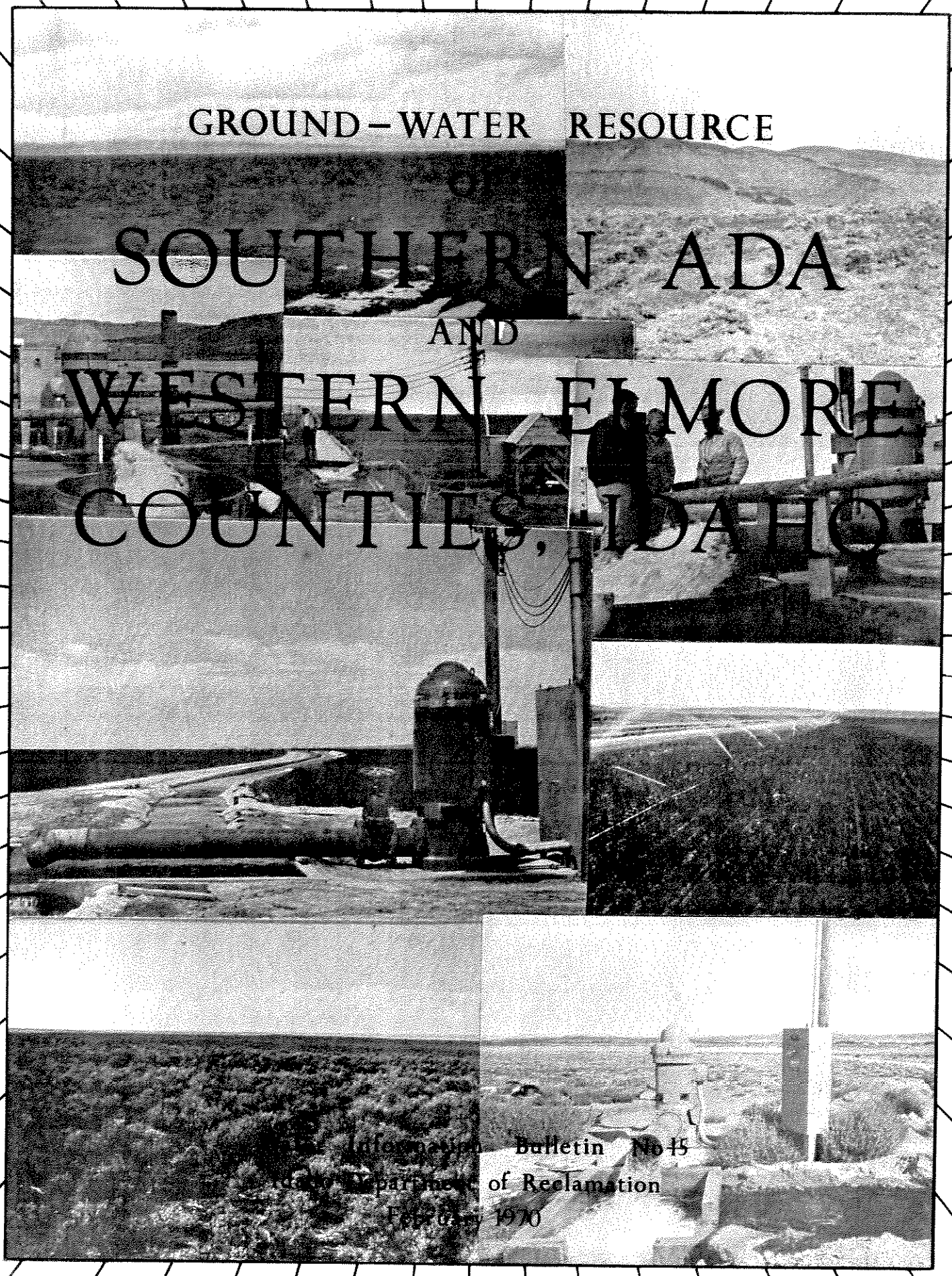
GROUND-WATER RESOURCE OF SOUTHERN ADA AND WESTERN ELMORE COUNTIES, IDAHO



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GROUND-WATER RESOURCE

of

SOUTHERN ADA AND WESTERN ELMORE COUNTIES, IDAHO

by

Dale R. Ralston

and

Sherl L. Chapman

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R. Keith Higginson

State Reclamation Engineer

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ABSTRACT

The study area is located in southern Ada and western Elmore counties. It includes approximately 940 square miles and is composed of three geographic features: an extensive plateau, the Snake River canyon, and a narrow valley floor along the river. All surface drainage in the study area is to the Snake River.

Four hydrogeologic units are important as aquifers in the study area: a lower sand and gravel unit, a basalt unit, an upper sand and gravel unit and a sand-silt unit. The greatest yields to wells are from the sand and gravel units and basalt unit. Other geologic formations present in the study area are: granitic rocks of the Idaho Batholith, the Payette Formation, Miocene basalt and Snake River basalt. None of these are important as aquifers in the study area.

Well development is concentrated in the northwestern portion of the study area and is the basis for delineation of two subareas: the Kuna subarea and the Orchard subarea. Wells in the Kuna subarea are less than 1,000 feet deep and derive water from any of the hydrogeologic units except the sand-silt unit. Many have yields exceeding 2,000 gallons per minute. Wells in the Orchard subarea range from 20 feet to 1,620 feet deep. Ground water in these wells is derived from the basalt unit or the sand-silt unit. Wells on Chattin Flat in the Orchard subarea derive warm, artesian water from the sand-silt unit.

Ground-water flow in the Kuna subarea is from the northeast to the southwest. The gradient or slope of the ground-water surface varies from 10 feet per mile beneath the plateau to 40 feet per mile near the Snake River. Ground-water movement in the Orchard subarea is generally from

north to south.

Water-level records were kept by the U. S. Geological Survey on 17 wells in and near the study area; five of these for more than a nine-year period. Hydrographs of wells northwest of the study area indicate recharge from irrigation. One well, in the southern portion of the study area, has undergone a general water-level decline of approximately one foot per year since 1967.

Chemical analyses were conducted on 27 samples of ground water from the study area and 90 field observations of temperature and electrical conductivity were made. The electrical conductivity ranged from 140 to 1,400 micromhos and high values are grouped in four specific areas. Temperature of the ground water ranged from 48 to 121°F. Sodium bicarbonate and calicum bicarbonate are the predominant types of water in the study area. Most of the ground water is suitable for both irrigation and domestic usages.

Recharge to the aquifers in the Kuna subarea is primarily from the Boise River, the New York Canal and laterals, and irrigation water applied in excess of consumptive use. The total amount of water recharged to the aquifers annually is believed to be approximately 50,000 acre-feet. Discharge from the subarea is believed to be primarily in the Melba vicinity in the form of springs and drainage wells. The only estimate of this discharge was the measurement of the winter discharge of several springs near Melba. This flow is estimated to be 36,500 acre-feet annually. Recharge in the Orchard subarea is from the Boise Front and Mt. Bennett Hills. Because of the low permeability of the rock mass in this area, the quantity of recharge is believed to be small. Discharge from the system is from springs and evapotranspiration.

The Department of Reclamation has 125 valid permits on file for a total diversion from ground water of 629 cubic feet per second from the study area. The greatest interest in ground-water development has been in the 1960's.

INTRODUCTION

Purpose

Surface-water supplies are scarce or non-existent in many portions of southern Idaho. Irrigated agriculture must depend on underground reserves for water in such areas. When previously undeveloped areas are explored and successful wells drilled, potential problems of well interference and water-level decline are created. Portions of southern Ada and western Elmore counties have undergone or are undergoing large increases in well development.

The State Reclamation Engineer has the responsibility for administering both the surface-water and ground-water rights within the state to assure that the resource is utilized to its fullest, yet preserved for continual use in the future. He has assumed an active role in the investigation of areas in which the present rate of development of ground water might affect the use of the resource and has authorized investigations of areas in which problems exist. This report on the ground-water resource of southern Ada and western Elmore counties is the third to result from such an investigation. Previous studies of the Mountain Home area and northern Owyhee County have been published (Ralston and Chapman, 1968 and Ralston and Chapman, 1969).

The ground-water resource in southern Ada and western Elmore counties is utilized as a source of water for both domestic and irrigation purposes. Surface-water supplies for irrigation are available along the northern edge of the study area from the Boise River and along the extreme southern portion of the area from the Snake River. The ground-water resource is valuable in the continuation of the present agricultural prosperity within the study area and as a basis for future development. The State Reclamation Engineer has become concerned about the lack of knowledge of the ground-water geology,

characteristics of ground-water movement, and the potential and quality of the resource in the study area. The present study was designed on a reconnaissance level to gather basic data and provide information about the extent and capability of the resource. It would also serve as a basis for a future, more intensive study if problems become apparent in the area.

The purposes for the study of the ground-water resource in southern Ada and western Elmore counties may be stated as follows: 1) to aid the State Reclamation Engineer in administering the water rights in the area, 2) to obtain a greater knowledge of the hydrology and geology of the area in order to assist landowners in developing the resource, and 3) to generally add to knowledge of the water resources of the State of Idaho.

Objectives

The objectives of the project were to determine the quantity, quality and occurrence of ground water in southern Ada and western Elmore counties, with special emphasis on the quantity of water available for and the effect of new well development in southern Ada County. The more specific objectives were to: 1) determine the geologic control of the occurrence of ground water in the area, 2) determine the areal extent and hydrologic characteristics of the aquifers present in the area, 3) determine the recharge-discharge characteristics of the aquifers, 4) determine the quality and temperature of the ground water and its suitability for domestic and irrigation usages, and 5) denote areas where special consideration is needed in administering the use of the ground-water resource.

Location and Extent

The study area includes approximately 940 square miles located in the southern portion of Ada County and the western portion of Elmore County in

southwestern Idaho (fig. 1). It is bounded on the south by the Snake River, on the west by the Ada-Canyon County line and on the east by Canyon Creek. The northern boundary from west to east is the Mora Canal, the New York Canal, the township line common to townships 2 and 3 North, Interstate 80 North, and the road connecting Black's Creek, Mayfield and Mountain Home.

Field studies, consisting of a well inventory and reconnaissance geology, were conducted during the period January 1969 through August 1969. One water-level recorder was operated for a short period. Twenty-five samples of water from springs and wells were collected and chemically analyzed as a part of the study.

Previous Investigations

The ground-water hydrology has not been studied in detail over most of the Ada-Elmore area. Nace, West and Mower (1957) studied the feasibility of pumping large quantities of water onto the western portion of the study area from the Boise Valley. Only limited reference was made to potential ground-water resources underlying what was called the "Mountain Home Plateau." The general geology of the Ada-Elmore area has been studied by several individuals. The most recent study, by Savage (1958), is concerned primarily with economic geology. Some basic data on wells in the area were collected by Dion and Griffiths (1967) as a result of the initiation of an observation well network in southwestern Idaho.

Well Numbering System

The well numbering system used in this study is the same as that used by the U. S. Geological Survey in Idaho. This system indicates the locations of wells within the official rectangular subdivisions of the public lands, with reference to the Boise Base Line and Meridian. The first two segments

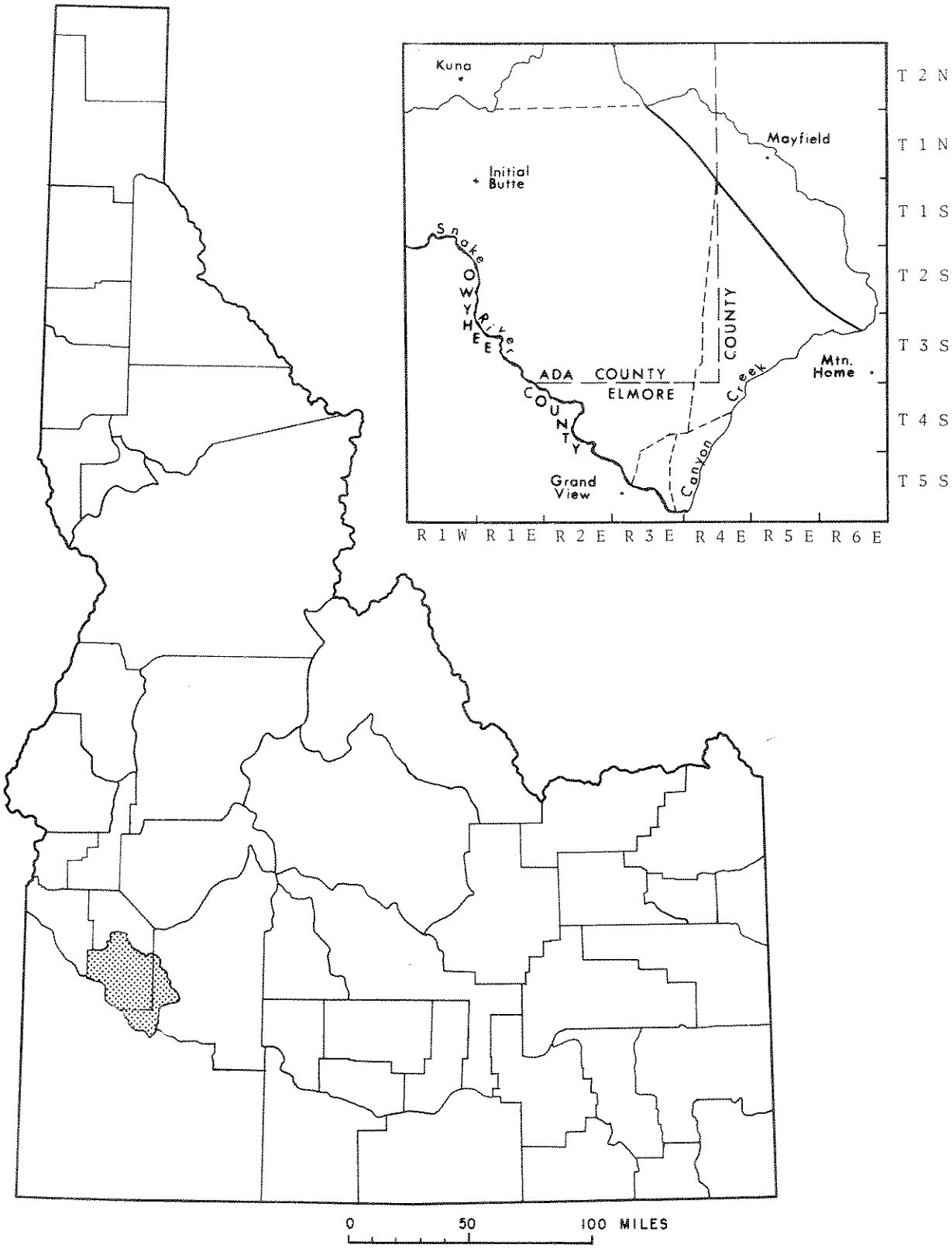


FIGURE 1. Index map showing the area covered by this report

of a number designate the township and range. The third segment gives the section number, followed by two letters and a numeral, which indicate the quarter section, the forty acre tract, and the serial number of the well within the tract. Quarter sections are lettered a, b, c, and d in counterclockwise order, from the northeast quarter of each section (fig. 2). Within the quarter sections, forty acre tracts are lettered in the same manner. Well 1S 1E 30bb1 is in the NW¼ of the NW¼ of section 30 in township 1 S., 1 E., and is the first well designated in that tract.

Geographic Setting

The Ada-Elmore study area consists of three major geographic features: an extensive plateau, the Snake River canyon and a narrow valley floor along the Snake River. The plateau includes most of the study area. It is an undulating lava plain dotted with small vents and isolated cinder cones. Shallow gullies and small canyons have been eroded by ephemeral streams. The entire plateau slopes gently southward towards the Snake River. The Snake River canyon is present along the southern boundary of the study area. The north side of the canyon is characterized by a steep basalt wall from 50 feet to over 700 feet in height. The valley floor along the river is widest near Grand View. It is farmed extensively in this area and is used primarily for cattle grazing downstream. The surface is generally level in the Grand View area and becomes hummocky downstream.

The drainage in the area is to the Snake River. Numerous small intermittent streams issue from the Boise Front and Mt. Bennett Hills. Small reservoirs have been constructed on several of these to store water during periods of flow. The largest of these reservoirs are on Indian Creek and Black's Creek.

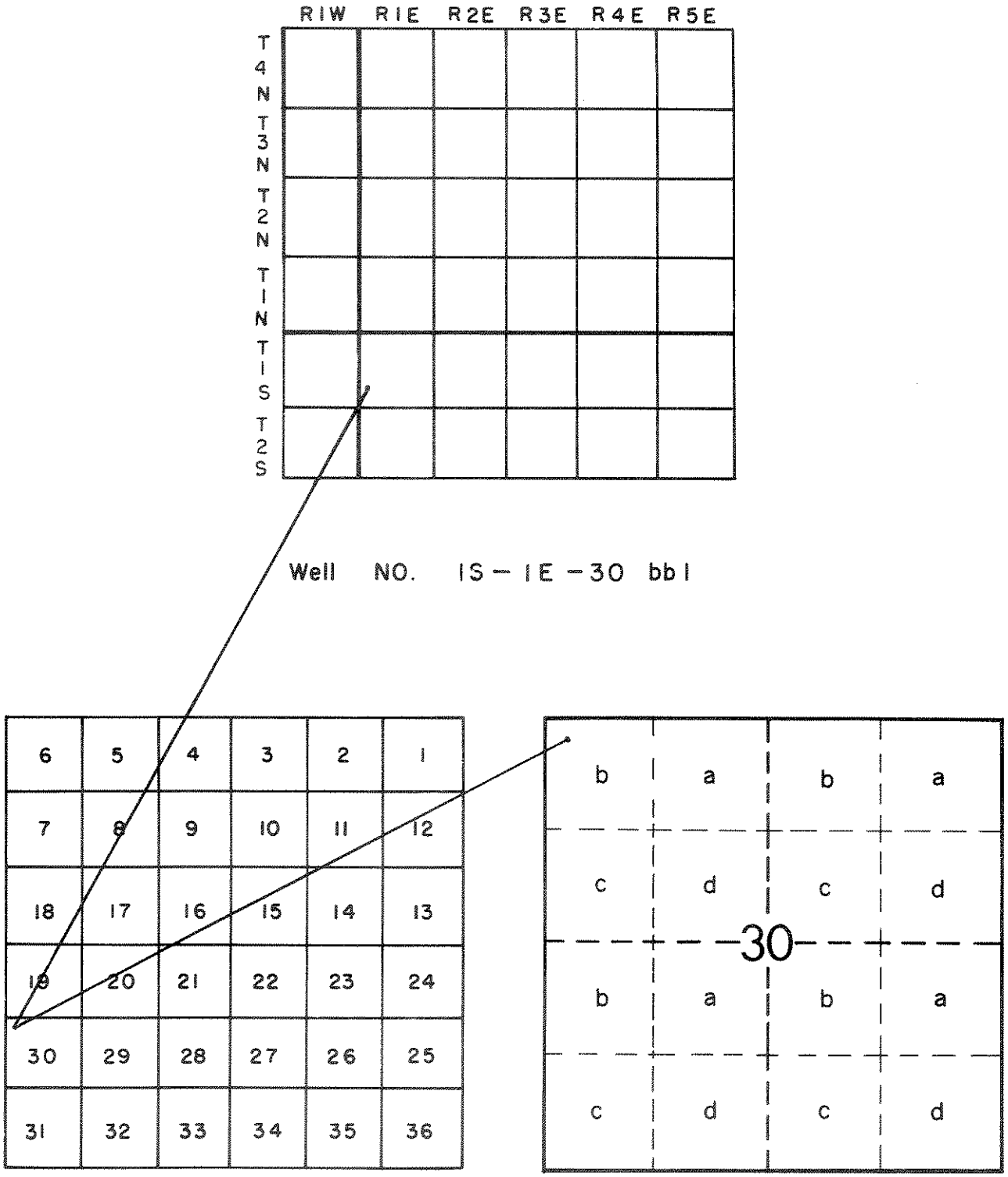


FIGURE 2. Well numbering system.

The climate of the study area is semi-arid. Data from the five U. S. Weather Bureau stations nearest the study area are shown in table 1. The estimated average precipitation for the area is 9.3 inches and the estimated average temperature is 51.4 Fahrenheit (F) degrees. The period of greatest average precipitation is during the late winter and early spring months in the Boise-Kuna region; while the greatest precipitation occurs from March through June for the rest of the area.

Native vegetation is typical of a semi-arid environment. Sagebrush, rabbit brush, wheat grass, cheat grass and many other varieties of low brush and grasses inhabit the area. Most of the crops in the area are irrigated. Some dry land grain crops are grown. Cities and villages near the area include Boise, Kuna, Melba, Orchard and Mayfield.

HYDROGEOLOGY

Four geologic units are important as aquifer systems within the study area: (1) a lower sand and gravel (fig. 3), (2) a basalt, (3) an upper sand and gravel and (4) a sand-silt. A thin upper basalt is present at scattered locations throughout the subarea, but is not important as a major aquifer.

Lower Sand and Gravel Unit

The lower sand and gravel unit underlies the western portion of the study area. This unit is defined for this report as the coarse grained portion of the Idaho Formation (Kirkham, V. R. D., 1931) immediately underlying the major basalt unit (fig. 4). It consists of lenticular beds of poorly-sorted gravel and sand with lesser amounts of silt and clay. The sediments were derived from the mountains to the north and deposited on a rolling topography by the ancient Boise River and tributary streams. During this period of time, the Snake River occupied a valley north of its present

TABLE 1

AVERAGE MONTHLY PRECIPITATION AND TEMPERATURE

AT STATIONS NEAR THE ADA COUNTY STUDY AREA

	Swan Falls		Grand View		Mountain Home		Boise		Kuna	
Elevation (feet)	2325		2400		3190		2838		2685	
Years of Record	31	30	29	32	53	58	28	28	54	57
Month	Precip. (in.)	Temp. (°F)	Precip. (in.)	Temp. (°F)	Precip. (in.)	Temp. (°F)	Precip. (in.)	Temp. (°F)	Precip. (in.)	Temp. (°F)
January	.97	31.4	.71	29.4	1.04	28.3	1.32	29.1	1.12	29.0
February	.80	38.0	.58	35.4	.87	33.2	1.33	34.5	1.03	34.5
March	.99	44.7	.91	43.0	1.10	40.4	1.32	41.7	1.10	41.8
April	.85	50.2	.70	52.7	.84	49.6	1.16	50.4	1.03	50.3
May	.95	62.1	1.09	60.8	1.02	57.4	1.29	57.2	1.37	57.6
June	1.29	68.7	.83	67.9	.73	64.4	.89	65.8	.88	63.7
July	.24	80.1	.16	76.5	.24	73.7	.21	75.2	.19	72.0
August	.08	77.4	.11	73.4	.15	71.1	.16	72.1	.14	69.4
September	.42	67.3	.33	63.5	.30	62.2	.39	62.7	.40	61.3
October	.58	55.9	.47	52.3	.65	51.9	.84	51.6	.79	51.8
November	.95	41.0	.68	40.3	.93	38.7	1.20	38.6	1.18	38.8
December	.68	35.6	.69	29.8	.91	31.9	1.32	32.2	1.03	32.4
Total	8.80		7.26		8.78		11.43		10.36	
Average		54.2		51.6		50.2		51.0		50.2

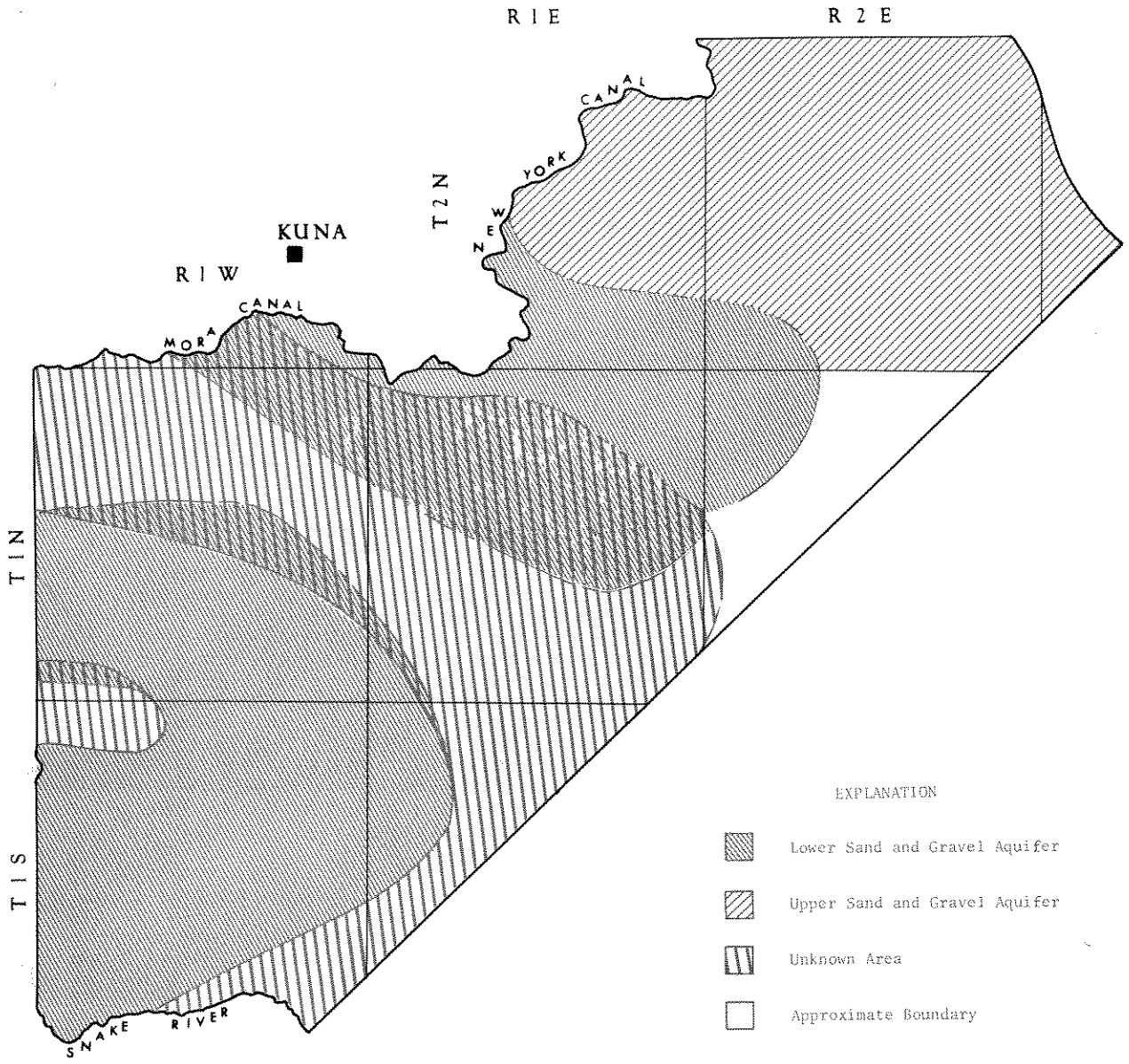
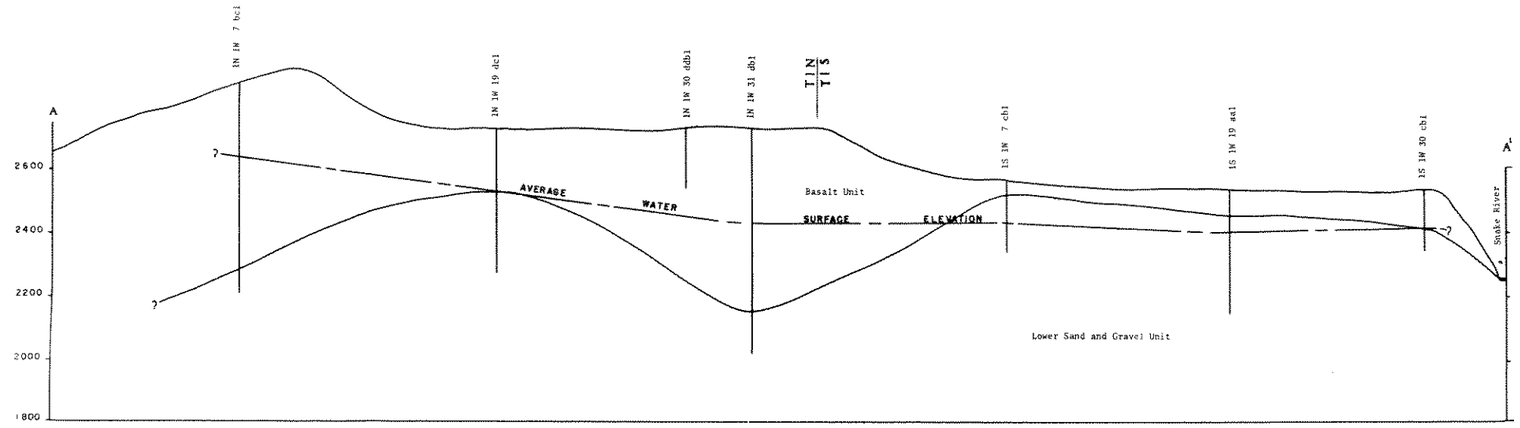
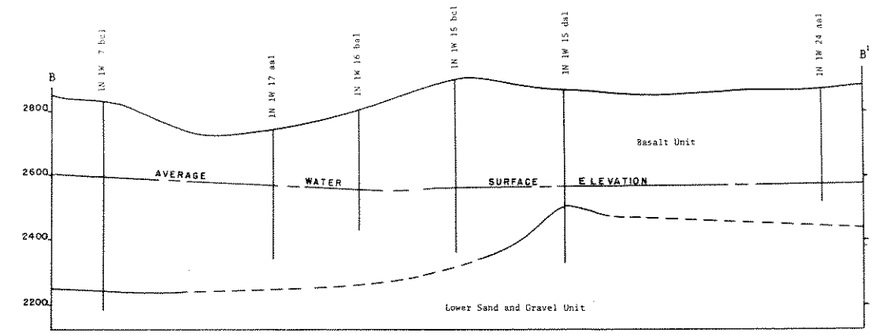
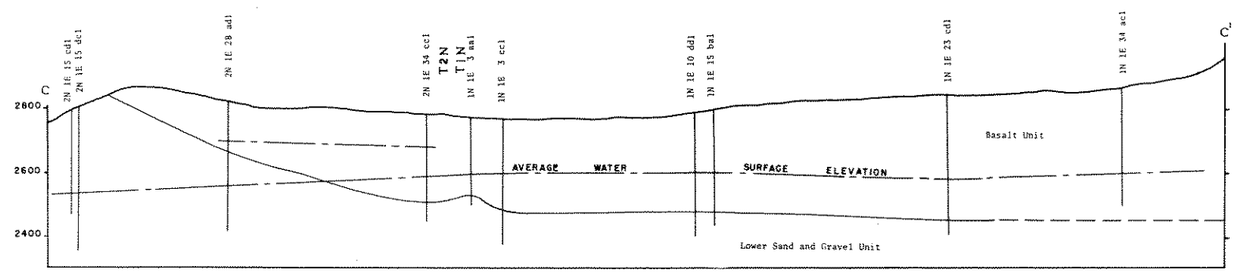
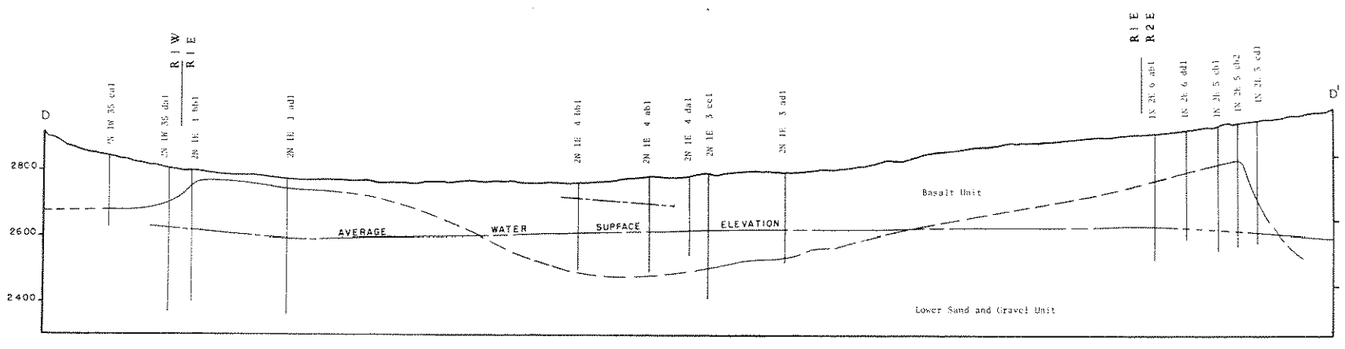


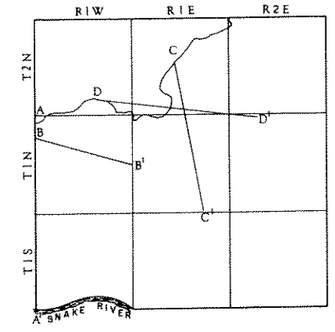
FIGURE 3. Hydrogeologic units in the Ada-Elmore study area.











Location of hydrogeologic cross sections

EXPLANATION

Geologic Contact, dashed where approximate or inferred

Average water surface elevation

SCALE

1" = 1/2 mile - Horizontal

1" = 200 feet - Vertical

FIGURE 4. Hydrogeologic cross sections of southern Ada County.

location (fig. 5). The ancient Boise River had a steeper gradient at this time because the mountains were much higher than at present. Large volumes of sediment, composed of porphyry, granite and quartzite, were carried out of the mountains by the river and deposited in a large fan that eventually spread south to the vicinity of Kuna. These sediments are believed to provide hydraulic connnection for some ground-water recharge from the present Boise River to the aquifers in the study area. Changes in drainage patterns and fluctuations in stream flow account for the extreme lateral and vertical variations in grain size. The maximum thickness of the unit is unknown, but is greater than several hundred feet where old valleys were filled.

The permeability of the lower sand and gravel unit varies greatly. The major controlling factor is the degree of sorting of the sediments. Where the sediments are well-sorted, yields-to-wells have exceeded 3,000 gallons per minute (gpm). However, where sorting is poor and large amounts of silt and clay occupy the pore spaces between the sand and gravel particles, ground-water movement is inhibited and yields-to-wells are low. Because of the lenticular nature of the unit, local artesian conditions are present. Water levels in several wells in the unit rose 10 to 20 feet above the top of the water-bearing strata during drilling. The lower sand and gravel unit has been developed for irrigation purposes.

Basalt Unit

The basalt unit consists of a thick sequence of lava flows present in most of the study area (fig. 3). The basalt was deposited from a chain of volcanoes which paralleled the Snake River during Middle Pleistocene time. These flows filled the then existing valleys and low areas in the study area to approximately 3,000 feet elevation. The individual flows were quite fluid

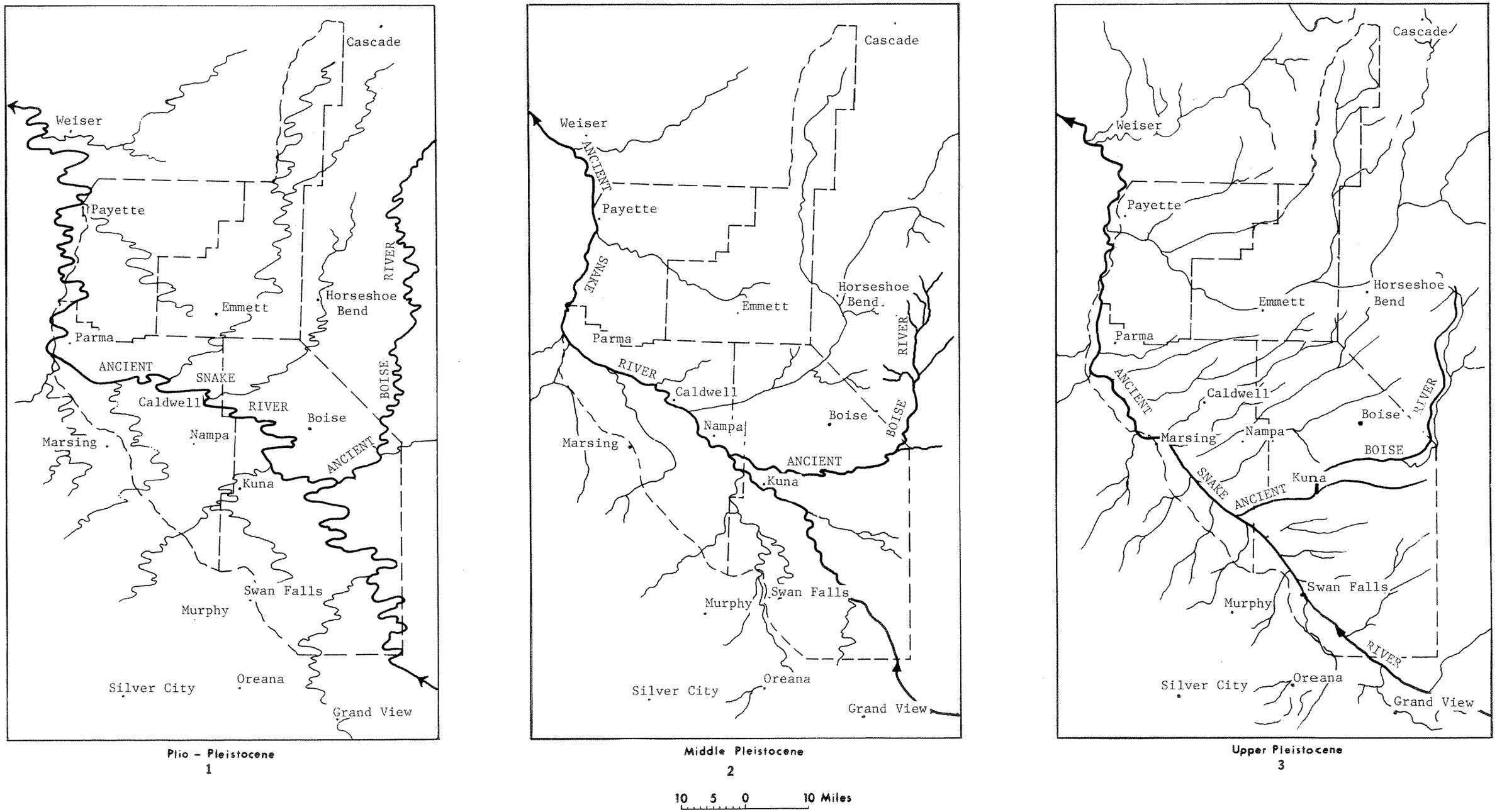


FIGURE 5. Postulated evolution of drainage in Southwestern Idaho. (Modified from Savage, 1958)

and, as a result, the contacts between flows are vesicular or porous and broken. Cinder beds and clay lenses were deposited between many flows. Well developed columnar jointing is present where the basalt is exposed, and well drillers' reports indicate this jointing extends throughout the unit. Thick interbeds of orange-brown tuff and volcanic debris are present near former vent areas. Fracturing of the basalt has occurred where individual flows terminated and along contacts with older flows. Because of the valley-filling nature of the flows, the thickness of the unit varies from 40 feet to approximately 600 feet in the study area.

The permeability of the unit varies, but is generally high. The broken zones, the columnar jointing, and the vesicular zones along the contacts all contribute to the general high permeability of the unit. Wells commonly yield more than 2,000 gpm.

Upper Sand and Gravel Unit

The upper sand and gravel unit is present in the northeastern portion of the study area (fig. 3). This unit was deposited by torrential streams issuing from the mountains to the north during Upper Pleistocene time (fig. 5). The unit ranges from silt to cobble-size granite, porphyry and quartzite, with small amounts of basalt and metamorphic rocks. Because of the high energy level of the streams depositing the gravel and the braided nature of the channels, individual beds are very discontinuous. Extreme variations in grain size and sorting, both laterally and vertically, are common. Thin layers of basalt were extruded from small fissures and are local in areal extent. The thickness of the unit varies widely, but is believed to be over 900 feet in township 2 N., 2 E. The well production from this aquifer varies from 1,000 gpm to 3,000 gpm.

Sand-Silt Unit

The sand-silt unit is composed primarily of granitic sand and silt with minor amounts of gravel. The unit underlies the basalt unit in the eastern portion of the study area. At some locations where the basalt is absent, the unit is covered by a thin layer of Recent alluvium. The maximum thickness of this unit is unknown in the study area, but is believed to be greater than 1,000 feet. Ground water is found primarily in the sand and gravel beds. Artesian conditions are present throughout most of the unit, and many flowing wells are present in the Chattin Flat area, township 5 S., 3 E., and near Melba in township 1 S., 2 W. Most of the ground water in the Chattin Flat area is warm. The source of heat for the warm water is believed to be deep circulation of ground water through buried fault zones beneath the sediments.

Other Geologic Units

Other geologic units which are minor aquifers in the study area are the Payette Formation (Lindgren, 1898, p. 632-634), the Snake River basalt and Recent alluvium. The Payette Formation is penetrated by a single well (2N 4E 19dc1) to a depth of 995 feet. The well driller's report indicates a yield of 11 gpm. The formation at this location consists of clay, shale, sand and thin gravel beds. It is believed that this great thickness of sediment is the result of the filling of an ancient valley.

The Snake River basalt is important as an aquifer for domestic purposes only. The basalt is close to the land surface and generally thin (50-100 feet). Yields-to-wells are low and quality is reported to be poor.

The Recent alluvium is a source of water for a few hand-dug wells in the study area. These wells are shallow, yields are low, and water quality is reported to be poor. These wells are usually situated near old springs

along the mountain front or near streams on the plateau.

The Boise Front and Mt. Bennett Hills are composed of a granitic core overlain by Miocene age basalt, sedimentary deposits of the Payette Formation, Idavada Volcanics (Malde and Powers 1962, p. 1,200) and in places, Pleistocene age canyon-filling basalt. The composition of these hills has an important effect on the quantity of recharge to the aquifers underlying the plateau. The hills are dominantly weathered granite from the Danskin Peak road, west (fig. 6). The permeability of this portion of the hills is believed to be extremely low, limiting the rate of recharge. Near the western edge of the study area, the granite is overlain by highly weathered basalt of Miocene age (U. S. Corps. of Engineers), ancient Boise River channel gravels, and Pleistocene age basalts. An unknown amount of water is believed to be recharged through the channel gravels from the Boise River to the aquifers in the study area. The hills, east of the Danskin Peak road, are composed primarily of the Idavada Volcanics (fig. 6). These rocks are gray, welded ash flows and are highly jointed and fractured. The permeability is considered to be high. This area is believed to serve as a recharge area for the aquifers in the Mountain Home area and the eastern portion of the study area (Ralston and Chapman, 1968).

Geologic Structure

The study area lies on the northern edge of a slightly tilted structural trough formed by the subsidence of the western Snake Plain. The lower sedimentary units in the study area have been tilted 2-3 degrees to the south. Major faulting in the area has occurred primarily along the mountain front. A sharp increase in the depth-to-water along a line parallel to the mountain front supports this conclusion. Also, granitic rocks present in the hills are

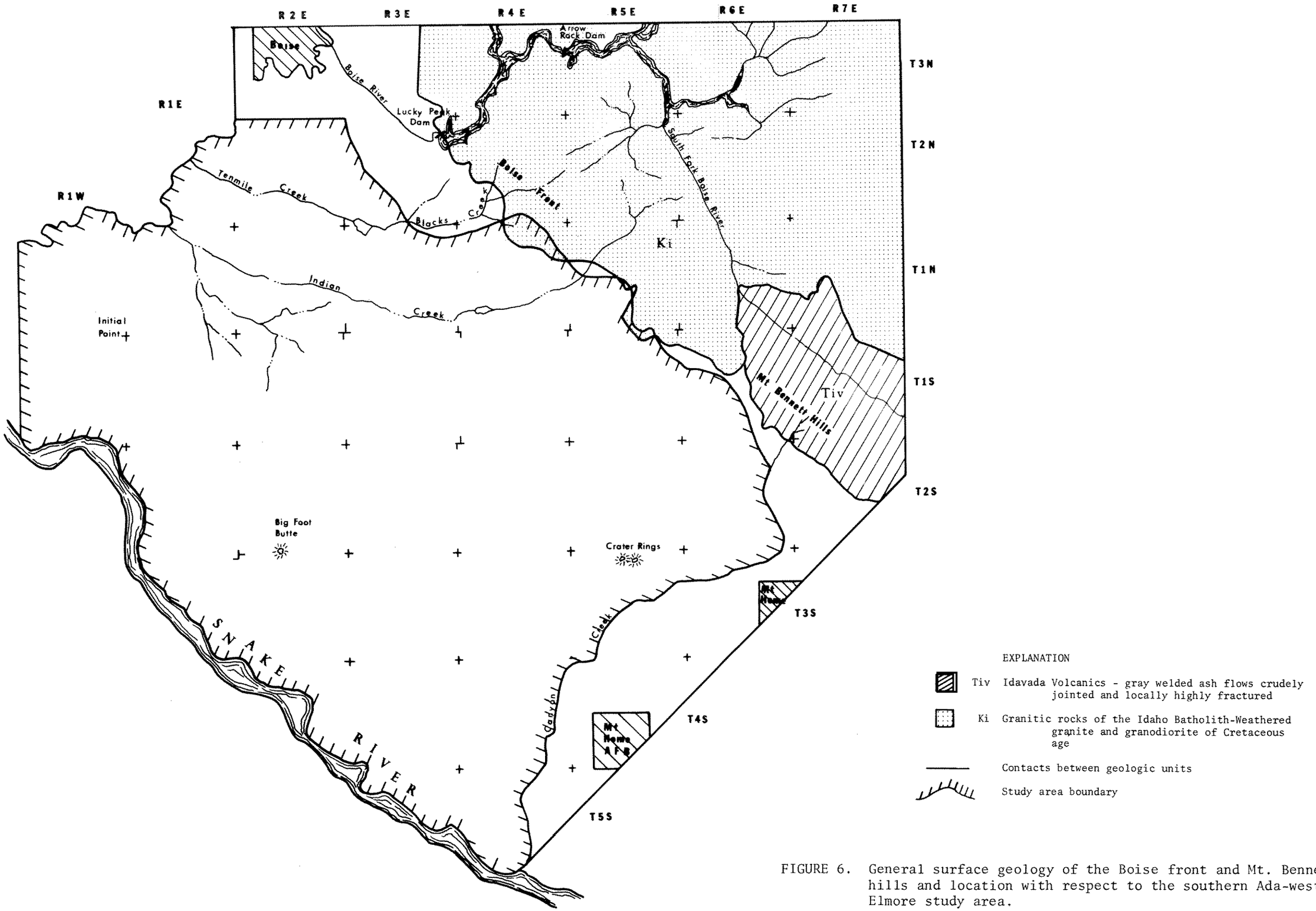


FIGURE 6. General surface geology of the Boise front and Mt. Bennett hills and location with respect to the southern Ada-western Elmore study area.

not encountered in any wells near the mountains except for in well 1S 5E 26aa1. Other faults are believed to occur near the edge of the Snake River canyon in township 4 S., 3 E. An unknown number of faults are believed to be buried beneath the basalt in the western portion of the study area because of anomalous water temperature data. Basalt dikes are present at widely scattered localities within the study area. Those observed have been in the upper sand and gravel unit and are local in extent.

Geologic History

During Late Pliocene time, southwestern Idaho was an area of extensive shallow lakes, ponds and streams. Erosion of the granitic mountains to the north and east produced great volumes of sand, gravel, and silt. These sediments were deposited in a thick sequence along the present Snake River Plain. During Lower Pleistocene time, much of this deposition ceased and erosion carved canyons and gullies into the soft sediments leaving a hilly topography. Coarse-grained sediments were then deposited upon the finer materials from the mountain front to the vicinity of Kuna. Volcanic eruption began from a chain of volcanoes along the Snake Plain during the Middle Pleistocene. This lava filled the old canyons and gullies and covered most of the hills. The lava dammed many of the streams forming small, shallow lakes. Fine grained sediments filled many of these to form interbeds between lava flows. As volcanic activity waned, erosion in the mountains deposited alluvium over the basalt. Deposition of coarse gravel over the basalt increased as alpine glaciers to the north melted and sediment laden streams emitted from the mountain front. These streams followed braided courses through the area depositing several hundred feet of sediments. During the deposition of the gravel, isolated volcanic eruptions took place resulting in scattered outcrops

and interbeds of basalt. One of the most prominent outcrops is near Lucky Peak Dam where a series of canyon filling flows diverted the ancient Boise River, turning it northwestward. Erosion again took place modifying the topography to its present state. Recent deposition has occurred along the mountain front in the form of alluvial fans and along streams as terrace and channel gravels.

WELL DEVELOPMENT

The ground-water resource in southern Ada and western Elmore counties has been developed for both irrigation and domestic water supplies. More than 50 large irrigation wells have been drilled since 1960. These wells supply water for all of the irrigated acreage in the area not included under the Boise Project or supplied by water from the Snake River. All of the domestic supplies in the area are derived from ground water.

The pattern of well development in southern Ada and western Elmore counties is shown in figure 7. More than 90 percent of the wells in the study area are located in the northwestern portion. For purposes of discussion, this more intensively developed area is delineated as the Kuna subarea. The sparsely developed remainder of the study area is designated as the Orchard subarea.

Kuna Subarea

The area included in the Kuna subarea has experienced one of the largest increase in well construction in the state during the past several years. New land has been opened by the desert land entry method as well as by continued development of deeded property. The location, depth and use of wells in the subarea are presented in figure 8. All of the wells in the area are less than 1,000 feet deep. The depth-to-water ranges from less than 50 feet

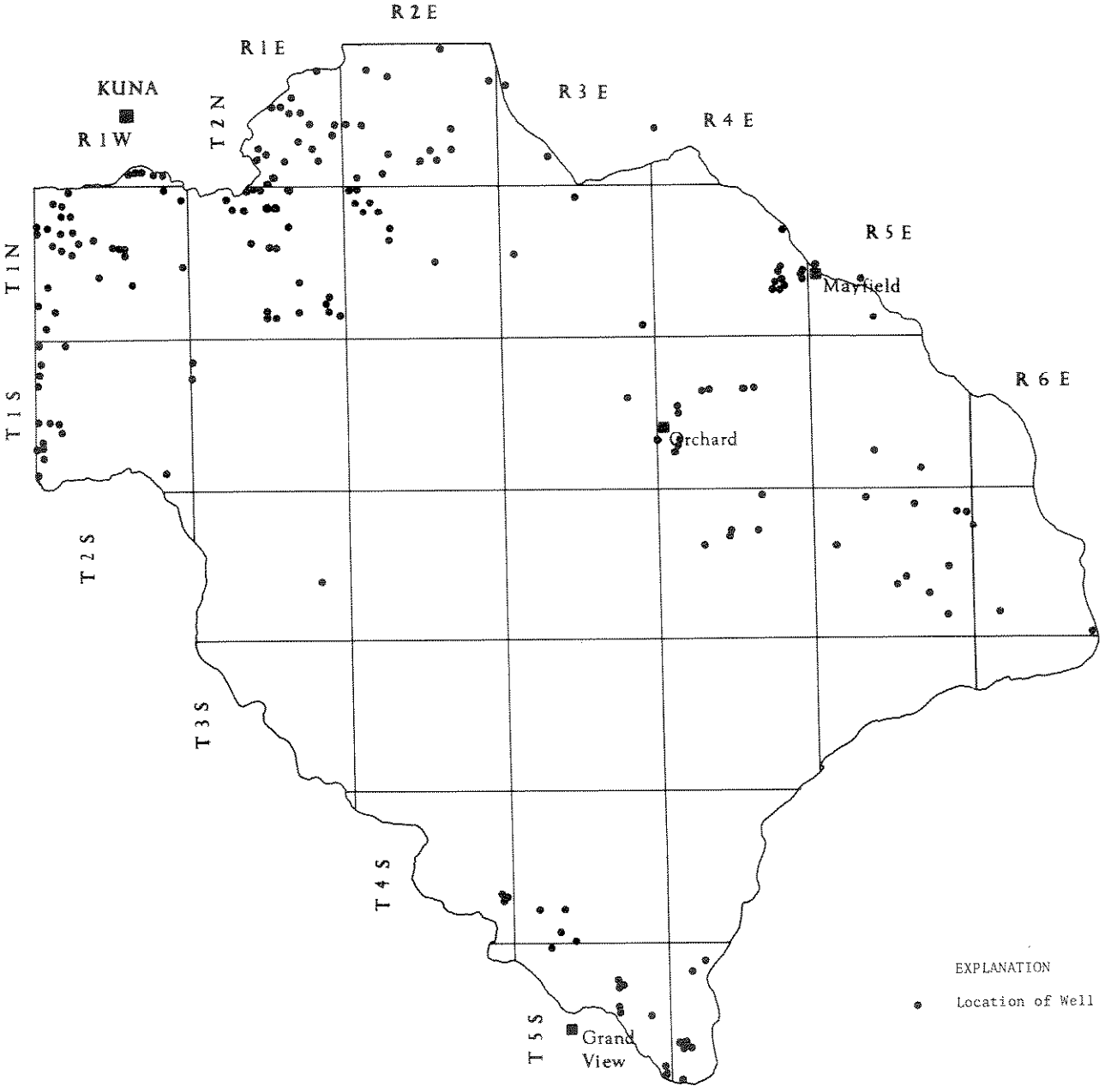


FIGURE 7. Pattern of well development in southern Ada and western Elmore Counties.

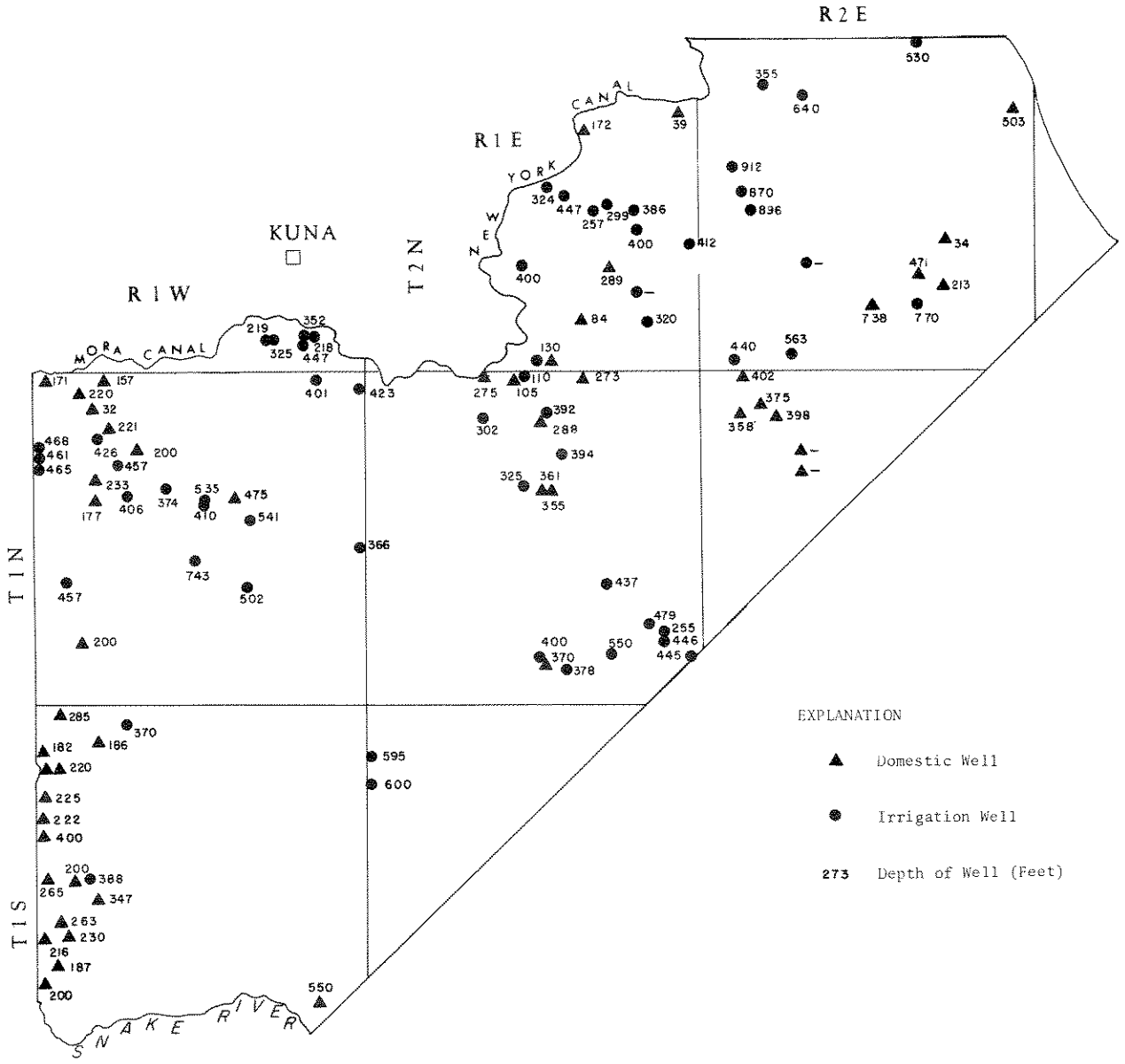


FIGURE 8. Location, depth and use of wells in the Kuna Subarea of southern Ada County.

to nearly 500 feet.

Most of the wells in the Kuna subarea obtain water from any or all of three hydrogeologic units: upper sand and gravel, basalt, or lower sand and gravel (see fig. 3). Yields greater than 1,000 gpm are obtained over a large portion of the subarea. The highest yields are derived from wells which penetrate the basalt. The northwestern portion of the subarea has the most productive aquifer system. A group of wells in township 2 N., 1 E., which obtain water from the upper sand and gravel aquifer, also have high yields. The relative magnitude of the transmissibility of the aquifers may be estimated by the relationship:

$$T = 2{,}000\ Sc$$

T = Transmissibility (capacity of the aquifer to transmit water) in gallons per day per foot, gpd/ft.

Sc = Specific capacity (discharge of well divided by the drawdown) in gallons per minute per foot, gpm/ft.

The transmissibility of the basalts at several locations exceeds 2,000,000 gpd/ft. according to the above relationship (Theis, Brown and Meyer, 1963, p. 332). The maximum transmissibility value indicated for the sand and gravel aquifers is 400,000 gpd/ft.

Orchard Subarea

The Orchard subarea includes approximately 80 percent of the study area but only a small portion of the well development. Irrigation wells have been drilled at several locations in the subarea with only limited success. Domestic supplies, however, have been obtained from ground water at most locations. The location, depth and use of wells in the Orchard subarea are presented in figure 9.

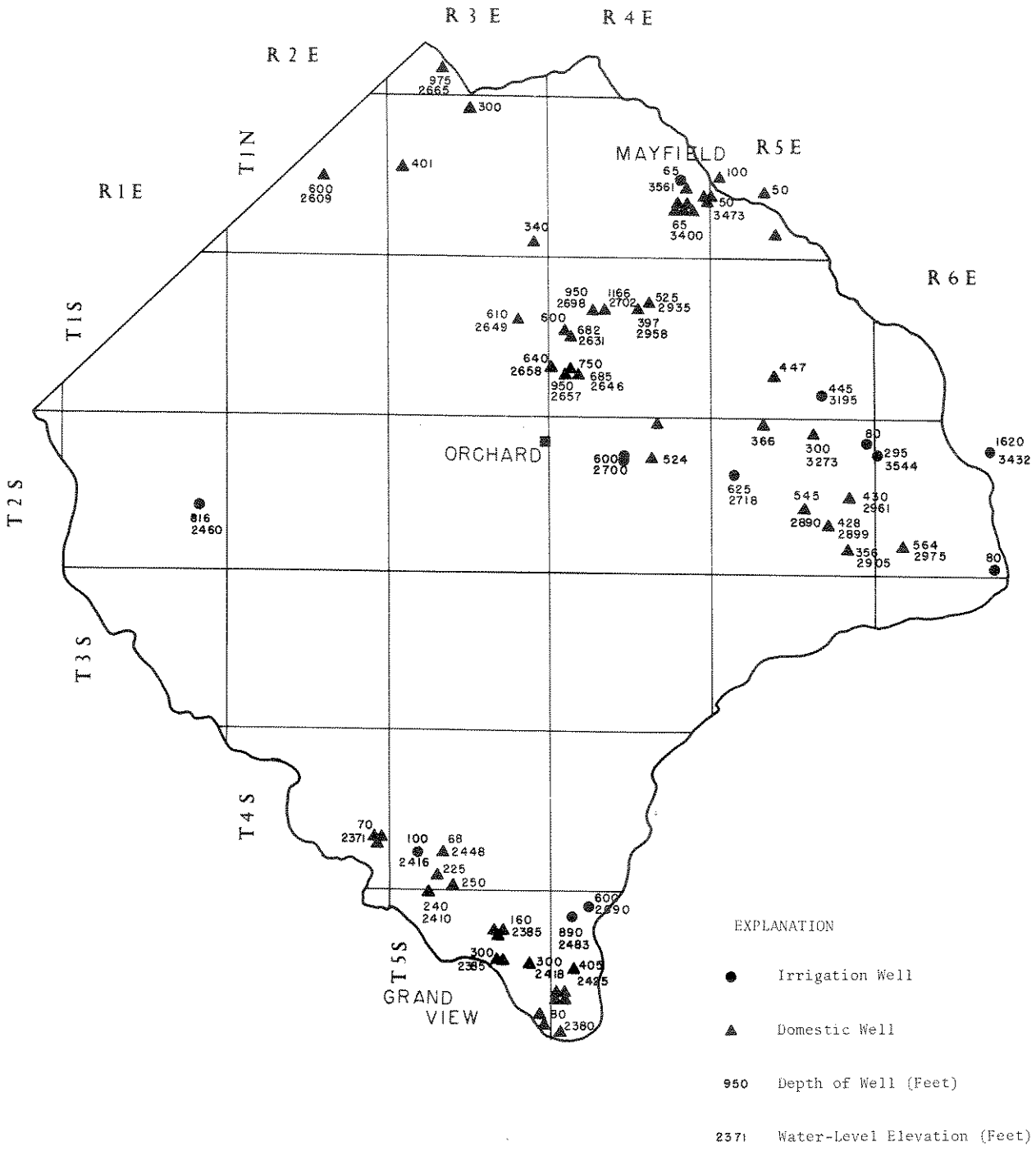


FIGURE 9. Location, depth and use of wells and water-level elevation in the Orchard Subarea of southern Ada and western Elmore Counties.

The wells in this subarea range in depth from 20 to 1,620 feet. The depth-to-water ranges from flowing at land surface to nearly 700 feet. The primary aquifers are the sand-silt and basalt units. The well development may be divided into several categories on the basis of well depth, water-level elevation and location. Many shallow (less than 150 feet) wells have been drilled and dug along the mountain front, particularly near Mayfield. More than 10 shallow wells were drilled in sections 23 and 24 of township 1 N., 4 E. These wells obtain water from a perched sand aquifer 30 to 40 feet below land surface. Reported yields to irrigation wells exceed 200 gpm in the spring but drop rapidly during the summer. Shallow dug wells were also constructed in sections 8, 18 and 28 of township 1 S., 6 E. The depth-to-water in these wells range from 10 to 20 feet. Many of the wells drilled near the mountains have been destroyed or abandoned. Only limited domestic supplies are presently being derived from the resource in this area.

A number of wells have been drilled to depths ranging from 350 to 1,166 feet on the plateau. Although several of the wells were drilled for irrigation supplies, none are presently being operated. The maximum reported yield is 750 gpm with a specific capacity of 6 gpm/ft. The transmissibility of the aquifer is thus low. Much of the central and western portions of the plateau are devoid of well development.

Many small flowing wells are present on Chattin Flat in the extreme southern portion of the subarea. Most of these wells obtain water from the sand-silt unit and were drilled prior to 1940. The reported depth of most of the wells range from 70 to 700 feet. One deeper well on the flat obtains hot ground water under artesian pressure. The ground-water resource is utilized in this area almost exclusively for domestic supplies.

Several deep wells (600 to 890 feet) have been drilled on the plateau above Chattin Flat in townships 5 S., 4 E. and 4 S., 3 E. for irrigation purposes. None of these wells are presently pumped. Four springs, which issue along a postulated fault line on the east margin of lowland, are used for stock watering and domestic purposes. A spring (4S 3E 30dcs1) is also utilized for these purposes. All of the reported yields in the southern portion of the study area are low except for two wells on the rim of the Snake River Canyon in sections 5 and 8 of township 5 S., 4 E. These wells have reported test yields of 2,200 and 1,300 gpm from the basalt and sand-silt units. The driller's report on the latter well indicated a specific capacity of 14 gpm/ft. or an approximate transmissibility of 28,000 gpd/ft.

CHARACTERISTICS OF GROUND-WATER FLOW

Ground-Water Movement in the Kuna Subarea

Ground-water flow in the Kuna subarea is from northeast to southwest (fig. 10). The gradient or slope of the ground-water surface is approximately 10 feet per mile over most of the subarea. As the flow nears the Snake River, the gradient steepens to 40 feet per mile. The water-level contours indicate recharge from the New York Canal and associated irrigation and possibly from the Boise River. Discharge from the aquifer system is believed to be in the southern portion of the subarea near the Snake River. Local occurrences of higher water levels are present in various portions of the subarea. The change in ground-water gradient in the subarea is believed to be the result of changes in the aquifer material. The gradient is flattest in the area where basalt is the primary aquifer because of the general high transmissibility.

The contours of water-level elevation presented for the Kuna subarea in figure 10 compare reasonably well with the water-level contours presented

FIGURE 10. Contours of water-level elevation in the Kuna Subarea of southern Ada County.

by Nace, West and Mower (1957, plate 5) for the Boise valley in 1953. The northern boundary of the present study approximately coincides with the southern boundary of the previous study. Nace, West and Mower (1957) suggested the location of a ground-water divide roughly along the alignment of the New York Canal from the Boise River to Kuna and then generally westward along the south side of Lake Lowell (see fig. 10). The divide indicates that any ground water to the north discharges to the Boise River and that to the south to the Snake River. If the ground-water divide is presently near the position suggested, all recharge to the Kuna subarea must then originate south of this line. The source of recharge to the aquifers in the Kuna subarea will be discussed in detail in a later section.

Elevation of the Water Surface in the Orchard Subarea

The general direction of ground-water flow in the Orchard subarea is from north to south. The values of water-level elevation, presented in figure 9, indicate that recharge is from the mountains. The water-level elevation varies from 3,500 feet near the mountain front to approximately 2,650 feet near Orchard and approximately 2,450 near the Snake River. Sufficient data are not available to construct a contour map or calculate a ground-water gradient. The total quantity of water in movement is unknown.

The ground-water development near the Snake River in the southern portion of the subarea may be divided into several systems. The four springs along the east margin of the lowlands and the irrigation well 4S 5E 5caal are believed to obtain water from the same aquifer system intercepted in wells near the Mountain Home Air Force Base to the east (Ralston and Chapman, 1968). The elevation of the water surface in the well, 2,690 feet, is 200 feet higher than any of the other levels in the area. The wells on the lowland near

the river have a maximum water-level elevation of approximately 2,450 feet. Since a large portion of the lowland is below this elevation, most of the wells flow. These wells obtain water from the sand-silt aquifer. Well 5S 3E 14cb1, of unknown depth, obtains warmer water under a greater head. The aquifer penetrated by this well is believed to be directly connected with the aquifer south of the river in Owyhee County (Ralston and Chapman, 1969).

Depth-to-Water

The estimated depth-to-water in the various portions of the study area is presented in figure 11. The contour interval in the western portion of the study area is smaller than the remainder because of the concentration of data. Only major topographic features were incorporated in the construction of the map.

Yields-to-Wells

Expected yields-to-wells are presented only in the western portion of the study area where sufficient data are available (fig. 12). The basis for delineation of these areas was reports of pump tests on irrigation wells. These data represent a maximum discharge, generally greater than the production rate. Expected yields-to-wells are greater than 1,000 gpm over a large portion of the Kuna subarea. Higher expected yields are noted in more localized areas. Several factors other than aquifer transmissibility may control the yield of a well in any particular location. These factors include the size, construction, and extent of development of the well.

Water-Level Fluctuations

Records of water-level fluctuations have been obtained from 17 wells in the study area by the U. S. Geological Survey as a part of the statewide

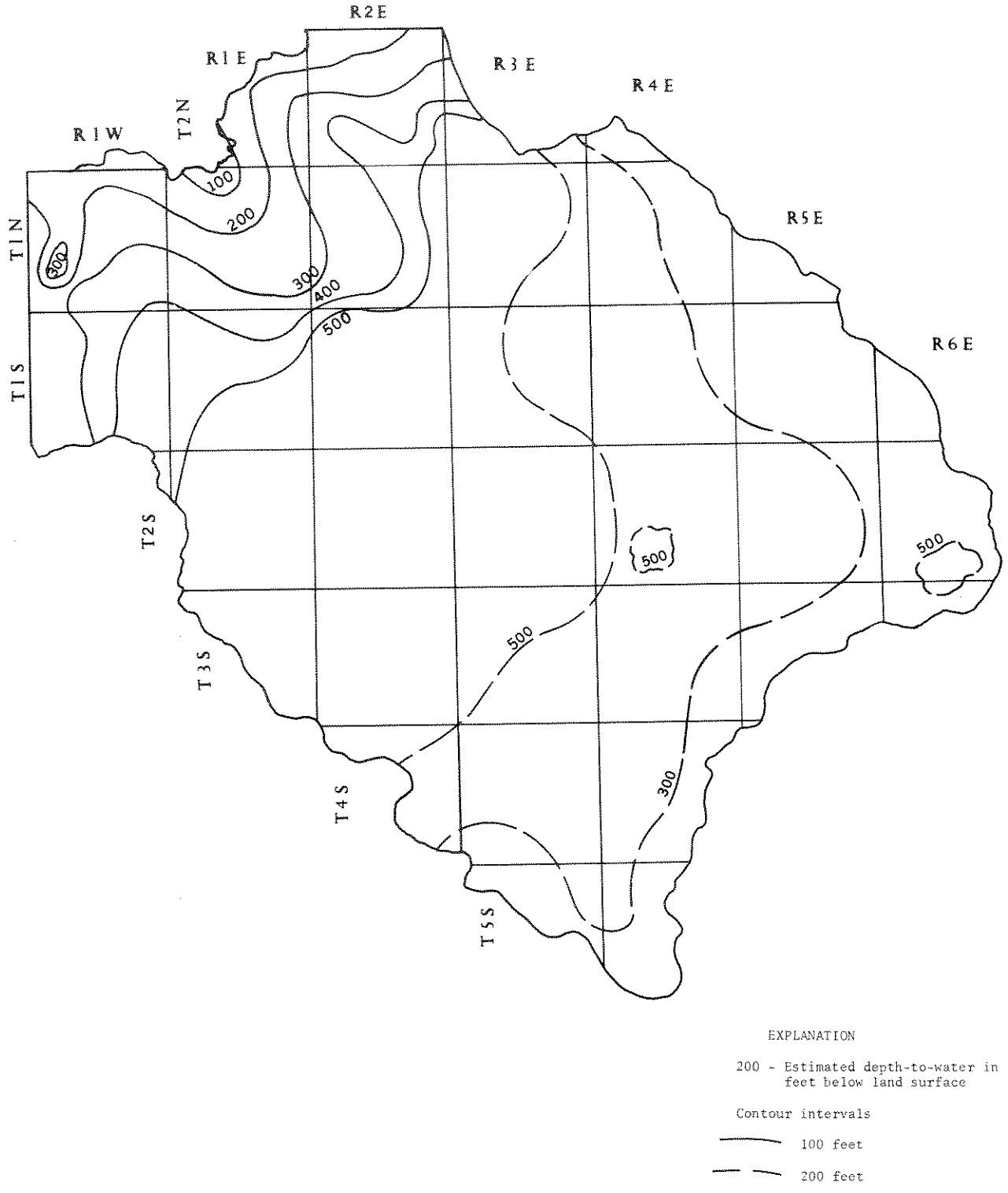


FIGURE 11. Estimated depth-to-water in southern Ada and western Elmore Counties.

FIGURE 12. Expected yields to wells in the Kuna Subarea portion of southern Ada County.

observation well program. More than nine years of record have been obtained on five of them. Wells 2N 1E 32aaa1 and 3N 1E 36ada1, located to the northwest of the study area, have hydrographs typical of areas where ground-water recharge is predominantly from irrigation; the water level reaches a high in late summer and a low in the spring. The yearly fluctuations of water levels in the wells are 7 and 13 feet respectively (fig. 13). Neither has undergone a general rise or decline in levels since 1955. The nine year records of water level for wells 1S 4E 10dad1 and 2S 5E 36bbb1 on the plateau do not indicate a change in either water-level elevation or fluctuation during the year. The other long term water-level record is from a shallow well near Mayfield (1N 4E 23aab1). The water levels in this shallow perched system are affected by the variation in stream runoff. No long-term trends were noted. Shorter records of water-level fluctuations are available on twelve additional wells in the study area. Measurements on all of these wells were initiated in 1967 (Dion and Griffiths, 1967). Although the length of record on the wells precludes most determinations, several patterns are notable. Hydrographs of wells 1S 1E 6ccd1 and 1S 4E 30aac1 indicate slight rises of approximately one-half foot per year. Both of these wells are equipped with continuous water-level recorders. The rises noted may be associated with the recharge of water from the Boise River, either directly or from associated irrigation. The hydrograph of well 5S 4E 5cca1 indicates a decline of nearly one-foot per year since 1967. This well is believed to derive water from the same aquifer system as that utilized near the Mountain Home Air Force Base (Ralston and Chapman, 1968). The declining water level may be the result of pumping in that area. The water level record from well 4S 3E 29ddd1 also indicates a decline. The aquifer in this area is recharged from

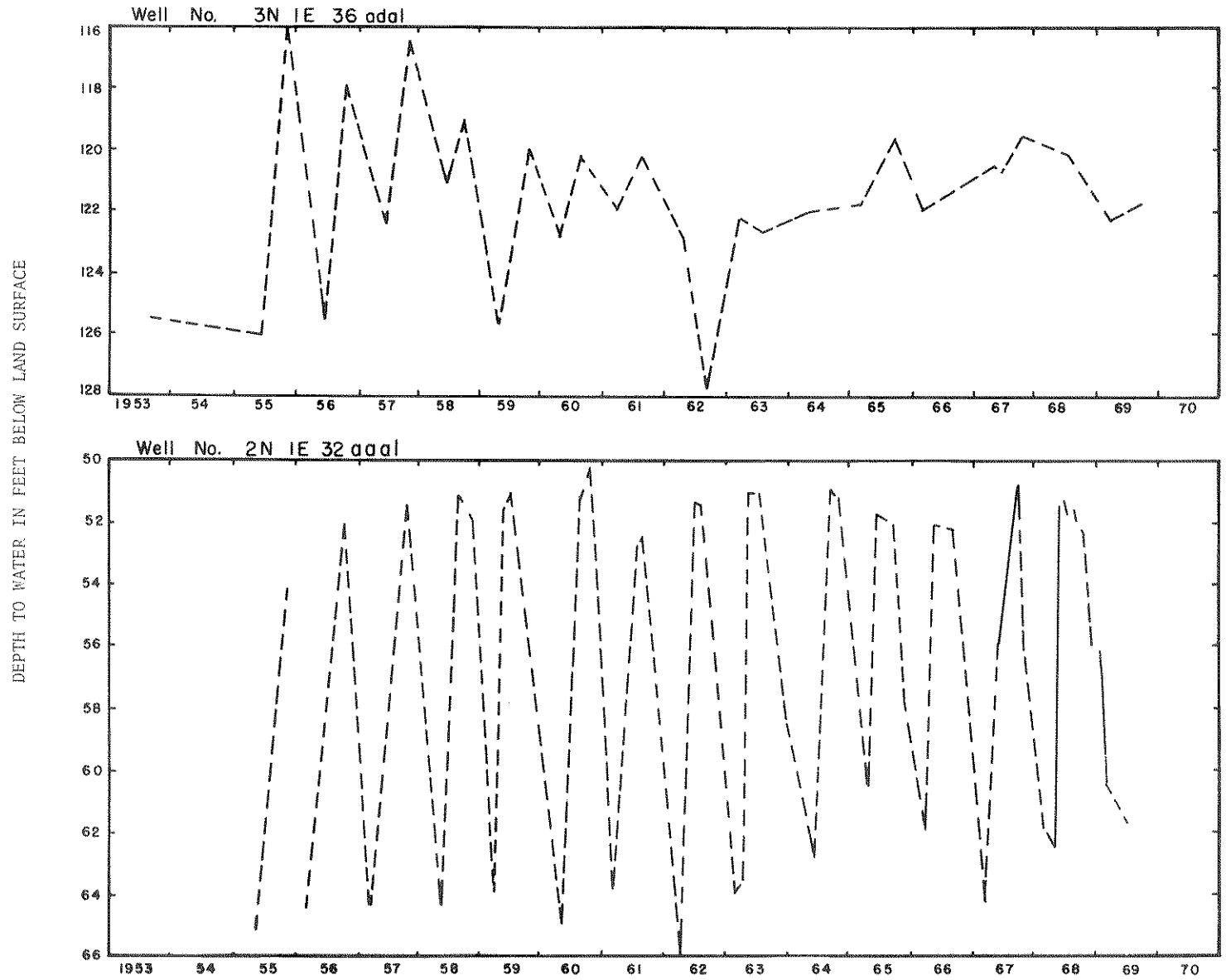


FIGURE 13. Hydrographs of wells 2N 1E 32aaa1 and 3N 1E 36ada1 in Ada County.

surface-water irrigation. Water-level records from the other observation wells in the area so not indicate any noteworthy patterns.

GROUND-WATER QUALITY

The quality of the ground water in the study area is generally suitable for domestic and agricultural purposes. Twenty-five samples of water from wells and springs were chemically analyzed by the U. S. Bureau of Reclamation in connection with this study (table 2). Two additional samples, analyzed previously by the U. S. Geological Survey, were also included. Ninety field observations of electrical conductivity and water temperature were obtained to supplement the chemical samples and extend the knowledge of the quality characteristics of the ground-water resource.

Electrical Conductivity

The field electrical conductivity (E.C.) data (approximately proportional to total dissolved solids), presented in figure 14, range from 140 to 1,400 mmhos (mhos x 10^{-6}). Six wells had E.C. values greater than 1,000 mmhos. Wells which had E.C. values greater than 600 mmhos are grouped in four portions of the study area. Two centers are near the Snake River. Higher concentrations of dissolved solids are expected at these locations because of the general north to south direction of ground-water movement. Higher E.C. values are also noted in two groups of shallow wells in the northwestern portion of the study area, possibly associated with recharge from surface-water irrigation. The E.C. values noted from wells and springs throughout the study area are all higher than the 70 mmho values noted for the Boise River and New York Canal. The E.C. values in the Snake River average 480 mmhos from the C. J. Strike Dam to Marsing.

TABLE 2

ANALYSES OF GROUND-WATER QUALITY FROM SOUTHERN ADA AND WESTERN ELMORE COUNTIES, IDAHO

	Location	pH	$EC \times 10^6$ at 25°C	Temp. °F	Ions in epm: Anions $HCO_3 + CO_3$	Cl	SO_4	NO_3	Cations: Ca	Mg	Na	K	SiO_2 ppm	F ppm	SAR
1.	2N 1E 22dd1	8.05	237	80	93.3	6.4	21.1	1.2	11.2	.5	39.1	1.6	26.2	1.60	3.1
2.	2N 1E 24da1	7.61	294	82	111.2	11.0	28.8	3.1	18.8	3.6	36.6	1.6	30.2	.56	2.0
3.	2N 1E 26bba1	7.90	271	78	109.2	9.9	23.1	3.1	13.6	1.8	42.1	1.6		.99	2.8
4.	2N 3E 7cd2	7.70	254	63	108.0	11.0	20.2		22.0	5.6	23.9				
5.	1N 1W 1ad1	7.22	316	66	119.0	9.6	37.9	1.9	23.6	1.6	40.0	2.3	27.0	.50	2.2
6.	1N 1W 7bcc1	7.82	478	58	153.8	26.2	66.3	9.3	35.9	14.0	40.9	6.3		.22	1.5
7.	1N 1W 8db1	7.75	658	64	170.2	40.4	98.0	18.0	40.7	18.7	60.7	5.5		.35	2.0
8.	1N 1W 15da1	8.01	307	70	126.3	12.8	21.1	4.3	15.2	5.6	39.1	5.1		.34	2.2
9.	1N 1W 19dc1	7.65	583	66	156.2	33.0	95.6	14.3	35.1	11.0	69.0	7.4		.29	2.6
10.	1N 1W 22dd1	7.45	270	74	108.0	9.6	20.2	2.5	21.4	4.6	25.7	1.6	36.8	.23	1.3
11.	1N 1E 4aa2	7.50	714	56	175.7	27.0	172.9	3.7	53.7	21.9	67.6	3.1		.04	2.0
12.	1N 1E 10ad1	7.54	497	66	142.8	25.9	85.5	8.1	49.5	14.6	25.7	5.5	46.0	.16	0.8
13.	1N 1E 15bb1	7.58	1308	66	222.1	119.1	339.1	6.8	123.8	48.8	85.1	9.4		.13	1.6
14.	1N 1E 23cd1	7.80	224	72	115.9	5.7	6.2	1.2	17.4	3.9	24.1	2.7		.39	1.4
15.	1N 1E 34ac1	7.32	591	67	137.3	46.8	89.3	15.5	35.1	21.5	48.7	69.2	46.0	.20	1.6
16.	1N 1E 36aa1	7.80	248	72	117.8	8.2	11.0	1.9	18.8	8.6	19.3	2.0	46.0	.27	0.9
17.	1N 2E 6dd1	7.59	354	62	156.8	13.5	25.9	1.2	18.4	4.9	50.6	3.1		.88	2.7
18.	1N 3E 3ba1	7.46	178	66	92.7	3.5	6.2	3.1	16.0	3.8	15.2	.8	42.5	.31	0.9
19.	1S 2W 3dds1	7.64	723	63	277.6	14.9	102.3	20.5	43.3	22.4	85.1	5.5	39.2	.46	2.6
20.	1S 2W 10bbs1	7.50	781	63	279.4	22.3	124.9	26.7	55.7	24.7	82.8	6.6	44.8	.40	2.3
21.	1S 1W 19cd1	7.89	271	66	131.8	6.4	14.4		9.4	2.2	46.9	3.1		.03	3.6
22.	1S 1W 30cc1	7.62	1330	60	280.0	11.7	437.1	27.9	75.8	55.8	138.9	9.4		.22	3.0
23.	1S 1W 35aa1	8.25	243	66	122.0	6.0	12.0	1.9	8.8	3.3	39.8	3.9		.48	0.3
24.	1S 4E 9cc2	7.60	237	62	126.3	5.0	12.0		23.0	5.0	20.0	2.3	41.0	.40	
25.	1S 4E 17cc1	7.40	220	65	111.7	5.7	8.2	1.9	23.4	5.7	12.4	2.4	55.5	.28	0.6
26.	4S 3E 35cas1	8.15	147	65	79.3	1.8	5.3	1.2	12.0	3.8	12.4	2.4	36.4	.30	0.8
27.	5S 3E 5ab1	7.65	732	66	478.3	8.9	5.3		19.6	9.1	127.8	9.4	62.0	.52	6.0

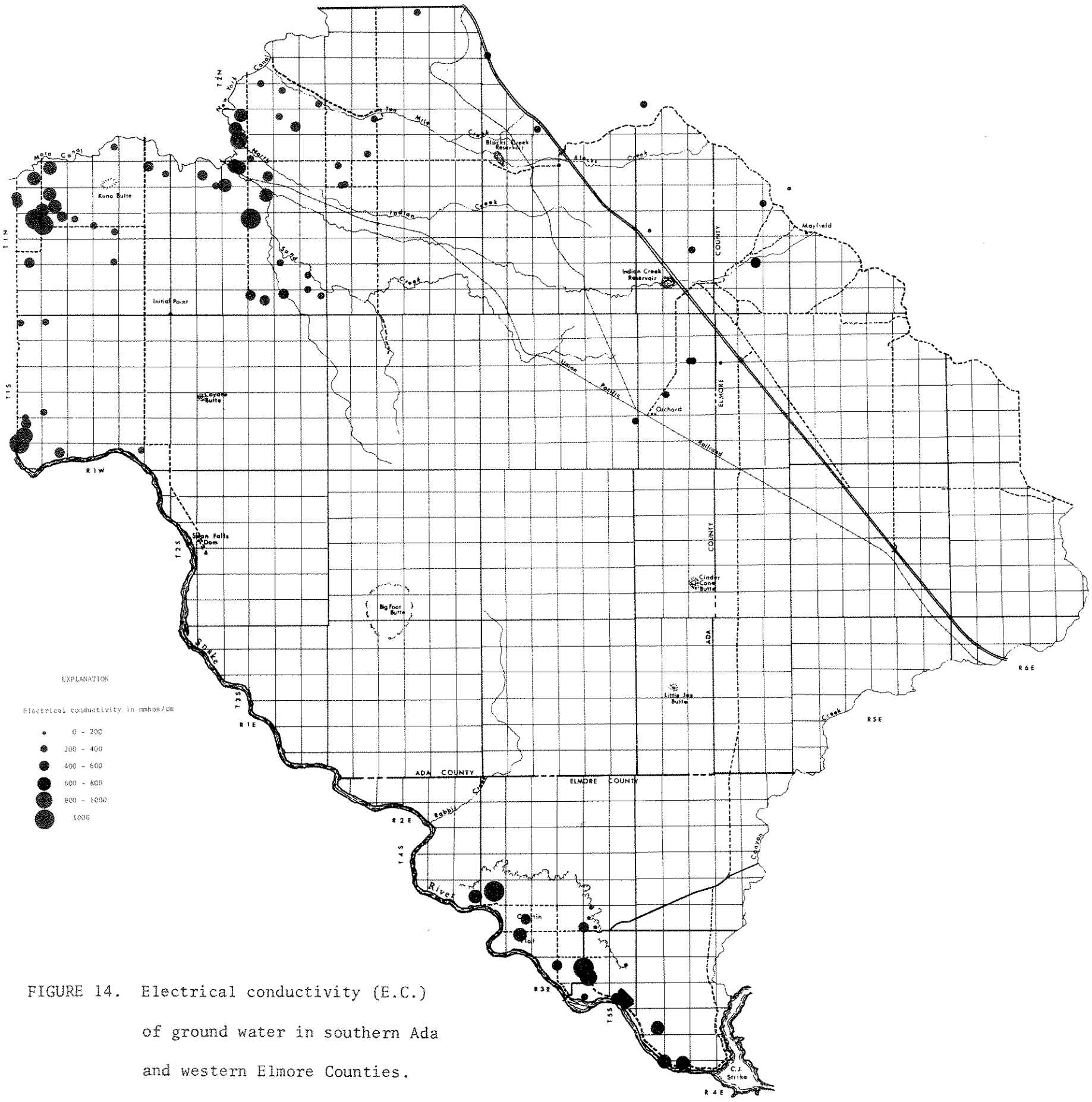


FIGURE 14. Electrical conductivity (E.C.) of ground water in southern Ada and western Elmore Counties.

Temperature

The temperature of the ground water in the study area varies from 48° to 121°F. The areal variation of temperature, presented in figure 15, indicates that most of the wells with temperatures less than 60°F are located near the areas irrigated by surface water, either from the Boise River, Snake River or small streams from the mountain front. The temperature values obtained from the irrigation wells in townships 1 N., 1 E. and 1 N., 1 W. average 70°F. Temperatures exceeding 80°F are found in several 900-foot wells in townships 2 N., 1 E. and 2 N., 2 E. and in the extreme southern portion of the study area in township 5 S., 4 E. The latter wells are believed associated with the aquifer system in northern Owyhee County (Ralston and Chapman, 1969). Since more than 80 percent of the temperature values are considered thermal (greater than the mean annual air temperature), a source of hot water must be present in the area. The most probable source of thermal water is from deep circulation of ground water. Faults believed buried under the study area could provide avenues for upward movement of this hot water.

Chemical Characteristics

Sodium and calcium are the primary cations and bicarbonate and sulfate the primary anions in the ground water in the study area. The chemical data presented in table 2 are depicted graphically as pattern diagrams in figure 16. The patterns, which indicate the concentrations of the six major ions in equivalents per million, allow visual comparison of the ground-water quality. Several dominant chemical characteristics can be noted from the figure. Wells in townships 2 N., 3 E., 1 N., 3 E. and 1 S., 4 E. have a common calcium-bicarbonate type of water. This water is believed to be derived from recharge on the mountains to the northeast of the study area. A

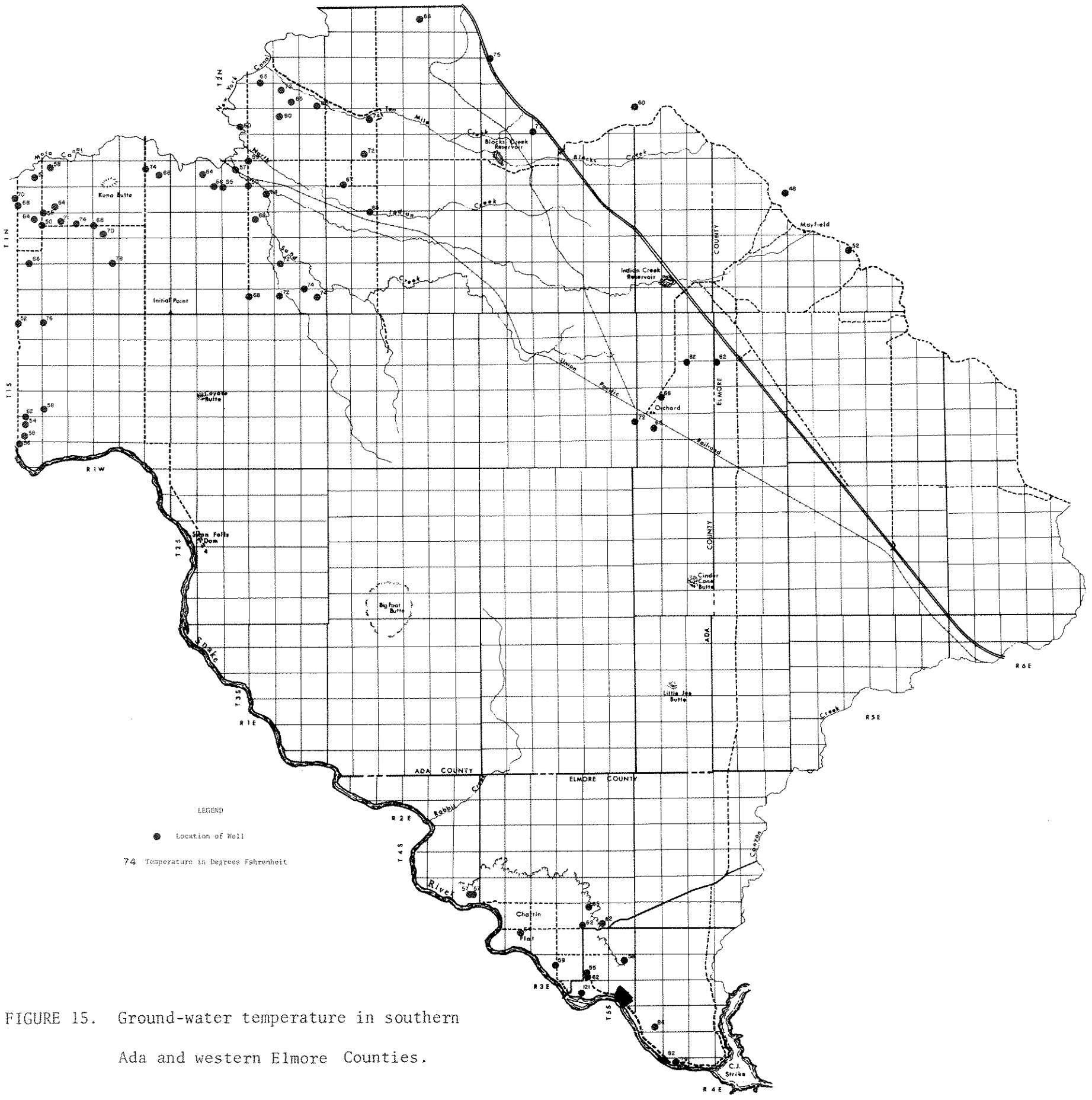


FIGURE 15. Ground-water temperature in southern Ada and western Elmore Counties.

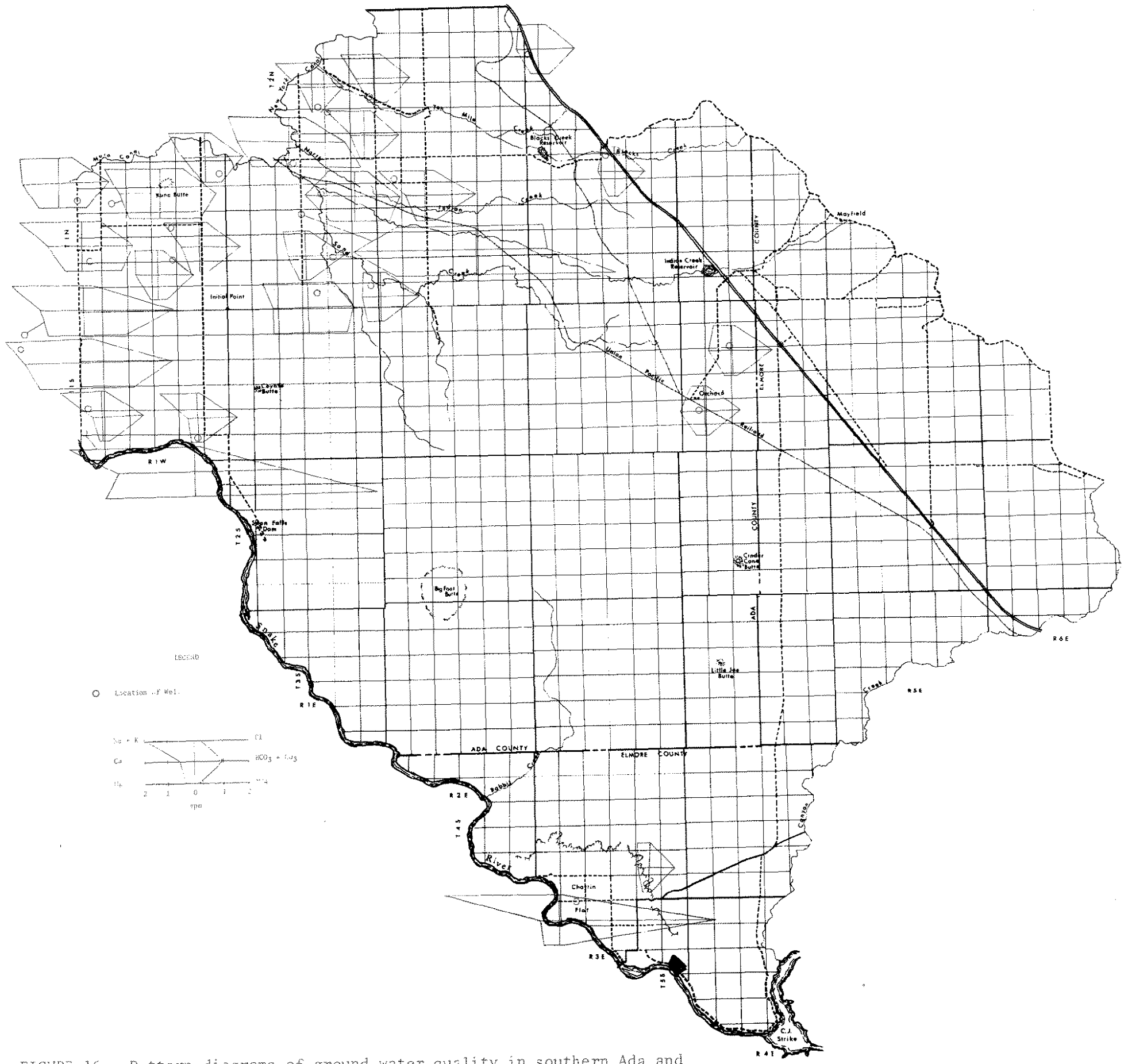


FIGURE 16. Pattern diagrams of ground-water quality in southern Ada and western Elmore Counties.

different but equally distinct pattern is noted from several wells in township 2 N., 1 E. Sodium is the predominant cation in this area. This type of water is believed to originate from recharge from the Boise River and New York Canal. Several of the samples from the northwestern portion of the area which have greater concentration of ions are from shallow wells which are believed to be closely connected with surface irrigation. The sample from well 1N 1E 4aa2, which is 105 feet deep, indicates a high concentration of sodium (Na), calcium (Ca), bicarbonate (HCO_3) and sulfate (SO_4). Pattern diagrams from the western portion of the area indicate higher concentrations of almost all ions. Water quality characteristics from the springs in section 10 of township 1 S., 2 W. are more concentrated forms of the second typical pattern described above. These springs discharge some return water from fields irrigated locally which probably affects the quality. Well 1S 1W 30cc1 has an unusual sodium-sulfate type water. This well is shallow and believed to be closely associated with surface-water irrigation. An unusual calcium-sulfate pattern is noted from well 1N 1E 15bb1. This well obtains water from fine grained sediments below the basalts which may contain evaporite deposits. The two patterns in the extreme southern portion of the study area are believed typical of two different aquifer systems. The chemical characteristics of well 5S 3E 5ab1 are similar to those noted in northern Owyhee County (Ralston and Chapman, 1969, p. 69). The sample from the spring 4S 3E 35cas1 is similar to the chemical characteristics found in wells near the Mountain Home Air Force Base (Ralston and Chapman, 1968, p. 50).

The suitability of water for irrigation is depicted in figure 17 by a plot of electrical conductivity (E.C.) versus the factor sodium-adsorption

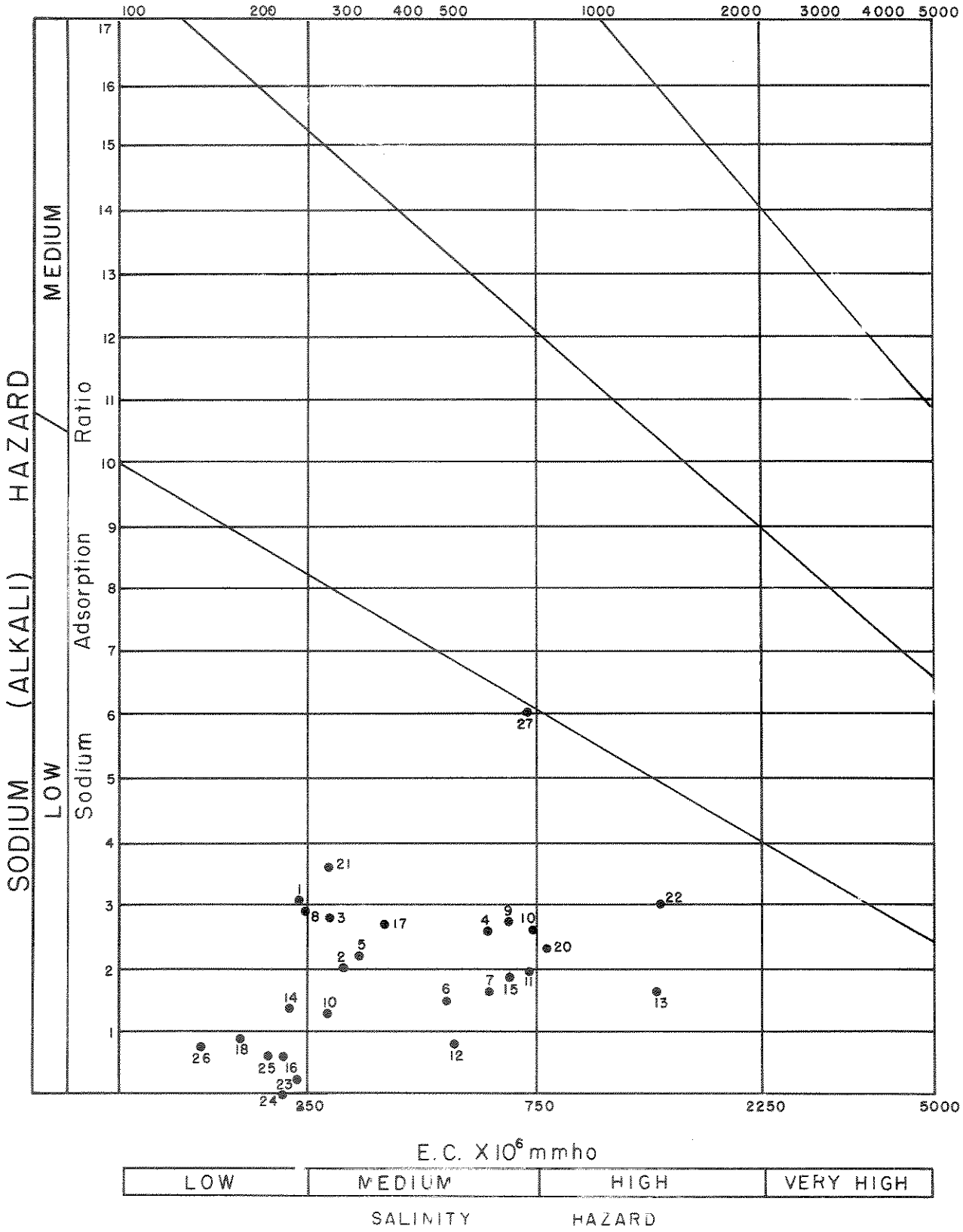


FIGURE 17. Classification of ground water for irrigation.

ratio (SAR) developed by the U. S. Salinity Laboratory (1954). The latter term defined below, relates the percentage of sodium to the other major cations, calcium and magnesium (Hem, 1959, p. 148).

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++}+Mg^{++}}{2}}}$$

All of the samples from the study area have a low sodium or alkali hazard. The salinity hazard as related by E.C., however, was low for 7 samples, medium for 15 samples and high for 3 samples. Most of the wells are suitable for irrigation for all but crops such as green beans, some fruits, clovers and others that have a low tolerance to saline water and soils (Hem, 1959, p. 249).

Only three wells sampled in the study area do not meet U. S. Public Health Service Drinking Water Standards (1962). Wells 1S 1W 30ccl and 1N 1E 15bbl exceed the recommended limits for total dissolved solids; well 1S 1W 30ccl also exceeds the limits on sulfate concentrations. One well, 2N 1E 2ddl slightly exceeds the recommended limit of 1.5 parts per million (ppm) fluorides. None of the samples are overly excessive.

RECHARGE-DISCHARGE CHARACTERISTICS

The characteristics of recharge to the aquifers and discharge from the aquifers are very important to the discussion of the ground-water resource of southern Ada and western Elmore counties. The recharge to the Kuna subarea is believed derived from two major sources: 1) the Boise River and 2) the New York Canal and associated irrigation. It is not believed that a significant quantity of recharge is derived from precipitation either on the mountainous regions or the plateau.

The quantity of ground-water recharge from the Boise River above Lucky Peak Dam is believed to be small. A major portion of the reservoir is underlain by relatively impermeable granite and weathered basalt. The reach of the Boise River from Lucky Peak Dam to the Capitol Boulevard streamgage is believed to be a source of recharge to the ground-water system. An estimate of the stream loss in this reach may be obtained by subtracting the gaged diversions from the river, from the difference between the streamflow at the gage below Lucky Peak and the gage in Boise. Because the above described calculation is the remainder of subtraction of several large numbers, it may be utilized only as a general estimation. The average stream loss in this reach of the river for the irrigation seasons (April-September) of 1960 through 1967 was approximately 43,000 acre-feet (fig. 18). Recharge to the ground-water system from stream loss in the Boise River is believed limited primarily to the irrigation season because of the extreme regulation of the river by the upstream dams during the remainder of the year. Part of the loss in this reach is the result of consumptive use of plants in the lowlands area and evaporation from the river. The annual consumptive use for this area was estimated as 26 inches by the Lowry-Johnson Method (Israelson and Hanson, 1962, p. 253). The Agricultural Engineering Department of the University of Idaho calculated the consumptive use of alfalfa, the crop most similar to the vegetation in the swampy areas near the Boise River, for the period of climatological record at Caldwell. A mean consumptive irrigation requirement of 26 inches was determined (Sutter and Corey, 1970). Using this value of consumptive use and an estimated area for discharge of 1,000 acres, an evapotranspiration loss of greater than 2,000 acre-feet was determined. Since most of the evapotranspiration occurs during the summer months, the average quantity of water available for recharge in the

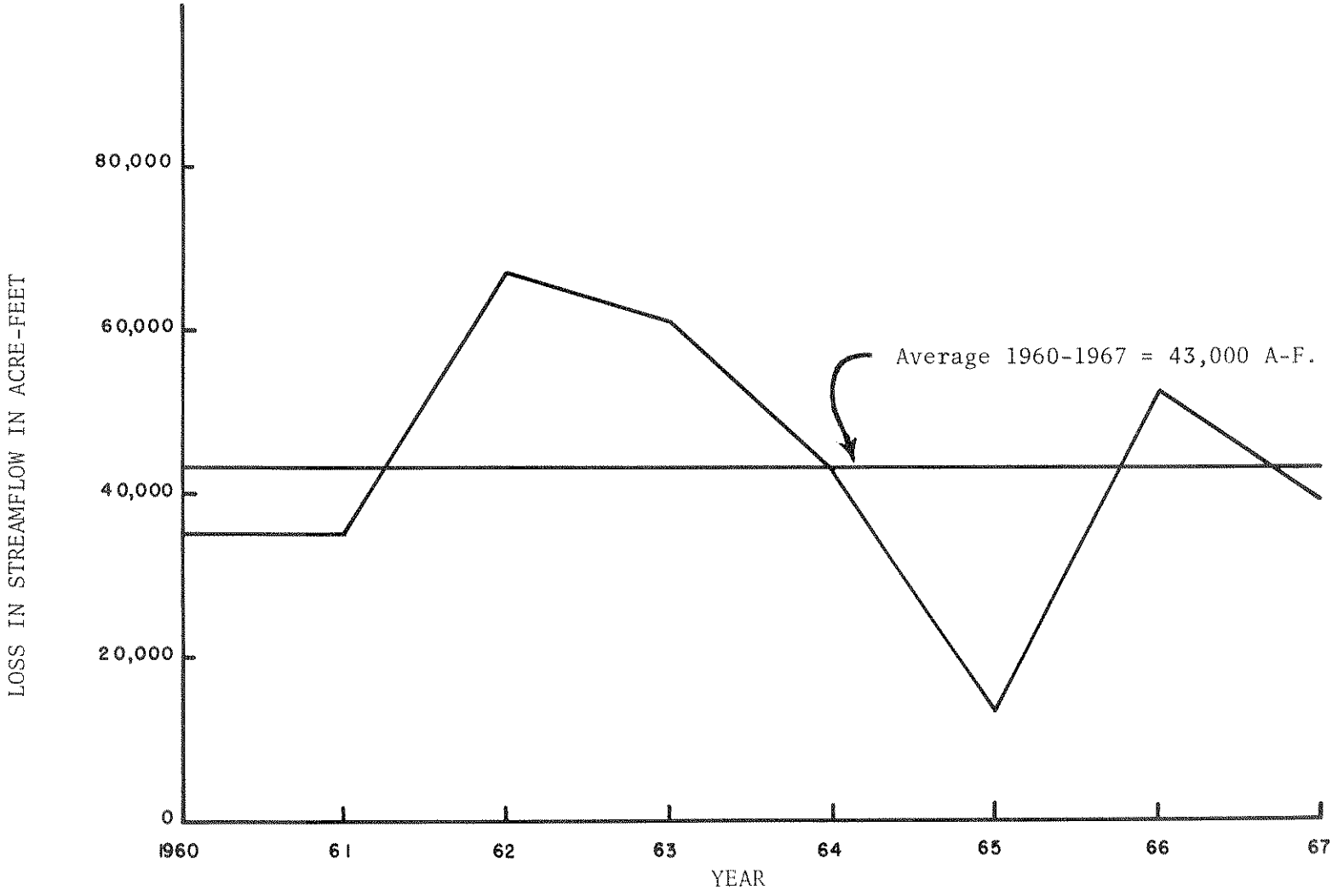


FIGURE 18. Average loss in streamflow in acre-feet in the Lucky Peak-Boise reach of the Boise river during the irrigation season (April-September).

1960-67 period was reduced to approximately 41,000 acre-feet. The recharge to the ground-water system from the Boise River in the reach described may either flow northwesterly and remain in the Boise ground-water basin or flow southwesterly toward the Snake River. The quantity of water recharging the resource in the study area depends on the location of the ground-water divide previously mentioned. Because of a lack of data, the interception of the divide with the river cannot be exactly located. The ground-water divide noted by Nace, West and Mower (1957), if extrapolated, intersects the river at approximately the diversion dam. Approximately 25 percent of length of the river between the gaging stations is upstream from the diversion dam. If it is assumed that the full length of the river loses water at an equal rate, then about 25 percent of the total loss between the stations may be noted as ground-water recharge to the study area. This quantity was about 10,000 acre-feet in the irrigation season of 1966. A sufficient head or water-level elevation is available in this reach of the river to provide the slope for the ground-water movement.

The second major source of recharge to the Kuna subarea is from the New York Canal and associated irrigation. The ground-water divide noted by Nace, West and Mower (1957) closely follows the alignment of the New York Canal. The ground-water mound represented by the divide indicates recharge to the ground-water system from the canal and associated irrigation. The recharge can be accomplished from three parts of the surface-water distribution system: leakage or losses from the main canal, leakage or losses in the laterals, and residual or extra water applied to the land beyond the consumptive use of crops. The main canal loss from the diversion dam to Lake Lowell in 1968 as noted in the Boise Project Annual Report (1968, p. 28) was slightly more than 26,000 acre-feet. The lateral losses in the same area totalled more than

274,000 acre-feet. The small loss in the main canal compared to the laterals is partially the result of concrete linings over a majority of the length of the main canal. The delivery of water in the Boise Project to the irrigator's headgate ranged from 2.17 to 4.75 acre-feet per acre for the period 1937-1968, and averaged 3.89 acre-feet per acre (Boise Project, 1968, p. 28). The consumptive use for the combination of crops most applicable to the area is approximately 2.1 acre-feet per acre (Sutter and Corey, 1970). Therefore, approximately 1.8 acre-feet per acre is available for either surface runoff or recharge to the ground-water system. The quantity of recharge from the main canal, laterals, and applied irrigation depends on the number of acres irrigated, amount of surface runoff, and the length of laterals on the south side of the ground-water divide. Data are not available to determine the percentages of ground-water recharge and surface runoff. For this study, it is assumed that one-third of the water applied in excess of consumptive use discharges as surface flow and two-thirds or 1.2 acre-feet per acre is recharged to the ground-water system. Approximately 12,000 acres of land are irrigated under the New York Canal system south of the ground-water divide. Thus, approximately 14,400 acre-feet (1.2 A-F/A times 12,000 A) of potential recharge is supplied from that part of the water applied to irrigation beyond consumptive use. Since the irrigated acreage south of the ground-water divide is about 7 percent of the total acreage under the New York Canal, it is estimated that losses from the laterals in that area would probably also be 7 percent of the total or about 22,000 acre-feet. The 14 percent of the total length of the main canal that is south of the ground-water divide would result in approximately 3,700 acre-feet of recharge. If it is assumed that very little of the precipitation on the plain results in recharge, the total

of the above factors, approximately 50,000 acre-feet, is the estimated annual supply of water to the underground resource.

Discharge from the ground-water resource in the Kuna subarea is more difficult to determine. This discharge is in the form of spring flow, evapotranspiration, well discharge, and inflow to the Snake River. The spring discharge in and near the subarea is limited primarily to the Melba area along the Snake River. Springs are located in section 32 of township 1 S., 1 W. and section 21 of township 1 S., 2 W. Both of these spring areas are partially supplied by seepage from irrigation and return flow. The evapotranspiration and well discharge in the Melba area are both related to the high water table. Well 1S 2W 10cc1 obtains water from cinders and gravel overlying clay. The water level stands at approximately 2,360 feet elevation, four feet below land surface. Shallow flowing wells are utilized to drain areas of high water in sections 3, 9, and 10 of township 1 S., 2 W. The confining bed for these artesian wells is a thin clay bed near land surface. The thick clay layer underlying this area is believed to hold the water close to the surface. Because of this thick clay layer, major inflow to the river other than the springs previously noted is believed doubtful. The only estimate of discharge made for this study was a measurement of the low winter flow of the springs in the Melba area. The flow of 50 cubic feet per second (cfs) measured is approximately equal to 36,500 acre-feet per year.

The primary source of recharge to the aquifers in the Orchard subarea is precipitation on the mountainous regions north of the study area. The annual precipitation rate in most of the mountain region is near 15 inches. Much of the mountain mass, however, is weathered granite which essentially does not allow percolation, recharge, or ground-water movement. The extent

of the granite portion of the region is shown on figure 6. Because of the large extent of impermeable material, only limited recharge to the aquifers underlying the Orchard subarea occurs. Recharge from the small runoff from the mountainous area is limited by the fine grained sediments which overlie the granite near the mountain front. Most of the runoff is lost by evapotranspiration. Well 1S 5E 28aa1 encountered granite at 427 feet below land surface. No significant supply of water was found in this well. No attempts were made to quantitatively determine the rate of recharge to this part of the study area.

The portion of the mountain area to the east of the granite (fig. 6) is composed of Idavada Volcanics. This material is highly fractured and can thus be more permeable than the granite. The recharge in this portion of the mountains is believed to be much higher than the area to the west. Sufficient data are not available to determine the quantity of recharge derived from this portion of the study area.

Ground water may be discharged from the aquifer in the Orchard subarea from four possible sources: spring flow, evapotranspiration, well discharge, and inflow to the Snake River. Springs in sections 30 and 35 of township 4 S., 3 E. and section 12 of township 5 S., 3 E. are utilized for domestic, stock watering and irrigation purposes. Discharge by evapotranspiration is limited to the lowlands area near the Snake River and is not believed to be large. The general ground-water system is encountered in wells several hundred feet below land surface. No estimate of discharge from wells had been made in this study. Although many small wells have been drilled in this area, the individual rate of discharge is low. Discharge from the aquifer systems directly to the Snake River is also believed to be small. The river is

thought to be effectively perched above the ground-water system. No indications of ground-water discharge have been found further to the west along the river in the subarea. The lack of evidence of recharge and discharge in the Orchard subarea indicates a very limited resource.

WATER RIGHTS

The Department of Reclamation has on file 125 valid permits or licenses for the withdrawal of ground water within the study area. The permits and licenses indicate a potential discharge of 629 cfs for domestic uses and irrigation of more than 33,000 acres. The distribution of ground-water filings by section are shown in figure 19.

The largest grouping of ground-water filings is in the area previously noted as the Kuna subarea. Filings are conspicuously lacking in the center portion of the study area. Other concentrations of filings are in the northeastern and southern portions of the area.

The historical interest in developing ground water in the study area is shown in figure 20 by the cumulative number of ground-water applications approved by year. The largest growth in potential ground-water development occurred in 1963. Twenty-two and twenty-three applications were approved in 1967 and 1968, respectively. It is significant to note that only 45 percent of the applications approved for this area are still presently in force.

SUMMARY

Four aquifers, delineated as the lower sand and gravel, basalt, upper sand and gravel and sand-silt are the primary sources of ground water in the study area. Yields greater than 1,000 gpm have been derived from the upper sand and gravel, basalt and lower sand and gravel units in the Kuna subarea.

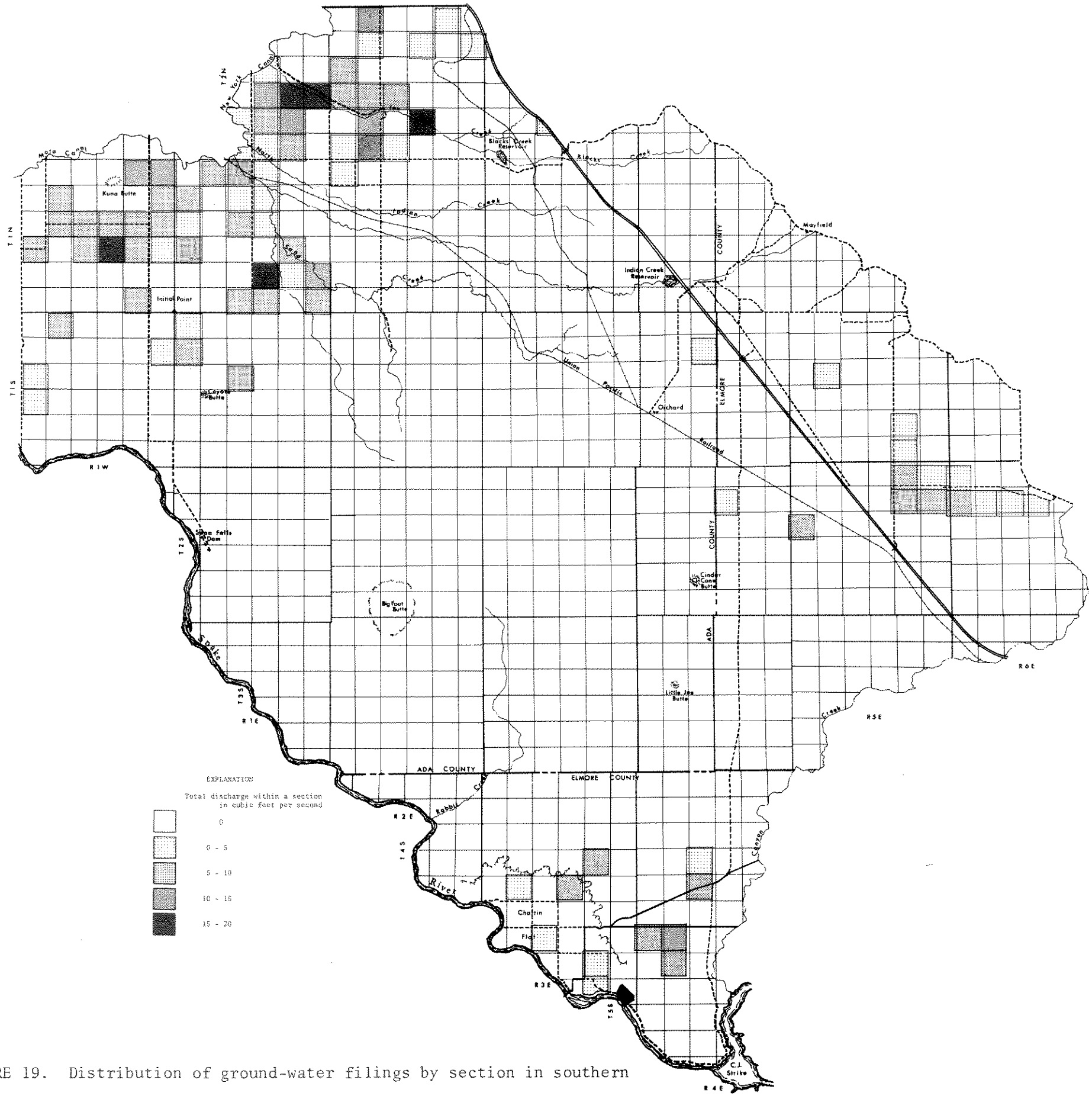


FIGURE 19. Distribution of ground-water filings by section in southern Ada and western Elmore Counties.

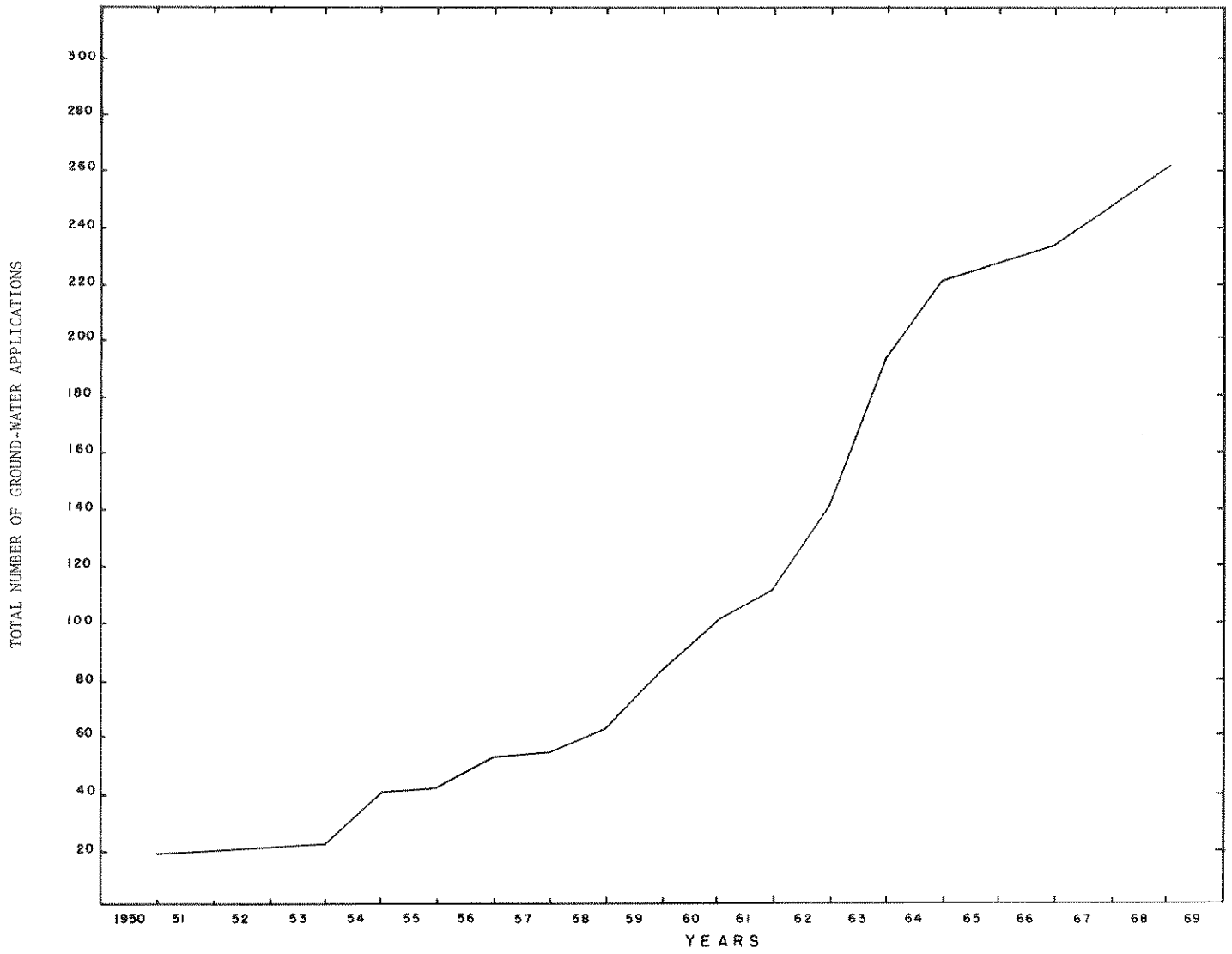


FIGURE 20. Cumulative number of applications approved to appropriate ground water in southern Ada and western Elmore Counties by year.

The basalt is the most productive. The basalt and sand-silt aquifers yield small quantities of water to wells in the Orchard subarea.

More than 90 percent of the wells in the study area are located in the Kuna subarea. The wells are less than 1,000 feet in depth; the depth-to-water ranges from less than 50 feet to nearly 500 feet. The depth of the wells in the Orchard subarea range from 20 to 1,620 feet with depth-to-water values as great as 700 feet.

The direction of ground-water movement in the Kuna subarea is from northeast to southwest. The gradient varies from 10 to 40 feet per mile. Ground-water flow in the Orchard subarea is from north to south.

No water-level declines have been noted in the majority of the study area. Well 5S 4E 5caal has undergone a one-foot per year decline since record was initiated in 1967, probably as a result of the well development near the Mountain Home Air Force Base.

The ground water in the study area is generally low in sodium and moderately high in salinity. It is suitable for all crops except those particularly sensitive to salinity. Three wells do not meet U. S. Public Health Service Drinking Water Standards because of excessive concentrations of dissolved solids, sulfates or fluorides.

A total of approximately 50,000 acre-feet of water is believed recharged annually to the aquifers in the Kuna subarea: 10,000 acre-feet from the Boise River, 14,400 acre-feet from irrigation in excess of consumptive use, and 25,700 from leakage from the New York Canal and laterals. The only estimate of discharge from the ground-water system, from the springs near Melba, equals approximately 36,500 acre-feet per year.

CONCLUSIONS AND RECOMMENDATIONS

The present well development is not exceeding the capacity of the ground-water resource in most of the study area. The effect of the well discharge in southern Ada County should be monitored closely in the future. Analysis of water-level fluctuations should continue as more data become available. It is recommended that no restrictions on permits for water-rights be initiated at this time in southern Ada County.

Additional investigations of the ground-water resource in the southeastern portion of the study area should be initiated as new data become available. The aquifer underlying townships 4 S., 3 E., 4 S., 4 E. and 5 S., 4 E. is believed to be the same aquifer as is being developed near the Mountain Home Air Force Base. Since declining water levels are being noted in the area, more detailed hydrologic and geologic information are needed for future administrative decisions. It is not recommended that this area be closed to additional water-right applications at this time.

REFERENCES

Boise Project Board of Control, 1968, Annual Operation and Maintenance Report.

Dion, N. P. and Griffiths, M. L., 1967, A Ground-Water Monitoring Network for Southwestern Idaho: Idaho Department of Reclamation Water Information Bulletin No. 2, 16 p.

Hem, J. D., 1959, Study and Interpretation of the Chemical Characteristics of Natural Water: U. S. Geological Survey Water-Supply Paper 1473, 249 p.

Israelsen, O. W. and Hansen, V. E., 1962, Irrigation Principles and Practices, New York, Wiley and Sons, 447 p.

Lindgren, Waldemar, 1898, U. S. Geological Survey 18th Annual Report: pp. 632-634.

Malde, H. E. and Powers, H. A., 1962, Upper Cenozoic Stratigraphy of Western Snake River Plain, Idaho: Geological Society of America Bulletin, v. 73, p. 1197-1220.

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.

Ralston, D. R. and Chapman, S. L., 1968, Ground-Water Resource of the Mountain Home Area, Elmore County, Idaho: Idaho Dept. of Reclamation Water Information Bulletin No. 4, 63 p.

_____, 1969, Ground-Water Resource of Northern Owyhee County, Idaho: Idaho Dept. of Reclamation Water Information Bulletin No. 14, 85 p.

Sutter, R. J. and Corey, G. L., 1970 (in press), Consumptive Irrigation Requirements for Crops in Idaho: Idaho Agricultural Experiment Station Bulletin.

U. S. Corps. of Engineers; Foundation Report - Lucky Peak Dam, Chapter II.