Ground-Water Resources of the Sevier River Basin Between Yuba Dam and Leamington Canyon, Utah

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GROUND-WATER RESOURCES OF THE SEVIER RIVER BASIN BETWEEN YUBA DAM AND LEAMINGTON CANYON UTAH

By L. J. Bjorklund and G. B. Robinson, Jr.

ABSTRACT

The area investigated is a segment of the Sevier River basin, Utah, comprising about 900 square miles and including a 19-mile reach of the Sevier River between Yuba Dam and Leamington Canyon. The larger valleys in the area are southern Juab, Round, and Scipio Valleys. The smaller valleys are Mills, Little, Dog, and Tinctic Wash Valleys.

The geology of parts of Scipio, Little, and Mills Valleys and parts of the surrounding highlands was mapped and studied to explain the occurrence of numerous sinkholes in the three valleys and to show their relation to the large springs in Mills Valley. The sinkholes, which are formed in the alluvium, are alined along faults, which penetrate both the alluvium and the underlying bedrock, and they have been formed by collapse of solution cavities in the underlying bedrock. The bedrock is mostly sandy limestone beds of the upper part of the North Horn Formation and of the Flagstaff Limestone. The numerous faults traversing Scipio Valley in a north-northeasterly direction trend directly toward Molter and Blue Springs in Mills Valley. One fault, which can be traced directly between the springs, probably is the principal channelway for the ground water moving from Scipio and Little Valleys to the springs.

Most of the recharge to the ground-water reservoirs takes place along the mountain fronts where streams emerge from canyons onto permeable alluvial fans. Water-table conditions usually are present in the unconsolidated deposits near the sides of the valley, whereas artesian conditions usually occur along the lower and middle parts of the valleys. The principal occurrence of water-table conditions is along the eastern side of southern Juab Valley. The principal occurrences of artesian conditions are in Round Valley and near Chicken Creek Reservoir in southern Juab Valley.

The ground water in Scipio Valley is unusual in that its levels change abruptly near the middle of the valley. This change of more than 200 feet is caused by drainage from a shallow ground-water reservoir in the southern part of the valley, through conduits underlying sinkholes, to a deeper reservoir in the northern part of the valley. The altitude of the lower water levels is controlled by the altitude of the point of discharge at Molten and Blue Springs, about 10 miles northeast of Scipio, and the hydraulic gradient of water moving through solution channels toward the point of discharge. A fairly consistent discharge from Molten Springs indicates a rather large amount of water in storage.

A relatively flat and uniform hydraulic gradient in the northeastern part of southern Juab Valley indicates a generally high transmissibility of the valley fill and a high potential yield from wells. The ground-water divide between northern

and southern Juab Valleys is about 2 miles south of Levan Ridge, the topographic divide between the two valleys.

In Mills Valley, water-table conditions exist along the margins of the valley above the flood plain of the Sevier River and in shallow flood-plain deposits. Artesian conditions exist in places in the alluvium at depth and in places in underlying bedrock. The water from Molten and Blue Springs is believed to issue from the bedrock into the alluvium and then to rise to the surface under hydrostatic pressure.

Ground water in Little Valley is believed to be mostly in valley fill under water-table conditions at depths generally more than 100 feet below the land surface. Part of the valley fill is underlain by water-bearing bedrock which contains solution channels that conduct water toward Molten and Blue Springs.

Little is known about the occurrence of ground water in Dog and Tintic Wash Valleys. At the only well in Dog Valley, the depth to water exceeds 440 feet. At the only well in Tintic Wash Valley, the depth to water is 43 feet. Tintic Wash Valley contains a considerable thickness of alluvium, some of which should be relatively permeable and saturated with water.

Most of the ground water in the area of investigation moves toward the Sevier River. Water moves from Round Valley to Scipto Valley, a closed basin, mostly by surface flow, and from Scipio Valley to Molten and Blue Springs by subsurface movement. The springs discharge near or directly into the Sevier River. Ground water moves from the east side of southern Juab Valley toward the vicinity of Chicken Creek Reservoir where it discharges to the land surface through springs, seeps, and flowing wells. From the reservoir most of the water moves toward the Sevier River by surface flow.

The movement of ground water downstream from beneath Sevier Bridge Reservoir above Yuba Dam is not related to the discharge from Molten and Blue Springs. Downvalley movement, however, may be related to the discharge from Chase Springs.

Six flowing wells in Round Valley discharged about 2,800 acre-feet of water during 1963. In southern Juab Valley about 2,600 acre-feet was pumped from nine wells, and about 1,200 acre-feet flowed from seven large and several small wells. Probably less than 25 acre-feet of water is discharged annually from wells in Scipio, Mills, Little, Dog, and Tintic Wash Valleys. Most of the water is used for irrigation.

Springs and seeps in Round, southern Juab, and Mills Valleys discharged about 28,000 acre-feet of water in 1963. Maple Grove Springs in Round Valley discharged about 4,300 acre-feet. Of the discharge from springs and seeps in southern Juab Valley, about 1,300 acre-feet reached Chicken Creek Reservoir. In Mills Valley, Molten Springs discharged about 4,400 acre-feet, Blue Springs about 16,000 acre-feet, and Chase Springs about 2,200 acre-feet.

Seepage runs on the Sevier River in March and October 1963 showed gains of 30.4 and 26.8 cfs (cubic feet per second), respectively, in the vicinity of Molten and Blue Springs. Gains of 5.6 and 4.5 cfs were noted below the springs in Mills Valley. Ground-water accretion to the river for the years 1955–62, as determined from flow records of the river and diversions near Lynndyl, is on the same order of magnitude as the accretion determined from seepage runs in 1963.

The five ground-water samples collected in Round Valley for chemical analysis were fresh. Three samples collected in Scipio Valley were fresh and one was slightly saline. Four samples from southern Juab Valley were fresh and five were slightly saline. Eight samples collected in Mills Valley were fresh and one was slightly saline. The only well in Little Valley yielded fresh water. When classified for irrigation, most of the ground- and surface-water samples were in the low sodium-hazard class and in either the medium or high salinity-hazard class. The water, however, is suitable for irrigation in the area.

INTRODUCTION

PURPOSE AND SCOPE OF THE INVESTIGATION

A study of the ground-water hydrology of the Sevier River basin in Utah was started in 1956 by the U.S. Geological Survey in cooperation with the Utah State Engineer. The present report is the result of an investigation of the segment of the basin between Yuba Dam and Leamington Canyon (fig. 1). The purpose of the investigation was to determine the source, occurrence, availability, chemical quality, movement, recharge, discharge, and use of ground water and the relation of ground water to surface water within this segment of the basin. Other areas within the basin which have been, or are being, investigated are: the upper Sevier River valleys, the central Sevier River valley, Sanpete Valley, and the Sevier Desert.

The senior author studied the hydrology of the area from October 1962 to December 1963 and in January 1966, and the junior author mapped the geology (pl. 1) of part of the area during a few months of 1963 and 1964. The purpose of the geologic mapping was to explain the occurrence of sinkholes in the area and to relate the sinkholes to the discharge of large springs.

LOCATION AND EXTENT OF THE AREA

The area studied is in central Utah, about 100 miles south of Salt Lake City (fig. 1), and it includes parts of Juab, Millard, Sanpete, and Sevier Counties. Although the reach of the Sevier River from Yuba Dam to the head of Leamington Canyon is only 19 miles along the trend of the valley (pl. 2), the area includes several tributary valleys that drain into the river, either by surface or subsurface flow within the 19-mile reach. Thus, the actual drainage-basin area is 60 miles long from north to south and 30 miles wide at its widest part from east to west. It includes about 900 square miles. The Sevier River, along its 19-mile reach, flows mostly through Mills Valley. The tributary valleys to the river include Round, Scipio, southern Juab, Tintic Wash, Dog, and Little Valleys (pl. 2).

The area is bounded by the Pavant Range and the Canyon and High (or Gilson) Mountains on the west, by the Valley and San Pitch Mountains (Gunnison Plateau) on the east, and by Long Ridge and the East Tintic Mountains on the north (pl. 2). The area of investigation was extended north of Levan Ridge, the northern boundary of southern Juab Valley, in order to determine the position of the ground-water divide between northern and southern Juab Valleys.

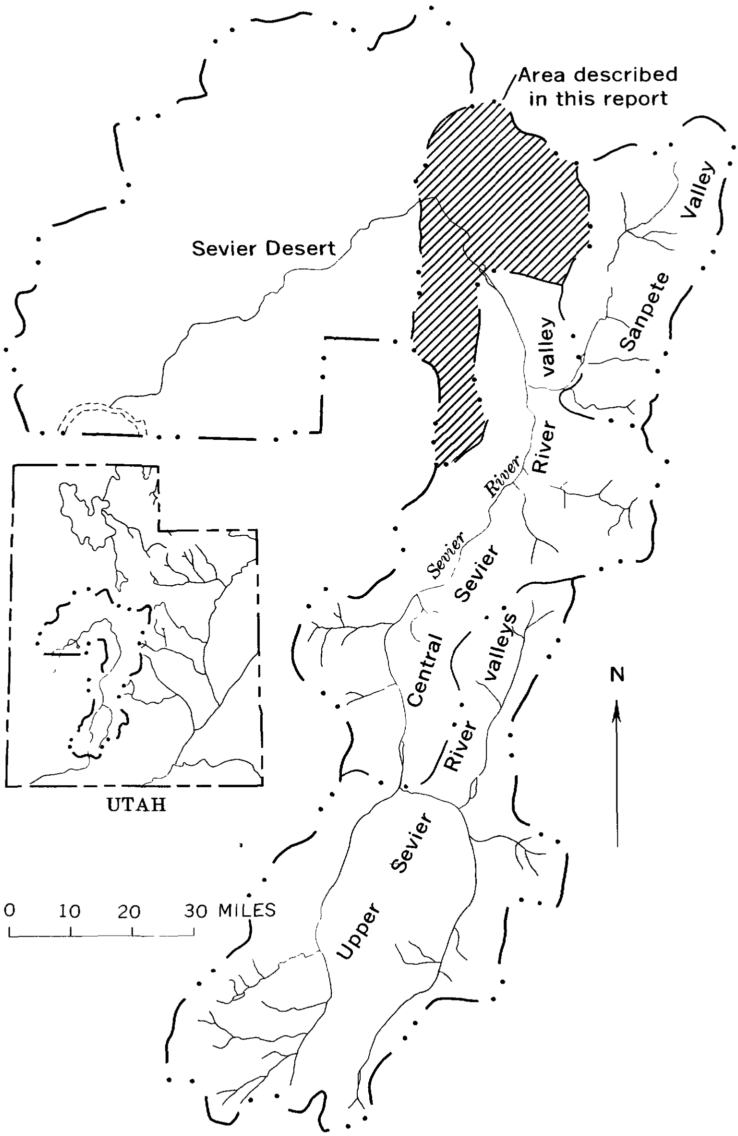

FIGURE 1.—Map of the Sevier River basin showing the area described in this report and other areas studied.

PREVIOUS INVESTIGATIONS

The ground-water resources of the area were first studied by Meinzer (1911, p. 67–78), who investigated Juab, Round, Little, and Dog Valleys as part of a reconnaissance of the ground water in a large part of southwestern Utah. Meinzer used different names and boundaries from those used in this report; his "Little Valley" included Mills Valley, Scipio Valley was called "Lower Round Valley," and southern Juab Valley was called "the south basin in Juab Valley." Since Meinzer's investigation, water levels in a few wells have been measured periodically by the U.S. Geological Survey; since 1935, records of these measurements have been published annually in U.S. Geological Survey Water-Supply Papers.

The surface-water resources of the Sevier Lake basin, with reference to geology, irrigation, drainage, storage, hydroelectric development, and other factors, are described by Woolley (1947). His report includes streamflow and other hydrologic data collected through 1937. Since about 1900, streamflow records collected in the Sevier River basin have been published annually by the U.S. Geological Survey. Records of diversions from the Sevier River for irrigation are compiled annually by the Sevier River water commissioners.

The geology of part of the area mapped during this investigation was described by Christiansen (1951, 1952) in his study of the central and southern Canyon Range. Gilliland (1951) described and mapped the geology of the Gunnison quadrangle, an area directly east of the area mapped for this investigation, and L. M. Tucker (written commun., 1954) made a similar investigation in the Valley Mountains and northern Pavant Range. Other reports of geologic investigations outside the area mapped for this report, but within the overall project area, were made by Spieker (1949), Muessig (1951), and Hardy and Zeller (1953). In addition, the geology of parts of the area are described in unpublished theses and maps on file at Ohio State University by R. E. Hunt, S. J. Muessig, J. W. Niehaus, and J. W. Vogel; at the University of Utah by J. K. Costain; and at Brigham Young University by H. J. Winkler.

METHODS OF INVESTIGATION

Records were obtained for 18 irrigation wells, 2 public-supply wells, 38 domestic and stock wells, 2 industrial wells, 30 unused wells, and 15 springs. Records for the wells and springs are given in table 4 and their locations are shown on plate 2. Drillers' logs of selected wells are given in table 7. All the wells and major springs in the area were visited, tenants or well owners were interviewed, and depths to water were measured monthly in nine wells. The rates of pump discharge and flow from wells were measured or estimated, and streamflow and spring discharge were measured. Altitudes of the land surface at wells were estimated from topographic maps, determined by altimeter, or determined by hand leveling. Water samples for chemical analysis were obtained from selected wells and springs and the Sevier River and its tributaries. These analyses are given in tables 5 and 6.

The geologic map and descriptions in the report were prepared partly from reports of previous investigations and partly from reconnaissance mapping. Mapping consisted of photogeologic study and field checking. Dips and strikes were determined at outcrops in the field.

WELL- AND SPRING-NUMBERING SYSTEM

The system of numbering wells in Utah is based on the cadastral land-survey system of the Federal Government. The well number, in addition to designating the well, locates its position to the nearest 10-acre tract in the land net. By this system the State is divided into four quadrants by the Salt Lake base and meridian, and these quadrants are designated by the capital letters A, B, C, and D. A is the northeast quadrant, B is the northwest, C is the southwest, and D is the southeast. Numbers designating the township and range follow the quadrant letter, and all three are enclosed in parentheses. The number after the parentheses designates the section, and the lowercase letters give the location of the well within the section. The first letter indicates the quarter section, which is generally a tract of 160 acres, the second letter indicates the 40-acre tract, and the third letter indicates the 10-acre tract. The number following the letters indicates the serial number of the well within the 10-acre tract. Thus, well (C–15–1)33acd–1, in Juab County, is the SE¼SW¼NE¼ sec. 33, T. 15 S., R. 1 W., and is the first well constructed or visited in that tract. Figure 2 shows the method of numbering wells as described above. In this report, springs and sampling sites are also located by this system, but the designation number within a 10-acre tract is omitted.

ACKNOWLEDGMENTS

The cooperation of residents of the area and of officials of counties, towns, and irrigation companies who gave information and permitted measurements at their springs and wells is gratefully acknowledged. Equipment furnished by the Scipio Irrigation Co. made possible a continuous record of flow in Scipio Creek during 1963.

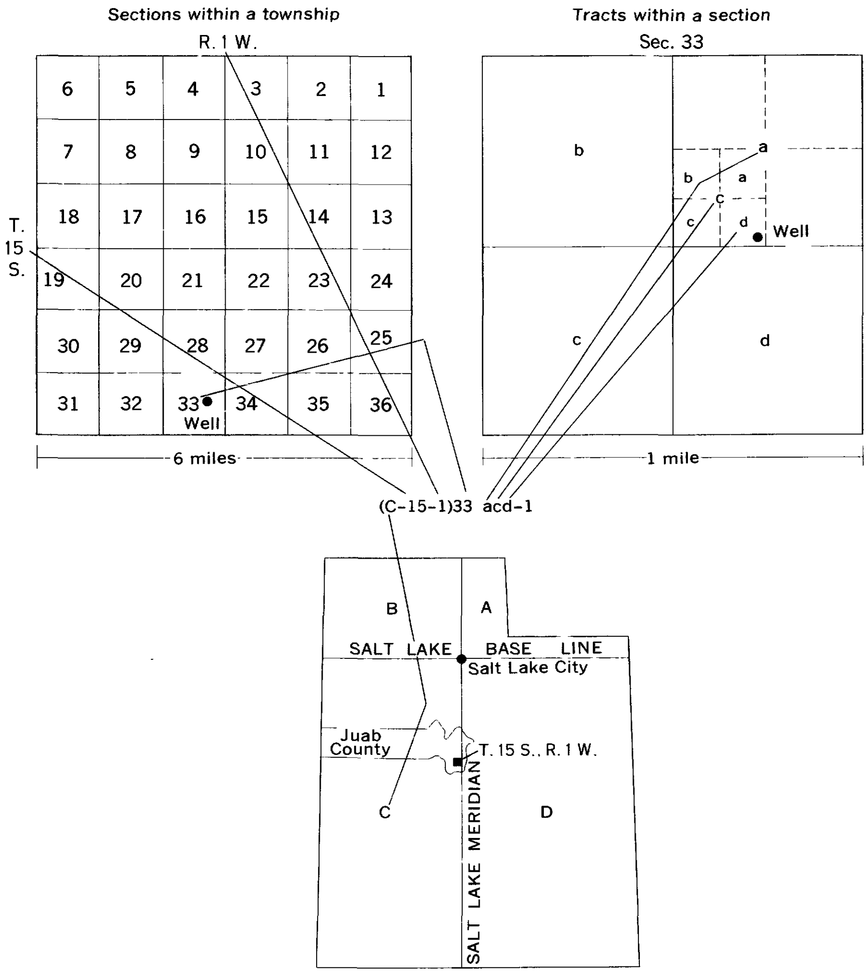

FIGURE 2.—Well- and spring-numbering system used in Utah.

GEOGRAPHY

PHYSIOGRAPHY AND DRAINAGE

The area of investigation is in the zone of transition between the High Plateaus of Utah section of the Colorado Plateaus physiographic province and the Great Basin of the Basin and Range physiographic province of Fenneman (1931, p. 294–299, 348–367). In this report, the boundary between the two provinces is considered to be along the west side of the Pavant Range and the west side of the San Pitch Mountains (Gunnison Plateau). Thus, the area contains parts of both psysiographic provinces.

The valleys in the area range from well-defined depressions, which are several miles wide and are between prominent mountain masses, to smaller depressions between low hills or bluffs. The most conspicuous valleys are southern Juab Valley, bounded on the east by the San Pitch Mountains and on the west by the West Hills, and Round and Scipio Valleys, bounded by the Valley Mountains on the east and the Pavant Range and Canyon Mountains on the west. The smaller valleys—Mills, Little, Dog, and Tintic Wash—are separated by low hills, bluffs, and hogbacks. Most of the area, particularly the northern half, can be visualized as a large depression about 15–20 miles wide between the San Pitch Mountains on the east and the Canyon Mountains on the west. This depression, however, is broken into many smaller valleys by hills and bluffs protruding from the large valley floor.

Mills Valley is drained by the main stem of the Sevier River below Yuba Dam. Most of the flow of the river is released from Sevier Bridge Reservoir at Yuba Dam for irrigation downstream from the area of investigation. Base flow in the river is dependent on ground-water discharge which is derived mainly from several large springs along or near the river channel. These are Molten Springs, (C–16–2)34aab, and Blue Springs, (C–16–2)27dbd, which discharge near the Sevier River; and Chase Springs, (C–16–2)2aad, which reaches the river through the drain from The Meadows (sec. 2, T. 16 S., R. 2 W., and sec. 35, T. 15 S., R. 2 W.). (See pl. 2.) The source and discharge of these springs are discussed on page 40.

The principal tributary drainage basin east of the Sevier River is southern Juab Valley; it receives water from several creeks flowing from the San Pitch Mountains (Gunnison Plateau), including Fourmile, Pigeon, Chicken, Deep, Little Salt, and Criss Creeks All these creeks are fed by springs and are perennial in their upper reaches, but they lose their water to the valley fill downstream from the mouths of their canyons either by seepage from the streambed or by diversions for irrigation, or by a combination of both. The water returns to the surface in the lower part of the valley, where it is discharged through springs and seeps and collects in Chicken Creek Reservoir (also called

Juab Lake). From the reservoir, the water flows through a narrow gap in the West Hills into Mills Valley where it is used for irrigation. Except during periods of high runoff, the water from southern Juab Valley does not reach the Sevier River as surface flow. Some of the water, however, seeps into the ground from irrigated fields in Mills Valley, seeps back to the surface in The Meadows in the lower part of Mills Valley, and flows to the river in a small creek draining The Meadows.

The principal tributary drainage basin south and west of the Sevier River consists of Round and Scipio Valleys. Surface flow begins mainly at Maple Grove Springs, (C–21–2½)2a, near the head (southern end) of Round Valley, and continues through Ivie Creek, a perennial stream, into Scipio Lake, a manmade reservoir. From Scipio Lake the water flows through Round Valley Creek into Scipio Valley where it is used for irrigation. No surface flow leaves Scipio Valley, because it is a closed basin cut off at its northern (downstream) end from the Sevier River by the Low Hills. The basin, however, is drained by the subsurface movement of water that discharges as part of the flow from Molten Springs, (C–16–2)34aab, and Blue Springs, (C–16–2)27dbd.

Tintic Wash, Dog, and Little Valleys contain ephemeral streams that reach the Sevier River only during periods of high runoff. Presumably, however, some water in these valleys moves in the subsurface and discharges into the river through seeps and springs along the riverbed.

CLIMATE

The valleys in the area have a semiarid climate, characterized by sunny days, large daily temperature changes, low humidity, and little precipitation. The precipitation on the adjacent mountains is considerably greater and is the source of most of the water used in the area.

According to records of the U.S. Weather Bureau, the mean annual temperature for the period 1930–61 at Levan was 49.4°F and at Scipio 47.8°F. Midday summer temperatures in the valleys of more than 90°F are common, and at times they may exceed 100°F, but summer nights are cool, with temperatures occasionally as much as 40° below the maximum. Midday winter temperatures are moderately cold, usually within 10° above or below freezing, and nighttime temperatures usually are 10°–30° colder.

The number of frost-free days at Levan and Scipio during the period 1948–61 ranged from 115 to 181 at Levan and from 57 to 124 at Scipio. The average number of frost-free days during this period was 135 at Levan and 100 at Scipio.

The mean annual precipitation for the period 1930–61 at Levan was 13.46 inches and at Scipio 11.87 inches. The period of least precipitation was from May through September, coinciding with the growing season. The precipitation in the valleys will support grass and brush and some dryland wheat and rye but most crops, such as alfalfa and row crops must be irrigated. The annual precipitation in the higher parts of the Pavant Range is more than 30 inches and in the Canyon and San Pitch Mountains more than 25 inches (U.S. Weather Bur., 1963). Most of the precipitation in the mountains falls during the October-April period, and much of it reaches the valleys as runoff from snowmelt or as discharge from springs along the mountain sides.

GEOLOGY

The geology of only a small part of the area was mapped during the investigation. This part, as shown on the geologic map (pl. 1), consists of most of Scipio, Little, and Mills Valleys, and was studied to explain the occurrence of numerous sinkholes in the three valleys and to show their relation to the ground water in the area and to the large springs in Mills Valley. The western half of the map was adapted with slight modification from Christiansen (1951, pl. 1). The modifications include alteration of the fault pattern at the north end of Scipio Valley and the addition of rocks of the Indianola(?) Group (Upper Cretaceous) on the southwest end of the Low Hills. A summary of the geologic section and the water-bearing properties of the formations exposed in the area mapped is shown in table 1, and the formations are described in detail in the following pages. Table 1 also summarizes the geologic section and water-bearing properties of the principal formations exposed in the remainder of the area of investigation. These formations are not described further in the text, but are described in various other reports listed in the sections "Previous investigations" and "Selected references" (p. 5, 78).

TABLE 1.—*Generalized geologic section and water-bearing properties of the principal formations exposed in the Sevier River basin between Yuba Dam and Leamington Canyon, Utah*

[Locations of outcrops outside of area shown on pl. 1 were adapted from Stokes (1963)]

System	Series	Stratigraphic unit	Approximate maximum thickness (feet) in area mapped	Character of material	Area of exposure	Water-bearing properties
Quaternary	Pleistocene and Recent	Alluvium (includes some pre-Lake Bonneville fan sediments.	500+	Includes alluvial-fan deposits, flood-plain deposits of the Sevier River, and lacustrine deposits of clay, silt, sand, gravel, and cobbles to boulders.	In all the major valleys and subvalleys (part shown in detail on pl. 1).	Moderate to high permeability in the alluvial-fan deposits; yields small to large quantities of water to wells and springs; low to moderate permeability in the flood-plain and lacustrine deposits, which yield small to moderate quantities of water to wells and springs.
	Pleistocene	Lake Bonneville Group	----------	Laminated to thick-bedded clay and silt and interfingered or interbedded silty and sandy fine gravel.	Little and Mills Valleys and in Leamington Canyon of the Sevier River (part shown in detail on pl. 1).	Silt and clay beds probably have low permeability; silty and sandy gravel deposits probably have low to moderate permeability; not known to yield water to wells in the area mapped.
Tertiary and Quaternary		Alluvial deposits	----------	Deposits and thin surface coverings of alluvium of uncertain age on mountain slopes and plateau surfaces; locally cemented.	Northern San Pitch Mountains and West Hills.	Probably low permeability due to lack of sorting and stratification; yield to wells and springs unknown.
		Volcanic rocks	----------	Pyroclastics and flows of andesite-trachyte-latite composition; also rhyolite-dacite-quartz latite ignimbrites.	East Tintic Mountains, unnamed hills between the High Mountains and the West Hills, Long Ridge, and northern San Pitch Mountains.	Permeability generally low, but locally high where fractured or jointed; yield to wells and springs unknown.
	Oligocene (?)	Fool Creek Conglomerate of Christiansen (1951)	1,800	Lithifield deposits of pebbles, cobbles, and boulders in matrix of clay, silt, sand, and grit	In patches on the foothills, in canyons, and on the divide of the Canyon Mountains (part shown in detail on pl. 1).	Not significant as a source of ground water.

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TABLE 1.—*Generalized geologic section and water-bearing properties of the principal formations exposed in the Sevier River basin between Yuba Dam and Leamington Canyon, Utah*—Continued

[Locations of outcrops outside of area shown on pl. 1 were adapted from Stokes (1963)]

System	Series	Stratigraphic unit	Approximate maximum thickness (feet) in area mapped	Character of material	Area of exposure	Water-bearing properties
Tertiary	Eocene	Goldens Ranch Formation of Muessig (1951)	------------	Chiefly volcanic conglomerate; minor volcanic flows and limestone interbeds.	South end of Long Ridge, West Hills, extension of West Hills south of Chicken Creek Reservoir, and along foothills on west-central part of the San Pitch Mountains.	Unknown.
		Green River Formation	------------	Thinly laminated shale and fresh-water limestone; minor lenses and interbeds of sandstone and conglomerate; shale, gray to greengray and limestone white to tan.	West Hills and southern half of San Pitch Mountains.	Probably has low permeability although sandstone lenses locally may have moderate permeability; fracture zones and permeable sandstone beds may yield small to moderate amounts of water to wells and springs.
		Colton Formation	------------	Fluvial "red-bed" shale, variegated red to gray and green and buff to brown and red sandstone; locally some limestone interbeds.	Southern half of San Pitch Mountains.	Probably has about same water-bearing properties as Green River Formation.
	Paleocene and Eocene(?)	Flagstaff Limestone	1,100+	Dense lacustrine limestone, argillaceous limestone, and sandy limestone that contain beds and lenses of sandstone and conglomerate; limestone usually massive and unevenly bedded and locally highly fractured; formation becomes progressively less clastic toward the east.	West Hills, small hills west and southwest of Sevier Bridge Reservoir, Valley Mountains, and central and southern San Pitch Mountains (part shown in detail on pl. 1).	Low primary permeability, but locally very high permeability in solution channels along joints and fractures along faults; in conjunction with the upper part of the North Horn Formation provides moderate to large yields to wells in Scipio and Round Valleys and to Molten and Blue Springs in Mills Valley.
				Medium- to thick-bedded locally calcareous sandstone that contains numerous interbeds of	West Hills, Canyon Mountains, Low Hills at the	Generally low intergranular porosity due to cementation; high secondary permeability in

Cretaceous and Tertiary	Upper Cretaceous and Paleocene	North Horn Formation	3,500	sandy limestone (mainly in upper part) and localized conglomeratic lenses and shaly partings; variegated shale predominates progressively eastward.	north end of Scipio Valley, Pavant Range, Valley Mountains, and central and southern San Pitch Mountains (part shown in detail on pl. 1).	solution channels along faults and joints in the limestone beds; in conjunction with the Flagstaff Limsetone provides moderate to large yields to wells in Scipio and Round Valleys and to Molten and Blue Springs in Mills Valley.
Cretaceous	Upper Cretaceous	Price River Formation	----------	Massive conglomerate, sandstone, and minor shale.	Pavant Range and San Pitch Mountains.	Probably has low permeability, except along bedding planes and where fractured; yield to wells unknown, but provides large yield to Maple Grove Springs at fault zone.
		——Unconformity——				
		Indianola Group and Indianola(?) Group	12,500	Pebble, cobble, and boulder conglomerate that contains interbeds of sandstone, siltstone, shale, and fresh-water limestone in its upper section; progressively finer grained and thinner eastward.	Hills between High Mountains and West Hills, Canyon Mountains, Low Hills at north end of Scipio Valley, and northern San Pitch Mountains (part shown in detail on pl. 1).	Not significant as a source of ground water in area mapped; water-bearing properties unknown east of area.
		——Unconformity——				
Jurassic	Middle and Upper Jurassic	Arapien Shale (includes Twist Gulch Member)	----------	Variegated red to gray siltstone, sandstone, and limestone; locally contains gypsum and rock salt. Twist Gulch Member is dark-red siltstone and white to gray sandstone.	Northern and central San Pitch Mountains.	Probably has very low permeability, although locally it supplies water to small springs in Chicken Creek Canyon; contaminates water with chloride and sulfate along east side of southern Juab Valley.
Pennsylvanian and Permian		Metamorphic and sedimentary rocks	----------	Interbedded quartzite, limestone, dolomite, sandstone, and shale.	High Mountains, hills on either side of Tintic Wash and Dog Valleys, and southern Long Ridge.	Unknown.
Silurian and Devonian		Dolomite	----------	Mostly dense unfossiliferous dolomite.	Northern High Mountains, southern Canyon Mountains and northern Pavant Range.	Unknown.
Precambrian, Cambrian, and Ordovician		Metamorphic and sedimentary rocks	15,000+	Quartzite, shale, conglomerate, limestone, and dolomite.	East Tintic Mountains, High Mountains, Canyon Mountains, and Pavant Range (part shown in detail on pl. 1).	Limestone beds of Cambrian and possibly Ordovician age supply small quantities of water to two wells in Scipio Pass.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

Much of the following description of the geologic formations is adapted from Christiansen (1951), Gilliland (1951), Spieker (1949), and L. M. Tucker (written commun., 1954).

PRECAMBRIAN, CAMBRIAN, AND ORDOVICIAN(?) SYSTEMS

According to Christiansen (1951, p. 5–9, pl. 1), a thick sequence (15,000+ ft) of rocks of Precambrian, Cambrian, and Ordovician(?) age form a large part of the central and southern parts of the Canyon Mountains. These rocks, composed mostly of quartzite, shale, conglomerate, limestone, and dolomite, have a complicated history of folding, thrusting, and normal faulting. They are not significant as a source of ground water in the area mapped.

CRETACEOUS SYSTEM

Christiansen (1951, p. 8–10, pl. 1) mapped and described a thick section (12,500 ft) of pebble, cobble, and boulder conglomerate in the northern part of the Canyon Mountains. This section, which also contains interbeds of sandstone, siltstone, shale, and fresh-water limestone in its upper part, tentatively was correlated with the Indianola Group of Late Cretaceous age (Christiansen, 1951, p. 8). Some of these rocks are shown on plate 1 of this report in the central and northern Canyon Mountains, as mapped by Christiansen, and on the southwestern tip of the Low Hills at the northern end of Scipio Valley. The rocks are not significant as a source of ground water in the area mapped and therefore are not described further.

CRETACEOUS AND TERTIARY SYSTEMS

The North Horn Formation of Late Cretaceous and Paleocene age is reported by Christiansen (1951, p. 10) to lie unconformably on the Indianola(?) Group in the Canyon Mountains. It also is widely exposed on the western flank of the northern Valley Mountains and in the Low Hills at the northern end of Scipio Valley. It is chiefly a brown, reddish-brown, tan, or gray, fine- to coarse-grained locally calcareous sandstone, which contains numerous interbeds of yellow or yellow-brown sandy limestone, mainly in its upper part, and abundant, but localized, conglomeratic lenses and shaly partings. In general, the sandstone beds are 2–4 feet thick, but locally are as much as 30 feet thick. The total thickness of the North Horn Formation in the area mapped and in adjacent areas is reported as 3,500 feet (Christiansen, 1951, p. 10), 2,650 feet (L. M. Tucker, written commun., 1954), and 1,578 feet, base not exposed (Gilliland, 1951, p. 23).

Detailed information is lacking concerning the water-bearing properties of the North Horn Formation in the area mapped and in adjacent areas. The sandstone and conglomerate beds generally are moderately to tightly cemented, and therefore probably have relatively low intergranular porosity. Joints and other fractures, however, are abundant locally in the formation. Where the limestone beds are fractured and the fractures have been widened by solution, they form an effective aquifer. Such solution openings in the limestone beds of the upper part of the North Horn Formation and in the Flagstaff Limestone provide the channelway for the movement of ground water from Scipio and Little Valleys and for the discharges from Molten Springs, (C–16–2)34aab, and Blue Springs, (C–16–2)27dbd. (See p. 18.) In conjunction with the Flagstaff Limestone, the North Horn Formation yields moderate to large quantities of water to wells in Round and Scipio Valleys.

TERTIARY SYSTEM

PALEOCENE AND EOCENE(?) SERIES

The Flagstaff Limestone of Paleocene and Eocene(?) age in the area mapped rests conformably on the North Horn Formation. Although the two formations differ in overall lithology and appearance, the gradational contact between them makes differentiation difficult. The two formations were separated in the field by placing the contact at the approximate boundary where limestone beds predominate above and sandstone and conglomerate beds predominate below. Thus, the contact on the geologic map is only approximate. The Flagstaff Limestone is exposed in the northern Valley Mountains, in the low dip-slope ridges northeast of the Low Hills, and in the ridges west of Sevier Bridge Reservoir (pl. 1).

Gilliland (1951, p. 26–30) divided his Flagstaff Formation in the Valley Mountains into five lithologic facies units, but none of these units are distinguished in this report. The formation consists mostly of dense lacustrine limestone, argillaceous limestone, and sandy limestone that contain interbeds of tan to brown sandstone, shale, and a few conglomeratic lenses. The limestone varies from yellow and yellow-tan to light gray, pink, red, and lavender; it generally is massive and unevenly bedded, although it contains some thin-bedded shalelike partings. It also contains fossil "algal balls" throughout most of its extent. Although the thickness of the Flagstaff Limestone in the area mapped is not known, about 1,100 feet have been measured several miles east in Hayes Canyon in the Valley Mountains (Gilliland, 1951, p. 26, 89–90).

Little is known about the water-bearing properties of the Flagstaff Limestone. The limestone beds are mostly dense and massive and probably have low primary permeability. However, the formation generally is greatly fractured and jointed along faults, and solution activity in these openings by percolating water has enlarged some of them and resulted locally in very high permeability. In fact, the large sinkholes in the alluvium of Scipio, Little, and Mills Valleys probably were formed by the collapse of solution channels in the underlying limestone beds in the Flagstaff and in the upper part of the North Horn Formation. Furthermore, the interconnected solution channels form a conduit for water in the subsurface from Scipio Valley toward Molten and Blue Springs in Mills Valley. Further discussion of the sinkholes and the solution channels in the limestone is found on pages 18 and 23.

OLIGOCENE(?) SERIES

Christiansen (1951, p. 10–11 and pl. 1) described and mapped "lithified" deposits in the Canyon Mountains consisting of pebbles, cobbles, and boulders in clay, silt, sand, and grit matrix derived from the formations exposed in the range. He defined these deposits as the Fool Creek Conglomerate of Oligocene(?) age. The formation, which is described as 0–1,800 feet thick, is largely "confined to patchy areas on the foothills, in the canyons, and on the broad divides along the crest of the range." A few of these patchy areas are shown on plate 1 of this report. The formation is not significant as a source of ground water in the area mapped and is not described further.

QUATERNARY SYSTEM

PLEISTOCENE SERIES

Deposits belonging to the Lake Bonneville Group of Pleistocene age are exposed as bluffs and rolling hills along the Sevier River flood plain and around Sevier Bridge Reservoir in Little and Mills Valleys (pl. 1). Crittenden (1963, p. E5) states that the highest level of the Bonneville shoreline is 5,115 feet above sea level at Leamington, 5,110 feet at Leamington Canyon of the Sevier River, and 5,090 feet at Sevier Bridge Reservoir. Gilliland (1951, p. 54–56) describes isolated sand deposits near Fayette in the Sevier River valley, about 15 miles upstream from Yuba Dam, which he correlates with Lake Bonneville deposits. He determined that these deposits are at altitudes near 5,350 feet. Snyder, Hardman, and Zdenek (1964) show an arm of Lake Bonneville extending up the Sevier River valley to a point almost to Axtell, about 27 miles upstream from Yuba Dam. During the present investigation, a field reconnaissance indicated that the highest level of the deposits in the area mapped is approximately 5,120 feet. In places within the area, however, the deposits occur at altitudes exceeding 5,120 feet, owing possibly to recent local uplift along faults (pl. 1). The thickness of the deposits in the area mapped is unknown.

The Lake Bonneville Group consists of deposits of well-stratified laminated to thick-bedded clay and silt and of interfingered or interbedded silty and sandy fine gravel. The silt and clay are mostly tan to light brown, but contain some zones that are reddish tan, red to brown, gray, white, and pale greenish white. The clay is partly bentonitic and is partly consolidated into claystone. The gravel and sand are only poorly stratified and sorted.

Wells in the area mapped are not known to derive water from the Lake Bonneville Group. The silt and clay beds probably have low permeability, and, therefore, would not yield water readily to wells. The silty and sandy gravel beds are poorly sorted and stratified and probably have only low to moderate permeability.

PLEISTOCENE AND RECENT SERIES

The Quaternary alluvium in the area mapped includes alluvial-fan deposits along the valley sides, flood-plain deposits along the Sevier River in Mills Valley, and fine-grained lacustrine(?) deposits near the center of Scipio Valley (pl. 1). Some of the alluvial-fan deposits are of pre-Lake Bonneville age, but they have not been separated from fans of Pleistocene and Recent age. The alluvial-fan deposits consist of interbedded and interfingered deposits of silt, sand, gravel, cobbles, and boulders. These deposits are lenticular and discontinuous and characteristically vary both horizontally and vertically in texture, composition, sorting, and stratification. They were derived from the highlands nearby and are composed of fragments from the local bedrock. They generally are coarsest near these highlands and are finer textured in the valley lowlands. The flood-plain deposits of the Sevier River consist of fairly well sorted sand and gravel in the channel deposits and of silt and fine-grained sand in the overbank deposits. The lacustrine(?) deposits near the center of Scipio Valley consist chiefly of clay, silt, and fine-grained sand and occasional lenses of fine gravel. As determined from drillers' logs of wells, the alluvium exceeds 350 feet in thickness in Scipio Valley, and may be more than 500 feet thick near Scipio. Locally, however, as near the northern boundary of the valley, the maximum thickness of the alluvium is less than 200 feet. The maximum thickness of alluvium in Little and Mills Valleys is unknown, but it probably is more than 400 feet.

The alluvium in the area mapped varies greatly in water-bearing properties. The alluvial-fan deposits have moderate to high permeability and yield small to moderate supplies to wells in the area mapped. Elsewhere in the area of investigation, they yield moderate to large supplies to wells, chiefly from the coarse and well-sorted sand and gravel lenses deposited in the stream channels of the fans. The river flood-plain deposits have low to moderate permeability, they are saturated, and although they are not known to yield water to wells in the area mapped, they conceivably could yield small to moderate quantities chiefly from the channel deposits. They supply small quantities to a flowing well, (C–15–2)22bcc–1, elsewhere in the area of investigation. The lacustrine(?) deposits of clay, silt, and sand have low to moderate permeability and yield small to moderate quantities of water to wells.

STRUCTURE

GENERAL STATEMENT

Scipio Valley is a graben basin, bounded on the east by the Valley Mountains and on the west by the Pavant Range and Canyon Mountains. Many apparently high-angle normal faults traverse the valley in a northeasterly direction, and in places appear as recent scarps in the alluvium. Movement along several of these faults has exposed a section of bedrock which forms the Low Hills (pl. 1) at the northern end of the valley.

Little and Mills Valleys, although not grabens, contain virtually the same structural features as does Scipio Valley. Many faults traverse the valleys, in places revealed by scarps in the alluvium and in other places by bedrock dip-slope ridges.

RELATION TO SINKHOLES AND SPRINGS IN SCIPIO, LITTLE, AND MILLS VALLEYS

Numerous sinkholes in the alluvium are alined along faults or fault zones in Scipio, Little, and Mills Valleys, particularly in the northern end of Scipio Valley (pl. 1). It is believed that the faults penetrate the bedrock underlying the alluvium in the valley and that solution by ground water moving along the fault planes and the fractures and joints associated with them is creating a series of connected caverns in the bedrock. The collapse of some of the caverns in the subsurface is causing collapse of the overlying valley fill and the consequent appearance of sinkholes at the land surface. Although few logs are available for wells that penetrate the bedrock, surface exposures indicate that the solution channels are forming in limestone beds in the upper part of the North Horn Formation and in the Flagstaff Limestone. Sinkholes have been found in outcrops of both formations in the area mapped, and both formations contain limestone sections which are highly fractured and susceptible to solution.

The sinkholes in Scipio Valley generally are steep sided and oblong. They range from a few feet to about 25 feet in depth, from less than 1 foot to more than 30 feet in width, and from a few feet to more than 200 feet in length (fig. 3). Some of the holes are connected by tunnels.

FIGURE 3.—Sinkholes in Scipio Valley, in sec. 31, T. 17 S., R. 2 W., looking northeastward. Lower photograph shows recent collapse beneath a stock-watering tank near a well. (Photographs by L. J. Bjorklund.)

The holes follow the fault trends in a northeasterly direction, roughly toward Molten and Blue Springs, about 8 miles from the northern part of Scipio Valley. Most of the holes are in open fields. Some are marked by uncleared brush around their edges, but some have formed in recent years in cultivated fields, and from a distance, show little indication of their presence.

Although most of the sinkholes are in the northern part of Scipio Valley, they have also formed in canyons between the valley and Molten Springs to the northeast. A line of holes in the canyon through the Low Hills in the NE¼ sec. 20 and the NW¼ sec. 16, T. 17 S., R. 2 W., apparently formed along the fault zone shown in the canyon on plate 1. This canyon appears to have once been the surface-drainage outlet for Scipio Valley, but now its streambed is 20–40 feet above the lowest part of the valley floor. Apparently, movement along the fault at the southern boundary of the Low Hills has uplifted the drainage outlet relative to Scipio Valley and thereby barred the surface-drainage outlet from the valley. As a result, the water had either to become impounded or to seek new outlets; eventually it established such outlets in the subsurface by dissolving caverns and solution channels along faults in the underlying limestone beds. Although water probably moves from the valley in several separate solution channelways that are controlled by the faults (pl. 1), the primary movement appears to be northward along the fault through the canyon in the Low Hills and along the fault at the base of the dip-slope ridge northeast of the Low Hills (secs. 4, 9, and 16, T. 17 S., R. 2 W.). This latter fault cuts northeast through the ridge at its northern tip (NE¼ sec. 4, T. 17 S., R. 2 W.), where it is marked by a canyon which apparently was formed in the past by the surface drainage from Scipio Valley. Sinkholes on the northeastern side of the ridge at the mouth of the canyon in the SW¼ sec. 34, T. 16 S., R. 2 W. (pl. 1), are evidence supporting the existence of the fault.

The fault apparently traverses Mills Valley beneath the alluvium and joins a third fault along the west side of the ridge northwest of Sevier Bridge Reservoir (pl. 1). The connection between the two faults, shown on plate 1 by dots, passes directly between Molten and Blue Springs. At present, ground water from Scipio Valley, as well as surface and ground water from Little Valley, presumably moves through or beneath the canyon in the NE¼ sec. 4. From there, the subsurface movement of ground water is directed by the fault in sec. 34 toward Molten and Blue Springs.

In addition to the sinkholes described above, several small holes were mapped in the sand dune area east of Mills Valley in the north-central part of sec. 12, T. 16 S., R. 2 W. (see pl. 1). Outside the area mapped, several small holes were observed at the southern end of Scipio Valley in secs. 29 and 30, T. 18 S., R. 2 W.; a few relatively large holes were observed in lower Round Valley in sec. 4, T. 19 S., R. 2 W.

Chase Springs, (C–16–2)2aad, lies along approximately the same trend line of faults and solution channels as does Molten and Blue Springs. However, the water from Chase Springs differs in chemical quality from the water of the other two springs (table 5), and it probably has a different source. Most of the water discharging from Chase Springs may be moving northward downvalley from the vicinity of Sevier Bridge Reservoir through The Washboard (pl. 2), either in the alluvium or in solution channels in bedrock beneath the alluvium. However, sinkholes about 1 mile southeast of Chase Springs, in sec. 12, T. 16 S., R. 2 W., indicate that some subsurface water moves in solution channels along the same fault zone as that conducting water to Molten and Blue Springs. Thus, some of the water may be coming either from the vicinity of Molten and Blue Springs or from the flood-plain deposits beneath the Sevier River. Evapotranspiration resulting from upward artesian leakage in the area of the springs would add to the high mineral content of the water. Evidence bearing on either of these possibilities is sparse; therefore, more detailed studies are required to determine the source of Chase Springs.

GROUND WATER

SOURCE AND RECHARGE

The source of virtually all the ground water in the area of investigation is precipitation that falls directly on the area. Some water, however, moves into the area in the subsurface from the Sevier River basin upstream.

Precipitation during the winter is greater than precipitation during the summer; therefore, the main period of recharge in the area is during the spring snowmelt. At that time most of the recharge to the ground-water reservoir in the alluvium is in the form of seepage from stream channels where they emerge from canyons onto permeable alluvial fans especially along the San Pitch and Canyon Mountains and along the Pavant Range. In addition, the fans absorb part of the precipitation that falls directly on them. Some recharge results by seepage from irrigation canals and irrigated land in Scipio, southern Juab, and Mills Valleys. The alluvium also receives some recharge by direct subsurface inflow from consolidated aquifers in the mountains.

OCCURRENCE

Ground water occurs in both unconsolidated and consolidated rocks in the area of investigation. It forms reservoirs in the unconsolidated alluvium in Round, Scipio, southern Juab, Mills, Tintic Wash, Little, and Dog Valleys; most of these reservoirs are separated by consolidated rocks which act as barriers. However, in some places the consolidated rocks contain considerable quantities of water, particularly in solution channels.

Ground water in the area occurs under both water-table (unconfined) and artesian (confined) conditions. Water-table conditions exist in the alluvium mainly in areas along the margins of the valleys adjacent to the larger mountains. Water-table conditions probably also exist locally in bedrock. In the northern part of Scipio Valley, ground water occurs under both conditions chiefly in solution channels along joints and faults in the North Horn Formation and the Flagstaff Limestone. Artesian conditions exist in the alluvium generally in the middle and lower parts of several of the valleys. Artesian conditions also exist in the consolidated rock, principally in Round Valley.

ROUND VALLEY

Ground water in Round Valley occurs mainly under artesian conditions, especially in the central parts of the valley. The water is in the alluvium and also in the underlying bedrock. The latter is sandstone of the North Horn Formation or limestone of the Flagstaff Limestone; or both formations may underlie the valley and be water bearing. Three large flowing wells—(C–20–2)27dcc–1 (587 ft deep), (C–20–2)34abc–1 (770 ft deep), and (C–20–2)34baa–1 (700 ft deep)—tap permeable zones in the sandstone, and together they discharge 1,300–1,800 gpm (gallons per minute). The water apparently is confined in the sandstone by beds of relatively impermeable clay and silt in the overlying alluvium, which, at well (C–20–2)34baa–1, is reported to be 460 feet thick. The alluvium also contains some water under artesian pressure. Well (C–20–2)27caa–1, which is only 292 feet deep, discharges about 4 gpm from sand beds interfingered with beds of clay and silt. Well (C–20–2)15abb–1, 855 feet deep and 3 miles north of well (C–20–2)27caa–1, penetrates 833 feet of alluvium before entering sandstone, shale, and hard brown rock at depths between 833 and 855 feet. Its discharge of about 35 gpm probably comes from permeable beds of sand interfingered with beds of clay in the alluvium. (See table 7.)

Ground water occurs under water-table conditions in the unconsolidated alluvium around the margin of Round Valley. These deposits, which generally are parts of alluvial fans, are permeable, accept recharge readily, and form good ground-water reservoirs. Well (C-19-2)35bbd-1, in such a deposit east of Scipio Lake, is 29 feet deep and penetrates saturated alluvium at 24 feet. At greater depths, however, the water may be under artesian pressure, especially beneath Scipio Lake, a few hundred feet to the west. Several small springs around the margin of the lake may be of either water-table or artesian origin.

Ground water also probably occurs under water-table conditions in the narrow valley of Round Valley Creek between Round Valley and Scipio Valley. This stretch becomes rather narrow and steep, as contrasted to the rather wide and flat area of Round Valley at and upstream from Scipio Lake. Downstream from the lake, the valley descends at a rate of about 600 feet in 6 miles, and many small seeps discharge in the creek bed. These seeps probably indicate the position of either the main or a perched water table. It is unlikely that large water supplies occur at depth in this area because the alluvium is relatively thin and the underlying bedrock probably has low permeability. If the rocks at depth in this area had high permeability, they undoubtedly would drain the upper valley (Round Valley) and cause water levels there to be deeper than they are.

SCIPIO VALLEY

The mode of occurrence of ground water is unusual in Scipio Valley, in that water levels in wells change abruptly near the middle of the valley. In the southern (upstream) part of the valley, water levels generally are 10-50 feet below the land surface. On the other hand, water levels in the northern (downstream) part of the valley generally are more than 250 feet below the land surface. The abrupt change of more than 200 feet is marked by closely spaced depth-to-water patterns about 2 miles north of the town of Scipio. (See pl. 2.)

The shallow ground water in the southern part of Scipio Valley occurs under water-table conditions. The source of water mostly is seepage from Round Valley Creek or seepage of irrigation water diverted from the creek. The ground water is in permeable beds in the alluvium, and it may be perched on relatively impermeable beds of clay or silt. These, in turn, may overlie a deeper aquifer in which water levels are at depths similar to those in the northern part of the valley. Wells in the southern part of the valley, however, are not deep enough to verify this supposition.

The deep ground water in the northern part of Scipio Valley probably occurs under artesian conditions. The major source of the water probably is recharge on alluvial fans from precipitation and runoff from the surrounding mountains because the chemical quality of the deeper water is very good as compared to the shallow water in the southern part of the valley. (See analysis of water from well (C-17-2)

28bac–1 in table 5.) This water is similar in quality to water from springs along the base of the Pavant Range, as is indicated by the analysis of water from Maple Grove Springs (C–21–2½)2a. The general concentration and proportion of chemical constituents of water from these sources is shown also by diagrams on plate 2. Lesser sources of recharge are seepage from the shallower, possibly perched ground-water body in the southern part of the valley, and the occasional flow of water into the many sinkholes in the valley. The bulk of the ground-water reservoir is in the consolidated rocks underlying the valley. These are limestone and sandstone of the North Horn Formation, or the Flagstaff Limestone, or both. Wells (C–17–2) 28 bac–1 and (C–17–2)31adb–1 are 373 and 346 feet deep, penetrate bedrock at 180 and 196 feet, and have water levels of 332 (measured, August 1963) and 296 (reported) feet below the land surface. Thus, the water levels are considerably below the alluvium-bedrock contact. Well (C–17–2) 31ccc–1, on the other hand, was drilled 286 feet entirely in unconsolidated material, and the water level was reported to be 265 feet below the land surface. Thus, part of the ground-water reservoir in the northern part of the valley is in the alluvium. Undoubtedly the water in the bedrock and the water in the lower parts of the alluvium are hydraulically connected, as is indicated by the sinkholes and the common deep water levels.

The large difference between the water levels in the southern and northern parts of Scipio Valley correlates with the known occurrence of sinkholes in the valley. (Compare pls. 1 and 2.) The sinkholes are believed to be caused by the collapse of caverns in the limestone underlying the valley and the consequent collapse of the overlying alluvium. The caverns originally were caused by solution by ground water moving along fault planes, fractures, and joints. As the solution channels became larger, the average permeability and draining action of the limestone increased and caused water levels to decline. The collapse of the caverns and overlying alluvium breached beds of clay and silt that supported shallow ground-water bodies and thereby drained the water to deeper levels. This process explains the abrupt change in ground-water levels along the southern (upstream) edge of the sinkhole area.

The altitude of the deep water levels in the northern part of Scipio Valley is controlled by the altitude of the area of discharge and the hydraulic gradient of the water moving toward the area of discharge through solution channels in the bedrock. The area of discharge is probably Molten Springs, (C–16–2)34aab, and Blue Springs, (C–16–2) 25dbd. (See pl. 2.) As determined from a U.S. Geological Survey topographic map, the water level in well (C–17–2)28bac–1 in the northern part of Scipio Valley in August 1963 was less than 10 feet higher than the water level at the springs, 5½ miles away. This rather small difference indicates that the water moving through the solution channels toward the springs has a very flat hydraulic gradient. That the springs drain the lower ground-water bodies in Scipio Valley is indicated also by the similarity of chemical quality of the water in the springs and water in well (C–17–2)28bac–1 in Scipio Valley. (See table 5 and pl. 2.) A fairly consistent annual discharge from Molten Springs (fig. 6) indicates that a relatively large amount of water is stored in the aquifer drained by the springs.

A few relatively small sinkholes were observed at the extreme southern (upstream) end of Scipio Valley in secs. 29 and 30, T. 18 S., R. 2 W., and some large ones were observed in sec. 4, T. 19 S., R. 2 W. These holes, like all the others described above, trend in a north-northeasterly direction and persumably follow fault lines. Local residents report that several unsuccessful attempts were made to construct domestic and stock wells in the sink area. Depths to water in the area are not known because of the lack of wells, but they probably are deep.

The greatest depth of water determined anywhere in the area of investigation is 783 feet in well (C–18–3)34dda–1. This well is at Scipio Pass, about 4 miles southwest of Scipio, between the Canyon Mountains to the north and the Pavant Range to the south. The well derives water from limestone or sandstone, and the water level in the well is at an altitude of about 5,337 feet above mean sea level. This is about 90 feet above the water level in well (C–18–3)13acd–1 in Scipio Valley.

SOUTHERN JUAB VALLEY

Ground water in southern Juab Valley occurs in the alluvium under both water-table and artesian conditions. Water-table conditions exist mainly in the northern and southern parts of the valley and around the margins of the valley where the alluvium consists largely of permeable coarse-grained material deposited in fans extending from the mountains. Artesian conditions exist in the lower middle part of the valley where beds of relatively impermeable clay and silt overlie and interfinger with water-bearing beds of gravel and sand. The total thickness of the alluvium is not known, but it may exceed 1,000 feet.

The main areas of water-table conditions in southern Juab Valley are along a 1 to 3-mile-wide strip near the east side of the valley and in the remaining part of the valley north of Levan. Water-table conditions exist also in the southern part of the valley southeast of Chicken Creek Reservoir. The actual line where the water-table conditions stop and the artesian conditions begin is indefinite, is difficult to define, and changes with changes in water level. Bodies of clay or silt may cause local artesian conditions in water-table areas. The probability of finding strictly water-table conditions generally increases from the center of the valley toward the San Pitch Mountains, which is the major source of the alluvium, because the coarseness and average permeability of the valley fill generally increases toward the mountains Depths to the water table in the valley range from a few feet in places near the margin of the artesian area in the lower parts of the valley to more than 200 feet along the mountain front east and north of Levan. (See pl. 2.)

Most of the area of artesian conditions in southern Juab Valley is included within T. 15 S., R. 1 W., although it may extend northward or southward or in both directions into adjoining townships. The main area of artesian conditions includes Chicken Creek Reservoir and the area to the east and north in which symbols for flowing wells appear on plate 2. The highest hydrostatic head above the land surface measured in the artesian area was 21.8 feet at well (C–15–1)15aaa–1 in May 1963.

The water table and piezometric surface of the ground-water reservoir in southern Juab Valley are parts of one continuous surface. This surface describes the hydraulic gradient from the sources of recharge along the base of the San Pitch Mountains to points of discharge, including springs, seeps, and flowing wells near Chicken Creek Reservoir (see pl. 2.)

The ground-water surface slopes in the same general direction as does the land surface but generally is flatter than the land surface. The relatively flat and uniform hydraulic gradient near Levan in the northeastern part of southern Juab Valley indicates a generally high transmissibility of the alluvium and, consequently, a high potential yield from wells. This potential is supported by the fact that the irrigation wells having the largest yields in the valley are near Levan. The flat gradient and high transmissibility are due to a thick section of permeable coarse alluvium near the mountains.

The steeper gradient in the lower parts of the valley indicates a lower transmissibility and, consequently, a lower potential yield from wells. The steeper gradient is due to the combined effects of several factors: (1) The alluvium in the lower parts of the valley contains a greater proportion of clay and silt; hence, it has a lower average permeability and, consequently, a lower transmissibility; (2) the fact that the alluvium along the west side of the valley probably is thinner than along the east side results in a lower transmissibility; (3) the piezometric surface is steepened locally in the general vicinity of the springs, seeps, and flowing wells owing to loss in hydraulic head as the water moves toward the points of discharge.

The highest yields from wells are obtained in the eastern part of the valley near Levan where a large alluvial fan extends into the valley from the mouths of the canyons of Chicken and Pigeon Creeks. The high yields are attributed to a relatively thick section of permeable saturated gravel and sand. Recharge to the alluvium in this area is mainly from water in the two creeks. During the 1963 water year, 2,180 acre-feet of water flowed in Chicken Creek near Levan (U.S. Geol. Survey, 1963, p. 250) and about 1,200 acre-feet flowed in Pigeon Creek. This water is diverted by the Levan Irrigation Co. to irrigate about 2,000 acres near Levan. The water supply is supplemented by water from an irrigation well, (D-14-1)31ada-1, owned by the company and three privately owned irrigation wells.

Some difficulty has been experienced in constructing satisfactory wells in the middle, western, and southern parts of the valley because of fine sand or silt that is discharged with the water. Three wells, (C-14-1)26acd-1, (C-14-1)27aaa-1, and (C-16-1)4aad-1, were undermined to the extent that they collapsed and became unusable.

The alluvium in the southern 4 miles of southern Juab Valley apparently is somewhat less permeable and less capable of yielding large quantities of water to wells than the alluvium in other parts of the valley. Two wells drilled in this part of the valley, (C-15-1)33acd-1 and (C-16-1)4aad-1, had small yields and rather large drawdowns (table 4).

The water-table divide between the underground reservoirs in southern Juab Valley and northern Juab Valley is about 2 miles north of Levan (pl. 2), which is 1-2 miles south of the land-surface drainage divide. The latter is at the crest of Levan Ridge, a large alluvial fan extending westward across the valley from Fourmile Canyon and nearby canyons in the San Pitch Mountains. However, the position determined for the ground-water divide is approximate, because only a few wells were suitable for water-level measurement in the vicinity of Levan Ridge. The principal source of ground water moving northward and southward away from the divide is recharge from streams flowing from Fourmile Canyon and nearby canyons onto permeable gravel deposits in the canyon floor and in the alluvial fan.

MILLS VALLEY

Ground water in Mills Valley occurs under both water-table and artesian conditions. The water is mainly in the alluvium, which consists of flood-plain deposits of the Sevier River and of alluvial-fan deposits, and in the underlying Lake Bonneville Group. Both the alluvium and the Lake Bonneville Group are unconsolidated to partly consolidated and consist of gravel, sand, silt, and clay. The bedrock underlying the valley, particularly limestone and sandstone of the North

Horn Formation and Flagstaff Limestone, also contains ground water in places.

Water-table conditions exist along the margins of Mills Valley and at shallow depths throughout much of the remainder of the valley. Most of the wells are slightly above the flood plain of the river, near sandy and gravelly bluffs, and they penetrate water-bearing materials at depths of about 20–60 feet. One well in the flood plain, (C–15–2) 21dad–2, penerates water-bearing materials at 8 feet.

Artesian conditions exist at greater depths at many places beneath the flood plain in Mills Valley. Well (C–15–2)22bcc–1 flowed slightly more than 1 gpm under a hydraulic head of 1.5 feet above the land surface in June 1963; local residents report that other flowing wells existed in past years in the vicinity of The Meadows in and near sec. 35, T. 15 S., R. 2 W. Further indication of artesian conditions is the discharge of three large groups of springs—Chase, (C–16–2)2aad, Blue, (C–16–2)27dbd, and Molten, (C–16–2)34aab. Although Blue and Molten Springs discharge from flood-plain deposits, the water is believed to be derived from solution channels in the underlying bedrock, which is limestone of the North Horn or Flagstaff formations. The water in Chase Springs may be derived from either the alluvium or the underlying bedrock.

LITTLE VALLEY

Few data are available concerning the occurrence of ground water in Little Valley. The principal aquifer in the valley is believed to consist of the Lake Bonneville Group and the overlapping and underlying alluvium in a series of coalescing fans that extend eastward from the Canyon Mountains. Both the Lake Bonneville and the alluvial-fan material are unconsolidated. They consist of gravel, sand, silt, and clay, with finer materials predominating in the Lake Bonneville Group, and coarser materials predominating in the alluvial-fan deposits. The source of most of the ground water in Little Valley probably is seepage from intermittent and ephemeral streams which flow from canyons in the Canyon Mountains and lose water by seepage into the alluvial fans at the canyon mouths.

The only producing well in Little Valley in 1964 was well (C–17–2) 9ad–1. It penetrates water-bearing gravel at depths of 165–175 feet below the land surface, and in January 1963 the water level in the wells was about 148 feet below the land surface. The relatively good chemical quality of the water sampled from this well indicates a source of recharge in the nearby Canyon Mountains. (See table 5.)

According to residents of Scipio Valley, wells at one time supplied drinking water for homesteaders living in and near secs. 17, 18, 20, 21, and 30, T. 17 S., R. 2 W. One of these wells, about a quarter of a mile north of the center of sec. 21, contains a 6-inch steel casing and was dry at a depth of 120 feet when visited in 1963. According to information in the files of the Utah State Engineer, a well was drilled in 1943 in the NW¼ sec. 17 to a depth of 290 feet, and the water level was 265 feet below the land surface. The valley fill at this site was reported to be 279 feet thick and to be underlain by conglomerate. These data suggest that ground water in most parts of Little Valley is more than 100 feet below the land surface and in some places is more than 200 feet below the surface.

The altitude of the static water level in well (C–17–2)9bad–1 is about the same as the altitude of Molten Springs, about 3 miles to the northeast. This similarity suggests that the water in the valley fill near the well discharges through Molten Springs. The orientation of the line of sinkholes which were mapped in Little Valley in the SW¼ sec. 9, T. 17 S., R. 2 W., indicates that solution channels in bedrock underlying the valley fill is part of the system of solution channels that drains Scipio Valley toward Molten and Blue Springs. Thus, part of the ground water in the valley fill in Little Valley is believed to find its way eventually to the Sevier River through Molten or Blue Springs.

DOG VALLEY

Little is known about the occurrence of ground water in Dog Valley. The only well in the valley, (C–13–2)14aad–1, was dry when sounded at a depth of 440 feet. The well was reported to be 550 feet deep when drilled. The water level, therefore, lies at depths of 440–550 feet. The type of aquifer is not known.

Although the well is dry, it indicates considerable permeability at depth. Air rushes in or out of the well during and following periods of changing barometric pressure. Once, when the well was visited during a period of low pressure, the outrushing air was heard about 50 feet from the well. If the rocks penetrated by the well are capable of absorbing and expelling great quantities of air, they are also capable of transmitting or storing large amounts of water.

The great depth to ground water in Dog Valley is attributed to several factors: (1) The altitude of the valley is about 500 feet above northern Juab Valley, about 2 miles to the east, and about 600 feet above the Sevier River, about 12 miles to the soutwest, which drains the area through ephemeral tributaries; (2) little precipitation falls on the valley and on the rather low mountains that surround it; (3) the valley has no perennial streams; and (4) the rocks underlying the valley may be permeable enough to allow water to move out of the area in the subsurface.

TINTIC WASH VALLEY

Little is known about the occurrence of ground water in Tintic Wash Valley. Part of the valley, in a 2- to 3-mile-wide troughlike area extending northward from Tintic Wash, is bordered on each side by moderately high mountains and coalescing alluvial fans, the latter apparently being composed partly of permeable gravel and sand. Coarse gravel is exposed in gullies on the valley floor cut by Tintic Wash and its tributaries. The depth to water in the only well in the valley, (C–13–2)31cc–1, is 43 feet. It is likely that the valley contains a considerable thickness of alluvium, some of which should be relatively permeable and saturated with water. Therefore, the valley appears to be a potential producer of water from underground sources. The ground water in Tintic Wash Valley probably is tributary to the Sevier River.

MOVEMENT

Ground water is seldom stationary; like water in streams, it moves under the force of gravity toward a lower position. The rate of ground water movement, however, usually is not more than, and generally is much less than, a few inches a day. The rate of movement depends upon the hydraulic gradient and on the permeability and effective porosity of the water-bearing materials. The quantity of water moving depends upon these factors and also upon the cross-sectional area of the water-bearing materials normal to the direction of movement.

Most of the ground water in the area of investigation moves toward the Sevier River, which is the natural drain for the area. Some of the water reaches the river, but some of it, where it comes near or to the land surface along the way to the river, is consumed by evaporation and transpiration. A small amount of water in southern Juab Valley moves away from the Sevier River toward northern Juab Valley; this movement is discussed on page 41.

ROUND VALLEY TO MOLTEN AND BLUE SPRINGS

Water moves directly from the rocks of the Pavant Range to the alluvium in Round Valley and to the bedrock underlying the alluvium, and water also seeps from surface streams into permeable alluvial-fan material at the eastern front of the Pavant Range. Some of the water discharges from Maple Grove Springs, (C–21–2½)2a, from other nearby smaller springs, and from several large flowing wells; this water flows in a ditch to Scipio Lake from whence it is eventually transmitted to Scipio Valley.

Some of the ground water in Round Valley moves in the subsurface to Scipio Valley, but the quantity probably is small. At Round Valley, the altitude of the land surface is about 600 feet above that of the head of Scipio Valley, about 4 miles downstream. In spite of this difference in altitude, ground water in Round Valley comes to the surface in small springs and seeps around Scipio Lake—a feature that indicates the existence of a ground-water barrier between Round and Scipio Valleys.

In Scipio Valley, water enters the alluvium by seepage from Round Valley Creek, seepage from irrigated fields, and seepage from streams into alluvial fans near the adjoining mountains. The water then moves northward through the alluvium, but midway in the valley the water descends through conduits beneath sinkholes to a deeper ground-water body in bedrock at 250 feet or more beneath the land surface. The water then moves northeastward, through solution channels formed in limestone along fault lines, toward Molten and Blue Springs. These channels are discussed at greater length on pages 18 and 23.

SOUTHERN JUAB VALLEY TO THE SEVIER RIVER

Water seeps from surface streams in southern Juab Valley into permeable alluvial-fan material near the San Pitch Mountain front, mainly near the canyon mouths of Fourmile, Pigeon, Chicken, Deep, Little Salt, and Criss Creeks. Within the ground-water reservoir, the water moves westward from the east side of the valley, thence southward and northward to the vicinity of Chicken Creek Reservoir in the lowest part of the valley, where it emerges at the surface in flowing wells and in small springs and seeps. The water-level contours on plate 2 demonstrate the hydraulic gradient that exists from the east side of the valley toward the reservoir.

Water from Chicken Creek Reservoir is used for irrigation on the east side of Mills Valley, and some of the water seeps to the ground-water reservoir. The ground water probably moves southwestward for a distance of ½–1 mile and then emerges at the land surface as part of the discharge from springs and seeps in a marshy area called The Meadows. A creek carrying about 2–4 cfs (cubic feet per second) drains northward from The Meadows to the Sevier River.

Very little ground water moves in the subsurface from southern Juab Valley to Mills Valley. A small range of mountains called the West Hills separates the two valleys. The hills consist of shale, conglomerate, and other rocks having low permeability which dip steeply eastward into southern Juab Valley. Because water seeping through the range would have to pass through all these formations, the West Hills undoubtedly forms an effective barrier to the movement of ground water. Some water, however, moves through the alluvium in the bottom of Chicken Creek gap through the West Hills. This flow is indicated by willows and other phreatophytes growing in the canyon along the creekbed and by a gain of less than ½ cfs in the stream. The amount of water moving through the alluvium is small, however, because the canyon is narrow and the alluvium in it probably is thin.

MOVEMENT DOWNVALLEY PAST YUBA DAM

Some water may move northward from the vicinity of Sevier Bridge Reservoir through the flood-plain deposits of the Sevier River or through the alluvium or underlying bedrock of The Washboard. (See pl. 2.) This water may discharge at Chase Springs, (C–16–2)2aad. Water collected at the springs contained 1,190 ppm (parts per million) of dissolved solids (table 5), almost three times that of Molten and Blue Springs, and nearer the average quality of both the ground and surface water in the Sevier River valley near Sevier Bridge Reservoir.

The following evidence indicates that the discharge from Molten Springs is not related in any way to subsurface movement of water from the Sevier Bridge Reservoir above Yuba Dam: (1) According to reports from local residents, the springs existed before the construction of the dam; (2) the temperature of water from Molten Springs was consistently 61°–62°F when measured at monthly intervals throughout 1963 (table 5); and (3) the dissolved-solids content of water from Molten Springs was always close to 400 ppm, as indicated by monthly measurements of the specific conductance of water from the springs. (See table 5.) If seepage from Sevier Bridge Reservior were an important factor influencing the discharge of Molten Springs, a greater fluctuation of temperature and chemical quality would be expected in the water discharge from the springs.

The temperature and chemical quality of the water from Blue Springs is quite similar to that of the water from Molten Springs (table 5). Local residents also state that Blue Springs existed before the construction of Yuba Dam. It is concluded, therefore, that the discharge from Blue Springs, as well as Molten Springs, does not originate from water in the Sevier Bridge Reservoir.

WATER-LEVEL FLUCTUATIONS

Water levels in wells fluctuate for many reasons. They rise with a net addition of water to the ground-water reservoir and decline with a net subtraction, and they fluctuate briefly because of barometric changes, earthquakes, tidal effects, and other causes. The various influences may operate singly or in combination and may be long term, seasonal, daily, or brief. Only long-term and seasonal fluctuations are discussed further in this report.

Water levels were measured at monthly intervals in nine wells during the period of field investigation, and hydrographs of these wells are shown in figure 4. Each of the valleys discussed in this report, with the exception of Dog Valley, is represented by one or more hydrographs.

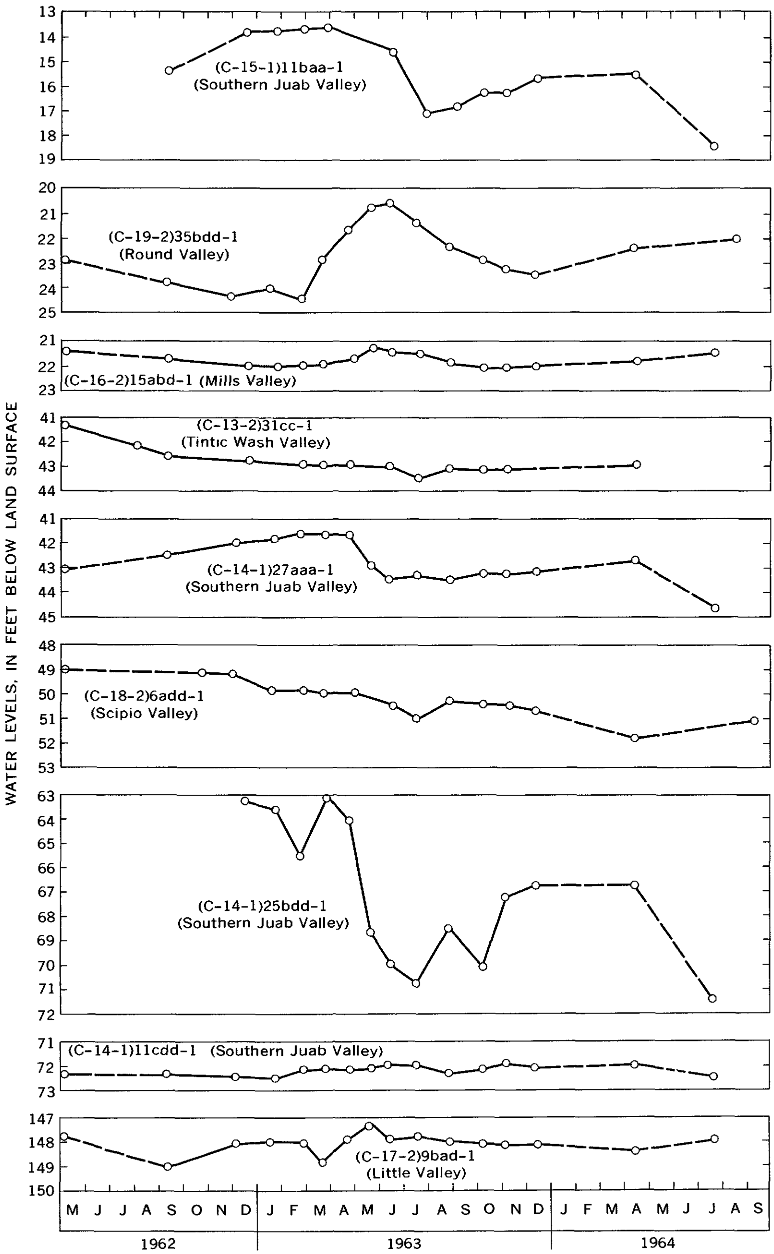

FIGURE 4.—Hydrographs of selected wells in the Sevier River basin between Yuba Dam and Leamington Canyon.

ROUND VALLEY

Water-level fluctuations near Scipio Lake in the northern part of Round Valley are shown in figure 4 by the hydrograph of well (C–19–2)35bdd–1, located about a quarter of a mile northeast of the lake. The water level in the well rises after the lake is filled and declines after the lake is emptied, both water-level changes lagging the lake changes by about 2 months.

Piezometric heads in the artesian aquifer in Round Valley probably have declined significantly in the southern part of the valley since three large-diameter flowing wells were constructed during 1957–61. These wells, (C–20–2)27dcc–1, (C–20–2)34abc–1, and (C–20–2)34baa–1, have flowed continuously since 1961 at a combined rate of more than 3 cfs. An unnamed spring, (C–20–2)33aab, about half a mile west of the well sites, flowed at the rate of 2.1 cfs in May 1956, but it stopped flowing soon after the completion of the flowing wells (Morrill Mathews, Supt., Scipio Irrigation Co., oral commun., 1964). The net discharge from the aquifers, therefore, was increased by about 1 cfs, and this increase should have caused some decrease in the hydrostatic pressure locally within the aquifer.

SCIPIO VALLEY

Shallow water levels in the southern part of Scipio Valley declined about 2 feet during 1963. (See hydrograph of well (C–18–2)6add–1 in fig. 4). Inasmuch as little ground water is pumped in Scipio Valley, the decline of water levels during 1963, which was a year of about normal precipitation, represents a return to average water levels after a rise during 1962. Parts of Scipio Valley were flooded in February 1962 during a sudden thaw that followed a period of heavy precipitation. A playa lake was formed in a local land depression about 1½ miles northwest of Scipio, and water remained in the lake until the following October. Seepage from the lake and from unusually large amounts of surface water applied to the land for irrigation raised the shallow water levels in the southern part of the valley. The gradual decline of water levels during 1963 followed.

Deep water levels in the northern part of Scipio Valley are believed to fluctuate little because they are controlled largely by the altitudes of Molten and Blue Springs. They probably rise slightly when a large amount of water flows into the many sinkholes in the area, as in February 1962, and then decline in response to increased discharge from the springs. The hydrograph of well (C–17–2)9bad–1 in Little Valley, which shows almost no long-term changes of water level, is believed to be typical of deep water-level changes in Scipio Valley. The water in well (C–17–2)9bad–1 stands at about the same altitude as the springs, which are also close to the altitude of deep water levels in Scipio Valley.

SOUTHERN JUAB VALLEY

Water levels in southern Juab Valley during 1963 declined about 3½ feet, half a mile northwest of Levan; 2 feet, 2 miles southwest of Levan; and 1 foot, 2½ miles west of Levan. These declines are indicated on the hydrographs of wells (C–14–1)25bdd–1, (C–15–1) 11baa–1, and (C–14–1)27aaa–1, respectively, shown in figure 4. Each of the three hydrographs indicates a large decline during the pumping season followed by a lesser recovery during the nonpumping season; thus the result is a net decline for the year. The amount of decline was greatest near Levan, where there is a concentration of irrigation wells (pl. 2), and it decreased toward the west. A hydrograph of well (C–14–1)11cdd–1, 4 miles northwest of Levan, shows no significant changes of water level, neither seasonal nor for the year.

The long-term relation of water-level fluctuations to precipitation is shown in figure 5 by comparison of a hydrograph of well (C–15–1) 12aba–1 for the years 1935–64 with a curve for cumulative departure from normal annual precipitation (1931–60) at Levan for 1931–63. Prior to 1960, the water level in the well rose during periods of greater-than-average precipitation and declined during periods of less-than-average precipitation. After 1960, the water level declined despite greater than average precipitation. This change in relationship was caused by pumping from wells for irrigation in the general vicinity of Levan.

MILLS, LITTLE, AND TINTIC WASH VALLEYS

Very little change of water levels during 1963 is shown by the hydrographs of wells in Mills, Little, and Tintic Wash Valleys (fig. 4). A slight decline, however, is indicated during 1962, following the wet winter and late winter floods of 1961–62, in the hydrographs of wells (C–16–2)15abd–1 in Mills Valley and (C–13–2)31cc–1 in Tintic Wash Valley. No overall change of water level is indicated for the southern part of Little Valley by the hydrograph of well (C–17–2)9bad–1. There is little pumping of ground water in this area, and water levels are controlled largely by the altitudes of Molten and Blue Springs. The control of water levels by these springs is discussed in greater detail on pages 23 and 29.

DISCHARGE

Water is discharged from the aquifers in the area of investigation by pumped and flowing wells, springs, seeps, evaporation, transpiration, and the subsurface movement of ground water out of the area.

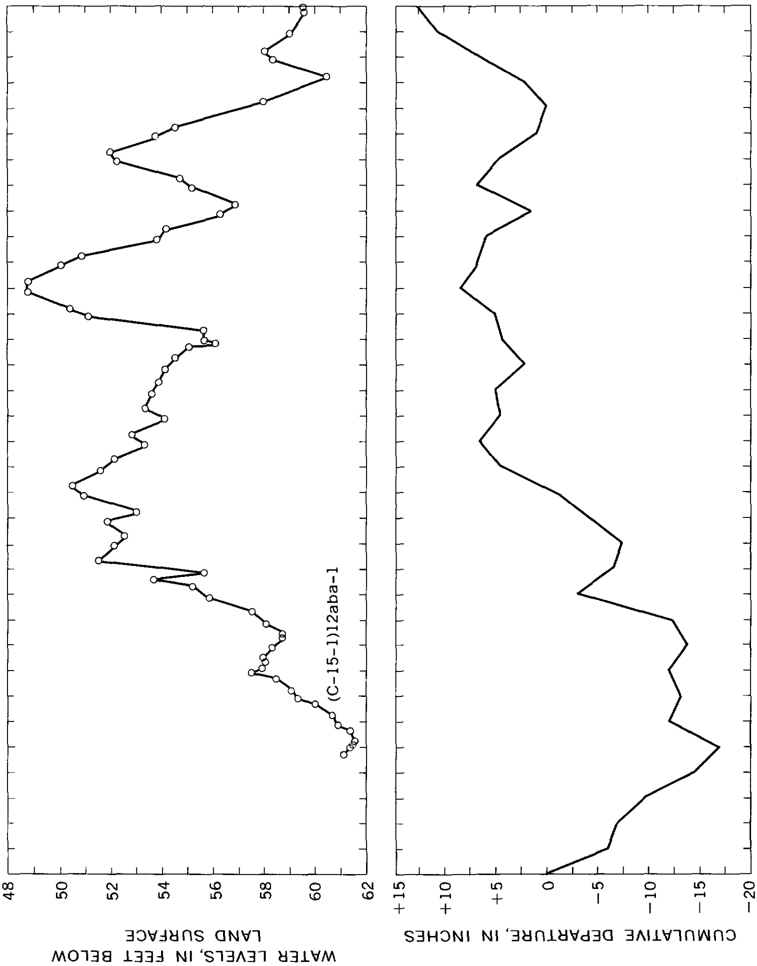

FIGURE 5.—Hydrograph of well in southern Juab Valley, 1935–64, and cumulative departure from the normal annual precipitation (1931–60) at Levan, 1931–63.

WELLS

The only wells that discharge large quantities of water in the area are in Round and southern Juab Valleys.

Round Valley.—During 1963 six flowing wells in Round Valley discharged about 2,800 acre-feet of water, and most of it was discharged by three large irrigation wells in the southern part of the valley. These wells, (C-20-2)27dcc-1, (C-20-2)34abc-1, and (C-20-2)34baa-1, tap artesian aquifers in the North Horn(?) Formation and (or) Flagstaff Limestone. Another well, (C-20-2)27caa-1, taps an artesian aquifer in the alluvium. The amount of water that is pumped from a few stock wells in the valley is negligible.

Southern Jaub Valley.—During 1963 about 3,800 acre-feet of water was discharged from wells in southern Juab Valley near Levan. This amount included about 2,600 acre-feet pumped from nine irrigation wells and about 1,100 acre-feet which flowed from seven wells. Most of the latter was discharged from four large wells, (C-15-1)16baa-1, (C-15-1)16bad-1, (C-15-1)16cbb-1, and (C-15-1)17dad-1. A few additional small flowing wells discharged an undetermined but relatively small amount of water, probably about 100 acre-feet. All the wells in southern Juab Valley tap the alluvium.

Scipio, Mills, Little, Dog, and Tintic Wash Valleys.—Scipio, Mills, Little, Dog, and Tintic Wash Valleys contain few wells, and the total discharge from wells is small. The only flowing well, (C-15-2)22bcc-1, is in Mills Valley, and it discharges about 1 gpm. Probably less than 25 acre-feet of water is discharged annually from wells in these valleys.

SPRINGS AND SEEPS

Springs and seeps which issue on and near the floors of Round, southern Juab, and Mills Valleys discharged about 28,000 acre-feet of water during 1963. Although they generally issue from the alluvium, most of their water is derived from the underlying bedrock. Scipio, Little, Dog, and Tintic Wash Valleys have no large springs, but small springs issue from either bedrock or from alluvium in the bottom of canyons tributary to these valleys.

ROUND VALLEY

Maple Grove Springs, (C-21-2½)2a, is the principal point of natural ground-water discharge in Round Valley. During 1963 these springs discharged about 4,300 acre-feet, as shown by the average of nine flow measurements about 1 mile below the spring area, in the creek fed by the springs. The actual discharge of the springs is somewhat higher because part of the water was used by the abundant vegetation near the springs. The springs flow from the east side of the Pavant Range along a steep colluvial slope at the base of cliffs formed of conglomerate of the Price River Formation (Upper Cretaceous). (See table 1.) They evidently discharge from the bedrock, probably along bedding planes and a fault line, into the rubble of the colluvial slope, and thence to the land surface. The temperature of the water is about 51°F, and the water is derived mostly from precipitation on the Pavant Range. Because the rock strata in the range locally dip southeastward, the water probably moves southward along the bedding planes toward the springs from the northern parts of the range. Local landowners report that the amount of water the springs discharge during a year depends largely on the amount of snow accumulated in the mountains the preceding winter. The combined flow from Maple Grove Springs, from a relatively small flow from a canyon south of the springs, and from three flowing wells in Round Valley is shown in a hydrograph of Ivie Creek (fig. 6). The discharge in December 1963 was considerably less than the discharge in December 1962 because 1963 was a year of below-normal precipitation whereas 1962 was a year of above-normal precipitation.

Several small springs and seeps discharge from the alluvium near Scipio Lake. It is not known if they are artesian springs or if they are perched on a clay zone in the alluvium and drain water from alluvial fans to the east and west. Most of the water is consumed by evapotranspiration near the springs and seeps.

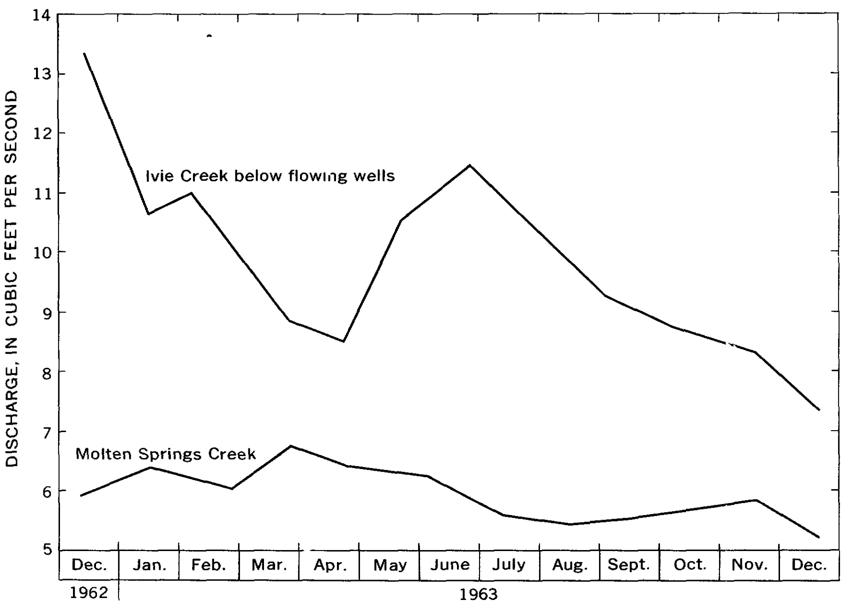

FIGURE 6.—Hydrographs showing flow during 1963 in Molten Springs Creek and in Ivie Creek below tributary flowing wells.

About 210 gpm (about 340 acre-feet per year) of water flows from improved springs, (C–19–2)9db, that discharge from alluvium along the creekbed in the valley narrows at the northern (lower) end of Round Valley. The water is used for public supply by the town of Scipio. The relatively low temperature (54°F) and low content of dissolved chemical constituents (see table 5) suggest that most of the water from the springs is derived from alluvial fans along the nearby Pavant Range, rather than from subsurface flow from Round Valley.

SOUTHERN JUAB VALLEY

Many artesian springs and seeps discharge in an area that includes about 6 square miles in the vicinity of Chicken Creek Reservoir. Water is forced upward by hydrostatic pressure in water-bearing beds of sand and gravel through overlying confining beds of silt and clay. Most of the springs are small and their discharge is diffused in seep areas; consequently, much of the water discharged is consumed by evaporation and by transpiration of meadow grasses near the springs and seeps. The actual discharge from the springs and seeps, therefore, is difficult to estimate. However, on the basis of releases from Chicken Creek Reservoir, from estimated evaporation losses from an open-water surface of 300 acres, and from the amount of water contributed by flowing wells, it is estimated that about 1,300 acre-feet of water reaches the reservoir from such springs. Some of these springs and seeps probably are in the bed of the reservoir.

Numerous springs discharge in the San Pitch Mountains in the canyons of Fourmile, Pigeon, Chicken, Deep, Little Salt, and Criss Creeks. The springs are about 4 miles upstream from the mountain front, and they individually discharge 200–900 gpm along a line marking the contact of the Arapien Shale of Jurassic age to the west and conglomerate and sandstone of the Indianola Group of Cretaceous age (see table 1) to the east. Ground water is forced to the surface along this line because the Arapien Shale is less permeable than the rocks of the Indianola Group, and erosion of the Arapien produces less permeable alluvium than does erosion of the Indianola. Furthermore, the gradients of the canyons upstream are much steeper than they are downstream. This decrease in permeability and hydraulic gradient causes the ground water to rise along or near the contact zone and to discharge into surface streams.

Springs also discharge in the canyons downstream from the Arapien-Indianola contact. Water seeps from the streams into permeable alluvium and returns to the land surface in spring discharge where it encounters less permeable alluvium or partial bedrock barriers across the streambeds. Springs (D–14–1)10abd, (D–14–1)11bcd, (D–14–1)11dda, (D–14–1)33cbb, and (D–14–1)34cbd are of this type.

According to local residents, many springs discharge in the high rolling country within the San Pitch Mountains. The water that flows from these springs is either consumed locally by evapotranspiration, finds its way into the canyons that drain into southern Juab Valley, or seeps into the rocks and eventually becomes part of the discharge from the springs in the canyons below. Some of the water originating in the high country may be discharged from springs on the eastern side of the mountains and flow into Sanpete Valley because although the prevailing dip in the sandstone and conglomerate beds is to the west, local dips are to the east.

MILLS VALLEY

The largest springs in the area discharge near or directly into the Sevier River in Mills Valley. During 1963 Molten Springs, (C–16–2) 34aab, discharged about 4,400 acre-feet of water; Blue Springs, (C–16–2)27dbd, about 16,000 acre-feet; and Chase Springs, (C–16–2)2aad, about 2,200 acre-feet, for a total of about 22,600 acre-feet. A hydrograph of Molten Springs showing monthly flow measurements for 1963 is shown in figure 6.

Molten and Blue Springs are only about half a mile apart, and because the water discharging from the two springs is similar in chemical quality and temperature, they may be regarded as parts of a common spring area. The source of the springs and their relation to the regional geology are discussed further on pages 18 and 23. Molten and Blue Springs are believed to be the principal discharge points for most of the area of investigation west of the Sevier River, including Round and Scipio Valleys and most of Little Valley and their adjacent mountain slopes.

Chase Springs discharges water having about the same temperature as water from Molten and Blue Springs, but it contains about three times the amount of dissolved solids. (See table 5.) Chase Springs, therefore, may derive its water from a different source than Molten and Blue Springs. (See p. 18.)

The Meadows is a swampy area, north and west of Chase Springs, in which many springs and seeps including Chase Springs discharge about 2,000 acre-feet of water per year. According to local residents, a few flowing wells once existed in this area; thus the ground water is evidently under artesian pressure. The measured discharge of a drain from The Meadows north to the Sevier River was a 3.8 cfs in March 1963 and 2.1 cfs in October 1963. The Meadows includes an area of about 700 acres of phreatophytes from which about 36 inches of water would be consumed annually by evapotranspiration. Thus the annual evapotranspiration would be about 2,000 acre-feet, an amount equal to a continuous flow of about 3 cfs. The total discharge in the The Meadows including Chase Springs, therefore, is about 4,000 acre-feet per year.

Most of the water discharging from the The Meadows probably has the same source as the discharge from Chase Springs. Some of the water discharged in the Meadows, however, originates as return flow from water used to irrigate about 1,000 acres of land along the east side of Mills Valley, near the community of Mills. This water is diverted from Chicken Creek Reservoir.

EVAPOTRANSPIRATION

Discharge by evapotranspiration generally is high where ground water is at or near the land surface. Shallow ground water may rise to the land surface by capillary action in the soil and be evaporated, or it may be taken in by roots of plants and discharged from the leaves into the air by transpiration. Plants that commonly extend roots into the zone of saturation or into the moist capillary fringe immediately above it are called phreatophytes. These plants transpire a relatively large amount of water where the growth is dense, the area covered is large, and the depth to water is not more than 10 feet. The most common phreatophytes in the area are saltgrass (*Distichlis stricta*), greasewood (*Sarcobatus vermiculatus*), rabbitbrush (*Chrysothamnus* sp.), willow (*Salix* sp.), cottonwood (*Populus* sp.), and saltcedar (*Tamarix gallica*). Saltgrass grows mostly in the wet meadows, greasewood and rabbitbrush in fringe areas near the wet meadows, and willow and cottonwood along streams and irrigation ditches. Saltcedar grows in only a few scattered sites along the Sevier River, particularly around Blue Springs and near the head of Leamington Canyon.

The lower parts of Round, Mills, and southern Juab Valleys are areas of high evapotranspiration in which the chief phreatophyte is saltgrass. Each area includes several square miles in which ground water, mainly under artesian pressure, seeps to the surface or is discharged by springs and flowing wells. The three areas include about half of the area shown on plate 2 where the depth to water is less than 10 feet. The wettest areas are in The Meadows in Mills Valley and in an area extending from the northeast edge of Chicken Creek Reservoir for about 2 miles northeastward in southern Juab Valley.

SUBSURFACE OUTFLOW

Water discharges in the subsurface from the area in two places. Probably at least 3 cfs moves downstream in the subsurface through Leamington Canyon. This discharge is indicated by a loss of more than 3 cfs in the last few miles of the river above the head of the canyon. (See p. 42.) Most of the water lost from the river must move down the canyon in the subsurface because only a small part of it can be accounted for by evapotranspiration. Most of the lost water apparently returns to the surface at several springs and seeps that issue from the alluvium near and above a bedrock outcrop which extends across the canyon about 2 miles downstream from its head.

A small amount of water moves in the subsurface from southern Juab Valley to northern Juab Valley where the ground-water divide between the two valleys is within southern Juab Valley, about 2 miles south of the topographic divide at Levan Ridge. (See pl. 2.) The amount of subsurface movement probably is less than 1 cfs because it is derived only from the recharge between the topographic and ground-water divides. No perennial streams and canyons that drain large areas enter the valley between the two divides and none of the area is irrigated; thus recharge between the divides would be mainly seepage from the runoff of the immediate mountain fronts bounding the valley and the precipitation on about 8 square miles of the valley floor. The amount of recharge on the valley floor must be very small because precipitation on the valley floor and the lower parts of the mountains is barely enough to support natural and dryfarm vegetation.

GROUND-WATER ACCRETION TO THE SEVIER RIVER

Two seepage runs were made on the Sevier River during March and October 1963 to determine the gains or losses in streamflow in the 19-mile reach between Yuba Dam and Leamington Canyon. The river was gaged at intervals, tributary inflow was measured, and water samples for chemical analysis were collected at each station. Details of the two seepage runs are given in tables 2 and 3, and a graphic representation of the gains and losses of the stream within the reach during the March seepage run is shown in figure 7.

The overall ground-water accretion to the river between Yuba Dam and Leamington Canyon during the two seepage runs was calculated to be about 33 cfs in March and 27 cfs in October. The greatest gains in the river were at Molten and Blue Springs, which together added 30.4 cfs in March and 26.8 cfs in October. Additional gains, amounting to 5.6 cfs in March and 4.5 cfs in October, were noted below the springs through Mills Valley. A loss of 3.4 cfs in the last 4-mile reach of the river above Leamington Canyon was noted in March, and a loss of 4.4 cfs in the last 2-mile reach was noted in October.

The ground-water accretion to the Sevier River in the area of investigation also was estimated from the records of the U.S. Geological Survey gaging station near Lynndyl, about 12 miles downstream from the area. Records for October and November were used because during these months (1) surface runoff to the river is small, (2) little or no water is released from Sevier Bridge Reservoir, (3) little water is

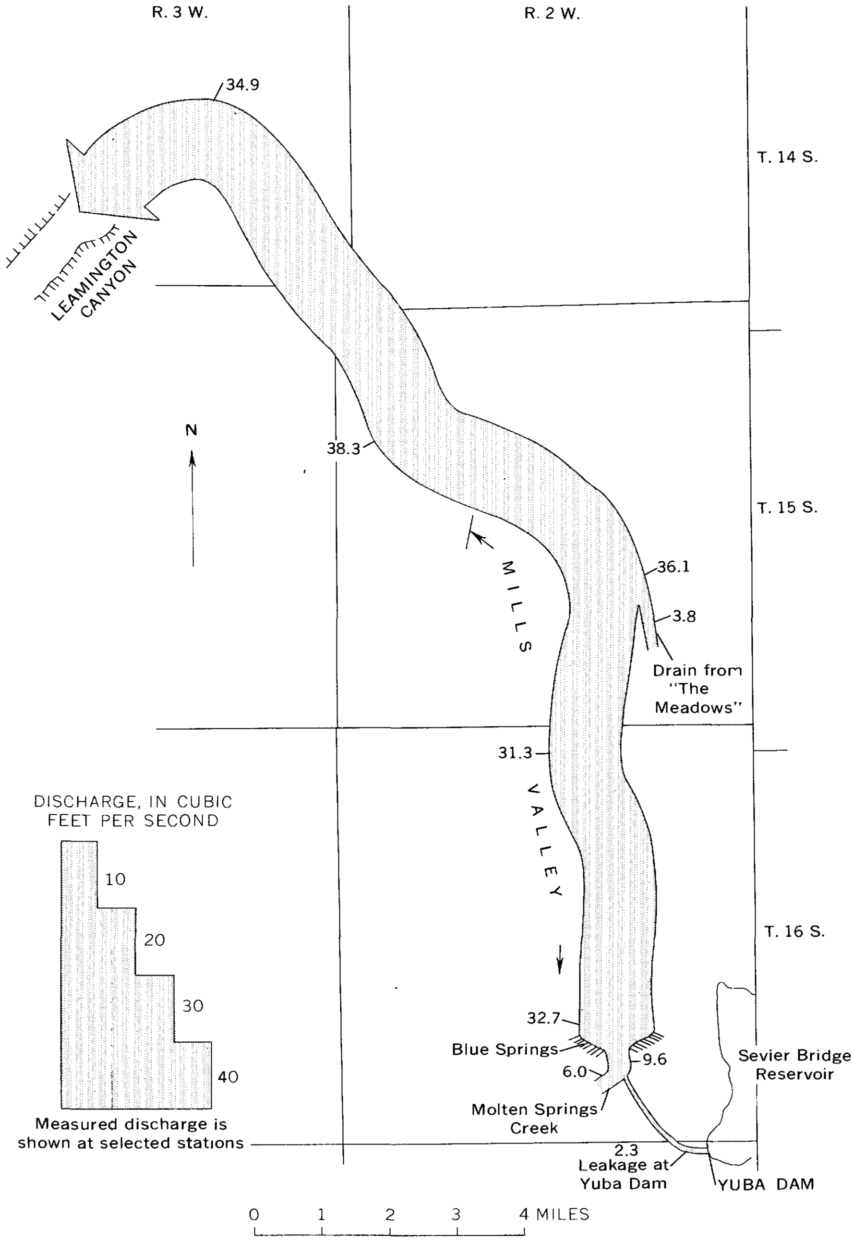

Figure 7.—Cumulative discharge of the Sevier River between Yuba Dam and Leamington Canyon during March 7–8, 1963.

TABLE 2.—*Approximate discharge of the Sevier River due to ground-water discharge between Yuba Dam and Leamington Canyon, March 7–8, 1963*

Location and description of measuring station	Approximate distance from Yuba Dam along trend of riverbed (miles)	Total flow at measuring station (cfs)	Flow at station due to ground-water discharge (cfs)	Net gain (+) or loss (−) due to ground-water discharge from preceding station (cfs)	Cumulative gain in riverflow due to ground-water discharge (cfs)
SW¼SE¼ sec. 35, T. 16 S., R. 2 W., below Yuba Dam in the Sevier River	0.3	[1] 2.3	0	0	0
NE¼NE¼ sec. 34, T. 16 S., R. 2 W., in Molten Springs creek	1.5	[2] 6.0	6.0	0	0
SW¼SW¼ sec. 26, T. 16 S., R. 2 W., below Molten Springs creek in the Sevier River	1.6	9.6	7.3	+7.3	7.3
SE¼NE¼ sec. 27, T. 16 S., R. 2 W., below Blue Springs in the Sevier River	2.1	32.7	30.4	+23.1	30.4
SE¼NW¼ sec. 3, T. 16 S., R. 2 W., in the Sevier River	6.6	31.3	29.0	−1.4	29.0
NW¼NW¼ sec. 26, T. 15 S., R. 2 W., in drain from The Meadows flowing into the Sevier River	9.2	3.8	3.8	0	29.0
SW¼SW¼ sec. 23, T. 15 S., R. 2 W., below drain and RR crossing, in the Sevier River	9.3	36.1	33.8	+4.8	33.8
SE¼ sec. 7, T. 15 S., R. 2 W., near Union Pacific RR milepost 683¾, in the Sevier River	14.5	38.3	36.0	+2.2	36.0
SE¼SE¼ sec. 22, T. 14 S., R. 3 W., above highway bridge, in the Sevier River	18.5	34.9	32.6	−3.4	32.6

[1] Seepage through dam headgates.
[2] Measured February 25, 1963.

diverted from the river above the gaging station, and (4) the flow usually is not retarded by freezing. Figure 8 shows the approximate ground-water accretion to the river between Yuba Dam and the gaging station near Lynndyl during the months of October and November 1955–62. A seepage run in November 1962 (R. W. Mower, oral commun., 1964) indicated a net loss of only about 2 cfs in the 12-mile stretch between the head of Leamington Canyon and the gaging station near Lynndyl. Thus the gains during the months of October and November 1955–62 (fig. 8), are believed to represent the approximate ground-water accretion in the reach between Yuba Dam and Leamington Canyon. The accretion estimated from the gaging-station records is on the same order of magnitude as the accretion determined by the seepage runs in March and October 1963 (fig. 8).

The approximate ground-water accretion to the Sevier River, as indicated primarily for the months of October and November in figure 8, probably is representative of most of the year; it is slightly greater than in months when large flows are released from the Sevier Bridge Reservoir. The flow of a release raises the water surface in the river several feet, and thereby decreases by a similar amount the hydraulic head of springs that discharge directly into the river from beneath.

TABLE 3.—*Approximate discharge of the Sevier River due to ground-water discharge between Yuba Dam and Leamington Canyon, October 21–22, 1963*

Location and description of measuring station	Approximate distance from Yuba Dam along trend of riverbed (miles)	Total flow at measuring station (cfs)	Flow at station due to ground-water discharge (cfs)	Net gain (+) or loss (−) due to ground-water discharge from preceding station (cfs)	Cumulative gain in riverflow due to ground-water discharge (cfs)
SW¼SE¼ sec. 35, T. 16 S., R. 2 W., below Yuba Dam in the Sevier River	0.3	[1] 3.3	0	0	0
NE¼NE¼ sec. 34, T. 16 S., R. 2 W., in Molten Springs creek	1.5	[2] 5.6	5.6	0	0
SW¼SW¼ sec. 26, T. 16 S., R. 2 W., below Molten Springs creek in the Sevier River	1.6	8.5	5.2	+5.2	5.2
SE¼NE¼ sec. 27, T. 16 S., R. 2 W., below Blue Springs in the Sevier River	2.1	30.1	26.8	+21.6	26.8
SE¼NW¼ sec. 3, T. 16 S., R. 2 W., in the Sevier River	6.6	30.3	27.0	+.2	27.0
NW¼NW¼ sec. 26, T. 15 S., R. 2 W., in drain from The Meadows flowing into the Sevier River	9.2	2.1	2.1	0	27.0
SW¼SW¼ sec. 23, T. 15 S., R. 2 W., below drain and RR crossing, in the Sevier River	9.3	33.3	30.0	+3.0	30.0
SE¼SE¼ sec. 36, T. 14 S., R. 3 W., below RR bridge and Union Pacific RR milepost 681¾, in the Sevier River	16.5	34.6	31.3	+1.3	31.3
SE¼SE¼ sec. 22, T. 14 S., R. 3 W., above highway bridge, in the Sevier River	18.5	30.2	26.9	−4.4	26.9

[1] Leakage through dam headgates.
[2] Measured October 1, 1963.

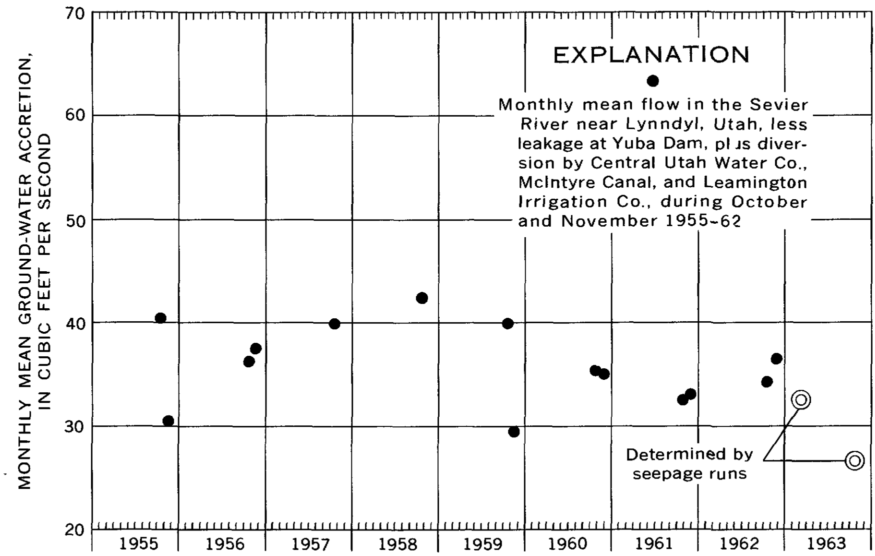

FIGURE 8.—Approximate ground-water accretion, to the Sevier River between Yuba Dam and Leamington Canyon during the months of October and November 1955–63.

Several of the Blue Springs are in the riverbed, and a rise of water in the stream would affect the discharge of these springs considerably because the toal head of the springs, as indicated by estimated altitudes of water level in wells (C–17–2)9bad–1 and (C–17–2)28bac–1, is not more than a few feet. The flow of most of the Molten and Blue Springs, however, would not be greatly affected because they discharge a few feet above the usual surface of the river.

The flow of the river at the gaging station near Lynndyl during the winter months generally ranges from about one-half to three-fourths of the estimated ground-water accretion to the river between Yuba Dam and Leamington Canyon. Most of the remaining one-fourth to one-half of the water is stored in the form of ice along the stream channel. During the early spring months the flow at the gaging station exceeds the ground-water accretion because of ice melt in the channel and runoff from melting snow.

UTILIZATION OF WATER

The alluvium, Flagstaff Limestone, and North Horn Formation are the principal sources of water to wells and springs in the area. Of the 90 wells and 15 springs visited during the field investigation, about 34 percent supplied water principally for livestock, 30 percent were not used, 24 percent supplied water mainly for irrigation, and 5, 5, and 2 percent supplied water mainly for public-supply, domestic, and industrial uses, respectively. Ten of the wells and springs were used for more than one purpose. (See table 4.)

IRRIGATION

SCIPIO VALLEY

All the water used for irrigation in Scipio Valley is derived from Round Valley, mostly from ground-water discharge. No land is irrigated in Round Valley. The principal source of water is Maple Grove Springs, (C–21–2½)2a, three flowing wells, (C–20–2)27dcc–1, (C–20–2)34abc–1, and (C–20–2)34baa–1, and the small flow from a canyon south of the springs. The discharge from the springs, wells and canyon combines to form Ivie Creek. The flow of the creek amounted to about 7,000 acre-feet during 1963 (fig. 6). From the wells, the water flows about 4 miles in Ivie Creek to Scipio Lake for storage until the irrigation season. A small amount of additional water reaches the lake from several nearby small springs and from surface runoff, which is mostly from Willow Creek Canyon at the south end of the valley. According to local landowners, other canyons yield only a little water by direct runoff because most of the water seeps into the ground before reaching the valley floor.

Water is released from Scipio Lake into Round Valley Creek and transmitted about 6 miles to the upper (southern) part of Scipio Valley. There it is used to irrigate crops on about 2,500 acres of land, about 80 percent of which supports alfalfa. Measurements on Round Valley Creek in the SE¼ sec. 5, T. 19 S., R. 2 W., indicated that about 5,000 acre-feet of water was delivered to Scipio Valley for irrigation during 1963.

SOUTHERN JUAB AND MILLS VALLEYS

About 4,000 acre-feet of water discharged from wells and springs in southern Juab Valley was used for irrigation in both southern Juab and Mills Valleys during 1963. About 2,600 acre-feet was used to irrigate lands in southern Juab Valley, southwest and west of Levan. This water was obtained from nine pumped wells and one flowing well. Four of the pumped wells supplied supplementary water to land irrigated with surface water diverted from Chicken and Pigeon Creeks.

The 1,400 acre-feet of water used in Mills Valley was discharged from four large flowing wells and many small springs that issue to the east and northeast of Chicken Creek Reservoir. The discharge from the wells and springs flows to the reservoir, and it is released from the reservoir during the growing season to irrigate about 1,000 acres near the community of Mills on the east side of Mills Valley. Substantially more than 1,400 acre-feet of water was discharged from the wells and springs during 1963. The differences between the amount of water discharged and the amount used represent losses by evapotranspiration at and near the reservoir.

PUBLIC SUPPLY

LEVAN

Levan (population 421, according to the 1960 census) obtains its water supply in Chicken Creek Canyon from a developed spring area called Rosebush Springs, (D–14–1)34cbd, and a short tunnel into a hillside, (D–14–1)33cbb, which drains a seep area. The total supply is about 450 gpm. The water issues from the alluvial fill in the bottom of the canyon, and its source probably is seepage from Chicken Creek upstream. The water flows from the springs to a headhouse having a capacity of 180,000 gallons, and thence it is delivered by gravity to the town. A chemical analysis of water from the springs is given in table 5. Well (D–14–1)31aab–1, having a reported yield of 700 gpm, is a standby well for the town system but it has not yet been used (1964).

SCIPIO

Scipio (population 328, 1960 census) obtains its water supply from Scipio Springs, (C–19–2)9db, a developed spring and seep area in the narrow valley between Round and Scipio Valleys. Fifteen collecting wells, 18–36 inches in diameter and 3–6 feet deep, tap these springs by a system of buried drainpipe along a 2,000-foot reach of and old creek-bed. The discharge of the system was measured during August 1963 at 210 gpm. The water is in alluvial deposits; some of it probably has moved through the alluvium from areas upstream, and some is derived from flanking alluvial fans extending eastward into the valley from the Pavant Range. From the springs the water flows by gravity to a headhouse, having a capacity of 64,000 gallons, near Scipio, and thence it is delivered by gravity to the town. A chemical analysis of water from Scipio Springs is given in table 5.

MILLS

The community of Mills (population about 30) obtains its water supply from well (C–15–2)25bdd–1, which taps the valley fill. The water is pumped directly into the mains, and pressure is maintained by a 22,000-gallon reservoir that is on a hillside above the well and is connected to the mains. A chemical analysis of water from the well is given in table 5.

DOMESTIC AND STOCK SUPPLY

About half a dozen homes in the area are served by individual wells, and of these only two wells are used strictly for domestic supply. The other wells supply water for combined domestic and stock use. Many abandoned homes in outlying areas have wells formerly used for domestic and stock supply, but these wells are not in use, destroyed, or used for stock only. The amount of water pumped for strictly domestic use, exclusive of public-supply systems, is negligible.

About two-thirds of the wells drilled in the area were intended for watering of stock, but about half of these wells are no longer used. (Used and unused wells are indicated on pl. 2.) The stock wells discharge about 50 acre-feet of water annually, most of which is discharged by small-diameter flowing wells in southern Juab and Round Valleys.

INDUSTRY

Three wells in the area were drilled for industrial use. Well (C–15–2) 26aca–1, which taps the valley fill, was drilled in Mills Valley in 1920 primarily to furnish water for steam locomotives. The well still furnishes water for various purposes, although the steam locomotive is no longer used on the line. Wells (C–18–3)34dda–1 and (C–18–3)34dda–2 were drilled in 1963 at Scipio Pass, 4 miles southwest of Scipio, to furnish water to a large telephone relay installation. These wells derive water from limestone and sandstone of Cambrian(?) and Ordovician(?) age at a depth of more than 800 feet. A chemical analysis of water from well (C–18–3)34dda–1 is given in table 5.

QUALITY OF WATER

Samples were collected for chemical analysis from 16 wells and 8 springs, mostly during 1963, from the Sevier River at several sites during seepage runs in March and October 1963, and from Chicken Creek during 1963. The results of the chemical analyses are shown in tables 5 and 6. The location of sampling sites and graphic presentation of selected chemical analyses are shown on plate 2.

CHEMICAL CONSTITUENTS AND SALINITY

Silica, calcium, magnesium, sodium, potassium, chloride, sulfate, and nitrate are the principal chemical constituents in water in the area of investigation. Other constitutents, such as iron, fluoride, manganese, and boron, are commonly present in small amounts. The concentration of soluble salts, formed by combinations of these and other minor constituents, may be called "salinity." Salinity can be expressed in units of dissolved solids or in units of specific conductance. The classification of water used in this report is that of Robinove, Langford, and Brookhart (1958) and is as follows:

Class	*Dissolved solids (ppm)*	*Specific conductance (micromhos per cm at 25° C)*
Fresh	Less than 1, 000	Less than 1, 400
Slightly saline	1, 000–3, 000	1, 400–4, 000
Moderately saline	3, 000–10, 000	4, 000–14, 000
Very saline	10, 000–35, 000	14, 000–50, 000
Briny	More than 35, 000	More than 50, 000

Of the 34 samples tabulated as ground water in table 5, 26 are fresh and 8 are slightly saline. Of the 22 samples tabulated as surface water in table 6, 16 are fresh, 5 slightly saline, and 1 moderately saline.

SALINITY OF GROUND WATER

ROUND VALLEY

The five ground-water samples collected in Round Valley were fresh. The dissolved solids in the samples ranged from 232 to 346 and averaged 289 ppm. Probably all the water in the valley is fresh, though some of the shallow ground water in a few marshy spots near Scipio Lake may be slightly saline. A sample of water collected January 27, 1966, from Scipio Lake, which derives virtually all its water from ground-water discharge, had a specific conductance of 504 micromhos per cm at

25° C—a dissolved-solids content of about 300 ppm. The water in the lake, therefore, is fresh, similar to the water sampled from nearby wells and springs.

SCIPIO VALLEY

Of the four ground-water samples collected in Scipio Valley, three were fresh and one slightly saline. Two wells tapping bedrock, (C–17–2)28bac–1 and (C–18–3)34dda–1, yielded water with dissolved solids of 350 and 380 ppm; whereas wells tapping alluvium, (C–18–2)6add–1 and (C–18–2)30abd–1, yielded water with dissolved solids of 1,610 and 546 ppm. The water in well (C–18–2)6add–1 is believed to be slightly saline because the well taps a perched ground-water reservoir that is recharged mainly by water applied to the land for irrigation in the southern half of the valley.

The unusually high nitrate concentration of 372 ppm in the water collected from well (C–18–2)6add–1 indicates the probability of contamination from the land surface. This contamination probably is from cattle that gather around the watering vats and a pond near the well.

SOUTHERN JUAB VALLEY

Of the nine ground-water samples collected from wells and springs in southern Juab Valley, four were fresh and the others were slightly saline. Although the dissolved solids ranged from 540 to 2,040 ppm, they averaged 1,089 ppm., and most of the samples were near the borderline between fresh and slightly saline water. The freshest water was from well (C–16–1)3cdd–1, a domestic and stock well obtaining water from a gravel bed about half a mile west of the San Pitch Mountain front. The most saline water was from well (C–15–1)33acd–1, a low-yielding irrigation well tapping silt and sand about 1½ miles west of the front. The relatively high salinity of water from well (C–15–1) 33acd–1 may be due to solution of minerals as the water passed through silt derived from the Arapien Shale, which composes much of the western San Pitch Mountains. Much of the ground water in the main part of the valley west of Levan is slightly saline. This salinity is due partly to the fact that the aquifer contains fine-grained sediments derived from the Arapien Shale, partly to concentration of minerals during evapotranspiration from natural wetlands on the valley floor, and partly to recirculation of water used for irrigation.

MILLS VALLEY

Of the nine ground-water samples collected in Mills Valley, eight were fresh and one was slightly saline. Molten and Blue Springs each yielded fresh water, but Chase Springs yielded slightly saline water. Molten Springs was sampled periodically throughout 196?, and the water remained consistent in quality. Water at depth in Mills Valley probably is fresh, but shallow water near Chase Springs and The Meadows is slightly saline.

Ground water moving through the alluvium in Chicken Creek gap east of Mills is slightly to moderately saline. This salinity is inferred from a moderately saline surface-water sample collected on June 3, 1963, in Chicken Creek at the SW¼NW¼ sec. 26, T. 15 S., R. 1½ W. The sample had a specific conductance of 7,270 micromhos per cm at 25°C and because the water originated at seeps upstream from the sampling site, the ground-water source of the seeps probably was slightly or moderately saline.

LITTLE VALLEY

The only existing well in Little Valley, (C–17–2)9bad–1, yielded fresh water with a dissolved-solids content of 350 ppm. All the water in Little Valley is probably fresh because much of the valley is filled with clean gravel and sand and recharge is mostly along the east front of the Canyon Mountains.

SALINITY OF SURFACE WATER

SEVIER RIVER

The salinity of water in the Sevier River below Yuba Dam during releases from Sevier Bridge Reservoir varies from season to season and from year to year depending on the amount of precipitation in the drainage basin upstream. The water is fresher following wet periods and more saline following dry periods. Furthermore, the salinity of the water in the reservoir can be increased seasonally by evapotranspiration and by influx of return flow from water used for irrigation in the Sevier River basin upstream. Water sampled from the Sevier Bridge Reservoir on May 6, 1949, was fresh, but a sample collected on August 7 of the same year was slightly saline (Connor, Mitchell, and others, 1958, p. 274–275). Data collected four times during 1964 (Hahl and Cabell, 1965) indicated that the water in Sevier Bridge Reservoir was slightly saline during most of 1964.

The salinity of water in the Sevier River changes during period of base flow along its 19-mile course across the area of investigation. Analyses of samples collected during seepage runs of the course in March and October 1963 are presented in table 6. The downstream change in salinity during the March seepage run is illustrated on plate 2 and figure 9.

The salinity of the river during the October seepage run was higher than during the March run at most of the sampling stations (Compare specific conductances for the two seepage runs in table 6.) This differ-

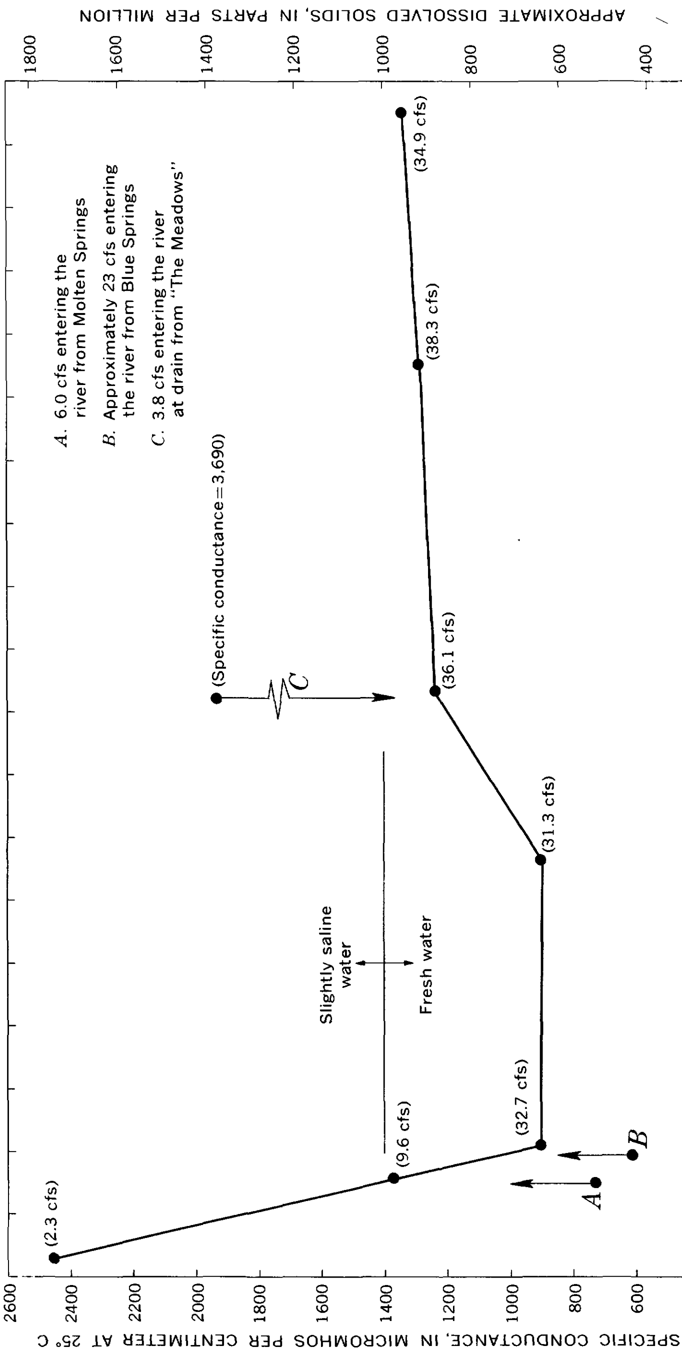

FIGURE 9.—Change in salinity of the Sevier River at base flow, March 7–8, 1963.

ence is attributed mainly to the effects of evapotranspiration during the intervening summer and fall. Data collected in 1964 (Hahl and Cabell, 1965) show the same variations in salinity as the seepage-run data. Although the salinity of water issuing from Molten and Blue Springs was about the same in October as in March, the salinity of water draining from The Meadows was about 10 percent greater in October than in March—the increased salinity showing the effects of evapotranspiration.

CHICKEN CREEK

Water sampled from the upper part of Chicken Creek at the gaging station in the San Pitch Mountains east of Levan was fresh (table 6). This water is believed to be representative in chemical quality of the water in the upper reaches of Pigeon, Deep, Little Salt, and Criss Creeks, which also flow from the San Pitch Mountains into southern Juab Valley. The source of most of this water is melting snow.

The water in Chicken Creek Reservoir is slightly saline. A sample collected in January 1966 had a specific conductance of 2,510 micromhos per cm at 25° C—a dissolved-solids content of about 1,500 ppm. Virtually all the water in the reservoir is derived from springs, seeps, and flowing wells in the lower part of southern Juab Valley. The water sampled from wells (C–15–1)16baa–1 and (C–15–1)16cbb–1, which flows directly into the reservoir, was slightly saline (table 5). Water discharging from nearby springs and seeps that feed the reservoir should have similar chemical characteristics. The water in the reservoir actually should be slightly more saline than the ground water that feeds it because of evaporation from the reservoir and evapotranspiration from nearby wet meadows.

Water in the lower part of Chicken Creek is locally moderately saline. A sample collected in the creek near Mills in the SW¼NW¼ sec. 26, T. 15 S., R. 1½ W., had a specific conductance of 7,270 micromhos per cm. The source of the water was small springs and seeps that issue below Chicken Creek Reservoir in Chicken Creek gap between southern Juab and Mills Valleys.

QUALITY IN RELATION TO USE

IRRIGATION

Among the principal factors in determining the suitability of water for irrigation are the total concentration of soluble salts and the proportion of sodium to other cations (U.S. Salinity Laboratory Staff, 1954, p. 69).

The total concentration of soluble salts, or salinity, affects plant growth by limiting the ability of the plant to take in water by osmosis. The rate at which water can enter the roots of a plant depends on the difference between the salinity of water within the plant and the salinity of the water in the soil. If the salinity of the irrigation water in the soil is appreciably less than the salinity of the water in the plant, the plant will assimilate the irrigation water rapidly. If the difference is small, the plant must be exposed to the water in the soil for a longer period of time in order to assimilate enough water to satisfy its needs. If the salinity of irrigation water in the soil is equal to or greater than the salinity of the water in the plant, the plant cannot assimilate the water by osmosis and may even lose water in the process. In this event the plant will die for lack of water. The degree of salinity in irrigation water is called the salinity hazard.

The proportion of sodium to other cations in irrigation water affects plant growth by affecting the extent to which a soil will adsorb sodium from the water. The adsorption of sodium breaks down the flocculation of the soil and makes it gummy, less permeable, less fertile, and difficult to reclaim. An index to this sodium hazard is called the sodium-adsorption-ratio (SAR), and it is expressed as

$$SAR=\frac{Na^{+1}}{\sqrt{\frac{Ca^{+2}+Mg^{+2}}{2}}}$$

where the concentrations of sodium, calcium, and magnesium are expressed as equivalents per million.

The salinity and sodium hazards of samples of ground and surface water collected in the area are classified in figures 10 and 11 according to the method of the U.S. Salinity Laboratory Staff (1954, p. 80). Use of this method places a water in one of four categories of sodium hazard and one of four categories of salinity hazard. Most of the water classified in figures 10 and 11 is in the low sodium-hazard class and in either the medium or high salinity-hazard class. There is little danger of sodium damage to irrigated lands in the area as long as fields are drained of excess water. The salinity hazard does not constitute a problem in the area because the crops commonly grown, alfalfa and grains, are moderately tolerant to salinity (Hem, 1959, p. 249).

Water classified in the medium sodium-hazard class and the very high salinity-hazard class was obtained from well (C–15–1)33acd–1 near the southern end of southern Juab Valley, from the drain from The Meadows in Mills Valley, and from the Sevier River, 0.3 mile below Yuba Dam. The latter was water leaking from Sevier Bridge Reservoir through the headgates at Yuba Dam. These waters are suitable for the irrigation of crops that are moderately tolerant or tolerant to salinity.

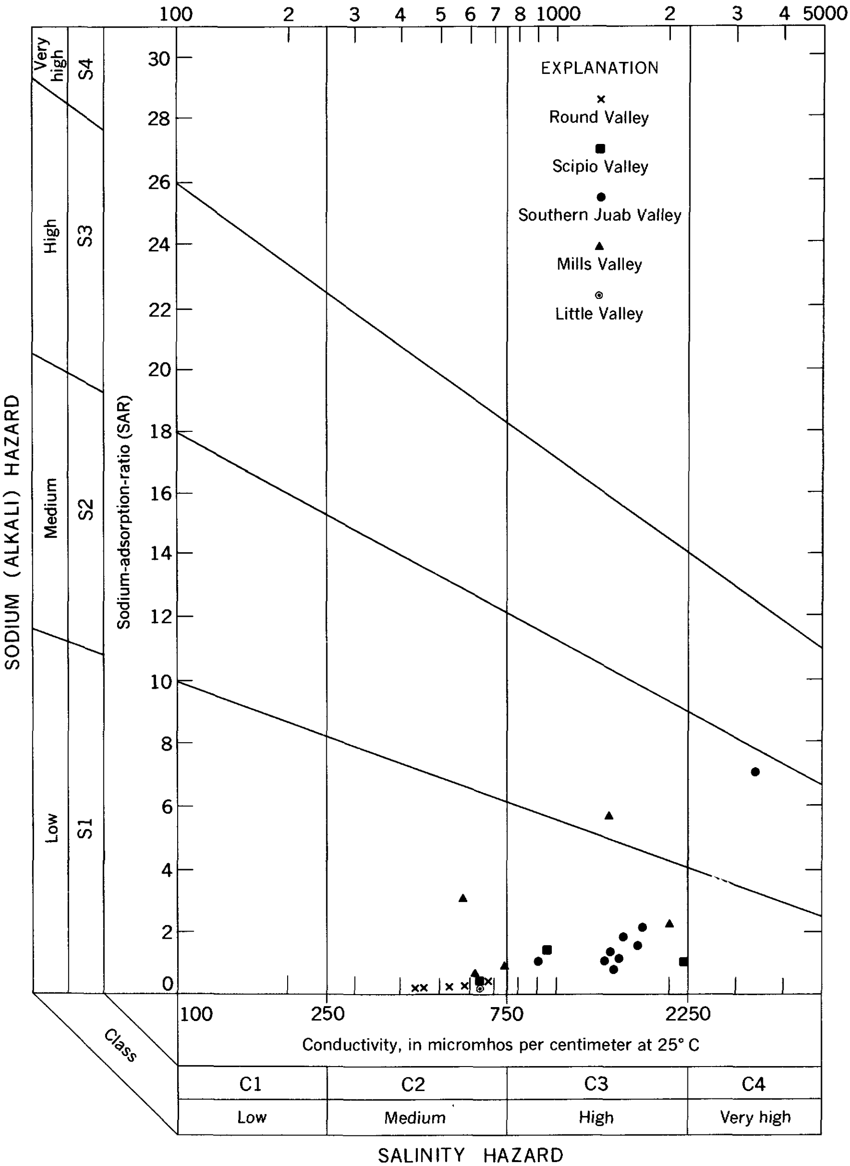

FIGURE 10.—Sodium hazard and the salinity hazard of selected ground-water samples collected from wells and springs.

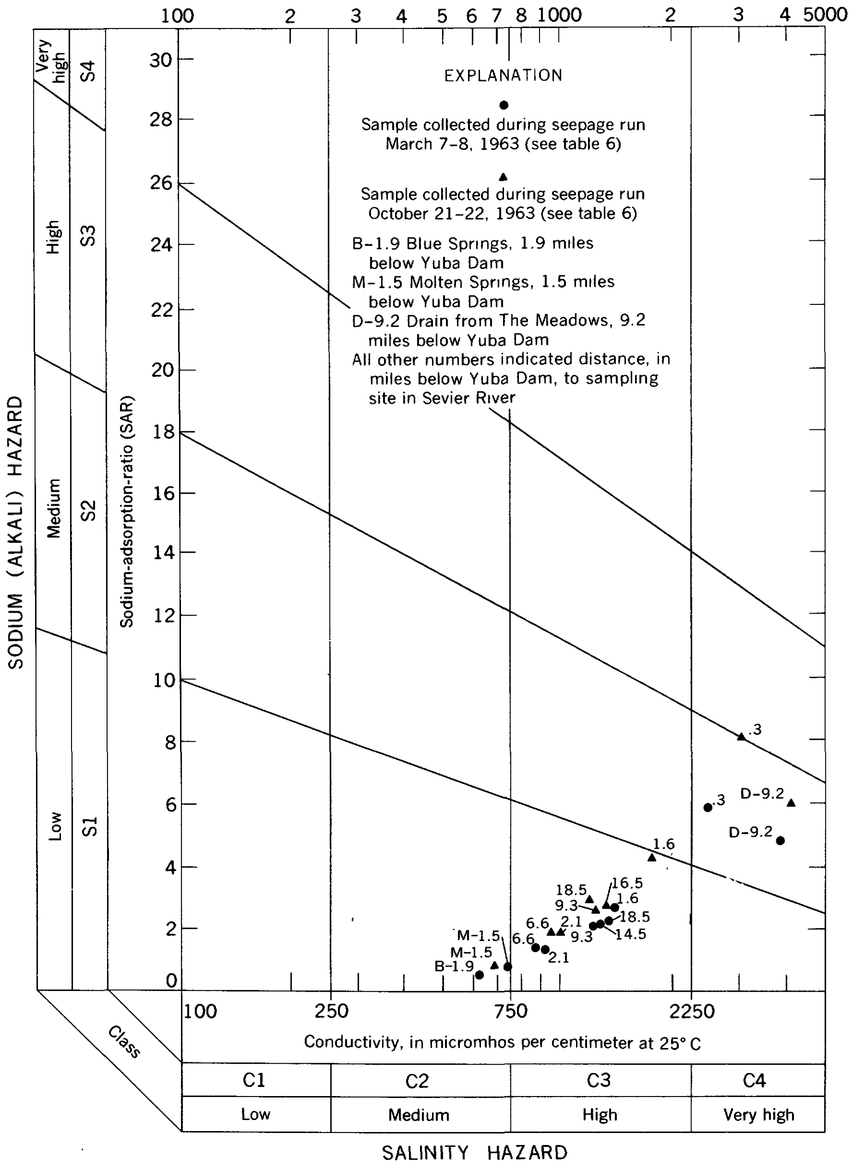

FIGURE 11.—Sodium hazard and the salinity hazard of selected surface-water samples collected from the Sevier River and tributaries.

The water of poorest quality for irrigation that was sampled in the area was from Chicken Creek in Mills Valley in the SW¼NW¼ sec. 26, T. 15 S., R. 1½ W. (See table 6.) This sample is not plotted in figure 11 because only the specific conductance was determined. The high conductance, however, indicates that the water is undesirable for irrigation because of excessive salinity hazard.

DOMESTIC AND PUBLIC SUPPLY

Drinking-water standards for domestic and public supply are suggested by the U.S. Public Health Service (1962). The suggested maximum concentrations of some of the more common chemical constituents are:

Substance	*Parts per million*	*Substance*	*Parts per million*
Chloride	250	Nitrate	45
Fluoride	(1)	Sulfate	250
Iron	.3	Dissolved solids	[2] 500
Manganese	.05		

[1] The suggested maximum fluoride concentration depends on the average maximum daily air temperature (U.S. Public Health Service, 1962, p. 8). According to this criterion, the maximum concentration at Levan should be 1.3 ppm and the maximum concentration at Scipio should be 1.2 ppm.
[2] If better water is not available, 1,000 ppm permitted.

In the analyses of ground water from 24 wells and springs listed in table 5, suggested maximum concentrations were exceeded in 4 analyses for chloride, 1 analysis for nitrate, 7 analyses for sulfate, and 13 analyses for dissolved solids. In 7 of the samples, the dissolved solids exceeded 1,000 ppm. The public supply for Levan, spring (D-14-1)34cbd, and Mills, well (C-15-2)25bdd-1, exceeded the recommended maximum dissolved solids with 925 and 756 ppm, respectively. Analyses were not made for fluoride, iron, nor manganese. Surface-water samples were collected at 12 sites along the Sevier River, Chicken Creek, and a drain from The Meadows; the analyses are listed in table 6. The suggested maximum concentrations were exceeded in 3 analyses for chloride, 2 analyses for sulfate, and 8 analyses for dissolved solids. An excess of dissolved solids was indicated also by a specific conductance of 7,270 micromhos per cm in a sample taken from Chicken Creek near Mills.

The hardness of water should be a consideration in any domestic or public supply because it affects the cleansing properties of water, it affects the amount of soap consumed, and it is related to incrustation from water (Hem, 1959, p. 145-148). The principal constituents that cause hardness in water are calcium and magnesium. The U.S. Geological Survey classifies water with respect to hardness as follows:

Classification	*Hardness (ppm)*	*Classification*	*Hardness (ppm)*
Soft	Less than 60	Hard	120-180
Moderately hard	60-120	Very hard	More than 180

Of the 24 sources of ground water that were sampled in the area, 23 yielded very hard water and 1 yielded hard water (table 5). The hardness ranged from 122 to 840 ppm and averaged about 440 ppm. Analyses of 21 surface-water samples showed that all the water was very hard. The hardness ranged from 228 to 1,220 and averaged 469 ppm. (See table 6.)

Water containing 372 ppm of nitrate was sampled from well (C-18-2)6add-1. Water with more than 45 ppm has been shown to be toxic to infants (U.S. Public Health Service, 1962, p. 47-50). Well (C-18-2)6add-1, however, is used only for livestock.

LIVESTOCK

Almost all the water within the area is suitable for use by livestock. The Officers of the Department of Agriculture and Government Chemical Laboratories of Western Australia (1950) list the following upper limits for concentrations of dissolved solids in water for livestock:

	Dissolved solids (ppm)		
Poultry	2,860	Cattle:	
Pigs	4,290	Dairy	7,150
Horses	6,435	Beef	10,000
		Sheep, adult	12,900

All water samples collected in the area, except one, contained less dissolved solids than any of the figures listed above. (See tables 5 and 6.) The one exception was from a seep area in the SW¼NW¼ sec. 26, T. 15 S., R. 1½ W. (table 6). It is unlikely that animals would drink this water, for better water is available in the vicinity.

TEMPERATURE OF GROUND WATER

Temperature is important in considering the use of a water for cooling. The temperature of the water from 39 wells and springs in the area ranges from 46° to 63°F and averages 55°F (table 4).

CONCLUSIONS

The Sevier River gains about 30 cfs from ground-water discharge in its 19-mile reach from Yuba Dam to Leamington Canyon. Most of this gain is from Round, Scipio, and Little Valleys; little of the gain originates in the Sevier Valley upstream from Yuba Dam. Most of the 30 cfs is discharged at Molten and Blue Springs, and the water is conducted toward the springs through solution channels along fault lines in limestone underlying Scipio and Little Valleys. Thus the two springs are the points of ground-water discharge for most of the area west of the river.

Water levels abruptly change more than 200 feet near the center of Scipio Valley. The abrupt change is in the same area where sinkholes indicate solution channels in underlying bedrock. These sinkholes are alined along faults that traverse the valley in a north-northeasterly direction.

Some water could be salvaged from evapotranspiration in the Sevier River basin between Yuba Dam and Leamington Canyon by lowering water levels in wet areas. This salvage could be accomplished by constructing and pumping wells that penetrate the underlying aquifers principally in the lower part of southern Juab Valley near Chicken Creek Reservoir and in Mills Valley near The Meadows. However, lowering the water levels in southern Juab Valley would affect the discharge of springs and flowing wells, and consequently, the amount of water collected in Chicken Creek Reservoir. Lowered water levels in Mills Valley would affect the discharge of the Sevier River.

Some lowering of water levels probably could be accomplished locally by drains, but drains would not be effective over large areas unless they were deep enough to penetrate underlying aquifers. Drains would be least effective in the lower parts of southern Juab Valley where the ground water occurs under artesian conditions.

More information is needed concerning the thickness, extent, and hydraulic characteristics of the aquifers in the area. Test drilling and aquifer tests are needed in southern Juab Valley to determine the total thickness of the alluvium and the amount and availability of the water in storage. Test drilling into the bedrock underlying the alluvium in the northern half of Scipio Valley, and subsequent test pumping of wells, would give valuable information regarding the possibility of developing future water supplies from the bedrock. Test drilling in Mills Valley would give information on the thickness of deposits of the flood plain, the alluvial fans, and the Lake Bonneville Group, and would indicate the feasibility of withdrawing water from these deposits by drains or pumped wells to salvage water that is lost to evapotranspiration in The Meadows. Test drilling in Little and Tintic Wash Valleys may locate additional water supplies. Aquifer tests in existing wells in Round Valley may indicate the feasibility of pumping from existing flowing wells to salvage water now lost through evapotranspiration.

BASIC DATA

TABLE 4.—*Records of wells and springs in the Sevier River basin between Yuba Dam and Leamington Canyon*

Well or spring: See text for description of well-numbering system.
Altitude above sea level: Altitudes at land-surface datum estimated from topographic maps or from altitudes of roads furnished by the Utah State Highway Commission.
Type of well: B, bored; Dr, drilled; Du, dug; S, spring.
Depth of well: Measured depths given in feet and tenths below land-surface datum; reported depths given in feet.
Character of material in principal aquifer: cg, conglomerate; g, gravel; ls, limestone; s, sand; ss, sandstone.
Measuring point description: Edp, end of discharge pipe; Hpb, hole in pump base; Ls, land surface; Tc, top of casing; Tel, top of pipe elbow; Tlpc, top of lower pipe clamp; Tmp, top of measuring pipe; Tbp, top of pump base; Tpc, top of pit curb; Tt, top of pipe tee.
Water level: Measured depths given in feet and tenths below or above land-surface datum; reported depths given in feet.

Method of lift and type of power: First letter—C, centrifugal pump; Cy, cylinder pump; F, flows; J, jet pump; N, none; T, turbine pump; Ts, submersible turbine pump. Second letter—B, butane; D, diesel; E, electric; G, gasoline; N, none; W, windmill.
Yield: E, estimated; M, measured; R, reported.
Use of water: D, domestic; I, irrigation; In, industrial; Is, irrigation supplementary to surface water; N, none; O, observation; P, public supply; S, stock.
Temperature: R, reported; others measured.
Remarks and other available data: A, chemical analysis listed in table 5; D, driller's log in table 7; Dd, drawdown, in feet; E, estimated; L, driller's log available in files of Utah State Engineer; M, measured; R, reported.

Well or spring	Owner, user, or name	Year drilled	Altitude above sea level (feet)	Type of well, or spring	Depth of well (feet)	Diameter of well (inches)	Character of material in principal aquifer	Measuring point		Water level		Method of lift and type of power	Yield		Use of water	Temperature (°F)	Remarks and other available data
								Description	Above land-surface datum (feet)	Above (+) or below (−) land-surface datum (feet)	Date of measurement		Rate (gpm)	Date of measurement			
Round Valley																	
(C-19-2)9db	Town of Scipio.	...	...	S	...	...	s, g	...	...	...	...	...	210E	8-14-63	P	54	Developed spring area; 15 shallow drainage wells in seep area along old creekbed. A.
35bdd-1	G. L. Robins	...	...	Dr	29.0	12	s, g	Tc	2.0	−24.0	1-16-63	Cy, W	...	...	S, O	...	
(C-20-2)4ddd	Keith McArthur.	...	...	S	...	...	s, g	...	...	...	...	...	4E	...	S	...	Seep area about 10 by 10 ft.
11cbb-1	Marden Stone.	...	...	Du	14.0	16	s, g	Tc	2.5	−9.5	12- 3-63	Cy, W	...	...	S	...	
15abb-1	Scipio Irrigation Co.	...	...	Dr	855	16	ss	...	...	Flows	4- 5-63	F, N	35E	4- 5-63	I, S	54	A, D.

15adb-1	L. R. Monroe			Dr	300+	8	ss	Tc	1.0	+.2	9-10-63	N, N			N		Well flows at times.
15baa	do	1930		Du	3	48	s, g	Tpc	1.0						N	46	Developed spring; A.
15bac	do			S			s, g						130E	5-23-63	S, I	50	Seep area with five main openings at foot of terrace; locally called Seven Springs.
27caa-1	Byron Probert.	1949		Dr	292	6	s, g	Tc	2.0	+7.1	5-22-63	F, N	4M	5-22-63	S	52	Discharge dropped when three large flowing wells were constructed half a mile southeast; L.
27dcc-1	Scipio Irrigation Co.	1951		Dr	587	16	ss					F, N	1,200E	6-25-63	I	54	D.
33aab	do			S			s, g								N		Large spring reported to have discharged 1-3 cfs before large flowing wells were constructed in the area; now dry.
34abc-1	do	1961		Dr	770	16	ss					F, N	200M	6-25-63	I	53	L.
34baa-1	do	1957		Dr	700	16	ss					F, N	290M	6-25-63	I	54	A, D.
(C-21-2½)2a	Maple Grove Spring; various water users.			S			ss or cg						2,550M	7-19-63	I, P	51	Discharges from slope below cliff; A.

Scipio Valley

(C-17-2)28bac-1	Leo Robins	1963	5,280	Dr	373	6	ls, ss	Tc	1.3	−331.7	8-28-63	Cy, G			S	54	A, D.
31adb-1	M. M. Hatch	1945	5,280	Dr	346	4	ss			−296	7-48	N, N	6R		N	59R	Well collapsed into sinkhole; D.
31ccc-1	M. V. Robins	1945	5,274	Dr	286	4	s			−265		N, N			N	59R	D.
(C-18-2)5cdb-a	N. O. Monroe	1953	5,281	Dr	59.0	4	s	Tc	1.5	−49.3	1-17-63	Cy, W	10R		S		D.
6add-1	Hatch and Walch.	1941	5,270	Dr	75	4	s, g	Tc	.5	−49.8	1-17-63	Cy, W			S, O	52	Well reported to have relatively high specific capacity; A.
(C-18-2)30abd-1	Merlin Monroe	1949		Dr	96	4	s, g			−55		Cy, G			S	52	A, D.
(C-18-3)13acd-1	do			Du	28.0		s, g	Tpc	.5	−18.6	12-10-62	Cy, W			S		
13bdb-1	H. L. Miller			Du	70		s, g			Dry	12-10-62	Cy, N			S		Reported to contain water in past years.
14bad-1	LeVoy Memmot.			Du	30		s, g			Dry	12-10-62	Cy, W			N		Reported to contain water in past years; was stock well.

TABLE 4.—*Records of wells and springs in the Sevier River basin between Yuba Dam and Leamington Canyon*—Continued

Well or spring	Owner, user, or name	Year drilled	Altitude above sea level (feet)	Type of well, or spring	Depth of well (feet)	Diameter of well (inches)	Character of material in principal aquifer	Measuring point		Water level		Method of lift and type of power	Yield		Use of water	Temperature (°F)	Remarks and other available data
								Description	Above land-surface datum (feet)	Above (+) or below (−) land-surface datum (feet)	Date of measurement		Rate (gpm)	Date of measurement			
Scipio Valley—Continued																	
(C-18-3) 24aac-1	M. B. Robins			Du	14.0	16	s, g	Tc	0.8	−7.8	2-10-62	Cy,W			S		
34dda-1	American Telephone & Telegraph Co.	1963	6,120	Dr	824	6	ss or ls			−783	4-8-63	Ts,E	10R		N		Test hole for well (C-18-3) 34dda-2; A; D; Dd 16R.
34dda-2	do	1963	6.120	Dr	852	6	ss or ls			−760	12-27-63	Ts,E	10R		In		Dd, 15R.
Southern Juab Valley																	
(C-13-1)23cdc-1	J. Greenhalgh		5,125	Dr	116.0		s, g	Tlpc	0.5	−97.0	4-24-63	Cy,W			S		
26aad-1	Evylan Kendall.			Dr			s, g					N,N			N		Well caved.
33cac	Orme Spring: stockmen.		6,000	S			cg						2E	4-25-63	S	50	A.
(C-14-1)1caa-1	F. O. Morgan	1935	5,238	Du	30.0	60	s, g			Dry	6-13-63	N,N			N		Reported to have yielded water in past years.
11caa-1	J. C. Ingram		5,240	Dr	96.0		s, g	Tc	0			Cy,W			S		Wet at bottom of well 12-6-62.
11cdd-1	C. H. Grace		5,222	Dr		8	s, g	Tc	0	−72.3	5-3-62	Cy,W			S,O		
14cac-1	J. E. Worthington.	1943	5,215	Dr	120	6	s, g	Tc	2.0	−81.4	12-4-62	Cy,W			S		L.
23dca-1	Herbert Malmgren.	1951	5,168	Dr	17.0	24	s, g	Tc	.5	−9.7	4-10-63	C,G			S		
23dca-2	do	1956	5,165	Dr	100	12	s, g	Ls	0	−8.0	4-10-63	Cy,W			S		Water level estimated from nearby measurement.

(C-14-1) 25bdd-1	Charles Paynter.	1951	5,224	Dr	227	16	g	Tc	.5	−63.3	12-17-62	T,G			Is,O		D.
26aba-1	Grant Nielson.	1961	5,180	Dr	840	16	s, g	Tmp	1.5	−28.4	4-10-63	T,D	1,350R		I		Dd, 190R.
26acd-1	do	1961	5,185	Dr	567	16	s, g					N,N			N		Well caved from pumping sand, destroyed; L.
26bbb-1	do			Dr	76.0	6	s, g	Tc	1.0			N,N			N		Well casing probably clogged.
27aaa-1	Ross Harper	1954	5,162	Dr	265.0	16	s, g	Tc	1.5	−41.8	1-23-63	N,N			N,O		Well originally 400 ft deep and used for irrigation, now caved below 265 ft; caved from pumping sand; L.
27ccd-1	do	1912	5,184	Dr	50.0	4	s, g			Dry		N,N			N		
34bdd-1	James Paystrup.		5,134	Dr	26.0	6	s, g	Tc	0	−14.3	5- 2-63	Cy,W			S		
34dda-1	do		5,156	Dr		4	s, g	Tpb	1.0	−21.0	4- 9-63	Cy,W			S		
35dcc-1	Almira Taylor.	1920	5,185	Dr	225	2	s, g			−18		Cy,N			N		
36adb-1	Lamar Winter.	1962	5,263	Dr	359	16	g	Hpb	1.0	−102.8	4-24-63	T,D	2,500R		Is		D; Dd, 147R.
(C-15-1)2bba-1	L. S. Jackman		5,163	Dr	30.0	2	s, g	Tc	3.5	−4.2	4- 9-63	N,N			N		
3abb-2	Hoitt Moss	1951	5,142	Dr	318	14	s, g	Tc	.5	−10.1	4- 9-63	T,B	600R		I		D.
4ddd-1	do		5,100	Dr	10.0	2	s, g	Tel	1.3	−8.4	4- 9-63	N,N			N		Water-level records available 1938-51.
9cba-1	do	1953	5,082	Dr	330	5	s, g	Tc	1.7	+2.8	6-12-63	C,G			D,S	57	Flows when not pumped; L.
10cad-1	Eugene Powell.	1958	5,110	Dr	224	12	s, g			Flows	5- 2-63	T,E	500R		I	54	Flows at 80 gpm; A; Dd 20R; L.
11baa-1	Ralph Jackman.	1951	5,156	Dr	260	16	s, g	Edp	6.0	−13.7	1-23-63	T,D	1,390M	5-21-63	I,O	57	A, D.
11bab-1	do	1917	5,141	Dr	97	2	s, g	Tt	1.0	−6.7	9-10-62	N,N			N		Has flowed 10 gpm. Water level affected by irrigation well a quarter of a mile east.
(C-15-1)11cca-1	Farrell Wankier.	1950	5,140	Dr	144	4	s, g			Flows	5- 9-63	F, N	.1E	5- 9-63	S	56	L.
12aba-1	R. C. Mangelson.	1934	5,197	Dr	117	6	s, g	Tc	1.5	−58.2	12-17-62	C, G			S		Water-level records available 1935-61.
14cab-1	Edger Christens.	1918	5,138	Dr	125	2	s, g	Tc	1.0	+.4	5- 2-63	N,N			N		Well clogged at 2 ft.
14cbd-1	do	1920(?)	5,125	Dr		6	s, g	Tc	1.0	+11.3	5- 2-63	F,N	10E	5- 2-63	S	58	
15aaa-1	Reese Paynter.	1934	5,117	Dr		4	s, g	Tc	1.0	+21.8	5- 2-63	F,N	2E	5- 2-63	S	56	Dd, 21M.
15aaa-2	do	1934	5,117	Dr		3	s, g	Tc	1.3	+1.0	5- 2-63	F,N			S		Water seeping to surface around casing.

TABLE 4.—*Records of wells and springs in the Sevier River basin between Yuba Dam and Leamington Canyon*—Continued

Well or spring	Owner, user, or name	Year drilled	Altitude above sea level (feet)	Type of well, or spring	Depth of well (feet)	Diameter of well (inches)	Character of material in principal aquifer	Measuring point: Description	Measuring point: Above land-surface datum (feet)	Water level: Above (+) or below (−) land-surface datum (feet)	Water level: Date of measurement	Method of lift and type of power	Yield: Rate (gpm)	Yield: Date of measurement	Use of water	Temperature (°F)	Remarks and other available data
Southern Juab Valley—Continued																	
(C-15-1)15dca-1	Eugene Powell.	1962	5,107	Dr	202	12	s, g			Flows	5- 2-63	F,N	30R	5- 2-63	I,S	54	Chemical quality reported to be good; D.
16baa-1	Juab Lake Irrigation Co.	1951	5,070	Dr	304	12	s, g			Flows	5-27-63	F,N	200E	5-27-63	I	55	A; D.
16bad-1	do	1951	5,070	Dr	220	10	s, g			Flows	5-28-63	F,N	140E	5-28-63	I	56	L.
16cbb-1	do	1934	5,060	Dr	100	12	s, g			Flows	6- 6-63	F,N	100E	6- 6-63	I	51	A.
17dad-1	do	1934	5,060	Dr	100	12	s, g			Flows	6- 7-63	F,N	140E	6- 7-63	I	54	
21adc-1	J. B. Watson		5,133	Dr			s, g					J,G			S		Water level probably within 10 ft of land snrface.
25bcb-1	Vernal Meldrum.		5,274	Dr	96.0	4	s, g	Tc	0	−87.9	5-28-63	Cy,N			N		
26adb-1	Clarence Meldrum.			Dr	160	4	s,g			−85	5-28-63	J,E			D		
26adc-1	Vernal Meldrum.		5,272	Dr	117.0	4	s, g	Tc	1.0	−86.6	5-23-63	N,N			N		
33aab-1	Robert Meldrum.		5,182	Dr		3	s,g	Tc	5.0	−30.0	4-25-63	N,N			N		
33acd-1	Frank Ballow	1952	5,206	Dr	358	16	s, g	Hpb	1.0	−49.0	4-30-63	T,B	250R		I	58	A; D; Dd, 180R.
(C-16-1)3[illegible]da-1	Rex Chase	1910	5,374	Dr	225	16	s, g	Tc	6.0	−205.6	4- 4-63	N,N			N		Originally an oil test.
3cdd-1	do	1963	5,398	Dr	252	6	s, g			−220		Ts,E	10R		D,S	56	Test pumped all day at 10 gpm; A.
4aad-1	Robert Ballow.	1952	5,281	Dr	320	16	s, g	Tc	2.5	−108.5	4-25-63	N,N			N		Irrigation well collapsed at bottom from pumping sand.

4bcd-1	Rex Chase	1925	5,256	Dr	135	6	s, g	Tc	1.5	−108.0	4-4-63	Cy,W			S		
10abc-1	do	1925	5,404	Dr	260	6	s, g	Tc	.5	−150.3	4-4-63	N,N			N		Reported low yield.
20ddd-1	George Barton.	1959		Dr	501							N,N			N		Reported to be a dry hole; L.
(D-13-1)17bdd-1	Origil Brothers.	1905	5,065	Dr	60	6	s, g	Tpc	2.0	−17.9	4-24-63	Cy,N			D,S		
17cab-1	U.S. Bureau of Reclamation.	1960	5,060	B	22	3	s, g	Tc	0	−13.8	4-25-63	N,N			N,O		
(D-14-1)4cb-1	A. E. Sutherland.		5,570	Dr	350	4	s, g					N,N			N		Reported dry at 350 ft; hole now filled in to depth of 40 ft.
6baa-1	C. H. Garrett.		5,310	Dr		6	s, g	Tc	1.0	−188	3-31-50	N,N			N		Observation well 1935-50; now covered or destroyed.
6dbb-1	State of Utah.	1916(?)	5,345	Dr			s, g			−185		Cy,N			N		Once the source of supply to many local residents; a large windmill lifted the water from well to tank.
10abd	A. E. Sutherland.			S			s, g						100 E	6-18-63	I,S	51	Water piped to small reservoir at mouth of canyon.
11bcb	do			S			s, g						200 E	6-18-63	I,S	55	Do.
11dda	do			S			s, g						150 E	6-18-63	I,S	51	Do.
30aad-1	D. R. Shephard.	1953	5,335	Dr	312	14	s, g	Edp	7.5	−158.0	4-9-63	T,D	2,000 R		Is		Irrigates 140 acres; D; Dd, 32R.
(D-14-1)31aab-1	Town of Levan.	1962	5,349	Dr	505	11	s, g	Tc	1.5	−180.8	3-27-63	N,N	700R		P		Well not yet used; D; Dd, 10R.
31ada-1	Levan Irrigation Co.	1959	5,367	Dr	405	16	s, g	Hpb	.5	−204.7	3-27-63	T,E	1,560M	5-28-63	Is	55	Supplements irrigation of about 300 acres; A; D.
33bcc-1	do	1959	5,487	Dr	500	16	s, g	Ls	0	−42.8	3-27-63	N,N			N		Drilled as exploratory test well and was not adequate; bottom 309 ft in shale; L.
33cbb	Town of Levan.		5,490	S			s, g						50E	6-19-63	P	51	Tunnel into hillside to collect "seep" water.
34cbd	do		5,680	S			s, g						400E	6-19-63	P	52	Developed spring area on canyon bottom called Rosebush Springs; A.
(D-15-1)7bbd-1	M. W. Mangelson.	1926	5,223	Dr	130	4	s, g					Cy,N			N		Casing clogged.

TABLE 4.—*Records of wells and springs in the Sevier River basin between Yuba Dam and Leamington Canyon*—Continued

Well or spring	Owner, user, or name	Year drilled	Altitude above sea level (feet)	Type of well, or spring	Depth of well (feet)	Diameter of well (inches)	Character of material in principal aquifer	Measuring point: Description	Measuring point: Above land-surface datum (feet)	Water level: Above (+) or below (−) land-surface datum (feet)	Water level: Date of measurement	Method of lift and type of power	Yield: Rate (gpm)	Yield: Date of measurement	Use of water	Temperature (°F)	Remarks and other available data
Mills Valley																	
(C-15-2)16cda-1	Morrell Mathews.			Dr	55+	6	s, g					Cy, W			S		
21dab-2	E. A. Russell.			Dr	44	4	s, g	Tc	1.0	−8.3	12-18-62	Cy, W			S		
22bcc-1	do			Dr		4	s, g	Tc	.5	+1.5	6-14-63	F, N	1M	6-14-63	S		Dd, 1.5E.
25bda-1	Harlin Williams.	1930	4,998	Dr	400	6	s, g			−60	6-14-63	Cy, N			S		Temporarily out of use.
25bdd-1	Mills Farmstead Water Co.	1945		Dr	465	12	s, g			−37	5-29-63	T, E			P		A, D.
26aca-1	Union Pacific RR Co.	1920	4,941	Dr	359	12	s, g					T, D	180R	5-29-63	In	58	A.
(C-16-1)7b-1	U.S. Bureau of Land Management.	1963		Dr	244	6	s, g	Tc	1.5	−88.4	4-15-64	N, N	20R		S		Dd, 10R.

(C-16-2)2aad	Chase Springs; various water users.	------	4,915	S	------	------	------	------	------	------	------	------	1,400E	------	I	62	Large seep area; A.
15abd-1	Clifford Peterson.	------	4,948	Dr	57.0	6	s, g	Tc	1.0	−22.0	1-23-63	Cy, W	------	------	S, O	------	
27dbd	Blue Springs; various water users.	------	4,938	S	------	------	ls, ss, s, g.	------	------	------	------	------	------	------	I	63	A.
34aab	Molten Springs; various water users.	------	4,940	S	------	------	ls, ss, s, g.	------	------	------	------	------	------	------	I	62	A.
(C-17-2)1bbc-1	Sevier Bridge Reservoir.	1958	------	Dr	80	6	ls	------	------	−50	------	J, E	------	------	D	------	

Little, Dog, and Tintic Wash Valleys

(C-13-2)14aad-1	U.S. Bureau of Land Management.	------	5,460	Dr	550	10	------	------	------	Dry	9-13-61	Cy, W	------	------	N	------	Well caved; dry at 440 ft.
31cc-1	Spencer Nielson.	------	5,120(?)	Dr	81.0	6	s, g	Tc	1.0	−42.8	12-20-62	J, G	------	------	S, O	------	
(C-17-2)9bad-1	Howard Memmot.	1950	5,088	Dr	175	8	s, g	Tc	.5	−148.0	1-17-63	T, G	40E	------	S, O	56	A, L.

TABLE 5.—*Chemical analyses of water from selected wells and springs in the Sevier River basin between Yuba Dam and Leamington Canyon*

[Analyses by U.S. Geological Survey unless indicated otherwise. Dissolved solids: Residue on evaporation unless indicated otherwise]

Well or spring	Date of collection	Temperature (° F)	Parts per million													Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos per cm at 25°C)	pH
			Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$				
Round Valley																			
(C-19-2)9db	8-14-63	54	6.4	69	33	22		347	0	21	33	2.5	346	308	23	13	0.5	634	7.7
(C-20-2)15abb-1	4-5-63	54	----	----	----	13		324	0	13	12	----	----	268	2	9	.3	510	7.3
15baa	4-5-63	46	----	----	----	16		326	0	16	25	----	----	284	17	11	.4	576	7.4
34baa-1 [1]	8-26-57	54	11	43	31	3.5	1.1	272	0	4.4	7.5	2.0	----	235	12	----	.1	436	7.7
(C-21-2½)2a (Maple Grove Springs)	7-1-63	52	6.8	57	21	4.1		273	0	5.6	5.0	3.1	232	230	6	4	.1	435	7.4
Scipio Valley																			
(C-17-2)28bac-1	9-10-63	54	13	58	38	21		322	0	22	42	0.1	350	300	36	13	0.5	621	7.7
(C-18-2)6add-1	3-28-63	52	14	172	100	66		158	0	19	378	372	1,610	840	710	15	1.0	2,090	7.2
30abd-1	5-2-63	52	14	53	62	64		504	0	30	38	35	546	386	0	27	1.4	938	7.9
(C-18-3)34dda-1 [2]	4-9-63	----	----	38	32	15	----	257	----	8	30	----	[3] 380	230	----	----	----	375	7.9
Southern Juab Valley																			
(C-13-1)33cac (Orme Spring)	4-25-63	50	24	114	52	94		223	0	68	308	15	936	496	313	29	1.8	1,450	7.7
(C-15-1)10cad-1	5-2-63	54	14	171	65	65		288	0	475	71	3.5	1,070	672	456	17	1.1	1,410	7.3
11baa-1	5-21-63	57	14	162	55	55		304	0	395	61	8.2	953	632	383	16	1.0	1,300	7.0
16baa-1	5-28-63	55	21	135	72	126		235	0	518	124	.7	1,180	634	441	30	2.2	1,610	7.1
16cbb-1	6-7-63	51	18	162	74	91		285	0	503	104	4.1	1,140	710	476	22	1.5	1,560	7.6
33acd-1	5-23-63	58	34	108	107	424		207	0	476	685	2.1	2,040	710	540	57	6.9	3,290	7.2

(C-16-1) 3cdd-1	11- 1-63	56	26	56	63	53	446	0	78	45	4.6	540	398	32	22	1.2	882	7.5
(C-14-1)31ada-1	5-28-63	55	13	184	57	47	296	0	456	53	8.2	1,020	696	453	13	.8	1,350	7.0
34cbd (Rosebush Springs)	6-19-63	52	11	155	51	75	306	0	361	92	.7	925	594	343	22	1.3	1,320	7.4
Mills Valley																		
(C-15-2)25bdd-1	5-29-63		21	34	32	193	201	0	113	250	1.1	756	216	51	66	5.7	1,350	7.4
26aca-1	5-29-63	58	50	20	18	78	228	0	38	45	.4	354	122	0	58	3.1	571	7.4
(C-16-2)2aad (Chase Springs)	6-13-63	62	25	130	84	138	268	0	214	370	7.2	1,190	670	450	31	2.3	1,910	7.4
27dbd (Blue Springs)	1-22-63	63	14	59	34	19	306	0	22	38	1.5	334	288	37	12	.5	607	7.7
34aab (Molten Springs)	10-23-62	62	13	63	38	33	310	0	35	68	1.5	410	315	61	19	.8	725	7.8
	12- 4-62	61	14	62	38	29	309	0	33	62	.2	399	312	59	17	.7	700	7.6
	1-16-63	61	13	63	42	34	311	0	38	76	1.3	433	328	73	19	.8	760	7.8
	3-26-63	62				34	310	0	37	66			312	58	19	.8	729	7.5
	4-23-63	61															742	
	5-21-63																687	
	6- 5-63	62															671	
	7-11-63	63															732	
	8-15-63	62															773	
	11-19-63	62	13	57	38	31	309	0	26	60	2.8	381	300	47	18	.8	674	7.9
	12-19-63	62															681	
Little Valley																		
(C-17-2)9bad-1	3-28-63	56	14	60	36	17	322	0	18	34	2.4	350	296	32	11	.4	615	7.7

[1] Contains 0.1 ppm fluoride.
[2] Analysis by Western Filter Co., Denver, Colo.
[3] Calculated from determined constituents.

TABLE 6.—*Chemical analysis of water from the Sevier River and tributaries between Yuba Dam and Leamington Canyon mostly during seepage runs in March and October 1963, and chemical analysis o fwater from Chicken Creek*

[Analyses by U.S. Geological Survey. Location No. and sampling site: Sampled in Sevier River unless indicated otherwise. Dissolved solids: Residue on evaporation]

Location No. and sampling site	Approximate miles downstream from Yuba Dam	Date of collection	Temperature (°F)	Parts per million													Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos per cm at 25°C)	pH	Discharge (cfs)
				Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$					
Seepage run on the Sevier River, mostly March 7-8, 1963																					
(C-16-2)35dc; at gaging station near Juab	0.3	3-7-63	...	...	...	...	324		336	0	400	420	...	...	580	304	55	5.9	2,460	7.4	2.3
(C-16-2)34aab; in Molten Springs creek	1.5	3-26-63	62	...	...	...	34		310	0	37	66	...	...	312	58	19	.8	729	7.5	[1] 6.0
(C-16-1)26ccb; below Molten Springs	1.6	3-7-63	...	...	...	...	125		308	0	156	210	...	...	440	187	38	2.6	1,380	7.4	9.6
(C-16-2)27dbd; in Blue Springs	1.9	1-22-63	63	14	59	34	19		306	0	22	38	1.5	334	288	37	12	.5	607	7.7	[2] 23
(C-16-2)27add; below Blue Springs	2.1	3-7-63	...	...	...	...	57		306	0	72	106	...	...	352	101	26	1.3	909	7.4	32.7
(C-16-2)3bdd	6.6	3-7-63	...	...	...	...	56		264	0	77	111	...	...	332	116	27	1.3	901	7.4	31.3
(C-15-2)26bba; in drain from The Meadows	9.2	3-7-63	...	...	...	...	372		326	0	720	675	...	...	1,160	893	41	4.7	3,690	7.4	3.8
(C-15-2)23ccd; at RR crossing near Mills	9.3	3-7-63	...	...	...	...	98		294	0	151	175	...	...	432	191	33	2.1	1,240	7.4	36.1
(C-15-2)7d; near Union Pacific RR milepost 683¾	14.5	3-8-63	...	...	...	...	107		296	0	166	184	...	...	442	199	35	2.2	1,290	7.4	38.3
(C-14-3)22dd; at head of Leamington Canyon	18.5	3-8-63	...	...	...	...	109		294	0	176	194	...	...	460	219	34	2.2	1,340	7.5	34.9

Seepage run on the Sevier River, mostly October 21-22, 1963

(C-16-2)35dc; at gaging station near Juab	0.3	10-21-63	59	21	80	105	462	326	0	508	592	3.7	1,920	630	363	61	8.0	3,050	7.7	3.3
(C-16-2)34aab; in Molten Springs creek	1.5	11-19-63	62	13	57	38	31	309	0	26	60	2.8	381	300	47	18	.8	674	7.9	[3] 5.6
(C-16-2)26ccb; below Molten Springs	1.6	10-21-63	64	15	72	69	204	305	0	221	302	2.9	1,050	464	214	49	4.1	1,720	7.7	8.5
(C-16-2)27add; below Blue Springs	2.1	10-21-63	65	14	63	48	80	306	0	87	130	2.1	577	352	101	33	1.9	1,000	7.7	30.1
(C-16-2)3bdd	6.6	10-21-63	63	12	53	49	80	274	0	89	134	1.4	560	332	107	35	1.9	978	7.5	30.3
(C-15-2)26bba; in drain from The Meadows	9.2	10-22-63	48	20	124	221	484	158	0	938	825	3.7	2,800	1,220	1,090	46	6.0	4,060	7.4	2.1
(C-15-2)23ccd; at RR crossing near Mills	9.3	10-22-63	50	12	59	60	118	280	0	147	190	1.2	724	396	166	39	2.6	1,230	7.5	33.3
(C-14-3)36dd; near Union Pacific RR milepost 681¾	16.5	10-22-63	54	11	63	70	125	278	0	192	202	.3	835	442	214	38	2.6	1,360	7.5	34.6
(C-14-3)22dd; at head of Leamington Canyon	18.5	10-22-63	55	11	59	58	125	274	0	147	200	.6	712	388	163	41	2.8	1,200	7.4	30.2

Chicken Creek

(D-14-1)33ca; at gaging station near Levan	------	3-8-63	------	------	------	------	54	238	0	119	72	------	------	304	109	28	1.3	807	7.5	1.2
		4-29-63	------	------	------	------	26	230	0	51	30	------	------	228	39	20	.7	535	7.5	1.0
SW¼NW¼ sec. 26, T. 15 S., R. 1½W; near Mills	------	6-3-63	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	7,270	------	.5

[1] Discharge measured on February 25, 1963.
[2] Discharge estimated on March 7, 1963.
[3] Discharge measured on October 1, 1963.

TABLE 7.—*Selected drillers' logs of wells in the Sevier River basin between Yuba Dam and Leamington Canyon*—Continued

[Driller in parentheses after well number. Altitudes are land surface at the well, in feet above mean sea level]

Material	Thickness (feet)	Depth (feet)
Round Valley		
(C-20-2)15abb-1 (Robinson Drilling Co.):		
Soil	3	3
Clay	9	12
Gravel	2	14
Clay, yellow	6	20
Gravel	15	35
Clay and gravel	5	40
Clay, yellow	25	65
Gravel	10	75
Clay	7	82
Gravel	10	92
Clay, blue	23	115
Clay, yellow	45	160
Gravel	25	185
Clay, yellow	20	205
Gravel and water	40	245
Clay, blue	10	255
Gravel, large; water bearing	15	270
Clay, yellow	30	300
Clay, blue	75	375
Clay, red	21	396
Gravel; water bearing	4	400
Clay, brown	15	415
Gravel	5	420
Clay, brown	5	425
Gravel and sandy clay	10	435
Gravel	10	445
Gravel and brown clay	10	455
Gravel	15	470
Gravel and sandy clay	15	485
Gravel	40	525
Clay, sandy	5	530
Gravel	10	540
Clay	15	555
Gravel, sandy, and brown sandy clay	10	565
Sand	10	575
Gravel	10	585
Gravel and sandy clay	5	590
Gravel	10	600
Clay	5	605
Clay and gravel	5	610
Gravel	20	630
Clay, sandy; contains gravel	5	635
Gravel	15	650
Sand and gravel	50	700
Sand and small amount of clay	10	710
Clay, sandy, and gravel	15	725
Clay, red, sticky	20	745
Clay and gravel	5	750
Sand	5	755
Clay, brown, sticky	20	775
Gravel, small	5	780
Sand	5	785
Sand and fine gravel	7	792
Clay, yellow	8	800
Clay, brown	10	810
Sand	12	822
Clay, gray, and shale	11	833
Sandstone, yellow	17	850
Shale	2	852
Rock, brown, hard	3	855
(C-20-2)27dcc-1 (Scott Stephenson):		
Surface	13	13
Gravel; water	2	15
Clay	23	38
Gravel; water	3	41
Clay	16	57
Gravel; water	3	60
Clay and gravel; water	24	84
Clay and sand	11	95
Clay, sand, and gravel in layers	40	135
Clay and sand	63	198
Sand and gravel	11	209
Clay, sand, and gravel, mixed	11	220
Clay, sand, and gravel in layers; water	67	287
Hardpan	4	291
Clay, sand, and gravel in layers	18	309
Hardpan	8	317
Clay, sand, and gravel in layers	6	323
Hardpan	8	331
Gravel; water	6	337
Clay, gravel, and boulders, mixed	21	358
Gravel, cobbles, and hardpan	86	444
Conglomerate, hard	9	453
Boulders, hardpan, and conglomerate	100	553
Clay, red	4	557
Sandstone	30	587
(C-20-2)34baa-1 (Robinson Drilling Co.):		
Surface	5	5
Gravel; small amount of water	4	9
Clay, blue	18	27
Clay, yellow	8	35
Clay, sandy, yellow	25	60
Sand, fine; little water	10	70
Clay, sandy, yellow	20	90
Clay, yellow	50	140
Clay, sandy, yellow	50	190
Sand, fine	10	200
Clay, sandy, yellow	20	220
Clay and small rocks	5	225
Sand, fine, and few small rocks	15	240
Clay, yellow, and few small rocks	8	248
Clay, yellow	4	252
Clay, sandy, yellow, and few small rocks	28	280
Gravel	2	282
Clay, yellow, and gravel	18	300
Clay, yellow, and small boulders or conglomerate	20	320
Conglomerate	44	364
Clay, yellow, and boulders	46	410
Clay and boulders	40	450
Sandstone and little clay	9	459
Sandrock and little clay	6	465

TABLE 7.—*Selected drillers' logs of wells in the Sevier River basin between Yuba Dam and Leamington Canyon*—Continued

Material	Thickness (feet)	Depth (feet)
Round Valley—Continued		
(C-20-2)34baa-1—Continued		
Clay, yellow, soft	5	470
Clay, yellow, and boulders	5	475
Clay, yellow	7	482
Clay and boulders	3	485
Sandstone	10	495
Sandstone, light brown	38	533
Shale, yellow	2	535
Sandstone	38	573
Shale, red	4	577
Gravel, coarse	8	585
Red bed and large gravel	10	595
Shale, brown	6	601
(C-20-2)34baa-1—Continued		
Red bed and some gravel	10	611
Shale, red	1	612
Sand, brown; water bearing	1	613
Sandstone, brown	30	643
Sandstone, red	7	650
Clay and fine gravel	2	652
Sandstone, red	6	658
Shale, sandy, red	20	678
Shale, extra hard	2	680
Shale, sandy, red	14	694
Shale, red	6	700
Scipio Valley		
(C-17-2)28bac-1 (C. A. Stephenson; alt 5,280 ft):		
Top soil	6	6
Clay	244	250
Limestone, broken	123	373
(C-17-2)31adb-1 (C. W. Anderson; alt 5,280 ft):		
Top soil	80	80
Clay, brown	80	160
Hardpan, brown	36	196
Rock, yellow	43	239
Sandstone, gray	33	272
Conglomerate, red	59	331
Clay, sandy, red	9	340
Gravel; water bearing	6	346
(C-17-2)31ccc-1 (C. W. Anderson; alt 5,274 ft):		
Top soil	84	84
Gravel and clay	12	96
Clay, brown	180	276
Sand and gravel; water bearing	10	286
(C-18-2)5cdb-1 (C. W. Anderson; alt 5,281 ft):		
Clay	45	45
Sand	1	46
Clay	9	55
No record	4	59
(C-18-2)30abd-1 (C. W. Anderson):		
Clay, sandy	41	41
Sand, red	3	44
Clay, sandy	20	64
Clay, brown	15	79
(C-18-2)30abd-1—Continued		
Conglomerate	4	83
Clay, brown	11	94
Sand and gravel	2	96
(C-18-3)34dda-1 (Layne-Western Co.; alt 6,120 ft):		
Clay and boulders	6	6
Limerock, white	4	10
Limerock, creviced	13	23
Limestone	23	46
Sand and gravel, cemented	5	51
Sandrock	25	76
Sandrock, coarse	10	86
Sandrock, hard	38	124
Sandstone, red	52	176
Limestone; hard clay streaks	144	320
Sandrock	17	337
Limestone	32	369
Limestone; streaks of clay	9	378
Limestone, blue	45	423
Sandrock and limestone	59	482
Quartz	4	486
Limestone	18	504
Limestone and quartz	9	513
Quartz	10	523
Limestone	71	594
Limestone; clay streaks	13	607
Limestone, blue	40	647
Limestone, blue; red clay streaks	61	708
Limerock, white	75	783
Sandrock	3	786
Limestone, blue	38	824
Southern Juab Valley		
(C-14-1)25bdd-1 (P. C. Bradshaw; alt 5,224 ft):		
Clay	27	27
Clay and gravel	3	30
Clay, sandy	6	36
Clay	34	70
Clay and gravel; water bearing	3	73
Gravel	14	87
Clay	11	98
Gravel	3	101
Clay	7	108
Gravel	4	112
Clay	45	157
Clay and gravel	6	163
Clay	8	171
Gravel	4	175
Clay	25	200
Gravel	27	227
(C-14-1)36adb-1 (Stephenson Drilling Co., alt 5,263 ft):		
Top soil	18	18
Gravel and boulders, mixed	39	57
Clay	26	83
Gravel and boulders, mixed	4	87
Clay, gravel, and boulders; hardpan layers	14	101
Clay	7	108
Gravel and boulders, mixed	17	125
Gravel; water bearing	17	142
Clay	6	148
Gravel; water bearing	10	158
Clay, gravel, and conglomerate	12	170
Clay	3	173
Gravel; water bearing	2	175
Clay and gravel in layers	46	221
Gravel	9	230

TABLE 7.—*Selected drillers' logs of wells in the Sevier River basin between Yuba Dam and Leamington Canyon*—Continued

Material	Thickness (feet)	Depth (feet)
Southern Juab Valley—Continued		
(C-14-1)36adb-1—Continued		
Gravel and hardpan layers	15	245
Gravel and conglomerate layers	15	260
Clay, red	5	265
Gravel	13	278
Conglomerate	35	313
Clay and gravel, layers	21	334
Conglomerate, hard	3	337
Clay and gravel, mixed	10	347
Conglomerate, very hard	12	359
(C-15-1)3abb-2 (Davis-Alcorn Drilling Co.; alt 5,142 ft):		
Top soil	6	6
Sand and gravel	18	24
Clay, yellow	8	32
Gravel	28	60
Gravel with clay	50	110
Clay, yellow-blue	38	148
Clay, gravel streaks	52	200
Gravel, clean	20	220
Clay, stiff	32	252
Gravel, medium	66	318
(C-15-1)11baa-1 (P. C. Bradshaw; alt 5,156 ft):		
Clay	12	12
Clay and dry gravel	13	25
Gravel, dry	5	30
Clay	3	33
Gravel; water	7	40
Clay and gravel	10	50
Clay	10	60
Gravel	7	67
Clay	2	69
Gravel	2	71
Clay	3	74
Gravel	8	82
Clay	22	104
Gravel	4	108
Clay	8	116
Gravel	6	122
Clay	20	142
Gravel	6	148
Clay	24	172
Gravel	13	185
Clay and gravel	9	194
Clay, heavy, red	29	223
Clay, heavy, blue	3	226
Clay, red	3	229
Gravel	15	244
Clay	1	245
Gravel	8	253
Clay	7	260
(C-15-1)15dca-1 (Stephenson Drilling Co.; alt 5,107 ft):		
Clay and sand loam	16	16
Clay, silt, and sand, gray	10	26
Clay, pink	41	67
Gravel	4	71
Clay	3	74
Sand and gravel	8	82
Clay, gray	5	87
Clay, sand, and gravel, mixed	38	125
Clay, black sand, and gravel	4	129
Gravel	3	132
Clay and gravel, mixed	20	152
Gravel	1	153
Clay, pink	14	167
Gravel	4	171
Clay, light-gray	14	185
Clay, pink	17	202
C-15-1)16baa-1 (J. T. Woodhouse and Sons; alt 5,070 ft):		
Top soil	2	2
Clay, brown	17	19
Gravel; water bearing	16	35
Clay, brown	18	53
Gravel	3	56
Clay and gravel	14	70
Sand, brown	5	75
Gravel	3	78
Clay and gravel, mixed	15	93
Gravel	2	95
Clay, sandy, red	9	104
Clay, blue, and gravel	6	110
Gravel and clay, blue, mixed	17	127
Clay and gravel	40	167
Gravel; water bearing	13	180
Sand, white	5	185
Gravel, large; water bearing	7	192
Clay, brown	8	200
Gravel, pea size, and sand; water bearing	6	206
Clay, brown, and gravel	16	222
Clay, red	4	226
Sand	6	232
Clay, brown	8	240
Gravel and clay, mixed	60	300
Gravel; water bearing	4	304
(C-15-1)33acd-1 (P. C. Bradshaw; alt 5,206 ft):		
Soil	18	18
Gravel	6	24
Clay	38	62
Gravel; water bearing	1	63
Clay	15	78
Gravel	16	94
Clay	24	118
Gravel	4	122
Clay	15	137
Gravel	4	141
Clay	5	146
Gravel and clay	6	152
Clay	17	169
Gravel	11	180
Clay	33	213
Gravel	7	220
Clay	18	238
Clay, gravelly	3	241
Clay	21	262
Clay, gravelly	1	263
Clay	34	297
Clay, gravelly	3	300
Clay	38	338
Clay, gravelly	8	346
Clay	12	358
(D-14-1)30aad-1 (P. C. Bradshaw; alt 5,335 ft):		
Clay, sandy	35	35
Gravel	10	45
Clay, sandy	40	85
Gravel	23	108
Clay	36	144
Gravel; water bearing	2	146
Clay, sandy	44	190
Gravel	30	220
Clay	42	262
Gravel	16	278
Sand and clay	10	288
Gravel	16	304
Clay	8	312

TABLE 7.—*Selected drillers' logs of wells in the Sevier River basin between Yuba Dam and Leamington Canyon*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Southern Juab Valley—Continued					
(D-14-1)31aab-1 (C. A. Stephenson; alt 5,349 ft):			(D-14-1)31aab-1—Continued		
Top soil	19	19	Clay and conglomerate, layers	62	503
Clay and gravel, mixed	61	80	Clay	2	505
Clay and sand	23	103	(D-14-1)31ada-1 (Scott Stephenson; alt 5,367 ft):		
Clay and gravel, mixed	37	140	Top soil	18	18
Clay and sand, red	9	149	Clay, red	41	59
Gravel and boulders, mixed	11	160	Clay and gravel	10	69
Conglomerate	15	175	Gravel and clay layers	59	128
Clay and gravel, mixed	12	187	Clay, sandy	15	143
Clay and sand	18	205	Gravel and clay	60	203
Clay and gravel, mixed; water bearing	45	250	Conglomerate	10	213
Clay and sand	12	262	Gravel; water bearing; small clay layers	25	238
Gravel and hardpan; water bearing	15	277	Clay	4	242
Hardpan	21	298	Gravel	2	244
Clay and gravel, layers; water bearing	47	345	Clay, pink	18	262
Clay and conglomerate, layers	25	370	Gravel, cemented	13	275
(Not reported)	17	387	Clay	2	277
Clay and conglomerate, layers	13	400	Gravel, cemented	18	295
Clay and gravel, layers; water bearing	30	430	Clay	5	300
Conglomerate	11	441	Gravel, cemented	34	334
			Clay, light-colored	24	358
			Gravel, cemented	12	370
			Clay	10	380
			Gravel, cemented	25	405
Mills Valley					
(C-15-2) 25bdd-1 (J. T. Woodhouse):			(C-15-2) 25bdd-1—Continued		
Clay, brown	6	6	Clay, brown	15	210
Sand, rock, and clay mixed	6	12	Sand and gravel	9	219
Clay, brown	30	42	Clay, yellow	38	257
Gravel	3	45	Sand and gravel	21	278
Clay, brown	10	55	Gravel and sand, hardpan	12	290
Gravel; water bearing	10	65	Clay, yellow	5	295
Clay, brown	18	83	Sand	29	324
Gravel	11	94	Gravel, sand, and clay	6	330
Clay, brown, and gravel mixed	10	104	Clay, yellow; sand ribs	30	360
Gravel and brown clay	36	140	Sand, hardpan, yellow clay lenses	30	390
Sand, fine, white	10	150	Gravel, pea size, and sand	6	396
Clay, brown	20	170	Clay, yellow-white	46	442
Sand, gravel, and brown clay	15	185	Gravel, pea size, and sand	3	445
Sand, brown	10	195	Clay, yellow	2	447
			Gravel, pea size, and sand	18	465

SELECTED REFERENCES

Carpenter, C. H., Robinson, G. B. Jr., and Bjorklund, L. J., 1967, Ground-water conditions and geologic reconnaissance of the upper Sevier River basin, Utah: U.S. Geol. Survey Water-Supply Paper 1836.

——— 1964, Selected hydrologic data, upper Sevier River basin, Utah: U.S. Geol. Survey open-file rept., 29 p., 1 pl. (Duplicated as Utah Basic-Data Rept. 8.)

Carpenter, C. H., and Young, R. A., 1963, Ground-water data, central Sevier Valley, parts of Sanpete, Sevier, and Piute Counties, Utah: U.S. Geol. Survey open-file rept., 34 p., 1 pl. (Duplicated as Utah Basic-Data Rept. 3.)

Christiansen, F. W., 1951, A summary of the structure and stratigraphy of the Canyon Range, *in* Geology of the Canyon, House, and Confusion Ranges, Millard County, Utah; Intermountain Assoc. Petroleum Geologists Guidebook to the Geology of Utah, no. 6, p. 5–18.

——— 1952, Structure and stratigraphy of the Canyon Range, central Utah: Geol. Soc. Amer. Bull., v. 63, p. 717–740.

Conner, J. G., Mitchell, C. G., and others, 1958, A compilation of chemical quality data for ground and surface waters in Utah: Utah State Engineer Tech. Pub. 10, 276 p.

Criddle, W. D., Harris, Karl, and Willardson, L. S., 1962, Consumptive use and water requirements for Utah: Utah State Engineer Tech, Pub. 8 (revised), 47 p.

Crittenden, M. D., Jr., 1963, New data on the isostatic deformation of Lake Bonneville: U.S. Geol. Survey Prof. Paper 454-E, 31 p.

Fenneman, N. M., 1931, Physiography of western United States: New York, McGraw-Hill Book Co., 534 p.

Gilliland, W. N., 1951, Geology of the Gunnison quadrangle, Utah: Nebraska Univ. Studies, new ser. 8, 101 p., 11 pls.

Hahl, D. C., and Cabell, R. E., 1965, Quality of surface water in the Sevier Lake basin, Utah, 1964: U.S. Geol. Survey open-file rept., 24 p., 1 pl. (Duplicated as Utah Basic-Data Rept. 10.)

Hardy, C. T., and Zeller, H. D., 1953, Geology of the west-central part of the Gunnison Plateau, Utah: Geol. Soc. Amer. Bull., v. 64, p. 1261–1278.

Hem, J. D., 1959, Study and interpretation of the chemical characteristics of natural water: U.S. Geol. Survey Water-Supply Paper 1473, 269 p., 2 pls.

Maxey, G. B., 1946, Geology of part of the Pavant Range, Millard County, Utah: Am. Jour. Sci., v. 244, p. 324–356.

Meinzer, O. E., 1911, Ground water in Juab, Millard, and Iron Counties, Utah: U.S. Geol. Survey Water-Supply Paper 277, 162 p., 5 pls.

——— 1923a, Outline of ground-water hydrology, with definitions: U.S. Geol. Survey Water-Supply Paper 494, 71 p.

——— 1923b, The occurrence of ground water in the United States, with a discussion of principles: U.S. Geol. Survey Water-Supply Paper 489, 321 p., 31 pls.

Mower, R. W., and Feltis, R. D., 1964, Ground-water data, Sevier Desert, Utah: U.S. Geol. Survey open-file rept., 34 p., 1 pl. (Duplicated as Utah Basic-Data Rept. 9.)

Muessig, Siegfried, 1951, Eocene volcanism in central Utah: Science, v. 114, no. 2959, p. 234.

Officers of the Department of Agriculture and Government Chemical Laboratories, 1950, Water for agricultural purposes in Western Australia: Jour. Agriculture Western Australia, v. 27, ser. 2, 156 p.

Robinove, C. J., Langford, R. H., and Brookhart, J. W., 1958, Saline-water resources of North Dakota: U.S. Geol. Survey Water-Supply Paper 1428, 72 p.

Robinson, T. W., 1958, Phreatophytes: U.S. Geol. Survey Water-Supply Paper 1423, 84 p.

Snyder, C. T., Hardman, George, and Zdenek, F. F., 1964, Pleistocene lakes in the Great Basin: U.S. Geol. Survey Misc. Geol. Inv. Map I-416

Spieker, E. M., 1949, The transition between the Colorado Plateaus and the Great Basin in central Utah: Utah Geol. Soc. Guidebook to the geology of Utah, no. 4, 106 p., 1 pl.

Stokes, W. L., ed., 1963, Geologic map of Utah, SE¼ and SW¼: Utah Univ.

U.S. Geological Survey, 1900–60, Surface-water supply of the United States, pt. 10, The Great Basin: U.S. Geol. Survey Water-Supply Papers.

——— 1961, 1962, 1963, Surface-water records of Utah, 1961, 1962, 1963: 272 p., 270 p., 272 p.

U.S. Public Health Service, 1962, Drinking water standards: U.S. Public Health Service Pub. 956, 61 p.

U.S. Salinity Laboratory Staff, 1954, Diagnosis and improvement of saline and alkali soils: U.S. Dept. Agriculture Handb. 60, 160 p.

U.S. Weather Bureau, 1963, Normal annual precipitation (1931–60) for the State of Utah: Map of Utah, scale 1:500,000.

Utah State University, 1961, Normal annual water yield in the Sevier River basin, Utah: Map of Sevier River basin, Utah, scale 1:250,000.

Woolley, R. R., 1947, Utilization of surface-water resources of Sevier Lake basin, Utah: U.S. Geol. Survey Water-Supply Paper 920, 393 p, 33 pls.

Young, R. A., and Carpenter, C. H., 1965, Ground-water conditions and storage in the central Sevier Valley, Utah: U.S. Geol. Survey Water-Supply Paper 1787, 95 p., 6 pls.

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