE RIVER PLAIN, by R. F. Norvitch

The Snake River Plain extends eastward and northeastward roughly 200 miles from Bliss to about St. Anthony (fig. 17). It is a broad undulating surface of about 8,500 square miles bounded on the north, east, and south by mountain ranges and broad, alluvial-filled intermontane valleys; and on the west by a broad, lava-capped plateau area.

The rocks underlying the plain are a series of successive basaltic lava flows which include interflow beds of sedimentary materials. This series contains the Snake Plain aquifer, the most prolific water-bearing sequence of rocks in Idaho.

The agricultural value of this otherwise seemingly barren land is due to a perennial supply of water, both from surface and ground-water sources. The major streams in the areas are Henrys Fork, tributary to the Snake River in the northeastern part of the plain, and the Snake River which flows along the approximate eastern and southern borders of the plain.

The Snake River both contributes water to and receives water from the Snake Plain aquifer. Ground-water springs discharge water to the river in stretches from the mouth of the Blackfoot River to a short distance below American Falls Reservoir; and from below Milner, through the Hagerman Valley reach, to Bliss. Elsewhere, the river channel is above the regional water table and river water recharges the ground-water reservoir.

The major source of water to the Plain is precipitation on the surrounding mountains, especially to the north and to the east. Except for the Big Wood River drainage in the western part of the Plain, all streams that head in the northern mountains and that flow onto the Plain seep into the subsurface and add water to the aquifers that underlie the Plain.

The sources of recharge, in order of importance, are: 1) percolation from irrigation, 2) seepage from streams entering or crossing the Plain, 3) underflow from tributary basins, and 4) precipitation on the Plain. Direct precipitation on the Plain probably accounts for less than 10 percent of the total recharge to the aquifer. Total recharge from the 4 sources mentioned above currently amounts to about 6.5 to 7 million acre-feet annually.

Ground water occurs in sand and gravel alluvial deposits associated with the present drainage systems, but the overwhelmingly significant occurence of ground water is in the porous basalt and sedimentary interbeds which underlie nearly the entire Plain.

Water in the main aquifer occurs mostly under water table (unconfined) conditions. Some flowing wells occur locally in the Aberdeen-Springfield, the Market Lake, and the Mud Lake areas where local artesian conditions exist.

Secondary water bodies (perched water tables) have formed at places where beds of low permeability underlie areas of heavy irrigation. Egin and Rupert Benches and the Mud Lake area overlie perched water bodies.

Regional ground-water movement is west- and southwestward, from sites of recharge to sites of discharge, as shown in figure 17.

Natural discharge from the aquifer occurs almost wholly from springs along the Snake River. In 1965 about 4.7 million acre-feet issued from the springs below Milner, and probably about 2 million acre feet from the springs between American Falls and Blackfoot. Figure 18 shows the estimated annual mean flow in the springs below Milner. The growth of irrigation on the plain since the early 1900's is clearly reflected in these estimates. The net discharge from irrigation wells amounts to only a small part of the total annual discharge from the aquifer. Gross pumpage is large, but much of the water applied for irrigation returns to the water table through the permeable basalt. Figure 19 shows the annual amount of water pumped on the North Side Pumping Division, Minidoka Project of the U. S. Bureau of Reclamation. Private development has occurred adjacent to this project, irrigating about the same amount of land and pumping a similar amount of water.

The major areas of irrigation, both from ground- and surface-water sources are shown in figures 20, 21, and 22.

The total volume of water in storage in the Snake Plain aquifer is unknown, but is estimated to amount to about 250 million acre-feet. Wells for domestic and stock use, plus wells for municipal supplies, barely scratch the surface of the potential ground-water reserve. Development of the ground water supply for irrigation did not really begin until after World War II, and the number of irrigation wells in use today on the Plain is not known. However, it is more than 1,200.

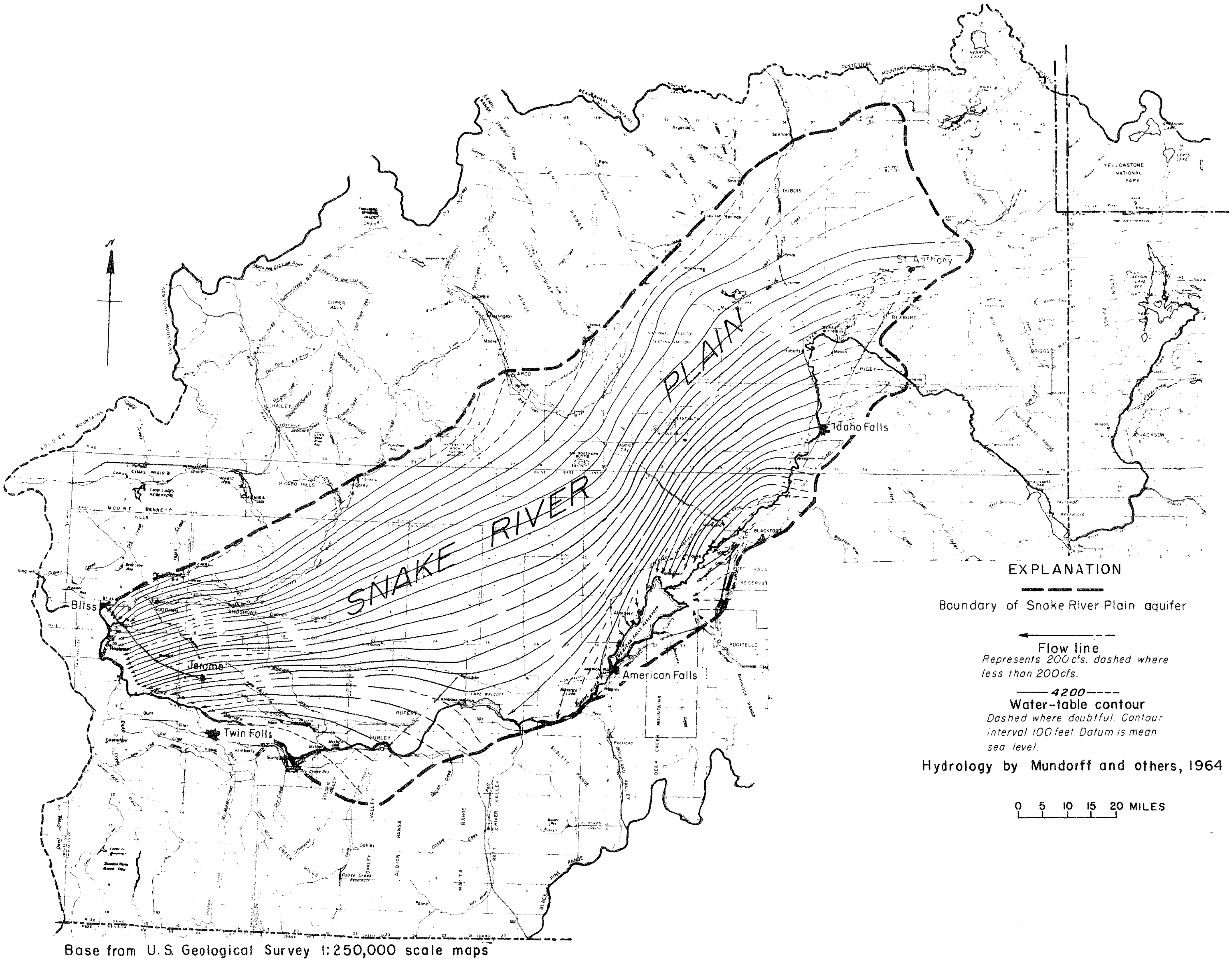


Figure 17. Map of the Snake River Plain showing the flow pattern and contours on the water table, 1959.

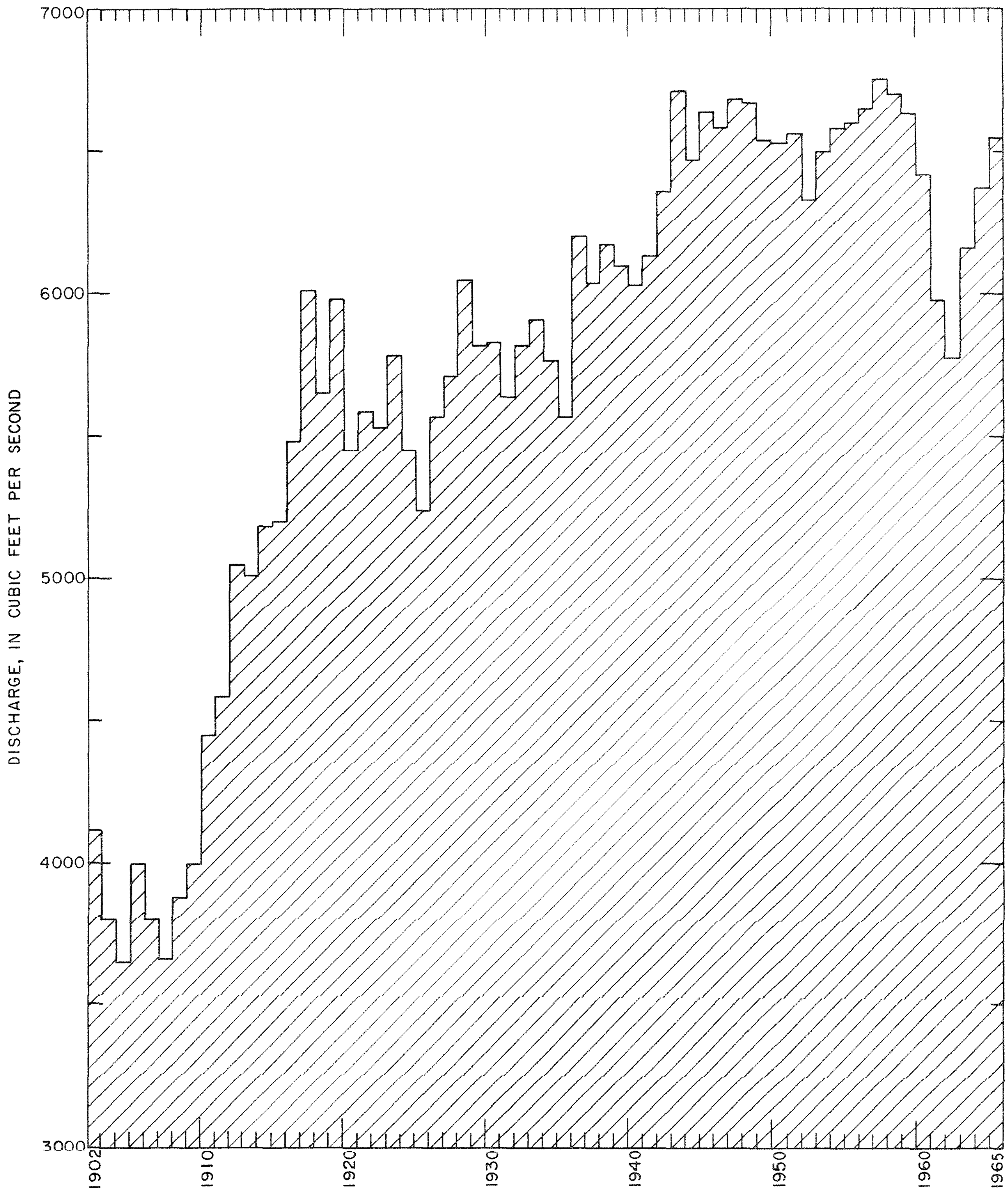


Figure 18. Graph showing estimated spring flow from Milner to King Hill.

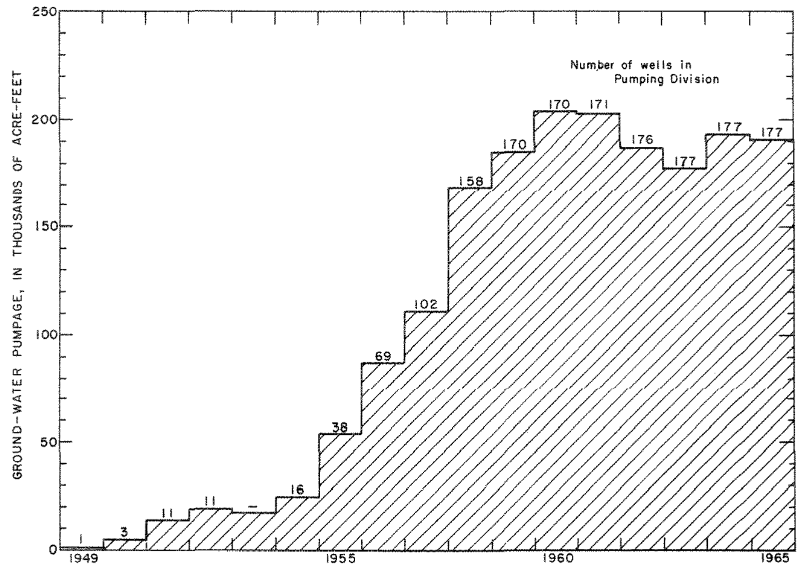


Figure 19. Graph showing ground-water pumpage from the Minidoka Project, North Side Pumping Division (U.S.B.R.), 1949-65.

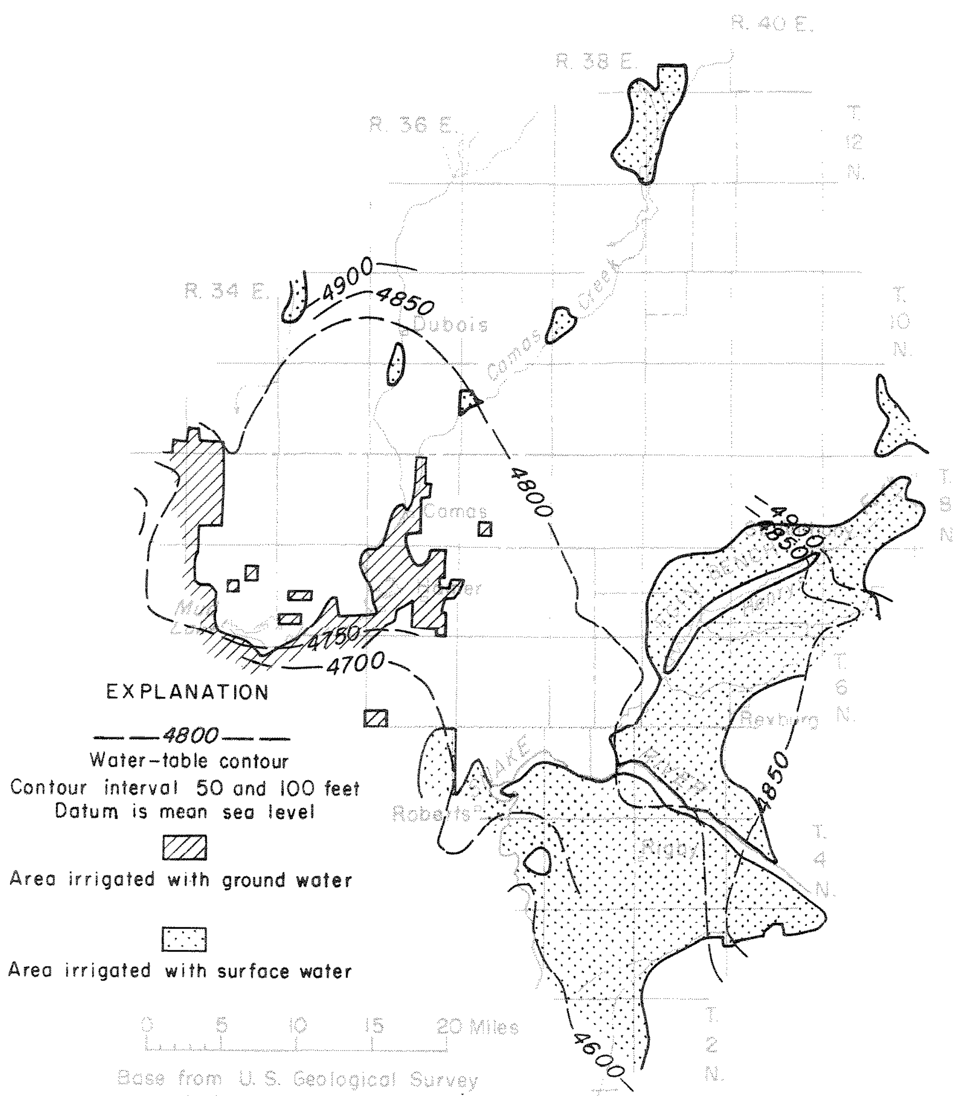


Figure 20. Map of the northeastern part of the Snake River Plain showing contours on the water table, Spring 1966 and boundaries of irrigated areas.

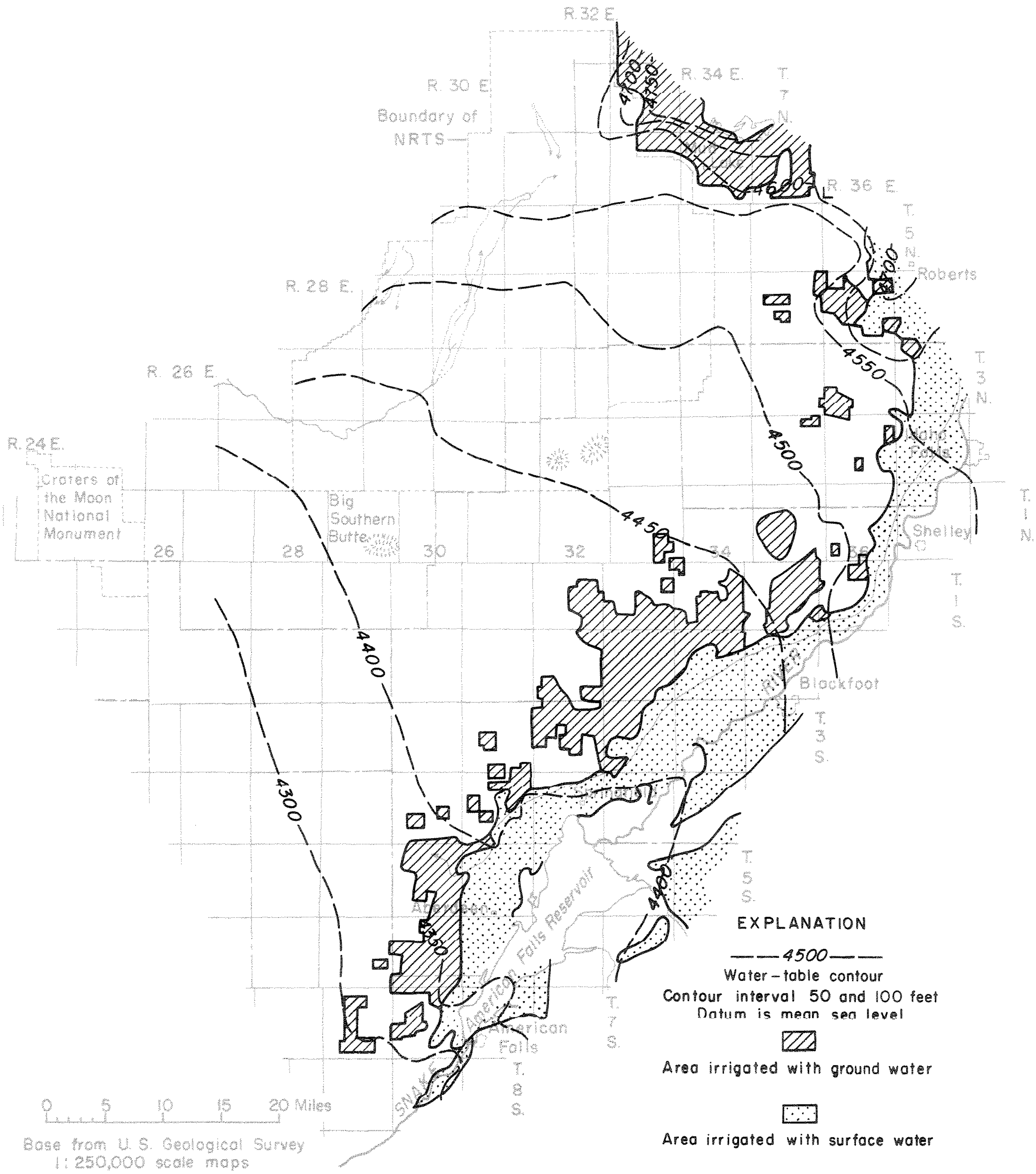


Figure 21. Map of the central part of the Snake River Plain showing contours on the water table, Spring 1966 and boundaries of irrigated areas.

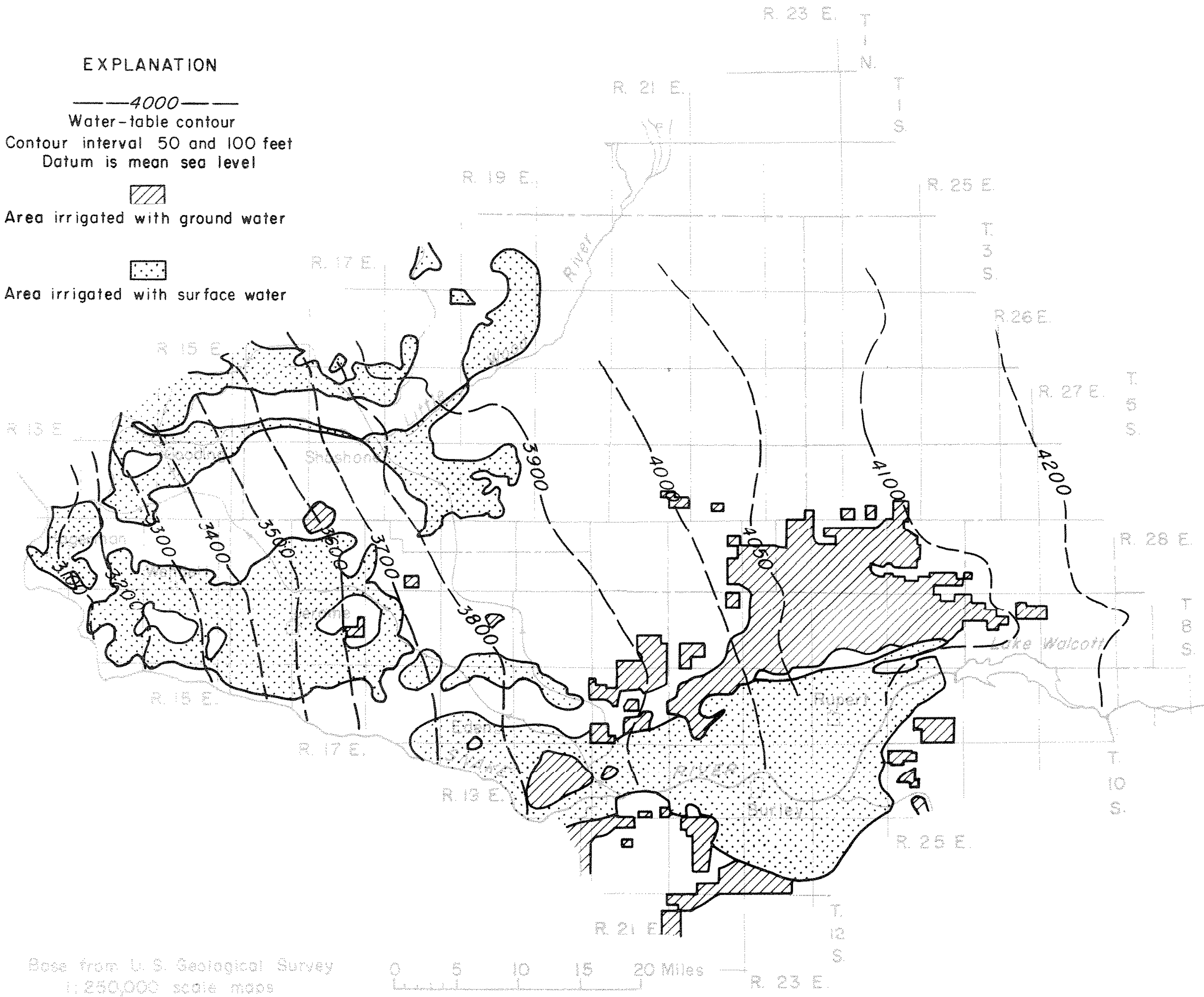


Figure 22. Map of the southwestern part of the Snake River Plain showing contours on the water table, Spring 1966 and boundaries of irrigated areas.

In most places irrigation wells yield at least 1,000 gpm (gallons per minute). Some wells in the Mud Lake area yield as much as 9,000 gpm.

The increased use of ground water for irrigation has contributed to a long-term decrease in ground-water storage under some parts of the Plain, reflected by a lowering of water levels in wells. The greatest decrease has occurred in the southwestern one-third of the Plain, that part shown in figure 22. In other parts of the Plain, little or no significant change has occurred.

Hydrographs of water levels in the northeastern part of the Plain (fig. 23) show a fluctuating long-term condition, either slightly rising or falling, depending on local conditions. Well 7N-35E-20cbl shows the annual seasonal effects of heavy ground-water pumping, while well 7N-38E-23dbl shows the annual seasonal effects of heavy surface-water irrigation.

Wells 5N-32E-36adl and 2N-31E-35dcl (fig. 24) show water-level trends in the central part of the Plain. Both wells show a general long-term decline until about Spring 1965, when an unusually high runoff caused water levels to rise abruptly in the wells near the mountain fronts.

The hydrograph of well 5S-31E-27abl (fig. 24) reflects water levels in the Aberdeen-Springfield area. This part of the aquifer shows almost stable long-term conditions.

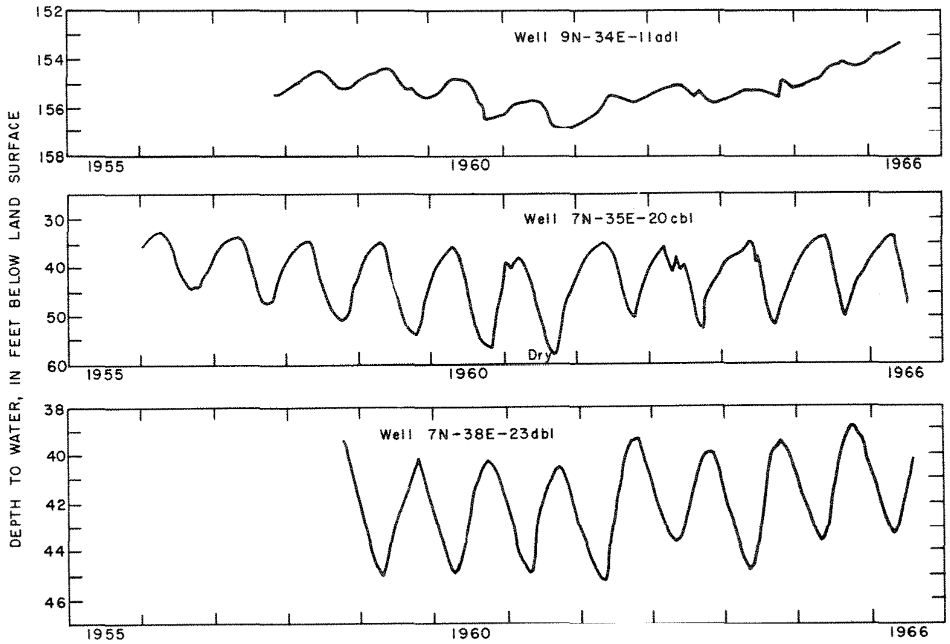


Figure 23. Hydrographs of wells 9N-34E-11adl, Clark County, 7N-35E-20cbl, Jefferson County, and 7N-38E-23dbl, Madison County.

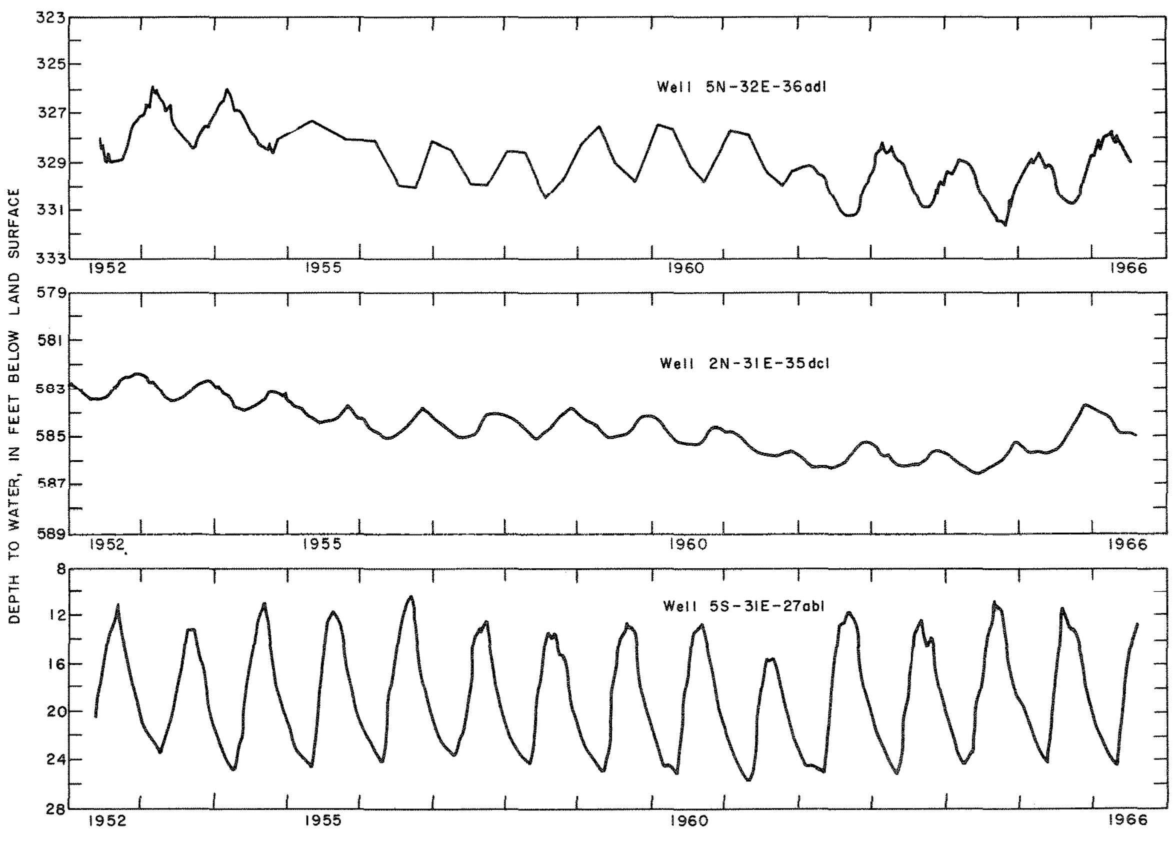


Figure 24. Hydrographs of wells 5N-32E-36adl, Jefferson County, 2N-31E-35dcl and 5S-31E-27abl, Bingham County.

Hydrographs of wells 8S-23E-2bal and 9S-20E-1dal (fig. 25) show significant water-level declines beginning in about 1954 and continuing until about 1962 when near stable conditions were reached. It seems now (1966) that a near balance between recharge and discharge exists in this part of the aquifer.

Figure 26 shows a generalized depiction of the net change in water levels from Spring 1952 to Spring 1966 in the southwestern part of the aquifer. The area of greatest decline, more than 10 feet, occurs down-gradient from the areas of greatest ground-water withdrawal in Minidoka and Jerome Counties. Discharge from the easternmost springs, in the vicinity of Twin Falls, has also decreased in the area of greatest water-level decline adjacent to the river.

The hydrograph of well 8S-14E-16bcl (fig. 25) shows less than a 1-foot drop since 1952. This well is located near the major spring-discharge area of the aquifer. It shows that significant effects of pumping have not reached the westernmost springs; therefore, discharge from this part of the aquifer has been little changed.

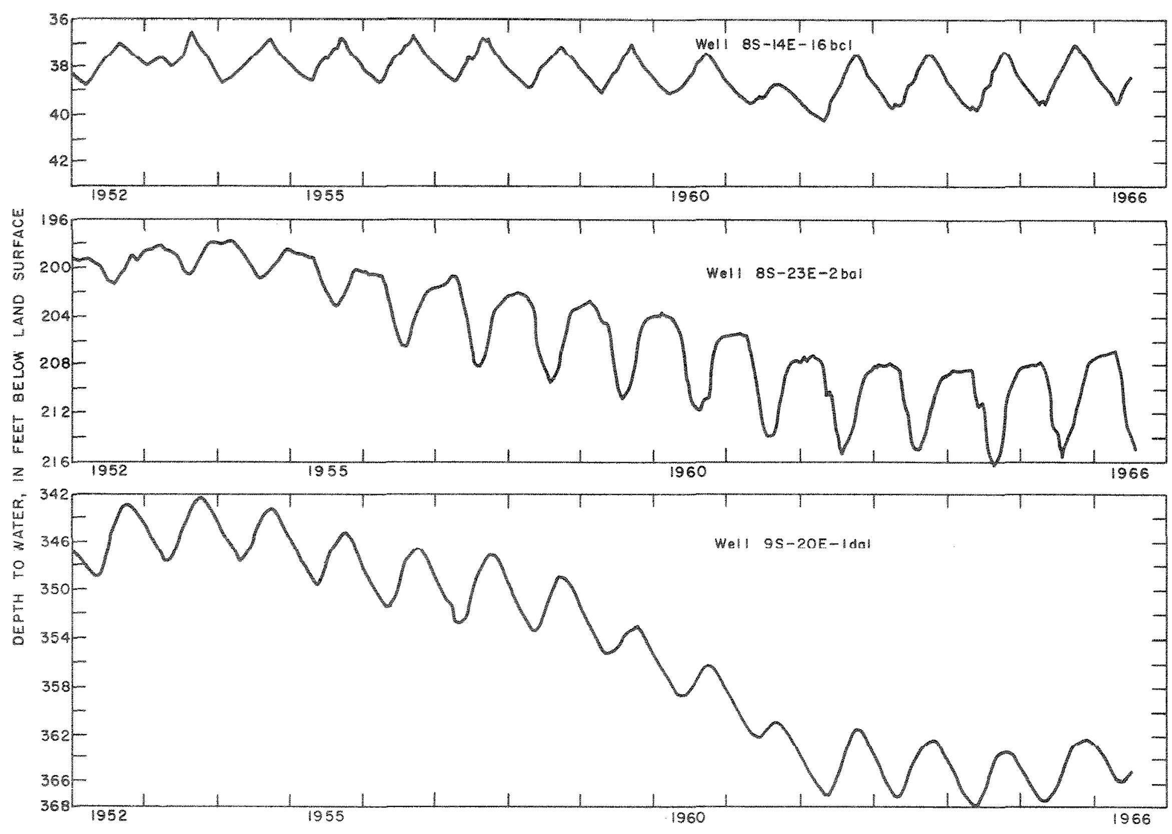


Figure 25. Hydrographs of wells 8S-14E-16bcl, Gooding County, 8S-23E-2bal, Minidoka County, and 9S-20E-1dal Jerome County.

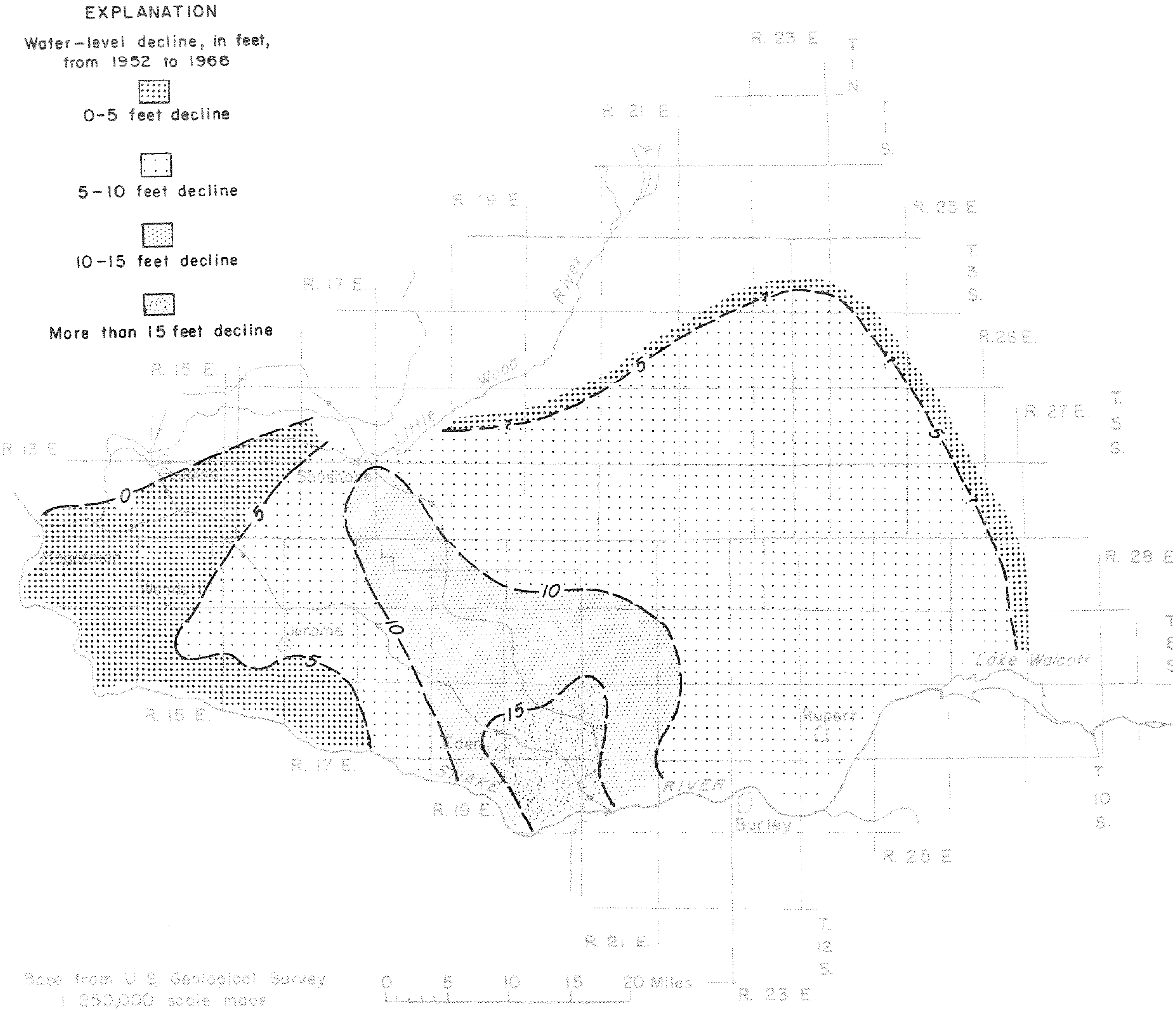


Figure 26. Map of the southwestern part of the Snake River Plain showing decline in water level, 1952 to 1966.

LOWER TETON AREA, by E. H. Walker

The Lower Teton area includes the floodplains and benchlands southeast of Henrys Fork from Ashton to the Snake River, and an indefinite area of the Snake River Plain north of Henrys Fork (fig. 27).

Ground water occurs in the basaltic and silicic lavas beneath the Rexburg Bench and its continuation to the northeast, in sheets of sand and gravel beneath the lowlands along Henrys Fork and the lower part of the Teton River, and in the basalt lavas which underlie the Snake River Plain and extend southward under the lowland alluvial deposits.

The ground water in the older silicic volcanics beneath the benchlands occurs under water-table conditions. Ground water in the alluvial deposits of the bottomlands is perched over broad areas, owing to the heavy recharge from streams and irrigated areas and the presence of fine-grained sedimentary layers which impede downward percolation. Water-table conditions prevail in the lavas of the Snake River Plain at a distance of a few miles northwest of Henrys Fork.

The aquifers beneath the Rexburg Bench and other higher lands receive recharge from precipitation and by infiltration from the channels of streams that cross these benchlands. Formations beneath lowlands are recharged by infiltration from the main streams and by the drainage from irrigated areas.

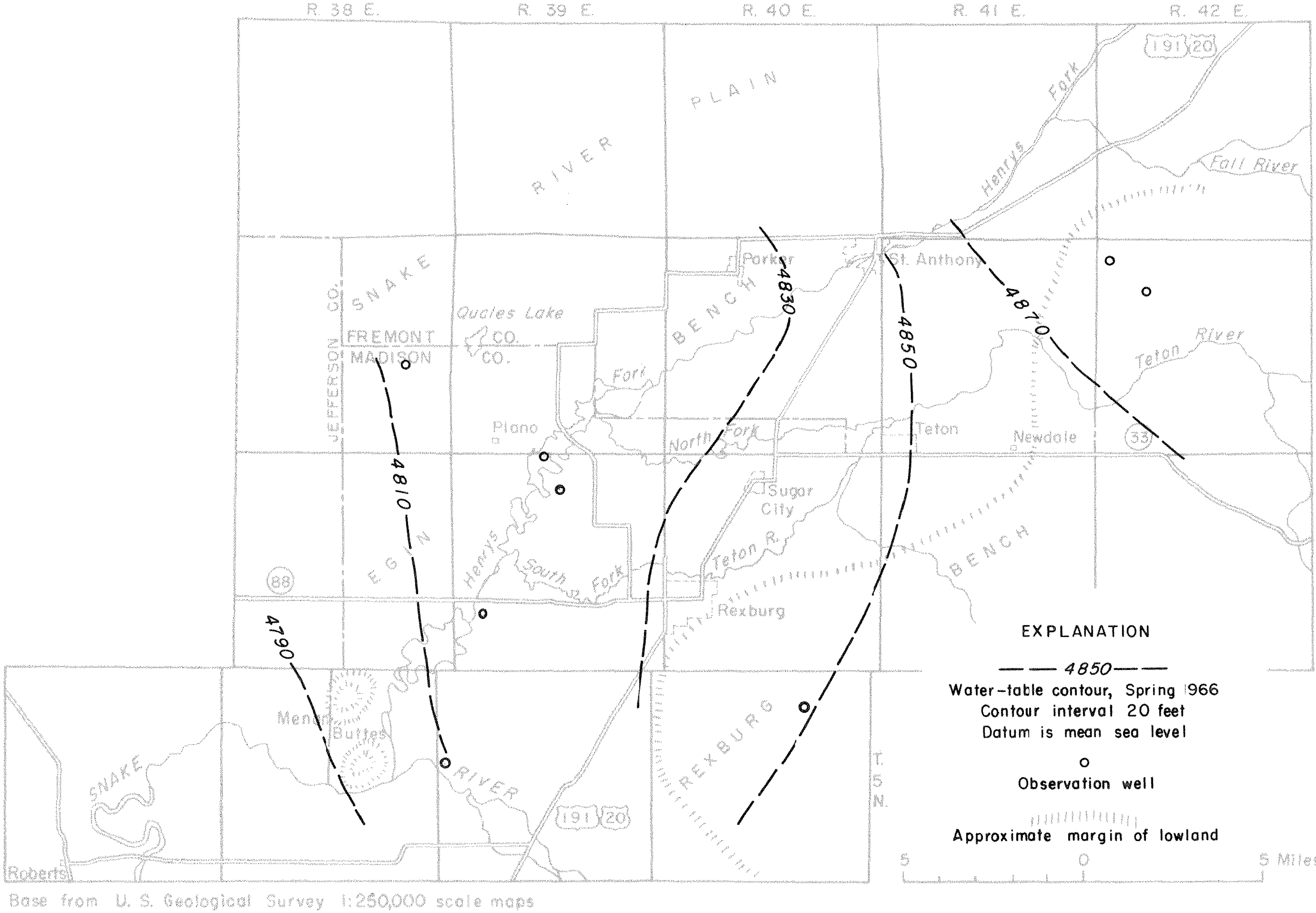


Figure 27. Map of Lower Teton area showing contours on the table and location of the observation wells.

The ground water in the older volcanic rocks moves generally northwestward, with much local variation caused by the geological structures of these rocks. Perched water south of Henrys Fork moves toward the channels of streams, and also percolates downward to the main water table. Recharge from irrigation forms a mound of perched water under the Egin Bench north of Henrys Fork, and the ground water moves both southward to Henrys Fork and northward and westward to descend to the main water table in the basalt lavas of the plain. Water at and beneath the main water table moves westward, as shown by the water-level contours (fig. 27), and eventually discharges to the Snake River, partly through the seeps and springs on the north side of the river between Blackfoot and the head of American Falls Reservoir, and partly through the great springs at the western end of the aquifers in the canyon of the Snake River between Twin Falls and Bliss.

At present about 25,000 acre-feet of ground water is pumped, mainly from wells penetrating the older volcanic rocks beneath the Rexburg Bench.

The water level in well 7N-38E-23dbl (fig. 28), representative of the main water table in the basalt lavas of the Snake River Plain, has risen slowly in the last few years and is now about 1.5 feet higher than in 1959 when measurements were first made. It should be noted that water levels in this sector of the Snake River Plain are considerably higher, perhaps several tens of feet higher in places, than they were before the irrigation developments of the early 1900's added large amounts of new recharge.

Wells 7N-42E-8cal and 5N-40E-11bcl are on the benchlands southeast of Henrys Fork, and measurements in them reflect water levels in the older volcanic rocks. The rise in water level in well 5N-40E-11bcl since late 1964 may reflect slightly higher than average precipitation and recharge from leaky stream channels near the well, and shows that pumping in this part of the aquifer has not depleted storage. The causes for the decline in water level in well 7N-42E-8cal is uncertain; longer records may show that water levels in this well, which is remote from recharging streams, may not respond to minor changes in precipitation.

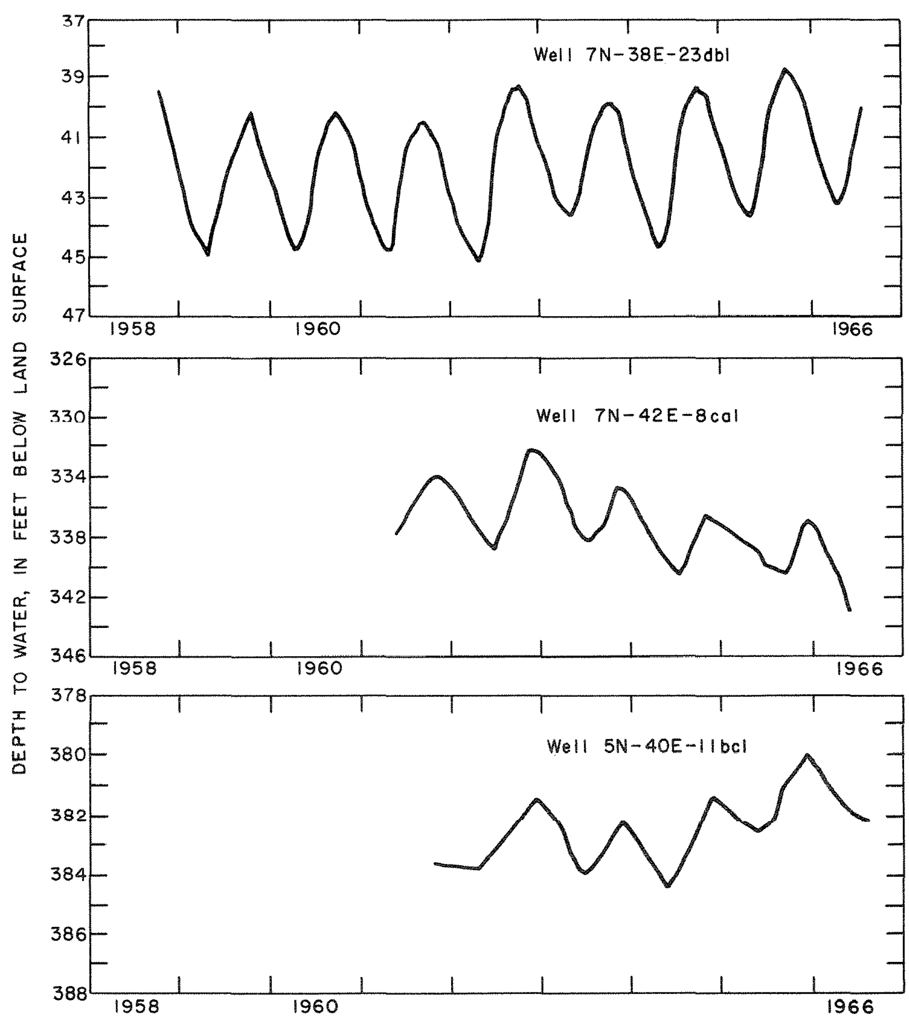


Figure 28. Hydrographs of wells 7N-38E-23dbl, Madison County, 7N-42E-8cal, Fremont County, and 5N-40E-11bcl, Madison County.

BRUNEAU-GRAND VIEW AREA, by E. G. Crosthwaite

The Bruneau-Grand View area is a lowland in northeastern Owyhee County and is a part of the Snake River Valley of southwestern Idaho. It is bounded on the north by the Snake River and on the east, south, and southwest by an upland sometimes referred to as the "Owyhee Desert". The lowland is drained by the Bruneau and Snake Rivers, and Little Valley, Shoofly, and other small creeks.

The main sources of water supply are the Bruneau and Snake Rivers and artesian ground water. Yearly precipitation is very low and little water, if any, is added to the ground-water supply from that source.

Ground water occurs in alluvial deposits along the Snake and Bruneau Rivers and in the underlying sand, gravel, and basalt, in older basalt and in silicic volcanic rocks beneath the older basalt. Water in the alluvial deposits is under water-table conditions, and that in the other rocks is under artesian conditions.

Ground water in the alluvial deposits is strongly influenced by the stages of the rivers and by water diverted for irrigation. At low river stages the alluvial deposits discharge water to the river and at high river stages the deposits receive recharge. Percolation of water diverted for irrigation also recharges the alluvial deposits.

The artesian aquifers are recharged by precipitation and stream losses on the outcrop area many miles south of the Bruneau-Grand View area. Pressure gradients in the artesian aquifer are generally northward. Well heads below 2,700 feet in altitude generally flow small to large quantities of warm to hot water from the artesian aquifers.

Wells in the alluvial deposits generally yield small to moderate quantities of water, but because of the limited thickness and small areal extent of the deposits, only small amounts of water are withdrawn from them.

Flowing artesian water was discovered in the early 1920's and many wells were drilled, but interest subsided because the yield of many wells diminished. Interest in irrigation wells was renewed in 1951 and there are now several dozen wells in use. Well depths range from 500 to more than 2,000 feet. The largest reported yield of a flowing wells is about 4,400 gpm.

The hydrograph of well 7S-5E-18bcl (fig. 29) shows a nearly steady decline in water level of about 12 feet for the period of record. Changes in water level reflect changes in the amount of water in storage in some part of the aquifer (fig. 30).

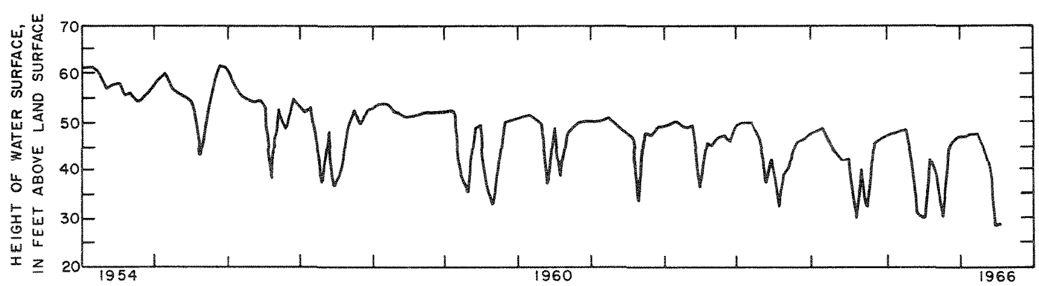


Figure 29. Hydrograph of well 7N-5E-18bcl, Owyhee County.

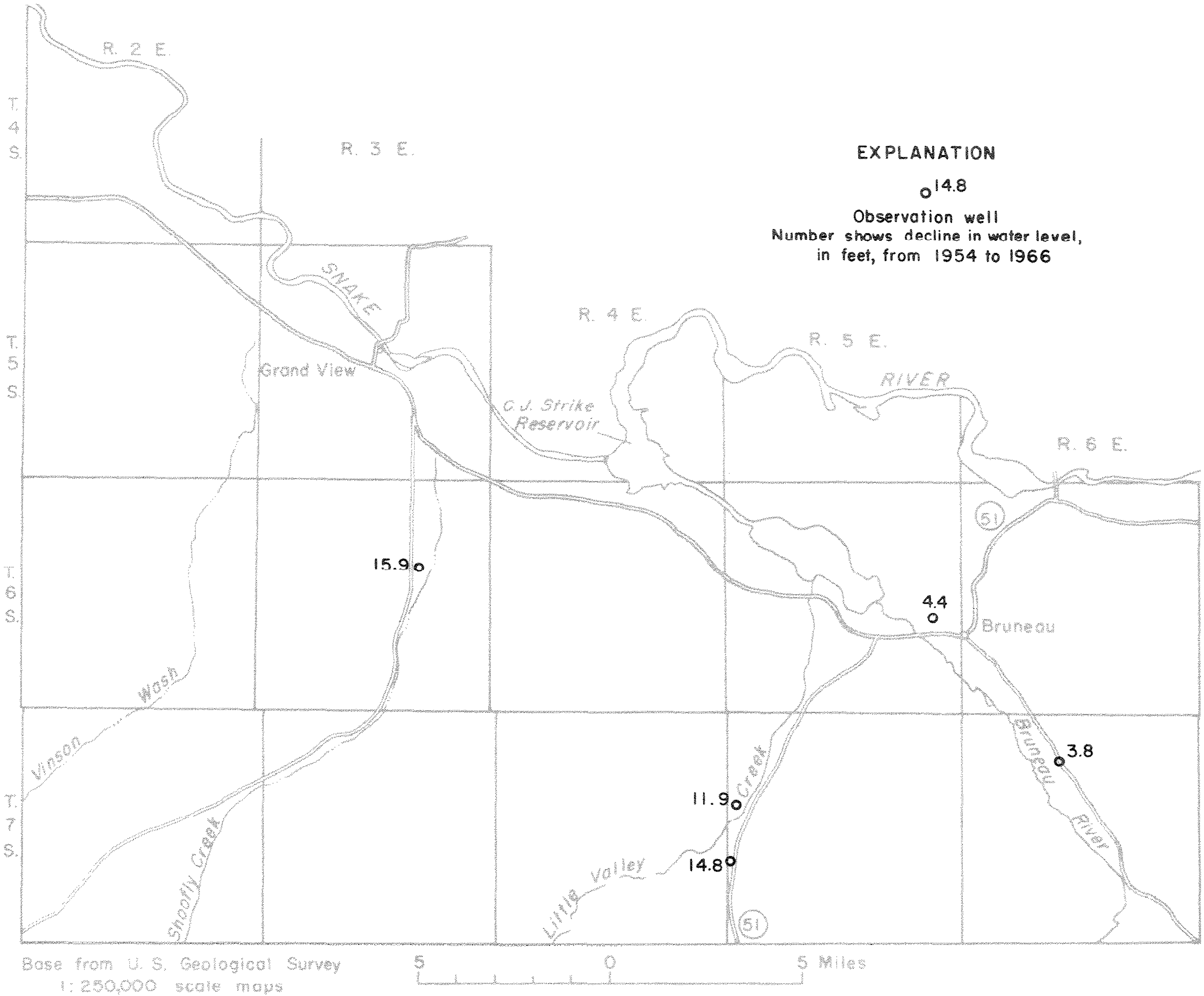


Figure 30. Map of the Bruneau-Grand View area showing location of observation welss and decline in water levels from 1954 to 1966.

SALMON FALLS TRACT, by E. G. Crosthwaite

The Salmon Falls tract is in southern Twin Falls County south of Twin Falls. The tract is bounded on the north by the Twin Falls South Side Project, on the east and south by the South Hills and other low mountains, and on the west by the canyon of Salmon Falls Creek. The tract is drained by Salmon Falls Creek, a perennial stream; Deep Creek, an intermittent stream; and Desert Creek, an ephemeral stream. All three discharge northward to the Snake River.

Ground water occurs under water-table conditions in basalt, lake deposits, and silicic volcanic rocks which underlie the tract. The basalt and silicic volcanic rocks yield small to moderately large quantities of water to irrigation wells at some places. The generally fine lake deposits do not yield water readily to wells. Alluvial deposits along Deep Creek contain perched ground water, as does the basalt west of Hollister. Southeast of Hollister, silicic volcanic rocks yield warm artesian water.

Ground water is recharged by infiltration of water diverted from Salmon Falls Creek for irrigation of several thousands acres in the tract, seepage losses from the canals and fields in the Twin Falls South Side Project immediately north of the Salmon Falls tract, and inflow from precipitation which percolates into the rocks in the mountains. Depth to water ranges from above land surface at a few flowing wells to as much as 700 feet beneath the surface in the northwest part of the tract.

The ground water moves generally northwestward (fig. 31) beneath the Twin Falls South Side Project and on to the Snake River. The amount of this underflow is estimated to be 100,000 acre-feet per year.

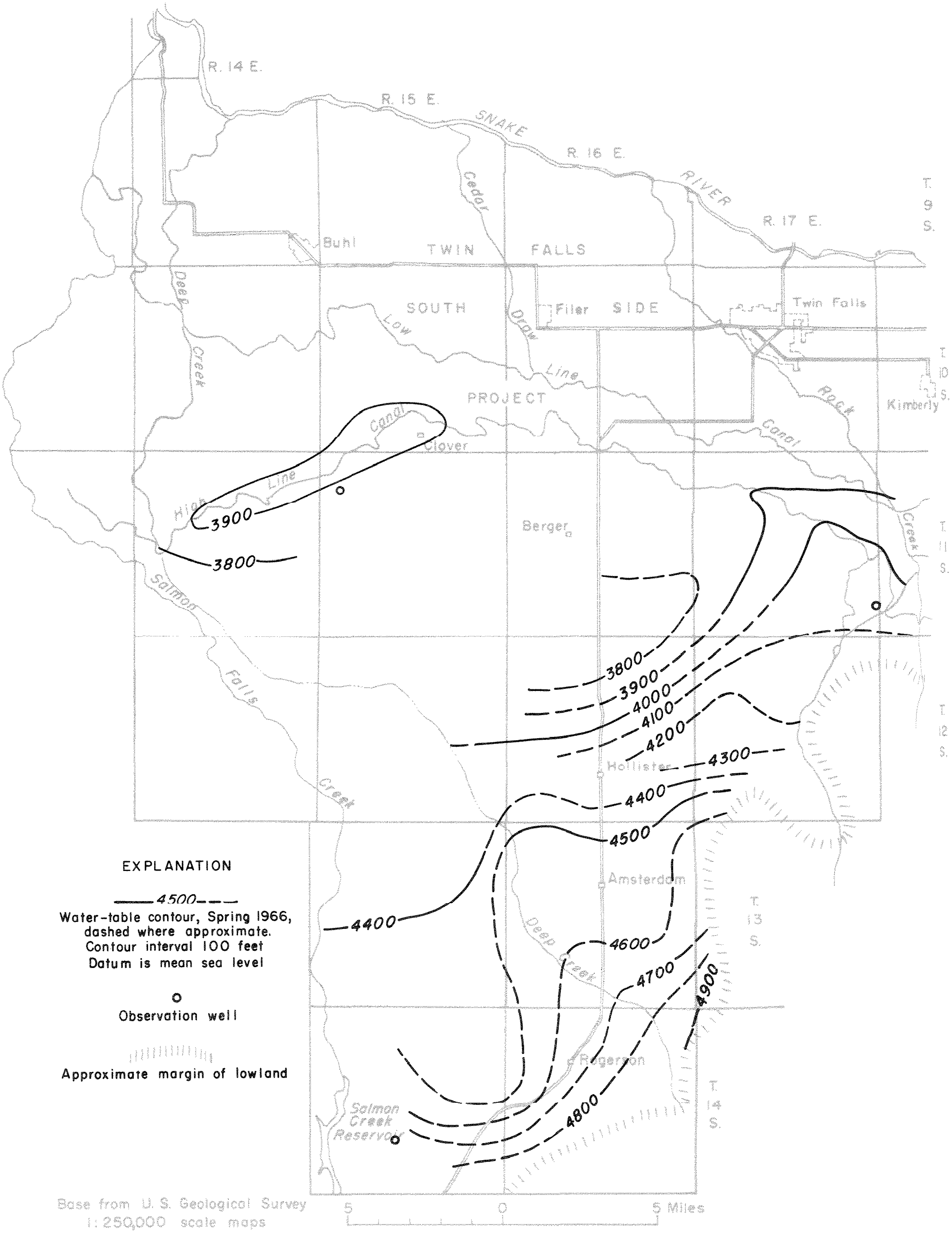


Figure 31. Map of the Salmon Falls tract showing contours of the water table and location of observation wells.

Ground water is used for irrigation, domestic, stock, and municipal supplies. Annual withdrawals are on the order of 8,000 acre-feet.

About 50 wells have been drilled for irrigation of which about 40 percent provide adequate supplies. Successful wells exist southwest of Rogerson, near Amsterdam and Hollister, southeast and northeast of Hollister, and in the northeast part of the tract just south of the Twin Falls South Side Project. Yields range from 300 to 2,500 gpm. Most farms have domestic and stock wells, and the Village of Hollister uses ground water. Rogerson obtains its ground-water supply from a small spring.

Water levels respond to snowmelt and irrigation diversions. Well 11S-17E-25dd2 shows that water levels are lowest in the Spring, rise rapidly until late Summer, and then decline until the next Spring (fig. 32). Water levels in 1965 were the highest of record. Pumping for irrigation has had little effect on water levels except locally. The greatest decline has been in the area of artesian pressures southeast of Hollister. Some formerly flowing wells now have water levels several feet below land surface.

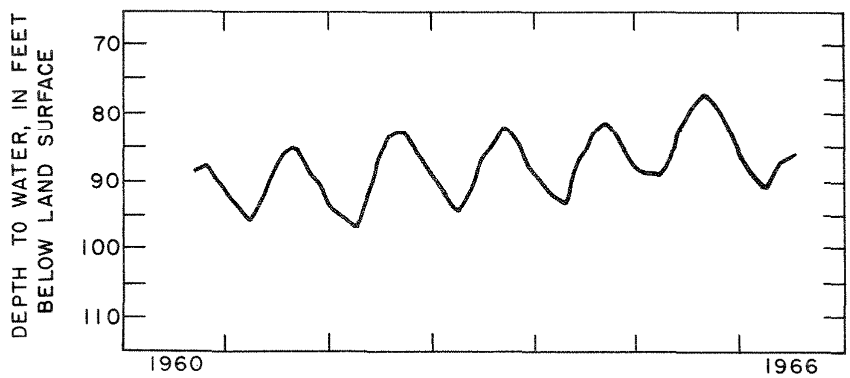


Figure 32. Hydrograph of well 11S-17E-25dd2, Twin Fllas County.

ROCK CREEK-GOOSE CREEK AREA, by E. G. Crosthwaite

The Rock Creek-Goose Creek area is south of the Snake River in eastern Twin Falls and western Cassia Counties (fig. 33). In general, the land surface slopes northward toward the Snake River and the Snake River Plain. Some volcanic hills 300 to 350 feet high are in the north part of the area. Rock Creek flows through the extreme western part and Goose Creek is in the eastern part. The Albion Range bounds the east side and the South Hills the southwest side.

Silicic volcanic rocks, basalt, alluvium beneath the lowland area, and limestone at the edge of the South Hills yield small to large quantities of water to irrigation wells. North of Oakley and south of Murtaugh the alluvium contains water under water-table conditions. Water occurs also under water-table conditions in basalt which underlies the northern half of the area. Silicic volcanic rocks underlie the alluvium and basalt and contain water under artesian conditions, but the pressures are not high enough to cause wells to flow. Ground water in the limestone aquifer is under weak artesian pressure. Depth to water varies widely and ranges from about 50 feet near Murtaugh to more than 500 feet on Burley Butte.

Ground water is recharged by infiltration of precipitation on the mountains and hills and by percolation of irrigation water diverted from the Snake River and from Goose Creek. A minor amount is derived from seepage losses of a few small streams which discharge from the mountains.

Ground water moves generally northward and northwestward toward the Snake River and the Snake River Plain at about right angles to the contours shown in figure 33. The contours represent the altitude of the water table, and generally do not show the altitude of pressure surfaces in the artesian aquifers except south of Murtaugh. From Oakley northward for about 6 miles the water levels in the artesian aquifers are about 200 feet below those shown in figure 33. In the Burley Irrigation District, a perched water-table occurs 5 to 25 feet below the land surface, and about 200 feet above the main water table.

Natural discharge of the water-table aquifers is to the aquifers beneath the Snake River Plain north of Snake River except downstream from Milner Dam where some water is discharged to the Snake River from numerous seeps in the canyon walls. The artesian aquifers discharge some water by leakage upward into the water-table aquifers but gradients indicate a general northward movement.

Irrigation, public supply, industrial, domestic, and stock wells withdraw an estimated 200,000 acre-feet annually.

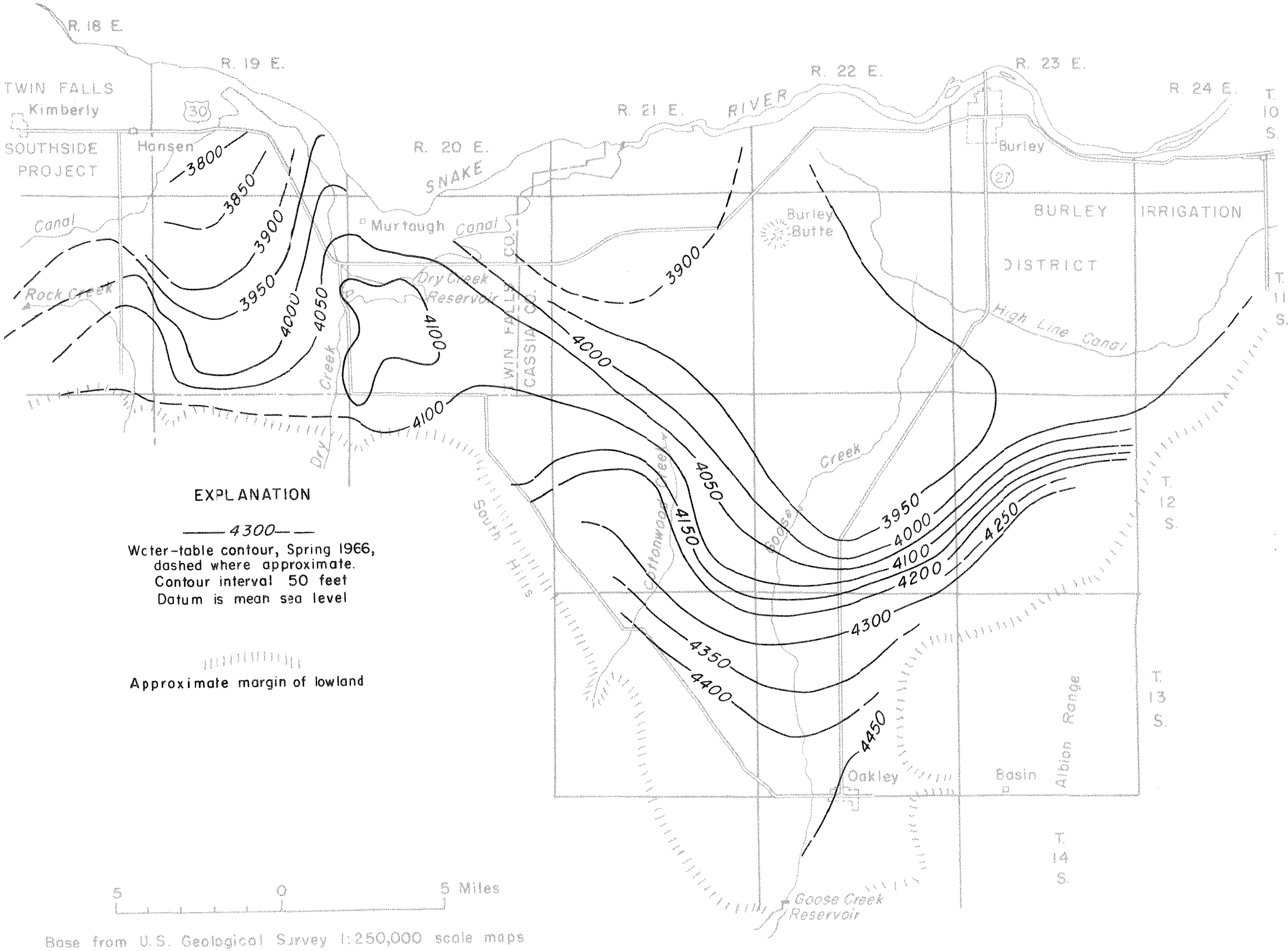


Figure 33. Map of the Rock Creek-Goose Creek area showing contours on the water table and location of observation wells.

Ground water is used principally for irrigation and about 425 wells yield about 185,000 acre-feet annually for that purpose. All municipal and industrial supplies, and nearly all domestic and stock supplies are from wells. The yield of irrigation wells ranges from 200 to 3,000 gallons per minute. In general, basalt yields the largest amount of water to irrigation wells. The silicic volcanic rocks yield moderate amounts, alluvium yields the least, although there are many exceptions locally. The yield from the limestone is highly variable, depending upon the number and character of fractures or openings intercepted by the well bore.

A few irrigation wells were drilled near the foot of the mountains south of Murtaugh between the years 1910 and 1915, but large ground-water development for irrigation did not begin until 1946. The rate of development has declined since 1962 when the issuing of well permits was discontinued.

Before ground-water development, the water levels in the water-table aquifers were usually at a low point in the Spring, rose during the Summer to a peak in October, and then declined until the following Spring. Annual fluctuations in the artesian aquifers were somewhat different, being highest in early Summer and lowest in late Winter. Ground-water pumping has modified the natural cycle of fluctuations so that the annual high in most aquifers occurs in the early Summer and the low in late Summer. Figure 34 shows hydrographs of wells that tap aquifers in the silicic volcanic rocks, basalt, and limestone. Well 11S-20E-32ccl is in the artesian rhyolite aquifer and shows a decline from 1954 to 1962. There has been little significant change since 1962. Well 11S-23E-34cdl, in a basalt water-table aquifer, shows little net decline but the magnitude of annual fluctuation has increased markedly. Well 13S-21E-18bbl in the limestone aquifer shows a steady net decline of 22 feet per year. The first irrigation wells drilled in 1910-15 flowed when drilled. At those localities the water level is now about 150 feet below land surface.

The changes in water level for a three year period, April 1963 to April 1966, are shown in figure 35. Recharge from surface-water irrigation in the northern part of the area is relatively large compared to withdrawals and relatively constant every year so that there has been no significant change in water levels in that part of the area for the period. Prior to 1965, the water yield of Goose Creek, Rock Creek, Dry Creek, and other smaller streams was below normal. The unusually wet year of 1965, and the smaller demand for irrigation water during that year, caused a dramatic rise in the water-table aquifers southwest of Murtaugh and north of Oakley. Heavy pumping in the northern part of T. 12 S., R. 21 E., has caused as much as 15 feet of decline of the water table during the 3-year period. Also, water levels in the artesian aquifers south of Murtaugh declined a similar amount. Sparse measurements indicate a significant decline also in the artesian aquifers just north of Oakley.

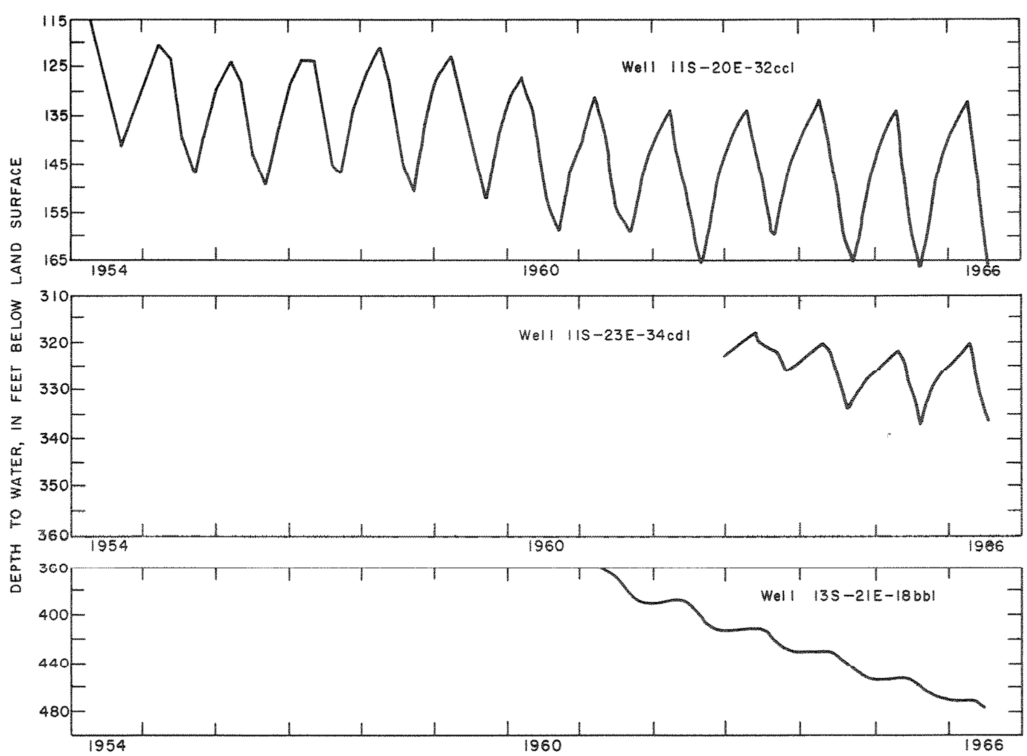


Figure 34. Hydrographs of wells 11S-20E-32ccl, Twin Falls County, 11S-23E-34cdl and 13S-21E-18bbl, Cassia County.

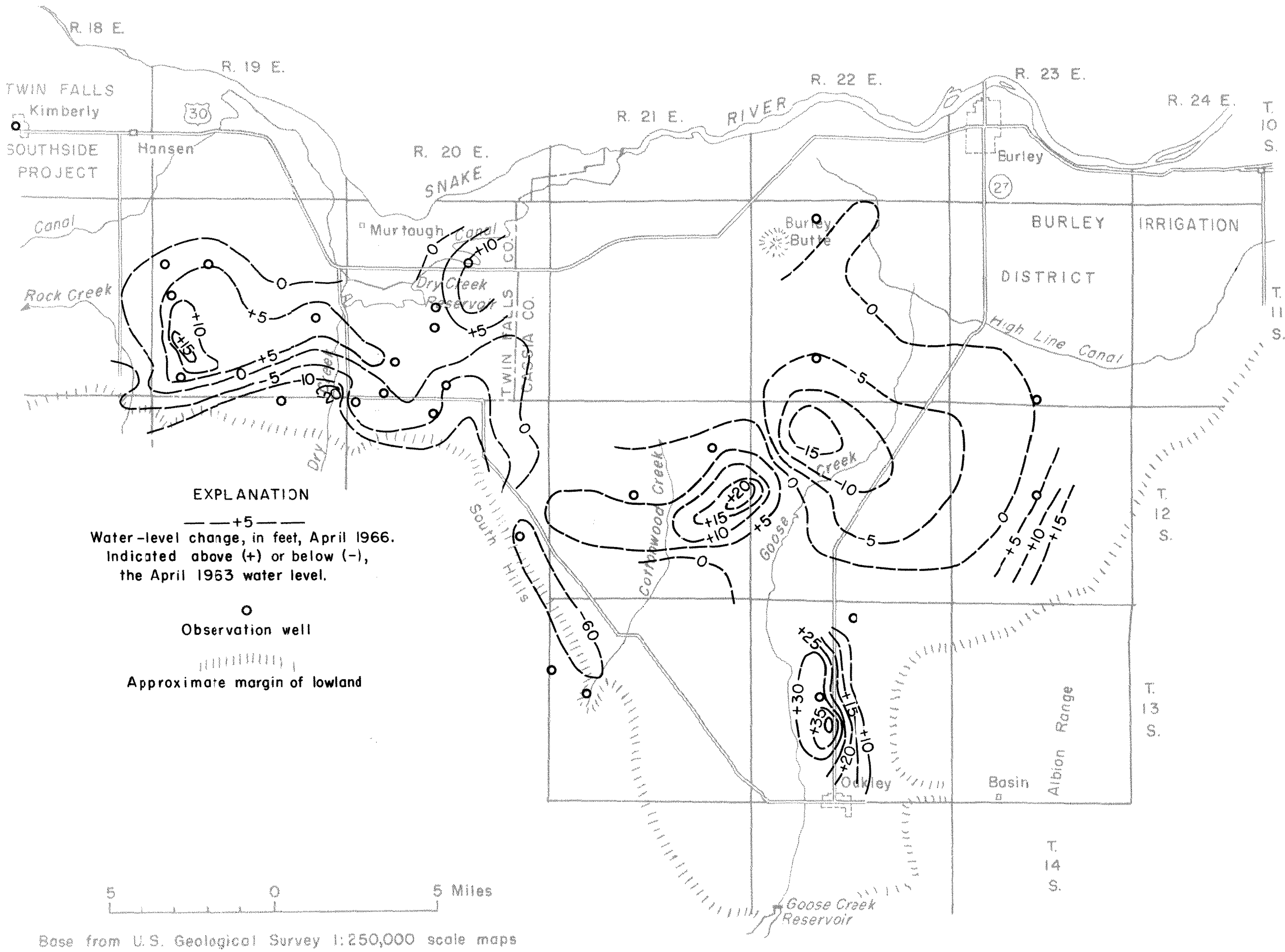


Figure 35. Map of the Rock Creek-Goose Creek area showing changes in water level from April 1963 to April 1966, and location of observation wells.

ALBION BASIN, by E. H. Walker

The Albion Basin includes about 45 square miles of lowlands in northern Cassia County (fig. 36). The basin is enclosed on the east by the Cotterell Range (Malta Range), on the south and west by the Albion Range, and on the northwest by the East Hills. The principal stream, Marsh Creek, drains the basin northward through a narrow valley.

Ground water has been developed in the basin from shallow stream gravels, and from older beds of semi-consolidated sand. Probably the volcanic rocks that were formed contemporaneously with the sand will also yield water.

The ground water in the unconsolidated sand and gravel aquifer occurs largely unconfined, but perched water occurs in places. Water in the underlying formations occurs under both water-table and artesian conditions.

The source of water in the basin is precipitation, mainly the snow on the Albion Range to the south where Harrison Mountain reaches an elevation of 9,265 feet. Ground water is recharged by infiltration from stream channels at and valleyward from the feet of the mountains and foothills, and moves toward the lower ground

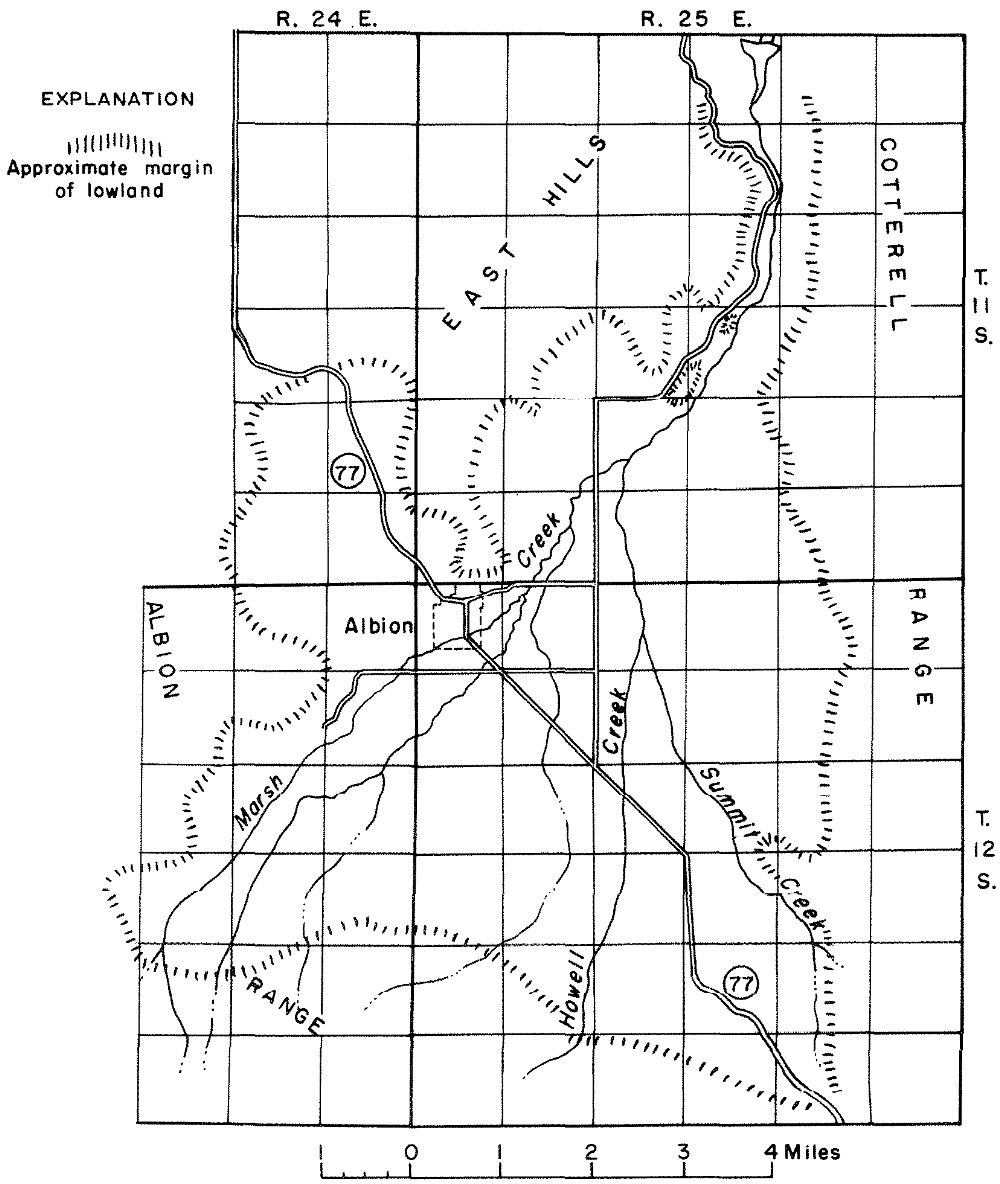


Figure 36. Map of the Albion basin.

around Albion. North of Albion, ground water begins to be discharged through seeps to Howell Creek and to Marsh Creek, and Marsh Creek gains until it passes through the narrows. Probably a significant, though unknown, amount of water leaves the valley as underflow, because permeable gravels and semi-consolidated sand underlie the northern narrows.

At present there are only a few irrigation wells in operation in the basin. The performance of these wells indicates that the semi-consolidated sand that they tap yields considerable amounts of water for irrigation, as it does in the Raft River basin to the east.

Total pumpage from wells of all types in the basin perhaps does not currently exceed 1,500 acre-feet a year.

Although no water-level records exist, it is reasonable to presume that the small amount of pumpage has not yet caused significant depletion of the ground water, and that the ground-water reservoir is nearly as full as it was under undistrubed natural conditions.

RAFT RIVER VALLEY, by E. H. Walker

The Raft River Valley (fig. 37) is located in Cassia County, and extends southward from the Snake River to the boundary with Utah. The valley is bounded on the east by the Sublett and Black Pine Ranges, on the south by the Idaho-Utah State line, and on the west by the Albion Range and the Cotterell Range. The Raft River enters Idaho from its headwaters in Utah and flows northeastward and then northward to join the Snake River. Lowland areas of the Raft River basin in Idaho cover about 360 square miles.

The main source of water for the valley is runoff due to precipitation, mainly snow, on the surrounding highlands. Precipitation apparently averages less than 12 inches upon most of the lowlands of the valley and contributes little to surface- or ground-water supplies.

Ground water occurs in alluvial gravels beneath the bottomlands; in older beds of sand that underlie most of the lowlands and some foothill areas; and, in the northern part of the valley, in basalt lavas and interbedded sand and gravel.

The ground water mostly occurs unconfined, under water-table conditions, but wells near the margins of the valley may encounter confined water that flows at the surface.

The ground water moves from the sites of recharge along the mountain fronts and then northward as shown by the water-level contours in figure 37.

A small amount of ground water is discharged through springs, but the flow of most springs sinks into the ground within a short distance to become ground water again. Natural bottomland vegetation, at present, consumes little ground water because the originally wet bottomlands were long ago developed agriculturally. A small amount of ground water seeps into the Raft River in the northern part of the valley within a few miles of the Snake River.

A large amount of ground water, estimated between 140,000 and 200,000 acre-feet per year, leaves the Raft River valley as underflow. This underflow moves northward and northwestward beneath the lava plains at the north end of the valley and then under the Snake River, which there is perched on sedimentary beds, to join the large body of ground water in the lavas beneath the desert north of the Snake River.

An estimated 154,000 acre-feet of ground water was pumped in 1965, and more than half of this, perhaps 75 percent, or 115,000 acre-feet, was consumed by evaporation and transpired by crops. The remainder returned to the ground-water body.

About 290 irrigation wells were in operation in the Raft River Valley in 1965. A large number of domestic and stock wells exist but the total quantity of water pumped from them amounts to a very small fraction of that pumped for irrigation. As shown in figure 38, less than 30 irrigation wells existed in the valley in 1948, and the number of irrigation wells increased steadily until 1963 when drilling was restricted by order of the Idaho State Reclamation Engineer. The slight increase since 1963 reflects drilling by those who still possessed permits.

Water-level fluctuations and trends in the Raft River valley are shown by the hydrographs of four selected wells (fig. 39). Water-level measurements beginning in 1957 in well 9S-26E-13ccl at the northern end of the valley show a small decline of about 3 feet that may be related to withdrawals from aquifers that underlie the Snake River Plain, rather than to conditions in the Raft River valley itself.

The withdrawal of ground water has produced distinct declines of water level in and about the areas of heavy pumping. The net decline since the first systematic measurements in 1952, (fig. 40) in some places exceeds 40 feet.

Water-level measurements in well 11S-27E-29aal, in the area of heaviest pumping in the valley, show a net decline of more than 35 feet since the early 1950's. The continuing decline there reflects the heavy pumping and the rather small amount of ground water that moves to this area from the dry ranges on the east side of the valley.

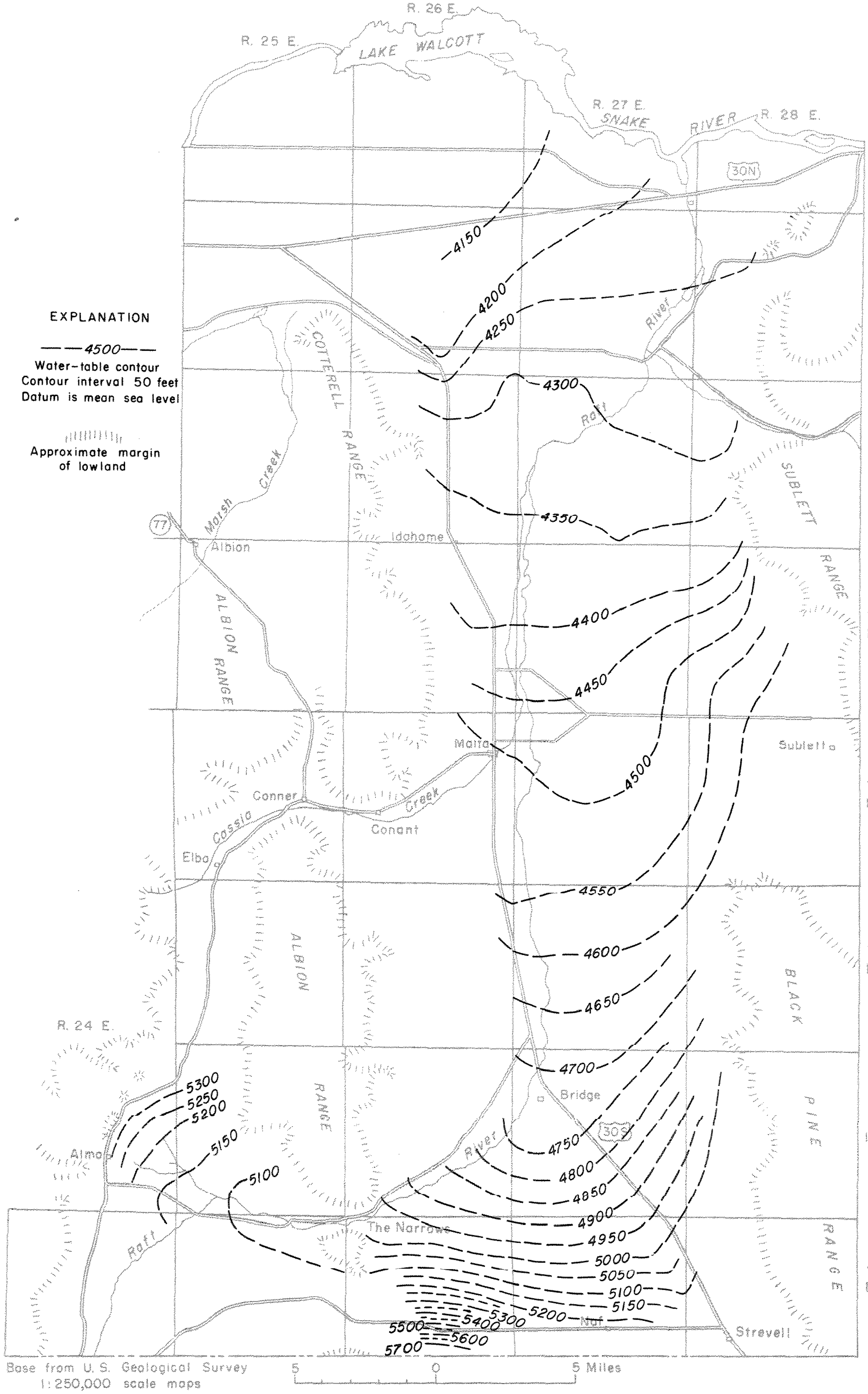


Figure 37. Map of the Raft River basin showing contours on the water table, Spring 1966.

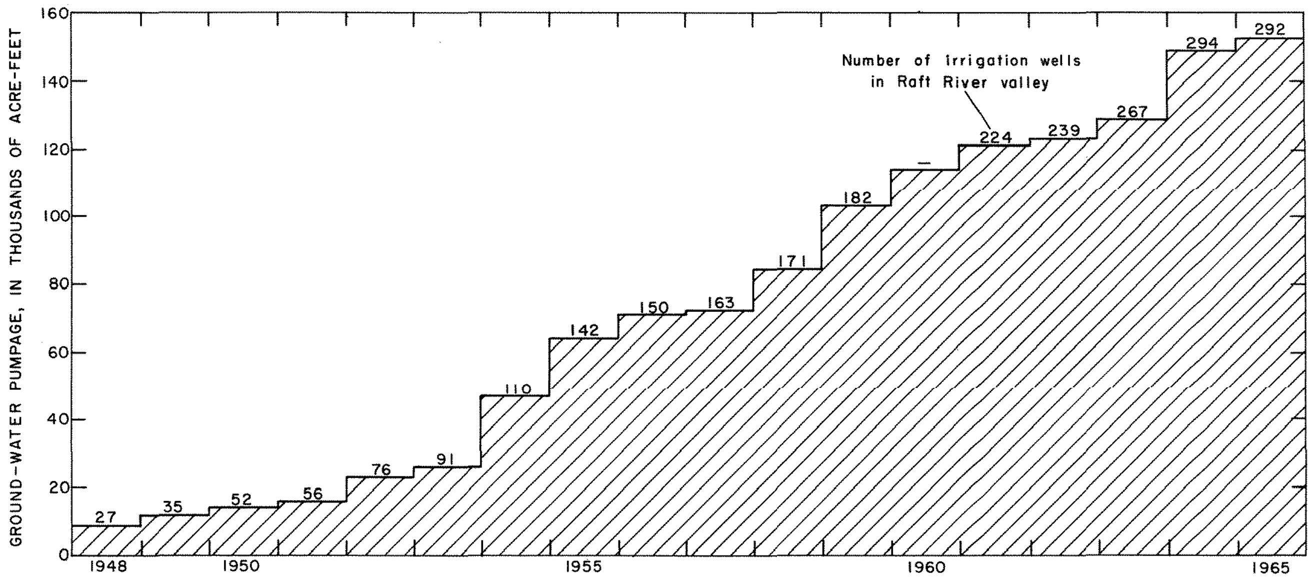


Figure 38. Graph showing ground-water pumpage and number of irrigation wells in the Raft River valley.

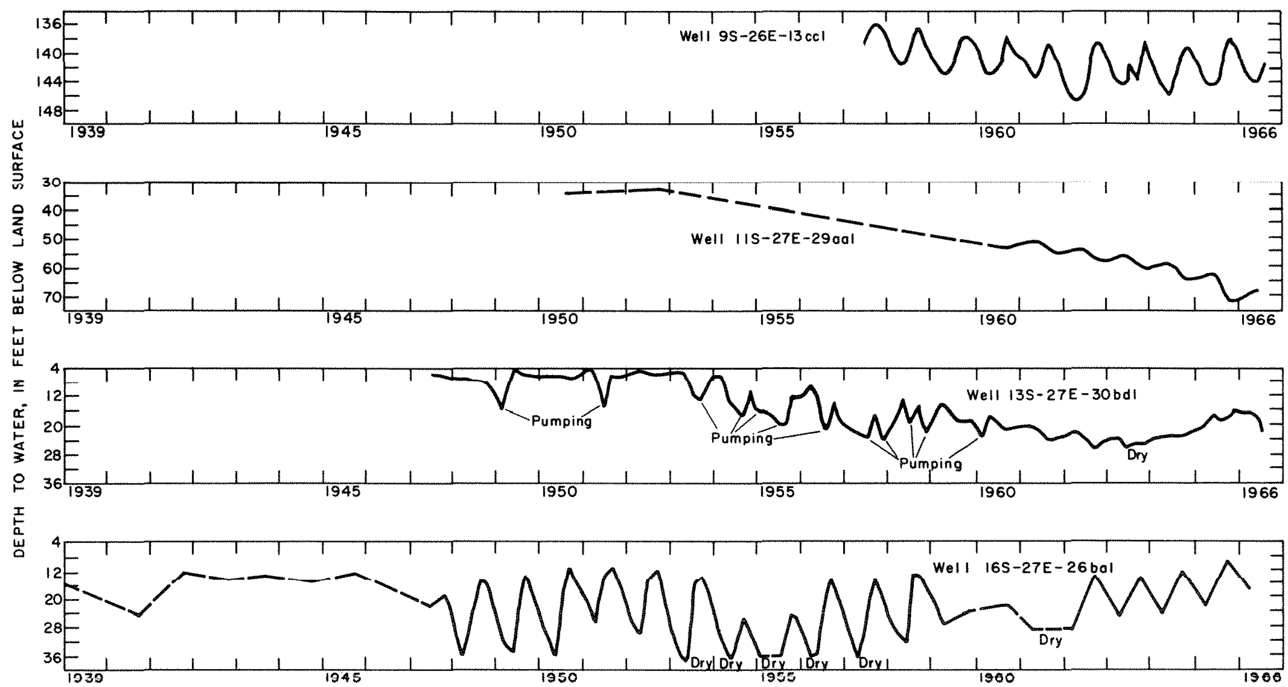


Figure 39. Hydrographs of wells 9S-26E-13ccl, 11S-27E-29aal, 13S-27E-30bdl and 16S-27E-26bal, Cassia County.

Water level in well 13S-27E-30bdl in the lowlands south of Malta declined about 25 feet from the late 1940's to 1963, as a result of pumping. After 1963, water levels recovered slightly owing to higher than average precipitation and runoff in the Raft River which loses water to the ground through this part of the valley.

Well 16S-27E-26bal is in the southern part of the valley near the foot of the Raft River Range, and shows long-term changes in water level in a part of the valley and aquifer that is distant from and unaffected by pumping.

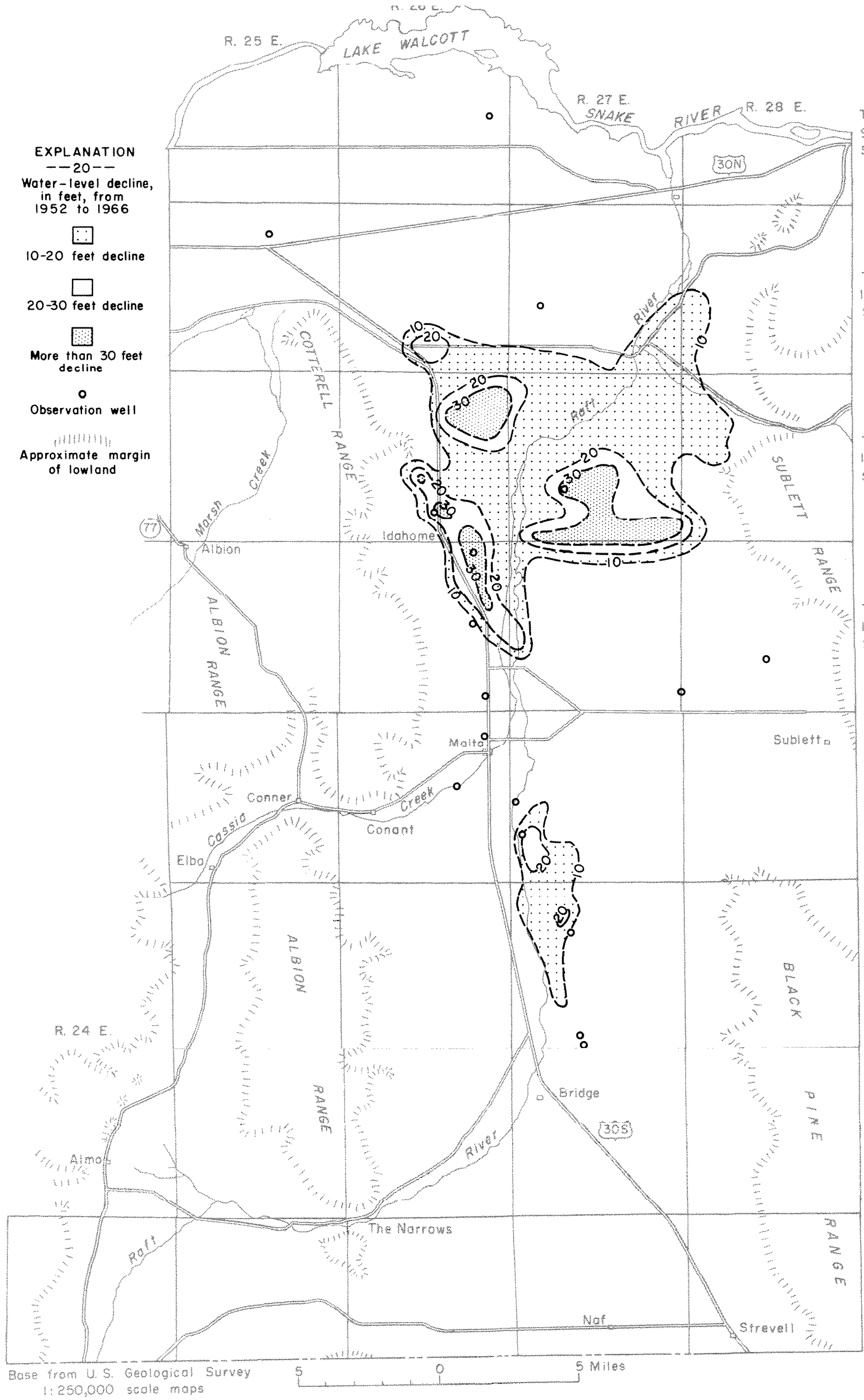


Figure 40—Map of the Raft River basin showing decline in water levels and location of observation wells.

MICHAUD FLATS, by E. H. Walker

Michaud Flats consists of a strip of benchlands 1 to 5 miles wide that extends along the south side of American Falls Reservoir from American Falls northeastward to and beyond Michaud (fig. 41). It is bordered on the south by a low bluff rising to the higher rolling benchlands and foothills that extend southward to the Deep Creek Mountains and Bannock Range. Bannock Creek crosses Michaud Flat to join American Falls Reservoir, but other drainage on the bench is only by ephemeral streams in shallow channels.

Water-bearing formations beneath the Michaud Flats are silicic volcanic rocks and interbedded sedimentary deposits, patches of basalt lavas in some localities, and beds of sand and gravel. Ground water occurs unconfined in the shallow aquifers and under artesian pressure in the deeper aquifers, notably the silicic volcanic rocks.

The source of ground water is mainly underflow from the higher lands to the south, and infiltration of storm waters from stream channels. Seepage from land irrigated with water pumped from the Snake River provides important amounts of recharge.

The water table beneath the Michaud Flats slopes toward the west and northwest, and much of the water in the unconfined aquifers seeps into American Falls Reservoir. The water in the deeper artesian aquifers moves generally northwestward, and much of it is believed to pass under the Snake River and to discharge eventually into the basalt lavas of the Snake River Plain.

In 1958 about 15,000 acre-feet of water was pumped to irrigate about 6,000 acres in the Michaud Flats. Developments in the last few years, particularly on the eastern portion of the Michaud Flats that lies within the Fort Hall Indian Reservation, may have raised the yearly pumpage to about 20,000 acre-feet.

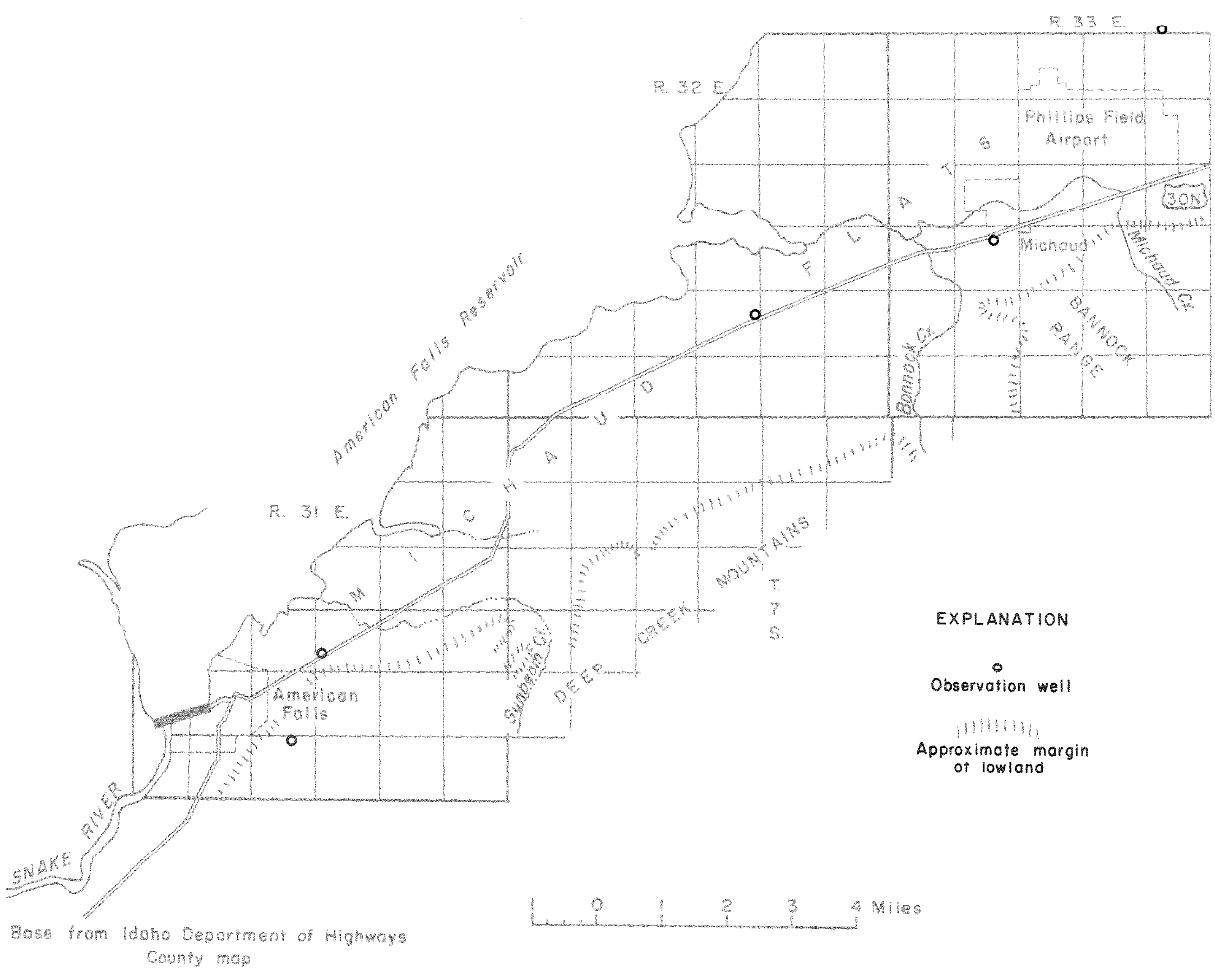


Figure 41. Map of the Michaud Flats showing location of observation wells.

Water-level records beginning about 1955 show a gradual decline of water levels to lows in 1960 and 1961, and thereafter a rise back to the earlier levels (fig. 42). At present, at least, the slow increase in pumpage is apparently balanced by the recharge that is added from tracts being irrigated with surface water.

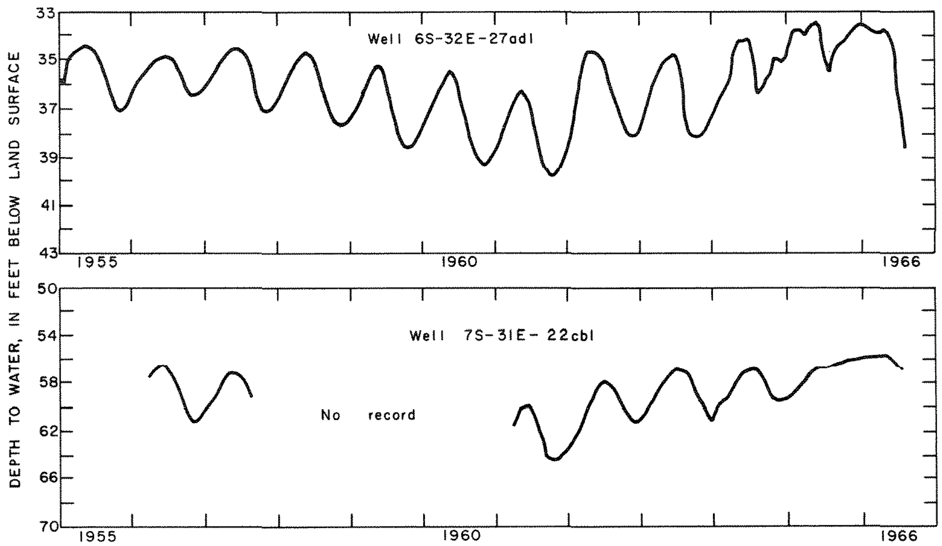


Figure 42. Hydrographs of wells 6S-32E-27adl and 7S-31E-22cbl, Power County.

MALAD VALLEY, by R. F. Norvitch

Malad Valley (fig. 43) in Oneida County, southeastern Idaho, has a broad flat floor trending north and south which is bounded by the Malad Range on the east and the Blue Spring Hills on the west. On the north, the valley forks into northwest and northeast branches, split by Elkhorn Peak of the Bannock Range. On the south, the broader part of the valley floor constricts into a narrow neck (about 3 miles wide) which extends into the State of Utah.

The Little Malad River is the largest of four streams which are nearly parallel in the wide north part of the valley and which converge to form Malad River in the south part of the valley. Most of the streamflow is stored and diverted upstream for irrigation.

The major source of water to the valley is precipitation on the drainage basin of the Malad River, particularly occurring as snow in the surrounding mountains. Average annual precipitation on the valley flat is about 14.6 inches (fig. 44), distributed rather evenly throughout the year with the lows being in July and August and the highs being in December and January.

Ground water occurs in the valley fill sediments which consist of irregular lenses and beds of clay, silt, sand, and gravel; a large part of the total thickness consists of fine-grained lake deposits.

Ground water in the valley occurs under both confined (artesian) and unconfined (water table) conditions. The principal area of confined ground water is south of the latitude of Malad City where confined water occurs from a few tens to more than 700 feet below land surface. The principal area of unconfined ground water is north of the latitude of Malad City where relatively coarse-grained delta-like deposits were built up near the northern mountain fronts.

Ground water moves from areas of recharge around the periphery of the valley, down the hyrdaulic gradient toward the center of the valley, and then southward, downvalley toward Utah. Internal, local movement is both downward as percolating recharge water and upward as leakage through imperfect confining layers in the artesian-aquifer system.

Artesian aquifers are recharged through their outcrops around the flanks of the valley, by underflow from unconfined aquifers that are continuous with or in contact with the artesian aqufiers, and by migration of water along faults that offset or are overlapped by the artesian aquifers. Unconfined aquifers are recharged by downward percolation from the surface, by underflow from adjacent sources, and by upward leakage from artesian aquifers.

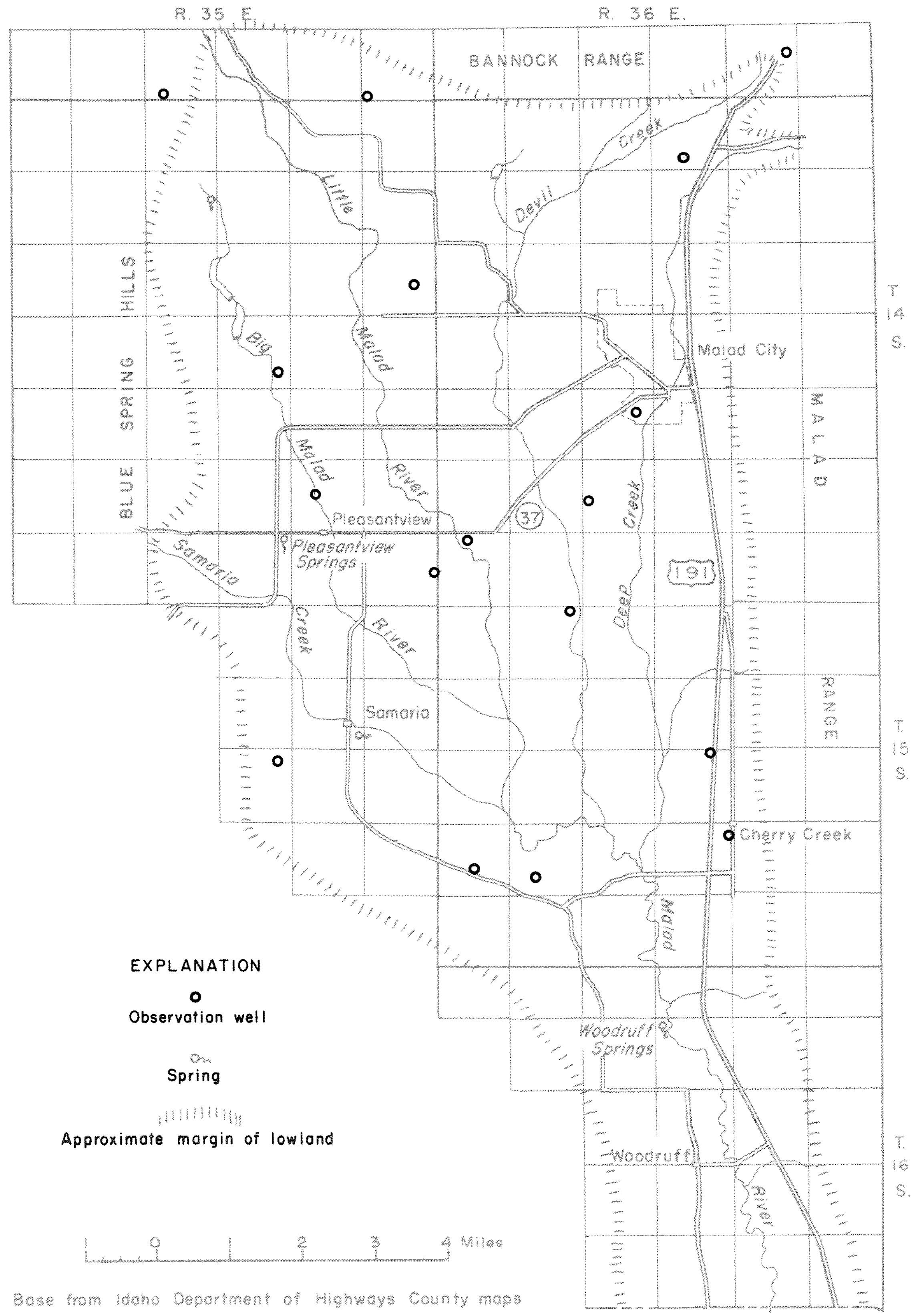


Figure 43. Map of Malad Valley showing location of observation wells.

Natural discharge from the artesian aquifers occurs as flow from springs and upward leakage into unconfined aquifers. A significant amount of artesian water is lost to evapotranspiration where it has migrated upward into the soil root zone or to the land surface in water-logged parts of the valley floor. Natural discharge from the unconfined aquifers occurs as flow from springs and seeps, and by evapotranspiration.

Underflow through the constricted part of the valley at the Utah border accounts for an undetermined amount of discharge from the area. Total flow in the Malad River at Woodruff, which is in part spring discharge, was 41,200 acre-feet in water year 1964-65.

In the early 1950's, there were about 300 flowing artesian wells in the valley, discharging about 13,000 acre-feet a year. Most wells in the valley are for domestic, stock, and irrigation uses. Generally, domestic and stock wells have small yields. Some of the irrigation wells pump more than 1,000 gpm (gallons per minute). The Malad City municipal well pumps more than 500 gpm.

Some of the water pumped from the artesian aquifers in the southern part of the valley is highly mineralized and classed as poor to unsuitable for irrigation. Also two springs in this area, Pleasantview and Woodruff (fig. 43), yield highly mineralized water classed as poor and unsuitable, respectively, for irrigation.

Figure 44 shows a hydrograph of water-level fluctuations in a flowing well near the center of the valley. The short-term fluctuations on the graph reflect yearly recharge and discharge cycles. The long-term trend shows a general decline in water levels beginning about in 1953 and continuing through about 1962 when a slight rise began. These trends roughly compare with the cumulative departure from average precipitation. The net drop in water level in this well since the beginning of record is about 10 feet. Most water levels in wells completed in the artesian aquifers have declined between Spring 1948 and Spring 1966. The maximum measured drop during this period was about 17 feet in well 14S-35E-13dbl.

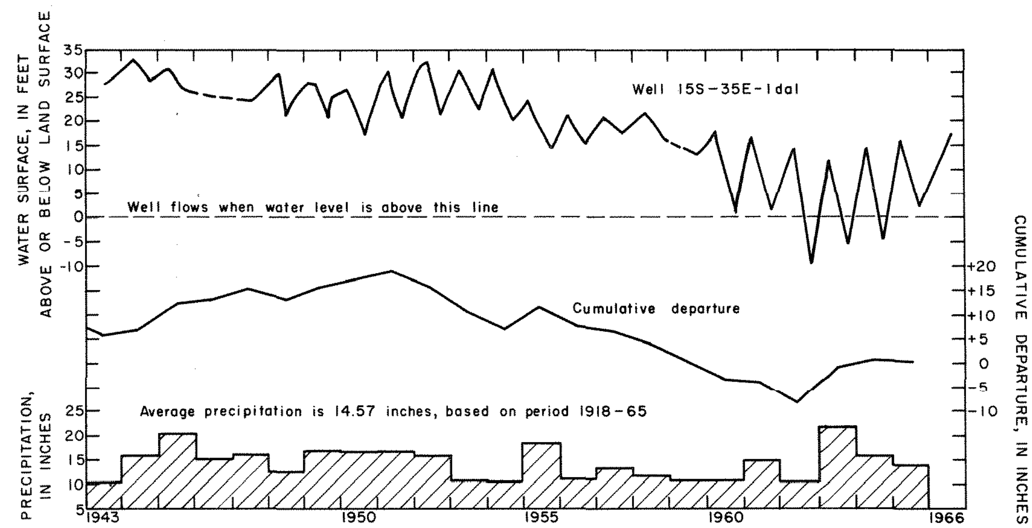


Figure 44. Graph showing annual precipitation and cumulative departure from average annual precipitation at Malad (from U.S. Weather Bureau records) and hydrograph of well 15S-35E-1dal, Oneida County.

AREAS OF GROUND-WATER POTENTIAL THAT HAVE NOT BEEN DEVELOPED EXTENSIVELY

Areas in which ground water has not been extensively developed necessarily remain imperfectly known. Drillers' logs of wells provide most of the information on subsurface occurrences of consolidated and unconsolidated formations. The position of the water table with respect to land surface is determined by measuring water levels in wells. The potential yields of aquifers can be determined only after they have been extensively developed by wells. The information presented in the section on areas not extensively developed is, therefore, based on scanty information. The summary provides a statement of what is known from surface features and from the records of the little development that has taken place. Interpretations of ground-water conditions are based on those items of information supported by analogy with comparable areas where more extensive development of the ground-water resource has been made. The interpretations are tentative and subject to change when more information becomes available.

KOOTENAI RIVER VALLEY, PRIEST RIVER VALLEY, BONNERS FERRY-SANDPOINT-HOODOO VALLEY AREA

Large volumes of ground water occur in lake beds, glacial till, outwash deposits, and alluvium that underlie the lowlands within Boundary and Bonner Counties. In the Kootenai and Priest River valleys, and in the Bonners Ferry-Sandpoint area fine-grained lake beds and glacial deposits yield water slowly in quantities suitable for domestic and stock use. Coarse stringers or isolated sand and gravel bodies within the glacial outwash may yield larger quantities locally. In the Hoodoo Valley area, only that part south of Cocolalla Lake contains deposits coarse enough to yield quantities suitable for irrigation. Abundant recharge keeps the water-bearing deposits filled during most years so that some areas become water logged and require drainage before the land can be put to productive use.

BENEWAH COUNTY

Situated almost entirely within the mountainous area of the state, Benewah County has a minimal potential for development of major ground-water supplies. Alluvium along the valleys of the St. Joe and St. Maries Rivers yields domestic and small municipal supplies from shallow depth. Near the western boundary, volcanic rocks of the Columbia Plateau, and alluvial deposits in the valley of Hangman Creek may contain supplies of ground water suitable for modest irrigation development. There are no data on which to base estimates of this potential. Elsewhere in the county, ground water in sufficient quantities for domestic and stock use may be developed from fractures and weathered zones in the bedrock and from small alluvial areas.

PALOUSE RIVER-POTLATCH RIVER AREA

Within the drainage areas of the Palouse and Potlatch Rivers, ground water may be developed in small quantities from volcanic rocks, sedimentary rocks and alluvium of limited areal extent, and the weathered man- of the granitic bedrock. In general, only domestic supplies have been developed in these areas. Coarse gravels along the principle streams may yield large quantities during some years, but the limited extent of these deposits cause uncertainties as to the permanence of such supplies.

LEWISTON AREA

The area south of the Clearwater River between the Snake River and Lapwai Creek contains volcanic rocks of the Columbia Plateau and alluvial deposits associated with the present drainages. The alluvium along the main rivers provides yields of moderate size. Supplies adequate for most purposes other than irrigaiton can be developed from the volcanic rocks away from the rivers, but such supplies are normally available only from considerable depth below the plateau surface.

CRAIGMONT-COTTONWOOD AREA

This area encompasses the Camas Prairie part of the Clearwater Embayment of the Columbia Plateau south of the Clearwater River. Deep wells obtain municipal water supplies from the volcanic rocks or underlying and adjacent granitic bedrock, and possibly water for irrigation could also be developed. There are few data to indicate the availablility of shallow ground water for local domestic or stock use, but there are a few known deposits on the plateau that contain such supplies. Adequate domestic and municipal supplies may be obtained from the narrow alluvial and river-channel deposits along the Clearwater River.

NORTH FORK PAYETTE RIVER VALLEY

From the Payette Lakes southward past Cascade to the southern end of Long and Round Valleys, extensive alluvium contains variable amounts of ground water. Basalt underlies parts of the lowlands, and will probably yield sizeable amounts of ground water. Except for widely-sacttered domestic and stock use, very little ground water is developed. Small domestic or stock supplies can be developed from the weathered mantle on the granitic bedrock of surrounding hills in some localities. Larger supplies may be available from the valley-filling deposits, but this potential has not been adequately explored.

WEISER RIVER BASIN

Volcanic rocks, probably associated with the basalt of the Columbia Plateau, and sedimentary deposits underlie most of the lowland areas of the Weiser River drainage. Locally, the volcanic rocks are known to yield as much as several hundred gallons per minute under artesian pressure. The sedimentary deposits are generally fine-grained, but yield supplies adequate for domestic and stock requirements. Sand and gravel units within the sedimentary deposits are known in some areas and, where saturated, yield moderate to large supplies.

The basaltic rocks are the best aquifers of the area. Properly constructed wells will yield moderate to large quantities from these rocks with only a moderate lift in the larger valley areas such as near Midvale and Council.

GARDEN VALLEY AREA

This small valley along the Middle and South Forks of the Payette River contains an unknown thickness of alluvial deposits within granitic- and metamorphic-rock boundaries. Marshy meadow areas near the downstream end of the valley indicate a high water table, and adequate supplies of ground water for domestic and stock use probably could be obtained from wells.

Thus far, water requirements of the valley have been met by diversion from the river or from small domestic wells. No large scale use of the ground water is known to have been attempted, and the general geologic setting suggests that large ground-water supplies probably are not present.

STANLEY BASIN

The valleys of Marsh Creek and the Salmon River north and south of Stanley contain alluvial and glacial outwash deposits of varying but unknown thickness underlain by glacial tell. These deposits are filled to overflowing with ground water and where adequate thicknesses of coarse materials are encountered, will yield moderate to large quantities to wells. No development of ground water for other than minor domestic and stock use is known in the basin. Natural outflow of ground water helps maintain the year-around flow of the Salmon River near Stanley.

CHALLIS-ROUND VALLEY AREA

The Round Valley area near Challis contains extensive alluvial-fan and apron deposits around the valley margins and an unknown thickness of alluvial fill in the central part of the valley. Abundant recharge from the Salmon River and large tributary creeks maintains the alluvium in a near-saturated condition. Domestic and small rural-use wells provide adequate water supplies from the ground-water reservoir, and a few wells yield sufficient water for irrigation needs. Additional irrigation supplies to supplement surface diversions could probably be developed from the alluvial deposits. Small domestic supplies can be obtained in most localities from the volcanic complex that forms the boundaries of the valley area.

PAHSIMEROI RIVER VALLEY

This valley in east-central Idaho is filled to depths of several hundred feet with coarse alluvial gravels which contain very little fine-grained material. The surrounding bedrock mountains yield a large annual recharge most of which drains through the coarse valley fill in a few months. Discharge is from the central lowland to the Pahsimeroi River and thence to the Salmon River.

Large amounts of ground water are available in the valley fill during most years, but little is developed for other than domestic and stock use. Much of the tributary surface flow is diverted for irrigation, which helps distribute the runoff and increase recharge of the ground water. Because of the free recharge and discharge capacity of the valley fill, water levels fluctuate strongly each year and are especially susceptible to long periods of drought. The water is of good to excellent chemical quality for all uses, and wells with large yields could be developed in many parts of the valley.

LEMHI RIVER VALLEY

Alluvial-fan and glacial-outwash deposits overlie a great thickness of tuffaceous, fine-grained older sedimentary rocks within most of Lemhi Valley. These deposits rest on the virtually nonwater-bearing bedrock complex that forms the mountains surrounding the valley. Although the older sedimentary deposits probably have a large storage capacity, their fine-grained texture would release the stored water only slowly to a well. The alluvial-fan and glacial deposits contain much coarse material that yields water freely to properly constructed wells. Consequently, where these and younger deposits of significant thickness are saturated, large yields of ground water could be developed.

Ground water is recharged freely from tributary streams on the upper slopes, moves toward the central valley area through the valley fill, and discharges in numerous springs along the Lemhi River, principally northwest of Leadore. The chemical quality is generally good for irrigation, domestic, and stock uses.

BIRCH CREEK BASIN

The ground-water regimen of the valley of Birch Creek is divided into two segments by a barrier of basaltic and conglomeratic rock about midway of the valley. Alluvium in the upstream segment of the valley contains a large supply of ground water which probably could be developed by wells. Most of this ground water now appears as streamflow in Birch Creek just upstream of the rock barrier.

Immediately downstream of the barrier ground water occurs in alluvium within about 30 feet of the surface. Farther downstream, however, it may occur as much as 600 feet beneath the surface.

Details of the character of the water-bearing alluvium are not sufficiently known to permit estimates of yield from individual wells.

HOMEDALE-MURPHY AREA

Ground water occurs under artesian conditions in the valley of the Snake River from Murphy downstream to the Oregon State Line. The water-bearing formations are sand, gravel, basalt, and tuff. These deposits yield small to moderate supplies to irrigation, public supply, domestic, and stock wells. The water is usually warm, has a high sodium content, and locally contains small quantities of natural gas. Alluvial deposits along the Snake River and some of the small tributary streams yield small to large supplies of water to wells.

MOUNTAIN HOME PLATEAU

Locally, sand and gravel contain sufficient water at shallow depth to meet municipal, domestic, and small irrigation needs. Little is known about ground water elsewhere in the area.

Silicic volcanic rocks are believed to underlie the area at depth, overlain by sedimentary strata that may contain some aquifer material. Basaltic lavas cover about half of the area and fill irregularities in the surface of the sediments. In some localities, moderate to large quantities of water may be obtained from this sequence of rocks, but water levels are often far beneath the land surface. Even though the deeper water is often under some artesian pressure, pumping lifts may be high.

CAMAS PRAIRIE

This structural basin, 25 miles north of Gooding, contains silicic and basaltic rocks, lake beds, and alluvium. Unconfined ground water occurs at shallow depths in the alluvium and shallow wells yield quantities sufficient for domestic and stock use. Rarely do the wells exceed 50 gallons per minute in yield.

Two extensive gravel and sand aquifers beneath clayey lake deposits contain water under artesian pressure. Wells of large yield may be developed in these aquifers. Some wells flow at land surface and yield several hundred gallons per minute. At a few places, basalt forms a major aquifer also. These places are mainly in the southeast part of the prairie where some wells yield in excess of 1,000 gallons per minute.

UPPER TETON BASIN

Large volumes of ground water of fair to excellent quality occur under water-table conditions in alluvial-fan and other stream deposits that underlie the Teton Basin in eastern Teton County. The coarse-grained deposits on the east side of the basin yield water more abundantly than the finer grained deposits on the west side and most irrigation wells are located on the east side of the basin. Depth to water ranges from 0 along the Teton River to more than 200 feet near the foot of the mountains. Basalt at the north end of the basin yields perched water to some domestic and stock wells.

Ground water occurs under perched and artesian conditions in silicic volcanic rocks in the north and north-west parts of the basin. The perched-water aquifer yields small supplies to domestic and stock wells. The artesian-water aquifer yields supplies adequate for stock and domestic use, and locally may be adequate for irrigation use.

OWYHEE UPLANDS

This area is composed of the Owyhee and other mountains and the adjacent plateau regions in Owyhee County. Water from the Owyhee River is used to irrigate parts of the area, and some of this water recharges the ground water of the area. Recharge from other sources is probably very small.

Occurrence of ground water is similar to that in the Mountain Home Plateau area. Water levels are generally far below land surface and only locally may small supplies be found in sedimentary deposits perched above the regional water table.

SAILOR CREEK AREA

Ground water occurs under low artesian pressure in sedimentary deposits, and in basaltic and silicic volcanic rocks beneath the upland area south of the Snake River in Owyhee, Elmore, and Twin Falls Counties. Recharge is derived from infiltration of precipitation on mountains south of the area near the State Line and in Nevada. The ground water moves northward toward the Snake River. The sedimentary deposits and basalt lavas yield adequate water supplies to stock wells, and in places enough for irrigation. In the southeastern part of the area, silicic volcanic rocks yield large amounts of water to some irrigation wells. The depth to water is estimated to exceed 500 feet in 50 percent of the area and 750 feet in 10 percent of the area.

ROCKLAND VALLEY

Ground water in the Rockland Valley occurs in narrow bands of alluvium near the stream bottoms; in basalt north of Rockland; and in ash, silt, clay, tuff, and volcanic flow rocks south of Rockland. Domestic and stock wells yield small quantities of water from shallow depths near the streams, but the water level is far below the surface toward the valley margins. Large supplies for irrigation are probably not available in most parts of the valley.

ARBON VALLEY

The southern part of the Bannock Creek valley area is designated Arbon Valley. A narrow band of alluvium occurs along Bannock Creek, but most of the valley floor is underlain with older unconsolidated sedimentary deposits and consolidated rocks of moderate permeability. Little is known of the occurrence of ground water in the valley, but it is expected that only minimal domestic and stock supplies would be available from wells.

PORTNEUF RIVER VALLEY

A variety of ground-water conditions occur within the Portneuf River valley, but in general, the ground water of the area has not been well explored or developed. In the upper part a few wells obtain large quantities of ground water at shallow depths from basalt. At places throughout the area other volcanic rocks and associated sand, conglomerate, and ash or pumice yield large quantities to wells. However, in large parts of the area, the rocks are much less permeable and yield only moderate quantities for domestic or stock use.

The city of Pocatello and large industrial and irrigation concerns obtain abundant supplies of ground water from wells in bouldery alluvium near the mouth of Portneuf River valley. Also, large yields have been reported from wells that encounter clean gravel that underlies the valley of Marsh Creek, upstream from Inkom.

WILLOW CREEK HIGHLANDS

This small subarea between Idaho Falls and Blackfoot Reservoir in the southeastern part of the state is underlain chiefly by older folded and faulted rocks of low ground-water yield. Some basalt occurs as canyon and channel filling material overlying the older rocks, but nothing is known of the ground-water conditions in the basalt.

Minor amounts of ground water to meet minimal domestic and stock needs can probably be obtained from basalt and local alluvial deposits in the area. Large-scale irrigation supplies probably cannot be developed.

GEM-GENTILE VALLEYS

These valleys lie between the upper valley of Portneuf River and the Soda Springs Hills. The valleys are floored and partly filled with permeable basalt so that there is virtually no surface drainage from them.

A low ground-water divide is thought to occur just southeast of Bancroft, separating the drainage to the Portneuf River from that to the Bear River. Because the basalt is so permeable, ground water drains out fairly rapidly and water levels in the basalt of Gem Valley may be quite deep below the surface. Ground-water conditions in Gentile Valley are not well known, but the principle occurrence is probably in the valley fill along the Bear River and Cottonwood Creek below Black Canyon. Such occurrence probably will not sustain large-scale use, but would be adequate for domestic and stock use.

CURLEW-POCATELLO VALLEYS

These small valleys in southern Idaho drain southward into Utah. Conditions of occurrence of ground water in the valleys are virtually unknown. However, the generally poorly permeable older sediments and consolidated bedrock of the area, and the limited amount of young alluvium suggests that large supplies of ground water probably are not available. Numerous small wells obtain domestic and stock water from depths of a few tens to a few hundreds of feet.

CACHE VALLEY AREA

Ground-water conditions within that part of Cache Valley north of the Idaho-Utah boundary are poorly known. The extensive alluvial deposits of the Bear River near Preston, and marshy conditions in Round Valley at the head of Sheep Creek suggest that a large ground-water body probably occurs within the valley-filling deposits. Most irrigation requirements are met with surface diversions from the Bear River and tributaries, but municipal and domestic supplies are adequately met from wells in the alluvium.

BEAR LAKE AREA

The broad valley extending northward from Bear Lake past Montpelier toward Soda Springs is almost completely served with springs and surface diversions from Bear River and the outlets from Bear Lake. Very little is known of the occurrence of ground water in the area. The great broad valley has extensive valley-fill deposits that should yield abundant water from the coarser strata. Water under artesian pressure may occur at depth in conglomerate that underlies fine-grained and cemented deposits beneath the alluvium of the valley. Some artesian pressure occurs locally in the shallow alluvial deposits.

The younger alluvium is coarsest on the east side of the valley where it yields adequate domestic and municipal supplies from shallow depths. Along the west side of the valley the alluvium is largely clayey and well yields are small and difficult to attain.

SELECTED REFERENCES

Barraclough, J. T., 1953, Records of wells in western Jefferson County, Idaho: U.S. Geol. Survey open-file report, 54 p.

Crosthwaite, E. G., 1956, Records of wells and water levels in western Jerome County, Idaho: U.S. Geol. Survey open-file report, 151 p.

Crosthwaite, E. G., 1957, Ground-water possibilities south of the Snake River between Twin Falls and Pocatello, Idaho: U.S. Geol. Survey Water-Supply Paper 1460-C, p. 99-145.

Crosthwaite, E. G., 1963, Ground-water reconnaissance of the Sailor Creek area, Owyhee, Elmore, and Twin Falls Counties, Idaho: U.S. Geol. Survey open-file report, 53 p.

Crosthwaite, E. G., and Scott, R. C., 1956, Ground water in the North Side Pumping Division, Minidoka Project, Minidoka County, Idaho: U.S. Geol. Survey Circ. 371, 20 p.

Fader, S. W., 1951, Water levels in wells and lakes in Rathdrum Prairie and contiguous areas, Bonner and Kootenai Counties, Northern Idaho: U.S. Geol. Survey open-file report, 89 p.

Fowler, K. H., 1960, Preliminary report on ground water in the Salmon Falls area, Twin Falls County, Idaho: U.S. Geol. Survey Circ. 435, 17 p.

Fowler, K. H., 1960, Basic well records, Salmon Falls area, Idaho: U.S. Geol. Survey open-file report, 51 p.

Hackett, O. M., 1963, Ground-water levels in the United States 1956-60, northwestern states: U.S. Geol. Survey Water-Supply Paper 1760, 222 p.

Idaho Bureau of Mines and Geology, 1964, Mineral and water resources of Idaho: Idaho Bureau of Mines and Geology, Special Report No. 1, 335 p.

Kilburn, Chabot, 1964, Ground water in the upper part of the Teton Valley, Teton Counties, Idaho and Wyoming: U.S. Geol. Survey Water-Supply Paper 1789, 60 p.

Littleton, R. T., and Crosthwaite, E. G., 1957 (1958), Ground-water geology of the Bruneau-Grand View area, Owyhee County, Idaho: U.S. Geol. Survey Water-Supply Paper 1460-D, p. 147-198.

Livingston, Penn, and McDonald, H. R., 1943, Underground leakage from artesian wells in Malad Valley, Idaho: U.S. Geol. Survey open-file report, 38 p.

Meinzer, O. E., 1924, Ground water in Pahsimeroi Valley: Idaho Bur. Mines and Geology Pamph. 9, 36 p.

Mower, R. W., 1953, Records of wells and ground-water levels in eastern Jerome County, Idaho: U. S. Geol. Survey open-file report, 91 p.

Mower, R. W., 1953, Records of wells, ground water levels, and ground-water withdrawals in the lower Goose Creek basin, Cassia County, Idaho: U.S. Geol. Survey open-file report, 92 p.

SELECTED REFERENCES (Continued)

Mower, R. W., and Nace, R. L., 1957, Water consumption by water-loving plants in the Malad Valley, Oneida County, Idaho: U.S. Geol. Survey Water-Supply Paper 1412, 33 p.

Mundorff, M. J., 1960, Results of test drilling and aquifer tests in the Snake River basin, Idaho in 1958: U. S. Geol. Survey open-file report, 146 p.

Mundorff, M. J., 1962, Feasibility of artificial recharge in the Snake River basin, Idaho: U.S. Geol. Survey open-file report, 49 p.

Mundorff, M. J., 1962, Ground water in Birch Creek valley, Idaho: U. S. Geol. Survey open-file report, 10 p.

Mundorff, M. J., Broom, H. C., and Kilburn, Chabot, 1960, Reconnaissance of the hydrology of the Little Lost River basin, Idaho: U.S. Geol. Survey Water-Supply Paper 1539-Q, 51 p.

Mundorff, M. J., and Travis, W. I., 1962, Water supply for a fish hatchery site, Clearwater Valley, Idaho: U.S. Geol. Survey open-file report, 35 p.

Mundorff, M. J., and Sisco, H. G., 1963, Ground water in the Raft River basin, Idaho, with special reference to irrigation use, 1956-60: U.S. Geol. Survey Water-Supply Paper 1619-CC, 23 p.

Mundorff, M. J., Crosthwaite, E. G., and Kilburn, Chabot, 1964, Ground water for irrigation in the Snake River basin in Idaho: U.S. Geol. Survey Water-Supply Paper 1654, 224 p.

Nace, R. L., 1952, Records of wells and springs in western Oneida County, Idaho: U.S. Geol. Survey open-file report, 51 p.

Nace, R. L., and Fader, S. W., 1951, Records of wells on Rathdrum Prairie, Bonner and Kootenai Counties, Northern Idaho: U.S. Geol. Survey open-file report, 49 p.

Nace, R. L., West, S. W., and Mower, R. W., 1957, Feasibility of ground-water features of the alternate plan for the Mountain Home project, Idaho: U.S. Geol. Survey Water-Supply Paper 1376, 121 p.

Nace, R. L., McQueen, I. S., and Van't Hul, Arthur, 1958, Records of springs in the Snake River valley, Jerome and Gooding Counties, Idaho, 1899-1947: U.S. Geol. Survey Water-Supply Paper 1463, 62 p.

Nace, R. L., and others, 1961, Water resources of the Raft River basin, Idaho-Utah: U.S. Geol. Survey Water-Supply Paper 1587, 138 p.

Russell, I. C., 1901, Geology and water resources of Nez Perce County, Idaho, part I: U.S. Geol. Survey Water-Supply Paper 53, 85 p.

Russell, I. C., 1901, Geology and water resources of Nez Perce County, Idaho, part II: U.S. Geol Survey Water-Supply Paper 54, 65 p.

Scott, R. C., 1955, Industrial ground-water possibilities in part of Bear Lake and Caribou Counties, Idaho: U.S. Geol. Survey open-file report, 27 p.

SELECTED REFERENCES (Continued)

Sisco, H. G., and Luscombe, R. W., 1963, Ten-year summary of records of observation wells and water-level fluctuations in the Aberdeen-Springfield area, Bingham and Power Counties, Idaho, through December 1962: U.S. Geol. Survey open-file report, 122 p.

Sisco, H. G., and Whitehead, R. L., 1966, Records of wells and water-level fluctuations in the Aberdeen-Springfield area, Bingham and Power Counties, Idaho, in 1965: U.S. Geol. Survey open-file report, 28 p.

Smith, R. O., 1959, Ground-water resources of the Middle Big Wood River-Silver Creek area, Blaine County, Idaho: U.S. Geol. Survey Water-Supply Paper 1478, 64 p.

Stearns, H. T., Crandall, Lynn, and Steward, W. G., 1938, Geology and ground-water resources of the Snake River Plain in south-eastern Idaho: U.S. Geol. Survey Water-Supply Paper 774, 268 p.

Stearns, H. T., Bryan, L. L., and Crandall, Lynn, 1939, Geology and water resources of the Mud Lake region, Idaho, including the Island Park area: U.S. Geol. Survey Water-Supply Paper 818, 125 p.

Stevens, P. R., 1960, Ground-water problems in the vicinity of Moscow, Latah County, Idaho: U. S. Geol. Survey Water-Supply Paper 1460-H, p. 325-357.

Stevens, P. R., 1962, Effect of irrigation on ground water in southern Canyon County, Idaho: U.S. Geol. Survey Water-Supply Paper 1585, 74 p.

Thomas, C. A., 1963, Investigation of the inflow to the Rathdrum Prairie-Spokane Valley aquifer: U.S. Geol. Survey open-file report, 46 p.

Thompson, D. G., and Faris, R. W., 1932, Preliminary report on water resources of Malad and Curlew Valleys, Oneida County, Idaho: U.S. Geol. Survey open-file report, 140 p.

Walker, E. H., 1964, Ground water in the Sandpoint region, Bonner County, Idaho: U.S. Geol. Survey Water-Supply Paper 1779-I, 25 p.

Walker, E. H., and Sisco, H. G., 1964, Ground water in the Midvale and Council areas, upper Weiser River basin, Idaho: U.S. Geol. Survey Water-Supply Paper 1779-Q, 26 p.

Walton, W. C., 1959, Results of test drilling and aquifer tests in Jerome, Lincoln, and Minidoka Counties, Idaho: U.S. Geol. Survey open-file report, 70 p.

Walton, W. C., 1960, Ground-water resources of Camas Prairie, Camas and Elmore Counties, Idaho: U.S. Geol. Survey Water-Supply Paper 1609, 57 p.

West, S. W., and Fader, S. W., 1952, Records of wells and ground-water withdrawals in the Dry Creek area, Cassia and Twin Falls Counties, southern Idaho: U.S. Geol. Survey open-file report, 114 p.

West, S. W., and Kilburn, Chabot, 1962, Ground-water data for part of the Fort Hall Indian Reservation, Bannock, Bingham, and Power Counties, Idaho: Idaho Dept. of Reclamation Ground Water Report No. 1, 45 p.

West, S. W., and Kilburn, Chabot, 1963, Ground water for irrigation in part of the Fort Hall Indian Reservation, Idaho: U.S. Geol. Survey Water-Supply Paper 1576-D 33 p.