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HYDROLOGIC RECONNAISSANCE OF RUSH VALLEY, TOOELE COUNTY, UTAH

by

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in cooperation with the
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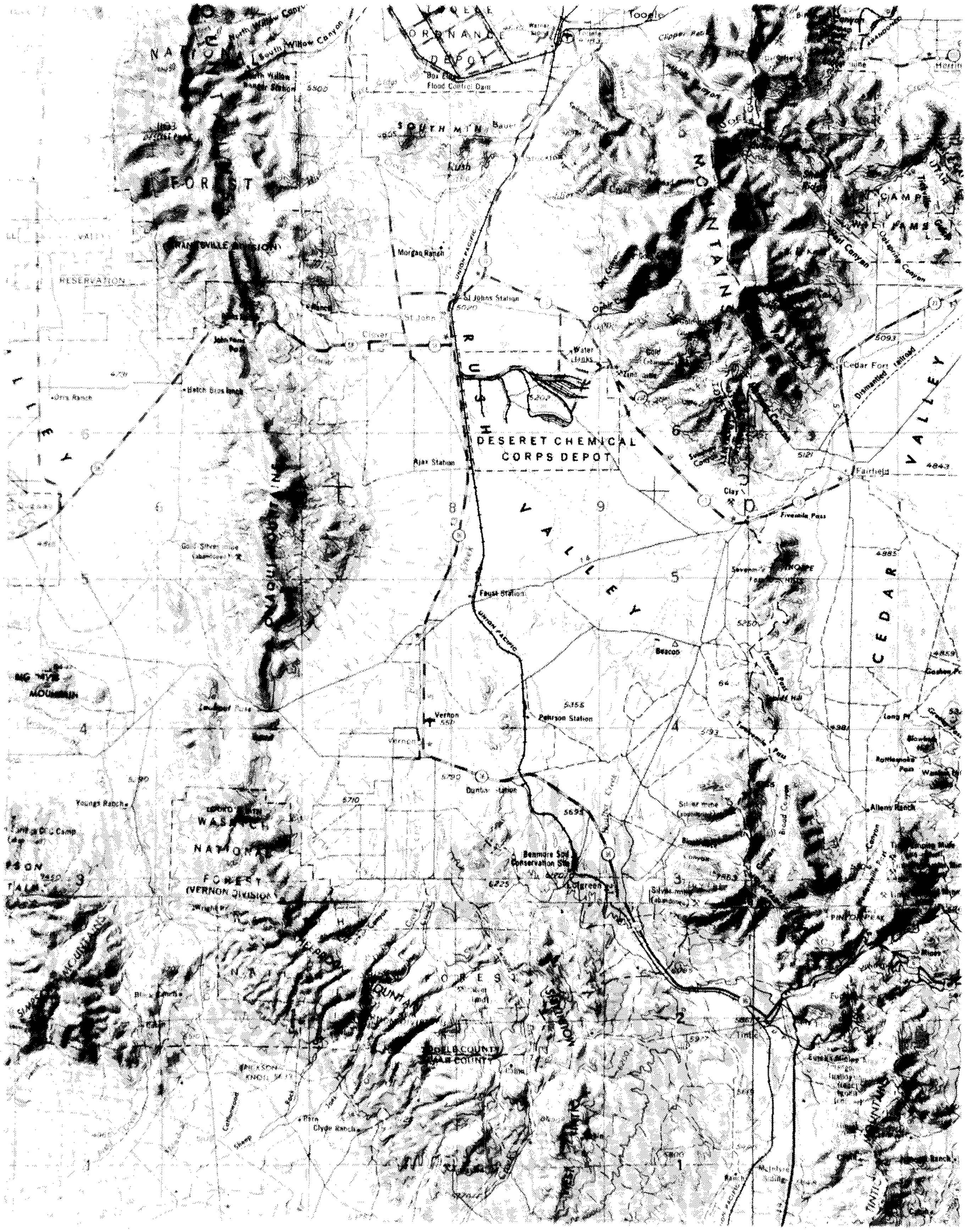

Relief Map of Rush Valley and vicinity
(From AMS 1:250,000 series, NK 12-10, Tooele, Utah
and NJ 12-1, Delta, Utah)

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ABSTRACT

Rush Valley is an elongated depression that covers about 250,000 acres and is part of a drainage basin that covers about 470,000 acres. The valley extends about 30 miles from Stockton in T. 4 S., R. 5 W., southward to the Sheeprock Mountains. The main ground-water reservoir is in unconsolidated rocks of late Tertiary(?) and Quaternary age.

The source of all water in Rush Valley is the 550,000 acre-feet of precipitation that falls mainly on the Oquirrh, Stansbury, Onaqui, and Sheeprock Mountains. The estimated maximum potential long-term average annual runoff from the uplands is 70,000 acre-feet of water. No surface water leaves the topographically closed valley.

The estimated average annual ground-water recharge to and discharge from Rush Valley is in the range of 34,000-37,000 acre-feet. Ground water is discharged from the valley by wells, by evapotranspiration (including spring flow), and by subsurface outflow through the east edge of the valley. In 1966, wells discharged about 4,800 acre-feet of water. Evapotranspiration accounts for about 70 percent of the total ground-water discharge, and subsurface outflow accounts for about 14 percent. The estimated perennial yield of ground water in Rush Valley is about 15,000 acre-feet (including current pumpage) if well spacing is carefully planned. Water in excess of this amount would have to be drawn from storage with resulting water-level declines. If water levels were lowered 100 feet, the estimated amount of recoverable water would be 1.6 million acre-feet.

The chemical quality of water in Rush Valley is generally good for irrigation and domestic purposes. The range of concentrations of dissolved solids in water in the drainage basin is 200-2,180 ppm (parts per million). Water from only three sources contained concentrations of dissolved solids in excess of 1,000 ppm.

Development of water in Rush Valley has been largely on the northern and western sides of the valley and at the Deseret Chemical Corps Depot. The main use of the water has been for irrigation. In 1966, an estimated 5,800 acres were irrigated partly with surface water and supplemental ground water and partly with ground water alone. Ground water is the main source of water for future development in the valley. Because Rush Valley is among the more densely populated of the desert basins in western Utah and because of increasing interest in the valley, a detailed water-resources study of Rush Valley is needed immediately.

INTRODUCTION

This report is the third in a series by the U. S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights, which describes the water resources of the western basins of Utah. Its purpose is to present available hydrologic data for Rush Valley, to provide an evaluation of the potential water-resources development of the valley, and to identify needed studies that would help provide an understanding of the valley's water supply.

The investigation of Rush Valley was made intermittently during 1966-67, and consisted largely of an office study of all available data for climate, geology, streams, wells, springs, and water use. These data were supplemented with data collected in May 1967 during a rapid field examination of land forms, vegetation, geology, and distribution of water use. Where well records were poor or not available, specific well data were sought. Under a cooperative program with the Utah Geological and Mineralogical Survey, many water sources in the Rush Valley drainage basin were sampled and analyzed (Waddell, 1967). The chemical analyses were supplemented with a few available records from Connor, Mitchell, and others (1958). Selected basic data assembled during the investigation are given in tables 2, 3, 5, 6, and 11-17.

Rush Valley is southwest of Salt Lake City; Stockton, at the north end of the valley is about 40 road miles from Salt Lake City, via the city of Tooele (pl. 1). The valley and alluvial slopes that border the adjacent mountain ranges cover about 250,000 acres (about 400 square miles). The drainage basin of the valley covers approximately 470,000 acres (730 square miles).

The valley is among the more densely populated of the desert basins in western Utah. Communities in the valley include Stockton (population 362, according to the 1960 census), St. John (140), Clover (95), Vernon (511), and the Deseret Chemical Corps Depot. (See frontispiece and pl. 1).

Few published sources of hydrologic data in Rush Valley are available, and in most sources the valley is discussed as part of a broader area. Carpenter (1913) included Rush Valley in a reconnaissance of Box Elder and Tooele Counties, Utah. Snyder (1963) included data on the valley in a description of the availability of stock water in the public domain. Mahoney (1953) discussed Rush and Tooele Valleys as a unit in his appraisal of the general disposition of precipitation in the Bonneville Basin, and Bagley, Jeppson, and Milligan (1964) included the valley in their analysis of water yields in Utah. Gates (1963a, 1965) compiled basic data and described ground-water conditions along the boundary between Rush and Tooele Valleys, and Feltis (1967) described recharge conditions in the Oquirrh Mountains in a report on ground-water conditions in Cedar Valley, on the eastern side of the southern Oquirrh Mountains.

Sources of geologic data are more abundant, and most sources are cited in the section on geology. Stokes (1964) used all available sources in compiling the State geologic map, which is the main basis for the geology shown on plate 1.

Wells, springs, and surface-water data sites other than gaging stations are numbered in this report using the system of numbering wells and springs in Utah, which is based on the cadastral

land-survey system of the Federal Government. The number, in addition to designating the well, spring, or other data site, 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 Line and Meridian. The quadrants are designated by the uppercase letters A, B, C, and D, thus: A, for the northeast quadrant; B, for the northwest; C, for the southwest; and D, for the southeast quadrant. Numbers designating the township and range, respectively, follow the quadrant letter, and the 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 that follows the letters indicates the serial number of the well or spring within the 10-acre tract. Thus, well (C-9-6)1dab-1, in Tooele County, is in the NW¼NE¼SE¼ sec. 1, T. 9 S., R. 6 W., and is the first well constructed or visited in that tract. (See fig. 1).

When the serial (final) number is preceded by an "S" the number designates a spring; if the spring is located only to the nearest 40 acres or larger tract, a suffixed "S" is used without the serial number. Thus, spring (C-5-6)32bba-S1 is the first spring recorded in the NE¼NW¼NW¼ sec. 32, T. 5 S., R. 6 W., and the location of spring (C-7-6)4d-S is known only to be in the SE¼ sec. 4, T. 7 S., R. 6 W.

When no serial number is suffixed to a location number for a 10-acre tract, the number designates a site at which surface-water data were obtained. For example, (C-5-4)28cdb designates a site where Ophir Creek was sampled for chemical analysis.

PHYSIOGRAPHY

Rush Valley is a part of the Great Basin and is in the area of internal drainage that once was occupied by Lake Bonneville (Gilbert, 1890). Although the drainage basin of Rush Valley is about 40 miles long, the valley is only about 30 miles long and reaches its maximum width of about 17 miles in T. 8 S.

The mountains that frame Rush Valley are folded and faulted blocks of sedimentary, metamorphic, and igneous rocks. The diverse topographic expression in the mountains generally reflects the complex internal structure of the blocks, but the present topographic relief is largely the result of movement along fault systems which as a whole trend northward.

The mountains consist of three main elements—the Oquirrh-East Tintic Mountain chain on the east, the Stansbury-Onaqui chain on the west, and the Sheeprock-West Tintic Mountain area on the south. The highest point on the drainage divide around Rush Valley is Lowe Peak (altitude 10,572 ft) in the Oquirrh Mountains (pl. 1). A substantial part of this massive upland area is above 9,000 feet, and the approaches to the mountains are abrupt. North of Ophir Canyon, the mountain front rises more than 3,000 feet in a little more than 1 mile. The highest point in the Sheeprock Mountains is Dutch Peak (alt 8,964 ft), and substantial parts of the mountains are above 8,000 feet. The highest point on the drainage divide in the southern Stansbury Mountains is Vickory Mountain (alt 10,305 ft); some small areas in the southern Stansbury Mountains range in altitude from 9,000 to 10,000 feet. The lowest point on the drainage divide is the top of the Stockton bar (alt 5,175 ft) near Stockton.

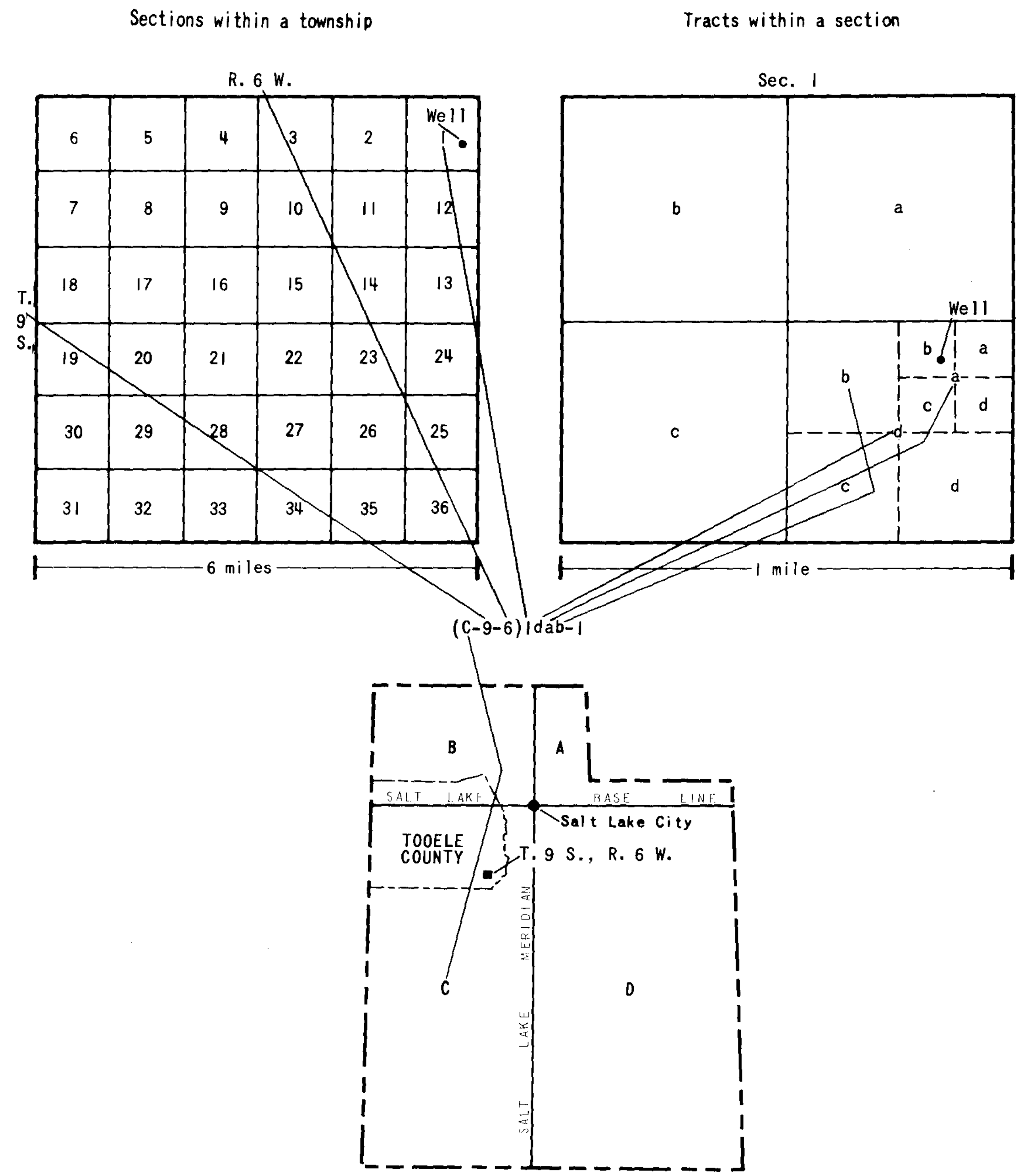


Figure 1.—Well- and spring-numbering system.

CLIMATE

Climatic conditions differ widely from one part of the Rush Valley drainage basin to another. The climate of the valley as a whole is semiarid, whereas that in the highest parts of the Stansbury and Oquirrh Mountains is humid to subalpine. The availability of climatologic data is summarized in table 1, and the locations of climatologic stations are shown in figure 2. Most of the stations are at low altitudes, but short records are available for two high altitude storage gages in the Oquirrh Mountains. Useful regional interpretations of climatic data are also available, such as those described by Peck and Brown (1962), who produced the isohyetal maps of Utah (U. S. Weather Bur., 1963a, 1963b, and fig. 2), and by Ashcroft and Derksen (1963), who provided tables of freezing temperature probabilities.

Average annual precipitation in the Rush Valley drainage basin is less than 10 inches in the central part of the valley (E. L. Peck, oral commun., 1967) and more than 40 inches in the Oquirrh Mountains; most of the valley receives 12 inches per year or less (fig. 2). The amount and distribution of precipitation is discussed in more detail in the section on water resources.

Data on air temperature in Rush Valley have been recorded only at St. John prior to 1930 and intermittently at Vernon since 1953. Based on lengthier records at Tooele, Government Creek, Orr's Ranch, Bauer, and Fairfield stations (fig. 3 and table 1), the average annual air temperature in the lowlands of Rush Valley is estimated to be 47°F and that on the higher part of the alluvial apron around the valley is estimated to be 50°F. The coldest average monthly temperatures at six stations in and near Rush Valley are 22-29°F in January and the warmest are 70-75°F in July. The range of observed daily extremes is from −36° to +110°F (fig. 3).

The length of the growing season is of particular importance with regard to the evaluation of transpiration by vegetation. The growing season is about the same length at most stations in the study area. Because the definition of killing frost differs depending on the type of vegetation, the U. S. Weather Bureau (1951-67) publishes freeze data that include the number of days between the last spring and first fall minimum temperatures of 32°F, 28°F, and 24°F. The available freeze data for St. John and for five stations near the valley are included in figure 3. Crops experiencing a killing frost at 32°F have an average growing season of 90-100 days in the lower parts of the valley, and probably have an average growing season of about 130 days on the upper slopes of the alluvial apron.

The semiarid climate and the high summer temperatures in Rush Valley cause high evaporation rates. Table 2 shows the estimated average annual evaporation at Saltair Salt Plant and at Utah Lake Lehi stations. The Saltair station is on the flats southeast of Great Salt Lake, 27 miles north-northeast of Stockton, and the Lehi station is near Utah Lake, and about 25 miles east-southeast of Stockton. The climatic environment at both stations is somewhat different from that in Rush Valley; at Saltair Salt Plant the evaporation is greater, and at Lehi it is believed to be lower. The average annual evaporation in Rush Valley, therefore, is between 43 and 57 inches per year and probably is on the order of 50 inches.

Table 1.—Stations at which climatologic data have been collected in and near Rush Valley through 1966

(Data published by U.S. Weather Bur., 1937, 1951-67, 1957, 1965.)

(P, precipitation; T, temperature)

Station	Location Lat.	Location Long.	Altitude (feet)	Period of record	Type of record	Remarks
Bauer	40°28′	112°22′	4,965	3- -41 to 12- 59	P,T	In Tooele Valley, 1.5 miles north of Stockton.
Benmore	40°00′	112°28′	6,200	8- -11 to 5- -17	P	7 miles SSW of Vernon; published as "Vernon" Aug. 1911 - Aug. 1915.
	40°01′	112°24′	6,100	5- -17 to 12- -48 1- -50 to 8- -53	P	1 mile east of Benmore, 7.3 miles SSE of Vernon.
	40°03′	112°25′	6,000	3- -57 to 6- -65	P	Storage gage; monthly totals prorated from observed totals.
Bingham Canyon	40°32′	112°09′	6,170	12- -40 to 12- -66	P,T	In Oquirrh Mountains west of Jordan Valley.
Eureka	39°57′	112°07′	6,530	3- -30 to 12- -66	P	Southeast of Rush Valley.
Fairfield	40°16′	112°05′	4,876	9-28-50 to 7- -65	P,T	In Cedar Valley; station moved to this location from CAA Station 5 miles NNE; converted to a recording special-purpose gage in 1965.
Fairfield CAA	40°21′	112°03′	4,963	12- -42 to 9- -50	P,T	In Cedar Valley; station moved 5 miles SSW on 9-28-50.
Government Creek	40°03′	112°40′	5,320	12- -00 to 11- -49	P,T	In Government Creek valley at James Ranch, also called Indian Springs Post Office; late part of record for summers only.
Grantsville Powerhouse	40°31′	112°31′	4,900	10- -42 to 5- -56	P	In Tooele Valley at mouth of South Willow Canyon.
Middle Canyon	40°29′	112°12′	7,000	7- -56 to 6- -65	P	Storage gage; monthly totals prorated from observed totals.
Ophir Canyon	40°24′	112°14′	6,900	9- -58 to 6- -65	P	Storage gage; annual totals only do not permit proration of monthly totals.
Orr's Ranch	40°24′	112°45′	-	1- -19 to 6- -20	P,T	Known as Sells through 1923; record poor through 1920.
	40°18′	112°44′	4,700	11- -20 to 4- -49	P,T	
St. John	40°16′	112°26′	5,200	5- -11 to 6- -15	P,T	6 miles south of St. John Post Office; known as Center Station.
	40°17′	112°26′	5,132	1- -16 to 8- -16	P,T	4 miles south of St. John Post Office; known as Center Station.
	40°21′	112°25′	4,900	11- -16 to 4- -18	P,T	
	40°22′	112°25′	5,016	11- -18 to 5- -29	P,T	At St. John Railroad Station.
Tooele	40°32′	112°18′	4,820	3- -96 to 12- -66	P,T	In Tooele Valley.
Vernon	40°05′	112°27′	5,485	9- -53 to 6- -55 9- -63 to 12- -66	P,T	Record discontinuous.

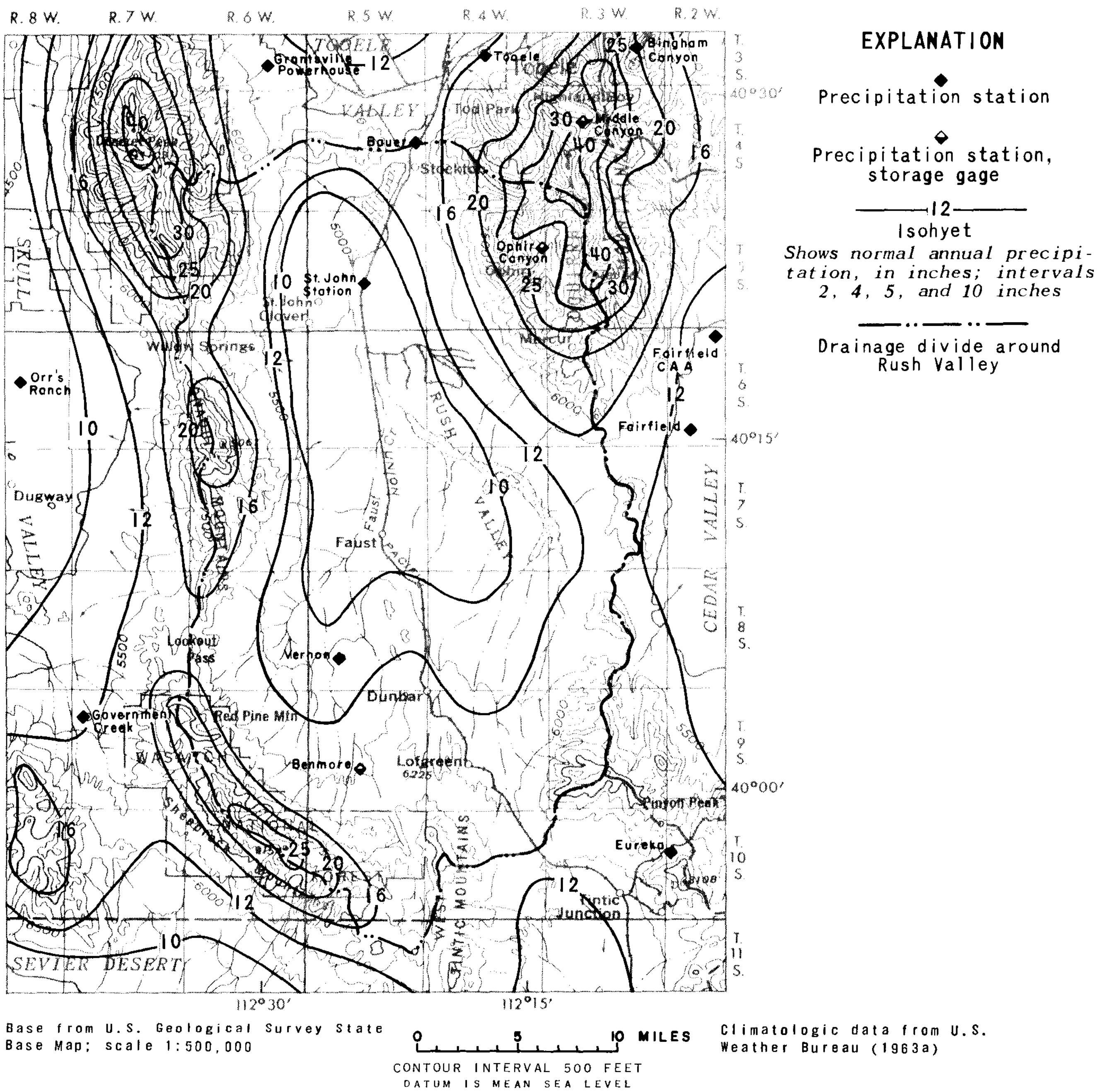
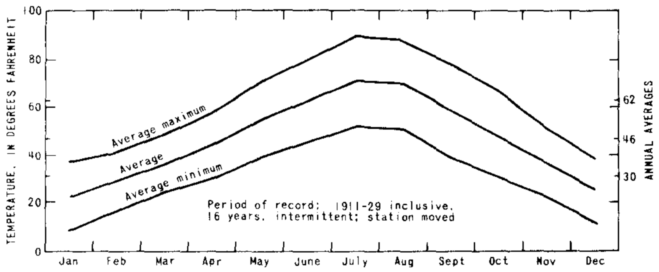


Figure 2.—Isohyetal map of Rush Valley and vicinity showing locations of climatologic stations listed in table 1.

Freeze data for 16-year period, 1911-29 inclusive: Average number of days between last spring and first fall minimum of 32°F or lower - 98 days
Extremes: Maximum, +110°F; minimum, -36°F

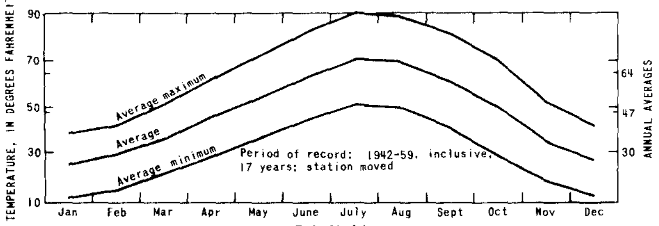


St. John

Freeze data for 15-year intermittent record during period 1950-63 inclusive:

	24°F	Year	28°F	Year	32°F	Year
	Number of days between last spring and first fall minimum					
Annual average for period	149	-	120	-	96	-
Longest period and year	188	1949	154	1949	121	1958
Shortest period and year	125	1954	77	1962	65	1959

Extremes: Maximum, +104°F; minimum, -31°F

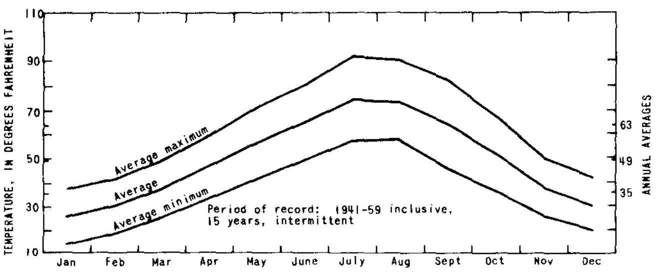


Fairfield

Freeze data for 9-year intermittent record during period 1949-59 inclusive:

	24°F	Year	28°F	Year	32°F	Year
	Number of days between last spring and first fall minimum					
Annual average for period	191	-	157	-	134	-
Longest period and year	208	1953	182	1951	147	1958
Shortest period and year	152	1958	141	1959	111	1950

Extremes: Maximum, +104°F; minimum, -21°F

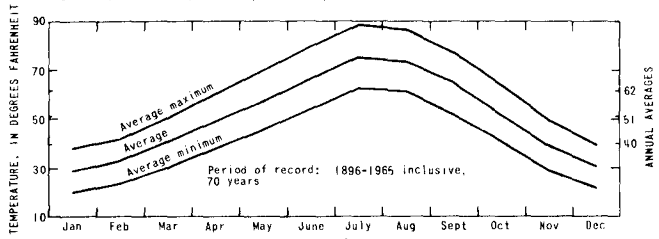


Bauer

Freeze data for 17-year period 1949-65 inclusive:

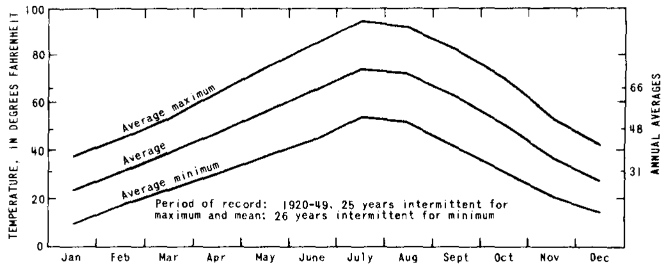
	24°F	Year	28°F	Year	32°F	Year
	Number of days between last spring and first fall minimum					
Annual average for period	226	-	195	-	168	-
Longest period and year	251	1949	242	1954	208	1952
Shortest period and year	205	1965	134	1965	133	1965

Extremes: Maximum, +104°F; minimum, -16°F



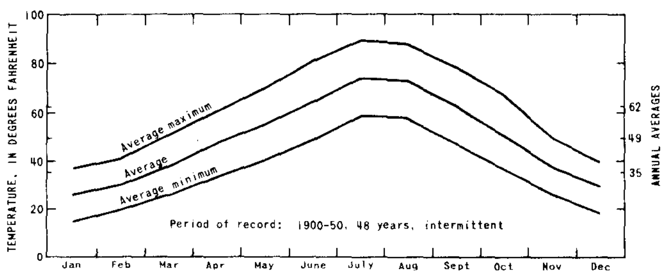
Tooele

Freeze data for 10-year period, 1921-30 inclusive: Average number of days between last spring and first fall minimum of 32°F or lower - 92 days
Extremes: Maximum, +105°F; minimum, -35°F



Orr' Ranch

Freeze data for 30-year period, 1901-30 inclusive: Average number of days between last spring and first fall minimum of 32°F or lower - 118 days
Extremes: Maximum, +105°F; minimum, -22°F



Government Creek

Figure 3.—Temperature and freeze data for six stations in and near Rush Valley.

Table 2.—Estimated average annual evaporation, in inches, for period of record at Saltair Salt Plant and Utah Lake Lehi

(Based on data from U. S. Weather Bureau, 1951-67, 1965. Adjustment to annual evaporation and pan coefficient estimated from Kohler, Nordenson, and Baker, 1959, pls. 3 and 4.)

Average of measured evaporation							Annual total for pan[1]	Annual evaporation from free water surface (rounded)[2]
May	June	July	Aug.	Sept.	Oct.	6-month total		
Saltair Salt Plant[3]								
9.48	12.33	15.18	13.32	9.01	5.82	65.14	81.43	57
Utah Lake Lehi[4]								
8.27	9.73	10.79	9.50	6.94	4.06	49.29	61.61	43

[1] May-October evaporation is estimated to be 80 percent of annual total. Annual total is 6-month total x 1.25.

[2] Evaporation from free water surface is estimated to be 70 percent of annual pan evaporation.

[3] Period of record: 1956-65. Station altitude: 4,210 feet. Location: Latitude 40°46′, longitude 112°06′, 27 miles north-northeast of Stockton.

[4] Period of record: 1931-65. Station altitude: 4,497 feet. Location: Latitude 40°22′, longitude 111°54′, approximately 25 miles east-southeast of Stockton.

GEOLOGY AND WATER-BEARING CHARACTERISTICS OF THE ROCKS

The data from Stokes (1964) and other investigators cited in the following discussion, together with field data, have been used to emphasize the relation of geology to the hydrology of Rush Valley.

Consolidated rocks

The consolidated rocks that form the mountains surrounding Rush Valley are divided into four units: (1) metasedimentary rocks of Precambrian age and the Tintic Quartzite of Early and Middle Cambrian age, (2) Paleozoic sedimentary rocks, which are mainly carbonates, (3) Tertiary intrusive and extrusive igneous rocks, and (4) the Salt Lake Formation of Pliocene age.

The Precambrian rocks consist of about 11,000 feet of argillite, quartzite, and other metamorphic rocks (Cohenour, 1959, p. 17). These rocks and the Tintic Quartzite crop out only in the Sheeprock Mountains, south-southwest of Vernon, and they have mainly low permeability

and act as a conveyance medium of surface runoff of precipitation. The rocks are cut by both high and low angle faults, which provide zones of locally high permeability. Because the rocks are exposed at a high altitude where precipitation is great, they yield some ground water to springs above 6,500 feet and sustain a few perennial streams that are augmented by discharge from mines. The quantity of water stored in the Precambrian rocks is probably small because flow from springs and streams dwindles in August (Cohenour, 1959, p. 120). (See also section on surface water.)

The Paleozoic sedimentary rocks are exposed in most of the mountains and hills of the valley perimeter, and it is known that they underlie younger rocks in a part of Rush Valley. Detailed geologic maps (sources cited in Stokes, 1964) show that much of the section consists of carbonate rocks which have been strongly deformed by folding and repetitive faulting. Steep dips and cross faulting are common.

The Paleozoic sedimentary rocks have low primary permeability, but repeated fracturing by folding and faulting has caused the development of secondary permeability. Fractures and joints in the carbonate rocks have been enlarged by solution as water moves through them. Gilluly (1932) gives examples of secondary permeability for parts of the Oquirrh Mountains. He reports a mine tunnel penetrating "water courses" in limestone at or above 8,000 feet (pl. 29), open fissures in limestone in the west limb of the Ophir anticline (p. 155-156), and water developed in the Honerine Mine northeast of Stockton (p. 160). Gates (1963b, p. K-36) points out the role of the sedimentary rocks in surface-water loss in a canyon in the Oquirrh Mountains northeast of Rush Valley. The intake of water into the rocks probably accounts for the small surface runoff from the Oquirrh Mountains.

Elsewhere the Paleozoic sedimentary rocks apparently drain a part of the ground water from Rush Valley in the area between Fivemile Pass and Twelvemile Pass at the eastern side of the valley. (See section on ground water.) Spring (C-5-5)9cba-S1, which yields about 1,000 gpm (gallons per minute) (table 15), discharges from alluvium where the alluvium directly abuts limestone in a bedrock mass that crops out in the northern part of the valley. The authors believe that the water moves from the bedrock into the alluvium and thence to the surface at the spring.

Some formations of Paleozoic age in the Rush Valley drainage basin appear to be specifically associated with water. Among these are the Manning Canyon Shale and the Oquirrh Formation. The relatively impermeable beds of the Manning Canyon Shale control the location of springs in the southern Stansbury Mountains (Teichert, 1959, p. 66) and the Oquirrh Mountains (Gilluly, 1932, p. 31). Teichert (1959, p. 65) describes the occurrence of springs that discharge at the contact of the Manning Canyon Shale and the Great Blue Limestone along Clover Creek. The largest of these, Clover Creek Spring, (C-5-6)32bba-S1, discharged 4,500 gpm of water on September 21, 1964.

The Oquirrh Formation yields large quantities of water to two wells drilled north of Vernon and provides a specific example of the potentially large yield from fractured zones in clastic rocks. Well (C-8-5)6ddb-1 was drilled to 534 feet and produced water from 430-534 feet by natural flow at rates estimated to be from 900 to 1,450 gpm. The well subsequently was pumped at a measured rate of 4,100 gpm with a drawdown of 13 feet. Well (C-8-5)6ddb-2 was later drilled 40 feet from the first. The second well reportedly was test pumped at a rate of about

8,600 gpm with a drawdown of 61 feet. The water-bearing zone was from 440 to 583 feet and was identified as shattered quartzite of the Oquirrh Formation (M. D. Hubley, written commun., 1967). How much of the shattered rock penetrated is bedrock and how much is weathered debris *in situ* is not known.

The two wells described above are approximately on the trace of a covered fault that trends along Vernon Creek (Stokes, 1964 and pl. 1). By contrast, well (C-8-5)6ccd-1 was drilled about 0.6 mile west of the fault trace to a depth of 730 feet, the last 30 feet being in bedrock. Well (C-8-5)6ccd-1 reportedly was pumped at 700 gpm, but this amount is small compared to the yields of the former two wells that seem to be finished in a fault zone. It appears that the completion of a large yield well in that area depends on localized favorable conditions that can be determined only from more information than was available in the first half of 1967.

The igneous rocks of Tertiary age crop out in the south end of the Rush Valley drainage basin as volcanic flows of early Tertiary age and in the Oquirrh Mountains as small areas of porphyritic intrusive rocks. In both areas, the rocks have low permeability but probably interfere with ground-water recharge and movement only locally.

The distribution of consolidated rocks of Tertiary age in Rush Valley is only partly known because younger unconsolidated rocks cover them. Rocks of Eocene(?) age are described by Disbrow (1957) and Morris (1964, p. L-3), but nothing is known of the hydrology of these rocks and the small areas of outcrop are not shown on plate 1.

Rocks of late Miocene(?) to Pliocene age (Heylmun, 1965, p. 19-20) crop out in the vicinity of Faust. These rocks and others that crop out east of the West Tintic Mountains and near Boulter Summit are referred to as Salt Lake Formation by Stokes (1964). In the vicinity of Faust, the Salt Lake Formation as mapped by Heylmun (1965, fig. 4) is 5,000-8,000 feet thick, dips 15-40° westward, and is strongly faulted. The rocks consist mainly of volcanic tuff, claystone, and limestone. The log of well (C-7-5)27dbb-1 and probably the lower parts of the logs of wells (C-7-3)30acc-1 and (C-8-4)22aad-1 (table 13) are indicative of drillers' descriptions of cuttings from the formation.

In the Vernon area, wells penetrate thick clay beds, some of which contain glass shards (R. E. Marsell, oral commun., 1967) that are characteristic of the Salt Lake Formation. From the presence of these thick clays in numerous wells it is inferred that the formation underlies much of the Vernon area.

Heylmun's description, the data from drillers' logs, and a brief field examination indicate that the Salt Lake Formation in Rush Valley has low permeability.

Unconsolidated rocks

Rocks of late Tertiary(?) to Holocene (Recent) age constitute the principal ground-water reservoir in Rush Valley. Figure 1 shows the broad subdivisions of Tertiary and Quaternary rocks, which are based mainly on surficial distribution of lithologic types; the following discussion, however, describes the ground-water reservoir and its water-bearing characteristics in various areas of the valley.

The unconsolidated rocks in Rush Valley consist of clay, silt, sand, and gravel, and larger debris eroded from older rocks in the drainage basin. Much of the unconsolidated rocks, as reported in drillers' logs (table 13), is fine grained, and a part of the oldest of these rocks is conglomerate (cemented or partly cemented sand and gravel). In general, these rocks are coarsest near the mountains and finest near the center of the valley.

Wells in the southeastern part of the valley probably would yield less than 100 gpm of water because they penetrate few aquifers in the alluvium, colluvium, and older unconsolidated rocks. Near the base of the Oquirrh Mountains, the wells in sec. 5, T. 6 S., R. 4 W., obtain about 350 gpm from the sand, gravel, and conglomerate in the colluvium and alluvium of the alluvial apron. Northwest of Rush Lake, the colluvium and alluvium are mainly clay, but contain some beds of gravel that apparently are derived from the conglomerate and other older rocks of Tertiary and Quaternary age to the west. An irrigation well less than 100 feet deep in the clay and gravel strata yielded 1,100 gpm of water.

On the northwest side of Rush Valley, the unconsolidated rocks consist of 20-100 feet of coarse-grained deposits that rest on a thick section of pre-Lake Bonneville lacustrine(?) clay. The shallow permeable rocks yield 10-100 gpm of water to small-diameter wells; the maximum recorded yield in the area is 250 gpm of water from well (C-5-5)32dbb-1. South of the irrigated area near Clover Creek, few subsurface data are available, but wells near Ajax Station on the Union Pacific Railroad reportedly penetrated only clay.

In the Vernon area, several deep wells penetrated mainly clay below 300 feet. Most wells are finished at shallower depths in older alluvium that consist of thick beds of clay with intercalated thin beds of sand and gravel. The unconsolidated rocks of Quaternary age probably are 100-300 feet thick and have moderate permeability. These deposits and the shallowest underlying deposits of Tertiary age together yield no more than about 500 gpm of water to wells; the average large-diameter well in the Vernon area probably would yield no more than 200-300 gpm of water.

In northern and east-central Rush Valley, 25-100 feet of lakebed sediments (pl. 1) rest on older unconsolidated rocks or on the Salt Lake Formation. These deposits confine the water in the underlying rocks and act as a perching medium elsewhere. Where saturated, they provide for a large capillary rise that conveys ground water to the surface to be discharged by evapotranspiration in the lowlands at and south of Rush Lake.

The younger alluvium, of Holocene age, is hydrologically important only along stream channels where the moderately to highly permeable deposits receive water from or discharge water to the streams. Elsewhere the deposits consist only of thin additions to the alluvial aprons and soils and of semistabilized windblown sand along the south edge of the Oquirrh Mountains.

Thickness of unconsolidated rocks

The total thickness of the unconsolidated rocks differs from one part of the valley to another, depending both on the structure of the underlying consolidated rocks and on the location with respect to the sources of the material. The unconsolidated rocks are about 75 feet

thick at the mouth of Ophir Canyon and about 215 feet thick at well (C-8-3)6aad-1 (table 13). By contrast, more than 400 feet of sand, gravel, conglomerate, and clay were penetrated by the supply wells at Deseret Chemical Corps Depot, which is west of the boundary faults near the base of the Oquirrh Mountains.

In the western half of Rush Valley, the thickness of the unconsolidated rocks may exceed 1,000 feet in a strip of the valley from the central part of T. 5 S., R. 5 W., southward to the central part of T. 7 S., R. 5 W. The boundaries of the strip of valley are the inferred faults indicated on plate 1. A group of faults, mainly in Tps. 5 and 6 S., R. 5 W., are inferred from gravity surveys (Cook and Berg, 1961, p. 85; W. W. Johnson, written commun., 1958), and indicate that a bedrock high extends from South Mountain to the junction of State Highways 36 and 58. This bedrock high is confirmed both by the outcrop of Paleozoic sedimentary rock in the northwest corner of T. 5 S., R. 5 W., and the report of bedrock at a depth of 339 feet in well (C-5-5)21dcb-1. The west side of the strip is indicated by the inferred boundary fault west of Clover. Within this strip, well (C-5-5)32adb-1 was jetted to a depth of 1,004 feet (Carpenter, 1913, p. 77). The method of well construction indicates that unconsolidated rocks were penetrated.

The structural trough inferred in the vicinity of St. John may extend southward to the Vernon subbasin and possibly into it. This inference is drawn because the general trend of the bounding faults fits the regional trend of Basin and Range structures, because the structural attitude of the Salt Lake Formation east of Faust Creek suggests that the covered fault that follows the route of Vernon Creek (Stokes, 1964) may extend farther north, and because data from wells in the northwestern part of T. 8 S., R. 5 W., appear to confirm the location of that covered fault. A boundary fault along the base of the Onaqui Mountains, moreover, seems to be indicated by the discontinuous segments of fault from the St. John area southward to the area northeast of Lookout Pass. In this latter area, water-level data indicate a water-table trough that trends northeastward toward the mouth of the Vernon subbasin (fig. 1). Water levels in the area of the trough are deep, and it is inferred that deep permeable unconsolidated rocks are the cause of the trough. The accumulation of a thick section of permeable unconsolidated rocks in the area of the water-table trough, which parallels the inferred direction of boundary faulting, most likely would be related to the inferred faulting.

WATER RESOURCES

Precipitation

The normal annual precipitation in the Rush Valley drainage basin is less than 10 inches in the central lowlands, but reaches maximums of more than 40 inches in the Oquirrh and Stansbury Mountains and lightly more than 25 inches in the Sheeprock Mountains. (See fig. 3).

Precipitation is greatest in the basin in winter and early spring and least in July, August, and September. Table 3 shows the average monthly and annual precipitation at 12 climatologic stations in and near Rush Valley.

Table 3.–Average monthly and annual precipitation, in inches, at climatologic stations in and near Rush Valley

Data from U. S. Weather Bureau (1951-67). Numbers in parentheses show period of record, in years. Annual total is sum of monthly averages. See figure 2 for station locations.

	Bauer	Benmore	Bingham Canyon	Eureka	Fairfield	Government Creek	Grantsville Power House	Middle Canyon	Ophir Canyon	Orr's Ranch	St. John Station	Tooele	Vernon
January	0.96(18)	1.02(49)	1.90(24)	1.48(34)	0.86(15)	1.00(49)	1.20(14)	2.27(9)	-	0.62(31)	0.36(11)	1.29(69)	0.68(4)
February	.94(17)	1.23(49)	1.85(24)	1.34(34)	.70(15)	1.19(49)	.94(14)	3.81(9)	-	.88(30)	.64(11)	1.48(69)	.46(4)
March	1.54(16)	1.55(49)	2.37(24)	1.46(34)	.99(15)	1.60(49)	1.59(14)	4.02(9)	-	.87(31)	.80(11)	1.92(70)	.66(4)
April	1.58(17)	1.29(50)	2.45(24)	1.44(34)	.86(14)	1.32(49)	1.38(14)	4.40(9)	-	.91(30)	.94(11)	2.06(69)	.74(4)
May	1.54(17)	1.21(50)	2.11(25)	1.30(35)	1.21(15)	1.45(50)	1.29(13)	2.78(9)	-	1.03(28)	1.06(11)	1.80(69)	1.14(3)
June	1.03(16)	.78(50)	1.86(24)	.96(35)	.67(15)	.72(48)	1.18(13)	2.09(9)	-	.51(28)	.46(10)	.94(70)	1.40(4)
July	.85(16)	.85(49)	1.02(24)	1.00(35)	.77(14)	.79(49)	.89(13)	1.05(9)	-	.50(29)	.43(10)	.75(70)	1.25(3)
August	.72(17)	.95(50)	1.26(24)	1.31(35)	.92(14)	1.01(49)	1.09(13)	1.40(9)	-	.74(29)	.61(10)	.89(70)	1.25(3)
September	.48(18)	.69(49)	.82(24)	.72(35)	.74(14)	.70(49)	.53(13)	1.23(9)	-	.50(29)	.40(10)	.88(70)	.80(5)
October	1.10(18)	1.14(49)	1.36(24)	1.15(35)	.52(14)	1.15(49)	.96(14)	1.62(9)	-	.99(29)	.79(10)	1.45(70)	.47(5)
November	1.21(18)	1.02(49)	1.79(24)	1.07(35)	.71(14)	.97(48)	1.26(14)	3.06(9)	-	.69(29)	.62(11)	1.53(70)	.85(5)
December	1.20(19)	1.11(49)	2.04(24)	1.51(35)	.96(15)	1.01(49)	1.20(14)	2.94(9)	-	.81(29)	.72(11)	1.30(70)	.74(5)
Annual total	13.15	12.84	20.83	14.74	9.91	12.91	13.51	30.67	19.9[1]	9.05	7.83	16.29	10.44
1931-60 normal annual precipitation	-	-	-	14.08	-	-	-	-	-	-	-	15.48	-

[1] Based on seven measurements of annual accumulation.

The rate of precipitation in Rush Valley changes cyclically through long periods of time. Figure 4 shows periods of average to above-average precipitation and average to below-average (drought) precipitation for two long-term stations near Rush Valley. Total annual precipitation over a period of years, however, approaches the average of 550,000 acre-feet of water given in table 4. About 50 percent of the annual precipitation falls on the high mountains and adjacent steep alluvial slopes that make up 35 percent of the drainage basin. The distribution of precipitation is summarized in table 4.

Table 4.—Distribution of normal annual precipitation in the Rush Valley drainage basin

(Measured with planimeter from an isohyetal map prepared by the U. S. Weather Bureau (1963a) as modified by E. L. Peck, written commun., 1966)

Precipitation (inches)	Area (acres)	Precipitation (acre-feet, rounded)
>40	1,920	6,700
30-40	8,300	24,300
25-30	15,520	35,700
20-25	24,500	45,800
16-20	44,160	66,200
12-16	194,100	221,500
10-12	81,300	73,900
<10	100,100	72,500
Total (rounded)	470,000	550,000

Surface water

Some of the precipitation that falls in the mountains of the Rush Valley drainage basin flows to lower altitudes in streams. On the alluvial slopes of the valley much of the water in streams is lost by infiltration and by evapotranspiration in areas of cultivated and native vegetation. A small amount of streamflow reaches the playas in the east-central part of Rush Valley and at Rush Lake where it is evaporated. Although tributary channels are mostly well defined, the playas and parts of central and upper Faust Creek are not active drainage ways because they receive runoff from above-normal precipitation and snowmelt only infrequently. Most tributaries to the valley are intermittent and flow only in response to snowmelt and summer thunderstorms.

Eight streams in the mountains that surround Rush Valley are perennial, and all of them are sustained at low flow by ground-water discharge at moderate to high altitudes from springs, seeps, or mines. Clover Creek heads in the Johnson Pass area between the southern Stansbury and the northern Onaqui Mountains (pl. 1). Soldier and Ophir Creeks head in the Oquirrh Mountains and Vernon, Bennion, Dutch, Harker, and Oak Brush Creeks head in the Sheeprock Mountains.

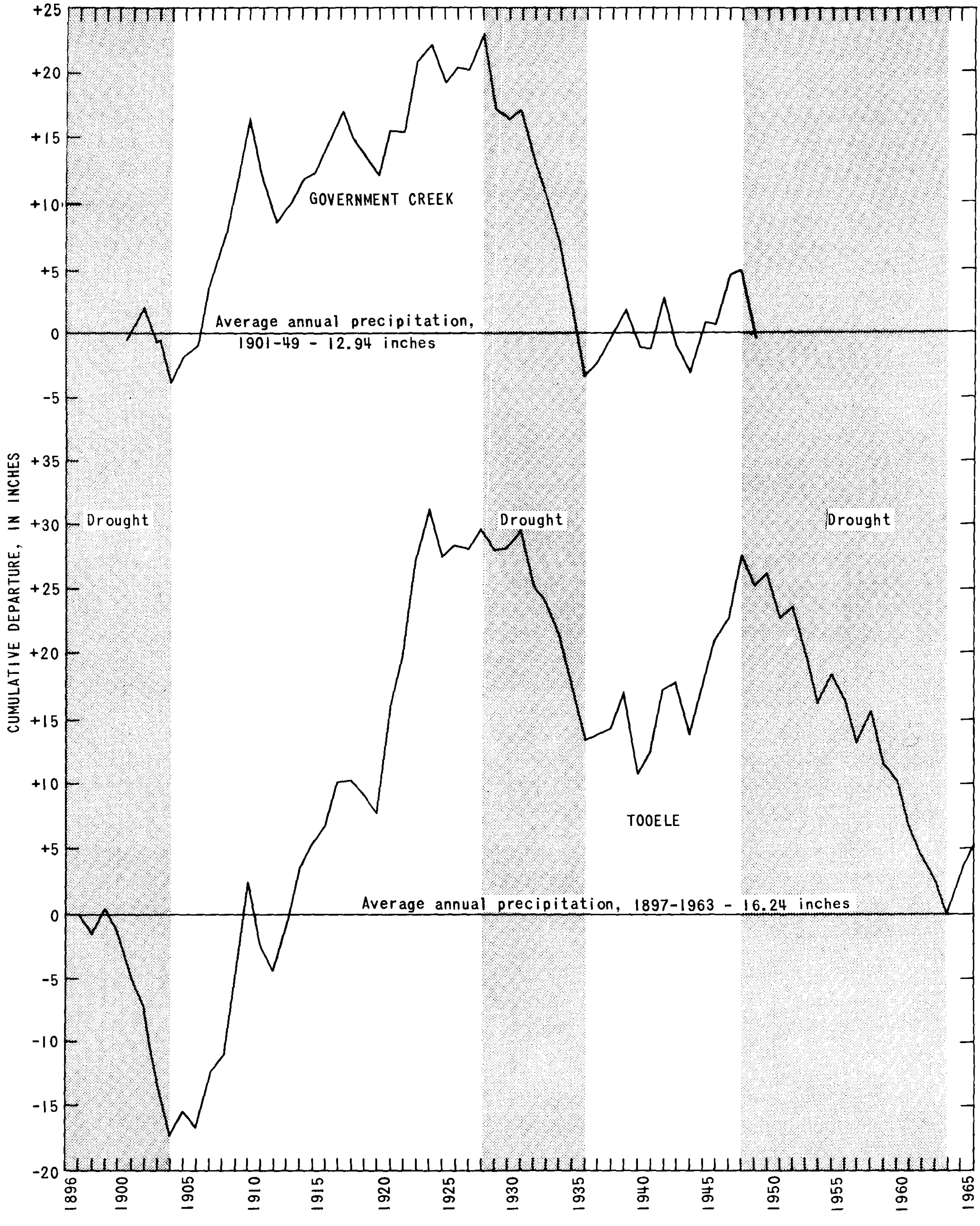


Figure 4.—Cumulative departure of annual precipitation from average annual precipitation at Government Creek and Tooele.

The flow of the perennial streams is variable during the year and generally reaches a maximum rate of discharge during the season of high altitude snowmelt. Water naturally available is supplemented by discharge from mines in Ophir Canyon (Gilluly, 1932, p. 148), Bennion Canyon, and North Oak Brush Canyon (Cohenour, 1959, p. 120). Low-flow conditions differ among the mountains ranges; but it seems probable that under natural conditions, all low flow would infiltrate the permeable alluvial apron at the mouths of canyons and be lost to the ground-water reservoir. In all the canyons named, however, water is conveyed across the alluvial apron to farmlands in Rush Valley.

The only available continuous record of streamflow in Rush Valley is for Vernon Creek in the NE¼NW¼SW¼ sec. 2, T. 10 S., R. 5 W. (pl. 1) and is designated as station 10-1727. Vernon Creek near Vernon (U. S. Geol. Survey, 1967, p. 265). A summary of the station record is given in table 5. Partial records have been obtained on Clover Creek (table 6) and at other sites as a part of the crest-stage gage program operated in cooperation with the Utah State Department of Highways. Miscellaneous measurements of streamflow, largely in connection with planning in the Vernon area, have been made by the U. S. Soil Conservation Service and are listed in table 11 together with estimates of discharge where streams were sampled for chemical analysis. Locations of sites are shown on plate 1.

The amount of streamflow that reaches the alluvial apron in Rush Valley cannot be computed directly because adequate records are not available. The potential long-term average runoff was estimated, however, using the isogram worksheets described by Bagley, Jeppson, and Milligan (1964, p. 56). In their study of water yields in Utah, they statistically analyzed the basins for which runoff is gaged. The derived parameters were then applied to other ungaged parts of Utah, such as Rush Valley, based mainly on the relation of precipitation to altitude.

The long-term average potential annual runoff from the uplands of the Rush Valley drainage basin was estimated by multiplying the area between adjacent lines of equal runoff, as shown on the worksheets at a scale of 1:250,000, by the average value for runoff in the area between the two lines. The total estimated potential runoff is 70,000 acre-feet (table 7).

The estimated 70,000 acre-feet of potential runoff into Rush Valley probably is a maximum figure, because the Oquirrh Mountains apparently do not yield flow in surface streams commensurate with the extent and altitude of the upland area as calculated by Bagley, Jeppson, and Milligan (1964).

Ground water

Source

Ground water in Rush Valley is derived entirely from snowmelt and rainfall within the drainage basin, mostly on lands above altitudes of 5,500-6,000 feet. The quantity of precipitation at these altitudes generally exceeds the immediate losses from evapotranspiration, so that some water infiltrates the consolidated rocks in the mountains and some collects in streams that discharge onto the adjoining alluvial fans and aprons. Of the stream water that reaches the fans, much is lost to evapotranspiration before and after infiltration; some adds to the soil moisture, and a part percolates to the water table.

The annual average rate of recharge from precipitation on lands below 5,500-6,000 feet is small because the amount of precipitation is generally small and most of it is held by the soil and subsequently discharged by evapotranspiration. The rate of recharge is highest in the coarse-grained deposits (Qag on pl. 1) and least or nonexistent in the fine-grained deposits.

Table 5.—Summary of record for station 10-1727, Vernon Creek near Vernon

Location: Lat 39°59′, long 112°23′, in W½ sec. 2, T. 10 S., R. 5 W., on right bank 7 miles upstream from confluence with Dutch Creek forming Faust Creek and 8 miles southeast of Vernon.

Drainage area: 25 sq mi, approximately.

Records available: June 1958 to September 1966.

Gage: Water-stage recorder. Altitude of gage is 6,200 ft (from AMS topographic map).

Extremes: Maximum discharge, 78 cfs Apr. 14, 1962; minimum, 0.4 cfs Nov. 20, 1961.

Monthly and annual discharge, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1958	-	-	-	-	-	-	-	-	-	112	104	96	-
1959	101	99	98	95	89	111	103	96	89	84	75	66	1,110
1960	65	71	75	83	90	113	129	163	103	92	71	74	1,130
1961	89	89	82	66	73	87	84	74	71	65	62	70	912
1962	72	81	90	89	125	97	349	211	135	119	86	115	1,570
1963	109	106	116	111	101	117	108	112	93	89	79	70	1,210
1964	81	84	87	86	80	95	141	353	159	104	104	92	1,470
1965	110	114	121	137	102	114	193	237	126	95	107	99	1,560
1966	111	112	112	115	111	133	127	124	94	88	88	88	1,300
Total	738	756	781	782	771	867	1,234	1,370	870	848	776	770	10,262
Years of record	8	8	8	8	8	8	8	8	8	9	9	9	8
Average	92	95	98	98	96	108	154	171	109	94	86	86	1,290

Table 6.—Measured and estimated discharge, in cubic feet per second, at station 10-1727.6 Clover Creek near Clover

(Crest-stage gage in SE¼SE¼NE¼ sec. 32, T. 5 S., R. 6 W.)

Discharge: Estimated unless indicated by a, indirect measurement of peak discharge, or m, measured with current meter.

Date	Discharge	Date	Discharge
Aug. 4, 1960	1.5	Oct. 22, 1962	2.25
Aug. 12	3.04m	June 7, 1963	3.7
Aug. 17	2	July 15	3.0
Aug. 26	2.7	Aug. 5	3.0
Sept. 8	3	Aug. 30	2.75m
Sept. 19	2	Sept. 18	3.0
Oct. 5	2.04m	Apr. 21, 1964	4.0
Oct. 17	2	May 15	22.8m
Nov. 8	3	June 7	35
July 28, 1961	1.5	June 22	10.0m
Aug. 8	1.5	July 24	7.41m
Sept. 3	2.0	Aug. 17	2.5
Sept. 28	1.3	May 3, 1965	14.8m
Feb. 1962	20	July 21	12
Feb. 15	3.0	Aug. 13	87.0a
July 16	8.4	Aug. 24	7.2
Aug. 1	6.4	Oct. 15	13.5a
			4.0
Aug. 28	3.5	May 18, 1966	8.42m
Sept. 14	3.0	June 20	5.25
		Nov. 11	2.04

Table 7.—Estimated potential average annual runoff from the uplands of the Rush Valley drainage basin

(Calculated from isorunoff maps described by Bagley, Jeppson, and Milligan, 1964, p. 56)

Interval between lines of equal runoff (inches)	Average runoff (inches)	Area (acres)	Estimated runoff (acre-feet, rounded)
1-2	1.5	27,500	3,400
2-4	3	25,000	6,300
4-8	6	59,500	29,800
8-12	10	13,100	10,900
12-16	14	8,000	9,300
16-20	18	5,100	7,600
More than 20	21	300	500
Total (rounded)		140,000	70,000

Estimated average annual recharge

The average annual recharge to Rush Valley was estimated by assuming that a fixed percentage of the average annual precipitation enters the ground-water reservoir in the valley. The method, described by Hood and Waddell (1968, p. 22), was derived from the method of Eakin and others (1951, p. 79-81). The recharge estimate for Rush Valley was made by considering the drainage basin as four areas—the Sheeprock Mountains, other upland areas, an excluded area in the Oquirrh Mountains, and areas of unconsolidated rocks in the valley.

In the Sheeprock Mountains, the maximum rate of precipitation is less than in the other high ranges, but the lithology and geologic structure of the rocks aid in delivery of water to the valley. The other uplands have in common an abundance of distorted carbonate rocks that dip steeply toward the valley and transmit water readily. An area in the Oquirrh Mountains, however, was excluded from the recharge estimate because the geologic structure is believed to inhibit recharge to Rush Valley. A part of the excluded area is in the Cedar Valley recharge area (Feltis, 1967, fig. 4) and a part is along the east side of Ophir Canyon and the east and north sides of Soldier Creek canyon where the rocks dip northeastward into the Pole Canyon syncline.

Recharge to unconsolidated rocks in Rush Valley is only a small percentage of the precipitation that falls on them. This small amount, which contrasts with the higher percentages assigned to the precipitation on lands at higher altitudes, is applied to more than one-half of the total drainage basin.

The estimate of the average annual ground-water recharge to Rush Valley is about 34,000 acre-feet (table 8) or slightly more than 6 percent of the estimated 550,000 acre-feet of precipitation that falls on the drainage basin.

Table 8.—Estimated average annual ground-water recharge in Rush Valley

(Areas of precipitation zones and excluded areas measured from isohyetal maps, geologic maps, and figure 4 in Feltis (1967))

Precipitation zone (inches)	Area (acres)	Estimated annual precipitation		Estimated annual recharge	
		Inches	Acre-feet	Percentage of precipitation	Acre-feet
		Areas of consolidated rocks[1]			
Sheeprock Mountains					
More than 25	3,300	26	7,200	30	2,200
20-25	5,600	22.5	10,500	25	2,600
16-20	4,300	18	6,400	17	1,100
12-16	8,000	14	9,300	12	1,100
All other uplands					
More than 30	5,400	32	14,400	30	4,300
25-30	7,200	27.5	16,500	25	4,100
20-25	10,800	22.5	20,200	17	3,400
16-20	20,500	18	30,800	12	3,700
12-16	33,500	14	39,100	10	3,900
Excluded area[2]	17,600	-	-	-	0
		Areas of unconsolidated rocks			
16-20	15,700	18	23,600	8	1,900
12-16	151,900	14	177,000	3	5,300
Less than 12	181,400	10	151,000	.5	800
Total (rounded)	470,000		510,000		34,000

[1] Includes small areas of thin alluvium that receive more than 20 inches of precipitation.
[2] Part of the Oquirrh Mountains in which geologic structure inhibits recharge to Rush Valley. (See pl. 1.)

Occurrence

Owing to the control of the geology, the occurrence of ground water in Rush Valley is sufficiently different from one part of the valley to another to warrant separate discussions by area.

Southeastern Rush Valley

In the valley east of Faust Creek and southeast of the mouth of Ophir Canyon, hydrologic conditions appear to be fairly uniform. The ground water in the southern part of the alluvial fan below the mouth of Ophir Canyon is unconfined, and unconfined (water-table) conditions probably occur in much of the southeastern part of the valley. In the fine-grained aquifers beneath the lowlands, nonflowing confined (artesian) conditions apparently occur. Water levels in wells near Faust Creek are shallow, but the depth to water increases eastward. The east edge of the valley from Fivemile Pass to Twelvemile Pass apparently is a discharge area where ground water drains from the fine-grained aquifers into limestone of Paleozoic age. The reported water level of 595 feet below the land surface in well (C-8-3)6aad-1 (table 12), which taps limestone, appears reliable, considering the depth of pump setting and the recent (1967) measurement of a dry depth of 340 feet. The record of the well indicates that the water level in the limestone is lower than the water level in unconsolidated rocks both in Rush Valley and in Cedar Valley to the east, as reported by Feltis (1967, fig. 4).

Vernon area

The Vernon area contains ground water under both confined and unconfined conditions in both consolidated and unconsolidated rocks. Some of the wells in the Vernon area flow; and others indicate nonflowing artesian conditions, mainly along the trend of Vernon Creek in the western part of R. 5 W. and the eastern part of R. 6 W. as far south as T. 9 S. Wells that flow are as shallow as 124 feet (table 12). The conditions that produce the artesian pressure are the fine-grained sediments in the unconsolidated rocks and the artesian head in the underlying consolidated rocks. Unconfined conditions in the Vernon area apparently exist in the moderately permeable unconsolidated rocks to a depth of about 100 feet, in the upper reaches of Vernon Creek, and possibly in the western part of the Vernon area where a trough occurs in the water table (pl. 1).

A few deep wells in the Vernon area have penetrated consolidated rocks of Paleozoic age and have obtained ground water that is under artesian pressure. Under specific favorable local conditions, water can be obtained in very large quantities. (See discussion in section on geology and water-bearing characteristics of the rocks.)

Northern Rush Valley

Northward from the Vernon area to the vicinity of Rush Lake, ground water generally occurs under unconfined conditions in a veneer of younger alluvium that overlies the older

fine-grained unconsolidated rocks. The deep, fine-grained unconsolidated rocks yield little water to wells but contain some water under artesian pressure, as at well (C-5-5)32adb-1. Structural distortion of the older unconsolidated rocks, as in the fault scarp in the eastern part of T. 6 S., R. 6 W., is responsible for a few springs and seepage areas on the alluvial slopes. The water-table contours, as shown on plate 1, indicate that the ground-water surface slopes steeply eastward and thus indicate that the older unconsolidated rocks control the depth to water along the western slope of the valley by preventing downward percolation from the veneer of younger, surficial rocks. A slight downstream convexity of the contours across Clover Creek shows that the creek there loses some water to the alluvium along its bed.

The occurrence of water in consolidated rocks in the immediate Clover-St. John area is unknown; but upstream, limestone yields water at Clover Creek Spring, (C-5-6)32bba-S1, and artesian conditions in the Paleozoic sedimentary rocks are indicated by the warm spring (C-5-5)9cba-S1.

On the northeast side of Rush Valley the fan below the mouth of Ophir Canyon contains unconfined ground water, as in the Deseret Chemical Corps Depot well (C-6-4)5bdd-1. Confined conditions are probable in the lower slopes of the fan. Unconfined conditions probably extend northward beyond the edge of the fan where it abuts older material that underlies a high erosional surface. The deep water level in well (C-4-5)36daa-1 near Soldier Creek indicates unconfined conditions, but confined conditions are possible at greater depths, owing to the intercalated thin beds of clay.

Ground water in the vicinity of Rush Lake occurs mainly under confined conditions. Springs along the southeastern side of the lakebed are believed to result from an abrupt lateral change in grain size within the unconsolidated rocks as well as a fine-grained confining bed at the land surface. Thus ground water moving toward the valley is retarded and moves to the surface. Water that issues from the warm spring, (C-5-5)9cba-S1, southwest of the lakebed, rises to the surface apparently for the same reason. At the northwest side of the lakebed, several shallow large-yield irrigation wells obtain water from gravel in what otherwise is a fine-grained section of unconsolidated rock. The deepest well in the area, (C-5-5)4baa-1, was drilled to 300 feet and reportedly flowed at 650 gpm.

Movement

Ground water moves from recharge areas at higher altitudes to discharge areas at lower altitudes. In Rush Valley ground water moves toward two different discharge areas, as indicated by the arrows on plate 1.

A ground-water divide extends from the eastern edge of the Onaqui Mountains, in the northeastern part of T. 7 S., R. 6 W., northeastward to the mouth of Ophir Canyon in the southwestern part of T. 5 S., R. 4 W. North of the divide, ground water moves from the northern Onaqui and southern Stansbury Mountains eastward and from the Oquirrh Mountains westward to the center of Rush Valley and thence northward toward Rush Lake.

South of the ground-water divide, ground water moves generally eastward across the valley to the vicinity of Fivemile Pass and Thorpe Hills. Some ground water moves southward

from the southern Oquirrh Mountains and northward from Boulter Summit and the West Tintic Mountains toward Fivemile Pass. Ground water in the area of Vernon moves toward a water-table trough northwest of Vernon and thence northeastward across the valley.

Both north and south of the ground-water divide, the slope of the ground-water surface beneath the lowest parts of Rush Valley is gentle. Although water undoubtedly is moving, the quantity of water is small because the aquifers have low permeability.

Storage

A ground-water system is in dynamic equilibrium under natural conditions; long-term average recharge and discharge are equal, and the amount of ground water in transient storage remains nearly constant. Development of wells for irrigation in Rush Valley has not appreciably altered the natural balance as of 1967. Water-level changes (table 14 and fig. 5) generally result from changes in precipitation on the drainage basin.

Recoverable ground water in storage is that part of the stored water that will drain by gravity from the ground-water reservoir as water levels are lowered. It is the product of the specific yield of the reservoir rocks, the saturated thickness, and the area.

Saturated unconsolidated rocks underlie about 250,000 acres in Rush Valley. The specific yield of these deposits is unknown, but it is known to differ from place to place in the valley and with depth. The following table gives estimated specific yields for the various types of unconsolidated rocks and the estimated volumes of recoverable water stored in the upper 100 feet of these rocks in the valley.

Material	Area (acres)	Estimated specific yield	Volume of recoverable ground water in upper 100 feet (acre-feet)
Mainly gravel and sand	40,000	0.20	800,000
Much clay, but some sand and gravel beds	30,000	.10	300,000
Mainly clay and silt with thin beds of sand	180,000	.03	540,000
Total (rounded)	250,000		1,600,000

The storage figure of 1,600,000 acre-feet, which is 46 times that of the estimated annual recharge, probably is a minimum figure because the unconsolidated rocks are much thicker than the 100 feet used for the estimate.

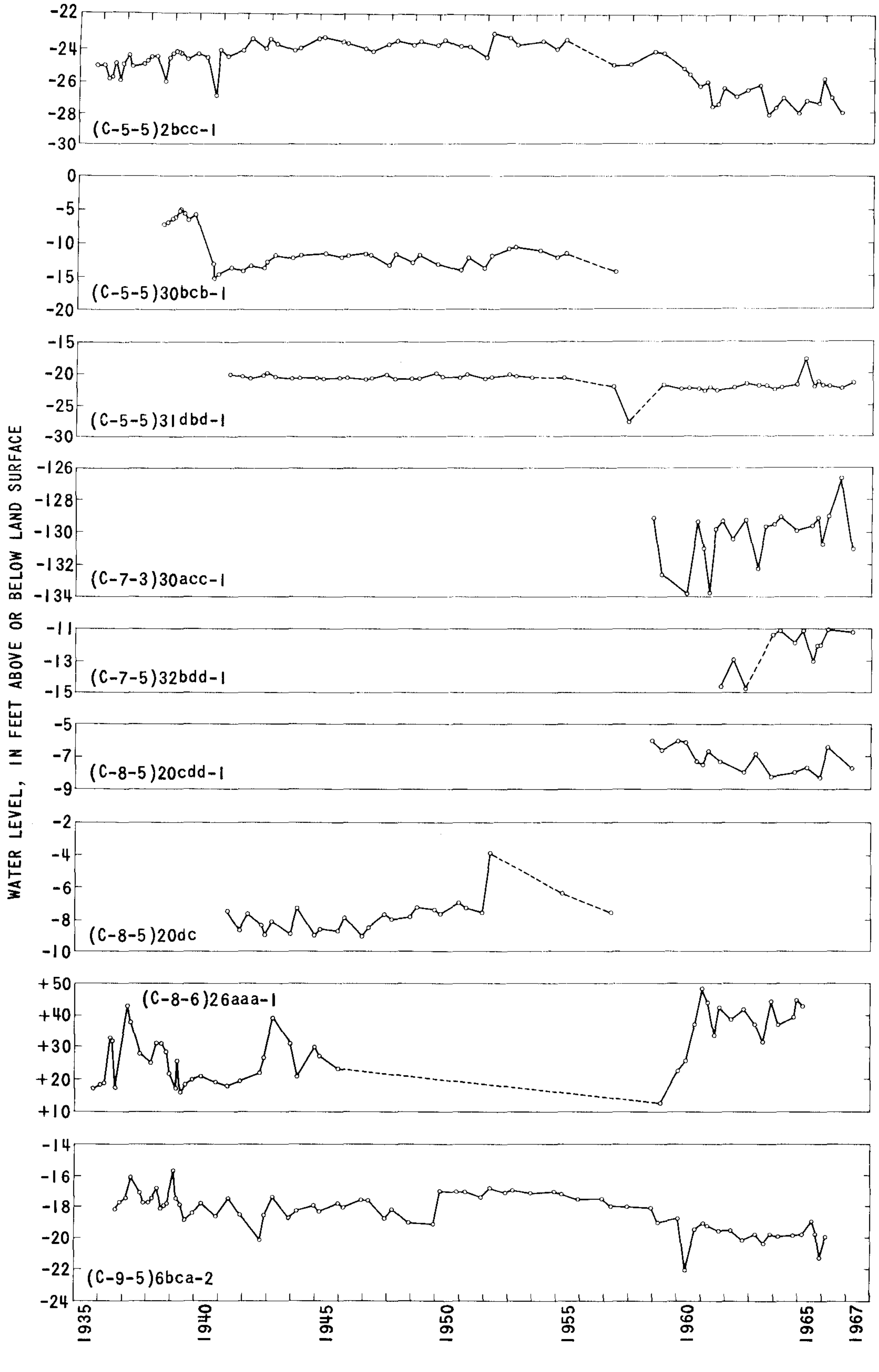


Figure 5.—Water levels in selected observation wells in Rush Valley.

Data are not available on which to base an estimate of ground water stored in consolidated rocks, but the quantity of recoverable water in storage probably is small because of the low bulk porosity of those rocks.

Discharge

Ground water is discharged from Rush Valley by wells, by evapotranspiration, and by subsurface outflow. The water that discharges from springs is included in the figure for evapotranspiration because all the spring water is eventually consumed by evapotranspiration within the valley.

Wells

Rush Valley contains many wells, which are concentrated mainly around the small centers of population. Wells provide domestic supplies of water for an estimated 750 people. The main use of ground water, however, is for irrigation, as shown in the following tabulation. Quantities are in acre-feet.

Use	1964	1965	1966
Irrigation	4,010	4,240	4,700
Domestic	130	130	130
Stock	10	10	10
Total (rounded)	4,200	4,400	4,800

Approximately 17 wells supplied water for irrigation during 1966, and most of the water supplemented surface supplies that were diverted from streams and large springs.

Evapotranspiration

A large part of the ground water that leaves Rush Valley is transpired by plants and is evaporated from soils where the water table is shallow enough to moisten the surface. The data used for the estimate of evapotranspiration were obtained from a rapid field examination of plant distribution and comparison of that data with a map of the depth to water in wells in the valley. In contrast to less populated and drier valleys in western Utah, the vegetation on more land in Rush Valley has been changed from its natural state and the valley receives more precipitation.

Vegetation.—Areas of phreatophytes are shown on plate 1. The areas shown are based on field observation of the distribution of the plants. However, known phreatophytes extend into parts of the valley where the plants use only soil moisture and are not truly phreatophytic. In preparing plate 1, therefore, the depth to water was used as a guide in outlining the areas of phreatophytes.

The phreatophytes grow where the depth to water does not exceed 50 feet. The principal phreatophytes are greasewood (*Sarcobatus vermiculatus*), rabbitbrush (*Chrysothamnus nauseousus*), and meadow grasses including saltgrass (*Distichlis stricta*) in the lowest, damp areas. Cattails (*Typha* sp.) grow in a few ponds in the Rush Lake bottom land and in the same area, sedges (*Carex* sp.) and rushes or wiregrass (*Juncus* sp.) grow in spots that are perennially damp. On some alluvial slopes, greasewood is mixed with small or stunted sage plants (*Artemisia* sp.) (Vallentine, no date, p. 2-5). A small beginning infestation of saltcedar (*Tamarix gallica*) grows on otherwise nearly bare ground near a railroad culvert in sec. 15, T. 6 S., R. 5 W., and patches of willow (*Salix* sp) are along streams on the upper alluvial slopes, as along Clover Creek.

In addition to these native plants, alfalfa (*Medicago sativa*), a cultivated phreatophyte, is grown in the Vernon area. This plant can extend roots to the water table where the depth to water is as great as 66 feet (Robinson, 1958, p. 60), and a well established stand growing over a shallow water table can withdraw 2-3 acre-feet of water per acre of alfalfa during a 5-month growing season.

A part of the Rush Valley bottom land is bare of vegetation, particularly in areas underlain by Lake Bonneville lacustrine silts. The bareness is partly due to the small amount of soil moisture in the silts but probably mostly due to soil salinity. The lowest areas of the valley, as the Rush Lake bottom land and the playas south of Deseret Chemical Corps Depot, are infrequently inundated; but the water stands on the surface for periods long enough to kill all but quick-growing xerophytes, such as whitetop (*Lepidium draba*).

Estimated average annual evapotranspiration.—The major areas of evapotranspiration are shown on plate 1, and an estimate of the average annual rate of ground-water discharge by evapotranspiration is given in table 9. Areas of cultivated land and irrigated grazing land in the Clover-St. John and Vernon areas are not separated from areas of phreatophytes, but the estimates for rate of ground-water use are adjusted accordingly.

The estimated quantity of ground water discharged by evapotranspiration in Rush Valley amounts to 27,000 acre-feet per year, which is about 70 percent of the estimated total annual ground-water discharge from the valley.

Subsurface outflow

Discharge toward the east.—Ground water in the unconsolidated rocks in Rush Valley apparently discharges into the structually distorted rocks of Paleozoic age that form the eastern margin of the valley from Fivemile Pass near the south end of the Oquirrh Mountains to the vicinity of Twelvemile Pass. The slope of the water table is toward the east (pl. 1), and a reported water-level measurement in well (C-8-3)6aad-1 (table 12) indicates that the water level in consolidated rocks is deeper than in the unconsolidated rocks. Thus there would be a hydraulic gradient into the consolidated rocks.

The quantity of water discharged from the eastern edge of the valley is estimated to be 5,000 acre-feet per year. Much of the water-bearing material in the eastern half of the valley is

Table 9.—Estimated average annual evapotranspiration in Rush Valley

Location and type	Area (acres)	Depth to water (feet)	Evapotranspiration: Acre-feet per acre	Evapotranspiration: Acre-feet
Middle to lower alluvial slopes in central and western part of valley (pl. 1). Mainly greasewood, but associated with rabbitbrush, other phreatophytes, and sage in the southern part of the valley.	36,700	20-50	0.2	7,300
Low areas of southern Rush Valley near Vernon. Mixed phreatophytes, including dense rabbitbrush along parts of stream channels. Sparser growths of rabbitbrush and greasewood along edges of area. Includes cultivated lands and areas of locally dense meadow in which part of crops use ground water.	11,300	0-20	.75	8,500
Central valley bottom land. Bare soil in playas and fine-grained lacustrine deposits.	3,800	15-25	0	0
Clover Creek channel area and middle to lower alluvial slope near St. John. Mixed phreatophytes including rabbitbrush, and subirrigated cultivated land and pasture. Rabbitbrush is very dense in some uncleared areas.	5,400	5-20	.75	4,000
Rush Lake bottom land.				
Grassland and bare soil that is moist to saturated. Wet during winter, moist in summer.	2,500	0-10	.8	2,000
Spring-fed or flooded marshy land. Dense grass, rushes, and hydrophytes; small ponds of open water. Area changes with season.	1,900	0-2	2.5	4,800
Totals (rounded)	61,600			27,000

reported to be clay, silt, and fine sand (table 13), and is estimated to have an average permeability of 30 gpd per ft^2 (gallons per day per square foot) (Johnson, 1963, p. 31). The saturated thickness of the material is on the order of 400 feet, and thus the coefficient of transmissibility (T) is about 12,000 gpd per ft. The slope of the water table (I) at the 5,000-foot water-level contour (pl. 1) varies from 50 feet per mile to less than 10 feet per mile and is estimated to average 25 feet per mile. The length (L) of the 5,000-foot contour is about 15 miles. The quantity (Q) of water discharged from the valley, thus is calculated from the equation

$$\begin{aligned} Q &= TIL \\ &= 12{,}000 \times 25 \times 15 \\ &= 4{,}500{,}000 \text{ gpd, or } 5{,}000 \text{ acre-feet per year} \end{aligned}$$

Discharge toward the north.—An estimate for subsurface discharge from the ground-water reservoir at the north end of Rush Valley is not included in this report, but it should be pointed out here that the amount is probably small but significant. Both Thomas (1946, p. 194-196) and Gates (1965, p. 22) have discussed the movement of a small quantity of water beneath the Stockton bar between Rush and Tooele Valleys. Gates points out the difference of about 300 feet in water levels between Rush Valley on the upper side and Tooele Valley on the lower.

Thomas (1946, p. 195) and Gilluly (1932, p. 117-118) summarized data from Gilbert (1890) and later sources to show that Rush Lake, the lowest part of Rush Valley, expands and recedes in response to changes in precipitation. In 1862, the lakebed contained a small pond and meadows; but in 1872 the lake was 4½ miles long and 10 feet deep, and the water was fresh enough for domestic use. By 1880, it had shrunk to half of its length in 1872, and the water was too brackish to be palatable. Since 1934 to the present (1968) the lakebed generally has been dry but has a small marshy area. Considering that Rush Lake is the lowest point in the valley, that it receives drainage from an extensive upland area, and that after the lowering of ancient Lake Bonneville the residue of the water trapped behind the Stockton bar would have receded to a low point, it would be expected that the lowest part of the Rush Lake bottom land would contain saline soil. The following analysis of soil from Rush Lake bottom land (analysis by the U. S. Bureau of Reclamation Regional Laboratory, Salt Lake City, Utah) indicates that the upper 6 inches of soil at the lowest point on the lakebed near the foot of the Stockton bar in the NE¼NW¼NW¼ sec. 26, T. 4 S., R. 5 W., contains no appreciable quantities of readily soluble evaporite minerals.

Sampling site:	(C-4-5)26bba
Sampling date:	May 17, 1967
Sampling depth:	0-6 inches, composited

Mechanical analysis

Particle size	Percentage of sample
Larger than 0.05 mm	8.2
0.05-0.005	28.0
0.005-0.002	6.0
Smaller than 0.002	57.8

Saturation extract

Specific conductance (EC x 10^6 at 25°C)	817
pH	8.8
Chemical analysis	Parts per million
Dissolved solids	648
Calcium (Ca)	55
Magnesium (Mg)	17
Potassium (K)	38
Sodium (Na)	97
Carbonate plus bicarbonate (CO_3 + HCO_3)[1]	294
Chloride (Cl)	40
Sulfate (SO_4)[2]	164

[1] CO_3 not reported separately because sample was dilute.
[2] Calculated.

The difference in water levels across the Stockton bar, the reported fluctuations in lake size and water quality, the silty clay in the lake bottom, and the chemical character of the clay suggest that (1) the lakebed receives and stores surface water during periods of above-normal precipitation, (2) part of the water is discharged by evaporation, (3) the remainder drains away very slowly from the north end of the lake to Tooele Valley, and (4) during periods of below-normal precipitation, both precipitation and fresh surface inflow flush saline residues in the lake-bottom deposits downward.

Ground-water budget

The average quantity of ground water recharged to and discharged from Rush Valley is estimated to be in the range of 34,000-37,000 acre-feet per year. The quantities of water involved are summarized in table 10.

Table 10.—Ground-water budget for Rush Valley

Item	Acre-feet per year
Recharge (table 8)	34,000
Discharge:	
Evapotranspiration (table 9)	27,000
Subsurface outflow (p. 28)	5,000
Total natural ground-water discharge	32,000
Wells, 1966 (p. 27)	4,800
Total discharge (rounded)	37,000

It should be emphasized that the figures in the budget are not precise and show only the order of magnitude of the quantities of water involved in the recharge-discharge relationship.

Perennial yield

The perennial yield of a ground-water reservoir is the maximum amount of water of suitable chemical quality that can be withdrawn economically each year for an indefinite period of years. The perennial yield cannot exceed the natural discharge; moreover, the yield will be limited to the amount of natural discharge that can be economically salvaged for beneficial use.

In Rush Valley, the maximum amount of natural discharge that is available for salvage is the estimated evapotranspiration loss of about 27,000 acre-feet per year (table 9). In some phreatophyte areas in Rush Valley a part of the water now lost to evapotranspiration could be salvaged if additional wells were drilled. Little, if any, of the subsurface outflow can be economically salvaged, however, both because of the depth to water and because wells finished in the fine-grained aquifers would have small yields. At present, the salvage of water appears most feasible in the area extending from the vicinity of Vernon to upper Faust Creek near Faust, where an estimated total of about 8,000 acre-feet of ground water is discharged annually by phreatophytes. Near Rush Lake, a part of the estimated 4,000-5,000 acre-feet of water discharged annually in and near the lakebed might be salvaged both by pumping and by distribution of spring discharge. In both areas, salvage of water would require a uniform lowering of the water table. It is estimated that an additional 10,000 acre-feet of ground water in Rush Valley might be diverted to beneficial use, but wells should be carefully spaced to achieve uniform lowering of the water table. If it is desired to withdraw appreciably larger quantities of water than can be salvaged from losses by evapotranspiration, the additional quantities would have to be mined from water in storage.

A part of the problem of assessing the potential salvage of water from loss by evapotranspiration lies in the beneficial use of water where cropland and grazing land are subirrigated. In such areas, pumping operations would simply redistribute water that is now partly used by man. A more detailed study is needed to determine the relative merits of existing conditions and redistribution by pumping.

CHEMICAL QUALITY OF WATER

The concentration of dissolved solids in water in the Rush Valley drainage basin ranged from 200 to 2,180 ppm (parts per million) (tables 16 and 17). The concentration of dissolved solids and chemical composition of water from the springs and streams in the mountains are uniform throughout the drainage basin (pl. 1). By contrast, both the concentration of dissolved solids and chemical composition of the ground water varies from one part of the valley to another and also varies locally.

Mountains

The concentration of dissolved solids in the water from the springs and streams sampled in the Stansbury, Oquirrh, and West Tintic Mountains ranged from 200 to 338 ppm. Calcium and bicarbonate are the principal constituents. The major perennial mountain streams which recharge the ground-water reservoir through the alluvial aprons and influence the chemical character of water in the valley are Soldier, Ophir, Clover, and Vernon Creeks. (See table 17 and analysis in table 16 for spring (C-5-6)32bba-S1, which is the major source of Clover Creek.)

Valley

The concentrations of dissolved solids in water sampled from wells and springs in the valley ranged from 238 to 2,180 ppm. Most of the water, however, contained less than 1,000 ppm of dissolved solids; water from only three sources exceeded 1,000 ppm. The principal constituents of most water in the valley were calcium and bicarbonate but magnesium, sodium, and chloride were the principal constituents in some of the water. The chemical composition of ground water from many of the wells along the alluvial slopes is similar to that of the perennial mountain streams (pl. 1).

The chemical analyses of water from springs and wells having different depths indicate local variations in the chemical quality of water along Faust Creek north of Vernon and north of St. Johns Station near Morgan Ranch. Along Faust Creek, 3½-8 miles north of Vernon, the concentrations of dissolved solids of ground water ranged from 344 to 2,180 ppm. Magnesium and bicarbonate were the principal constituents in the water containing dissolved solids in the range from 344 to 503 ppm; whereas sodium, magnesium, and chloride were the principal constituents in the water containing dissolved solids in the range from 767 to 2,180 ppm. The Salt Lake Formation underlies parts of this area and may be contributing to the local variation in the chemical quality of water.

Near Morgan Ranch, the concentrations of dissolved solids ranged from 368 to 1,040 ppm. The principal constituents in the water from sources near Morgan Ranch were calcium and bicarbonate; sodium, bicarbonate, and chloride; and sodium bicarbonate (pl. 1).

Two thermal springs were sampled in Rush Valley. According to White (1957, p. 1638), a thermal spring is one which has a temperature significantly above the mean annual air

temperature of the surrounding region. The range in annual average air temperature in Rush Valley is 47-50° F, and the springs, (C-5-5)9cba-S1 and (C-7-5)32aba-S1, yield water having temperatures of 75° and 68° F, respectively (table 16).

Changes in chemical quality

Significant changes in the chemical quality of ground water have been recorded during the period 1948-63 at two wells in Rush Valley. The water from public-supply wells (C-6-4)5bdb-1 and (C-6-4)5bdd-1 at the Deseret Chemical Corps Depot has fluctuated in concentration of dissolved solids and the relative concentrations of individual constituents. (See table 16 and fig. 6.) The relative concentrations of chloride increased with increased concentrations of dissolved solids, whereas the relative concentrations of bicarbonate decreased and sulfate plus nitrate and magnesium remained approximately the same. The relative concentrations of sodium plus potassium increased with increased concentrations of dissolved solids up to 460 ppm, then decreased as the dissolved solids increased from 460 to 497 ppm; whereas the relative concentrations of calcium decreased with increased concentrations of dissolved solids up to 460 ppm, then increased as the dissolved solids increased from 460 to 497 ppm.

These two wells are finished in the Ophir Creek alluvial fan and are within a quarter of a mile of Ophir Creek. The average concentration of dissolved solids in water from the wells is about 240 ppm greater than that in water from Ophir Creek, but the relative proportion of dissolved constituents in water from the wells is very similar to that in water from the creek (pl. 1). The records of chemical quality of water for Ophir Creek (1964-65) do not extend over as long a period as those for the wells, however, there is a possibility that the chemical composition of water from Ophir Creek varies enough to account directly or indirectly for the fluctuation of the chemical composition of water from the wells. During the period February-June—in contrast to the period August-November—the lower concentration of dissolved solids in water from the two wells (fig. 6) apparently results from greater recharge from Ophir Creek and reduced withdrawal of water from the wells. During the period August-November, recharge from Ophir Creek decreases and water levels in the wells generally decline due to increased pumping. This results in larger contributions of water stored deeper in the unconsolidated rocks. The deeper water apparently contains more dissolved solids than the water that is contributed directly from Ophir Creek.

Chemical quality in relation to use

Irrigation

Most of the water used for irrigation in Rush Valley is generally of suitable chemical quality for agricultural use. Water used for irrigation is mostly a combination of surface and ground waters; but in some areas, water is obtained only from wells. The principal irrigated crops are forage—alfalfa and small grains—and most of the cultivated land is in the northern and southwestern parts of the valley.

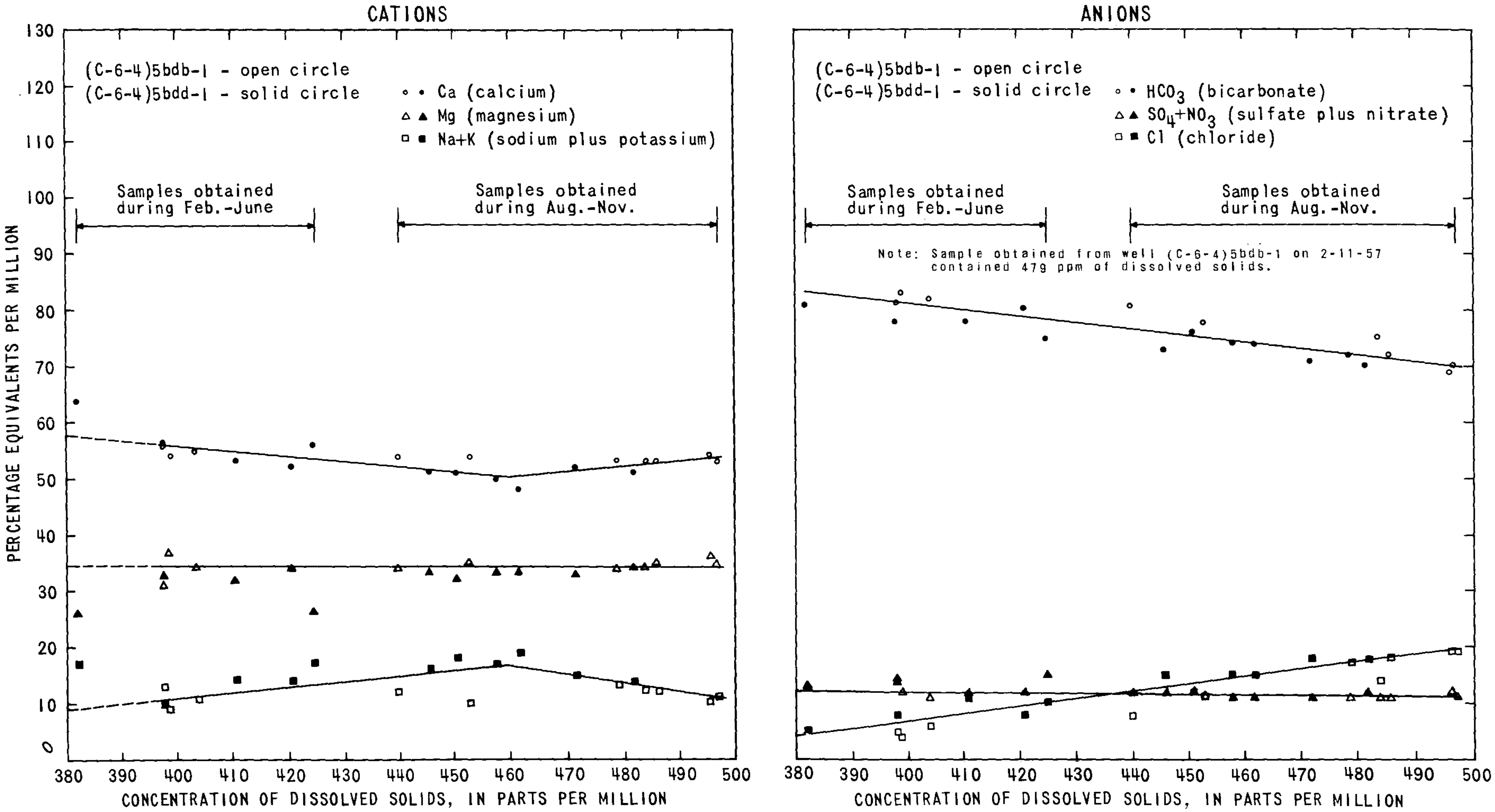


Figure 6.—Fluctuation of the chemical composition of water from wells (C-6-4)5bdb-1 and (C-6-4)5bdd-1 during the period 1948-63.

The suitability of water for irrigation depends upon the concentration of dissolved solids, the concentrations and relative proportions of some of the ions, and the characteristics of the soil where the water is to be used. The suitability of water for irrigation in this report is judged according to the classification developed by the U. S. Salinity Laboratory Staff (1954, p. 79-81) (fig. 7).

Most of the water in Rush Valley is classed as C_2S_1 or C_3S_1. Water in class C_3S_1 can be used for plants with moderate salt tolerance without special practices for salinity control, whereas water in class C_3S_1 should be used only on soils that have good drainage characteristics and for plants that have high salt tolerance.

Residual sodium carbonate was present in water from only two wells in Rush Valley. Well (C-7-4)14aac-1 yields water containing 2.51 epm (equivalents per million) of residual sodium carbonate and well (C-8-4)22aad-1 yields water containing 0.60 epm of residual sodium carbonate. According to the U. S. Salinity Laboratory Staff (1954, p. 81), water containing less than 1.25 epm probably is safe for irrigation. The concentration of boron exceeded the limits for sensitive crops (0.33 ppm) in water from spring (C-5-5)9cba-S2 and well (C-7-4)14aac-1.

Domestic supply

Much of the water in Rush Valley contained one or more constituents in concentrations that exceed the maximum limits for drinking-water standards recommended by the U. S. Public Health Service (1962). The recommended limits are:

Constituent	Parts per million
Sulfate (SO_4)	250
Chloride (Cl)	250
Fluoride (F)	1.3[1]
Nitrate (NO_3)	45
Iron plus manganese (Fe+Mn)	.30
Dissolved solids	500

[1] Maximum recommended for water used in public supplies at average annual maximum daily air temperature prevailing in Rush Valley.

The concentration of iron plus manganese exceeded the limits in many of the supplies. All nitrate concentrations were within the recommended limits, however, and fluoride concentration exceeded the limits in only two supplies.

Most of the water in Rush Valley contained more than 181 ppm of hardness as calcium carbonate ($CaCO_3$) and is classed as very hard by the U. S. Geological Survey.

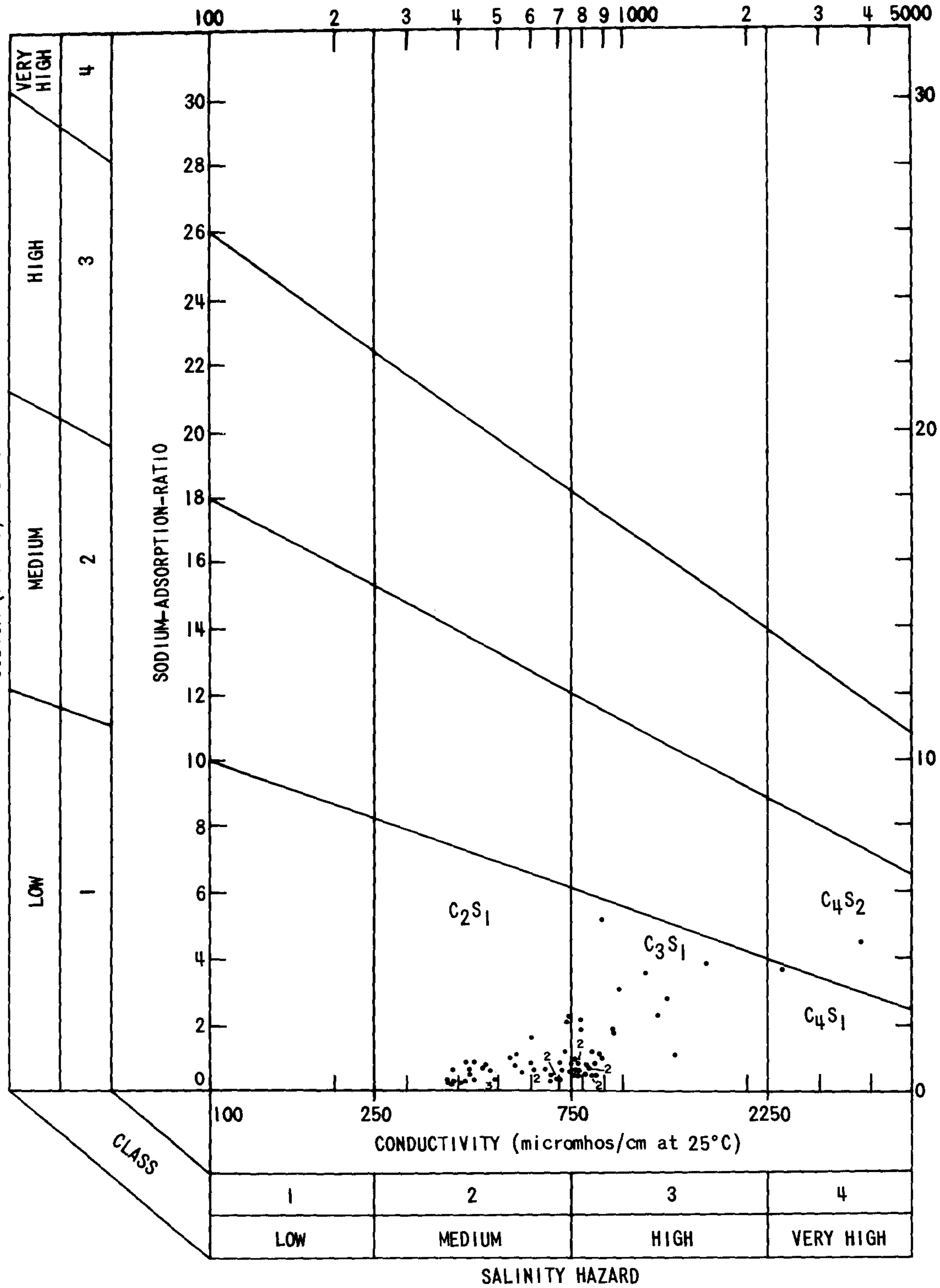


Figure 7.—Classification of water for irrigation in Rush Valley (method from U. S. Salinity Lab. Staff, 1954, p. 80). (Number by point is the number of analyses represented.)

LAND USE AND DEVELOPMENT OF WATER SUPPLIES

The Rush Valley drainage basin includes about 470,000 acres of land, but the valley and alluvial slopes that border the mountain ranges cover only about 250,000 acres. Less than half of the alluvial slopes are sufficiently gentle to permit agriculture if adequate water and suitable soil were present. The area in Rush Valley that can be developed for agriculture is further restricted because of poor soil, insufficient water, or water at excessive depths.

Past and present

About 90 percent of the Stansbury, Onaqui, Sheeprock, and West Tintic Mountains is owned by the Federal and State Governments, but about 70 percent of the Oquirrh Mountain area is privately owned. In the valley, about 80 percent of the area east of State Highway 36 is Federal and State land. About 80 percent of the land in the western part of the valley is private. Much of the public land and part of the private land in the drainage basin is used for stock grazing.

Use of water by settlers in the valley began some time after 1855. The town of Bauer was established in 1855 at the north side of the Stockton bar (in adjacent Tooele Valley), and in that year the native hay meadows in the Rush Lake bottom land were included in a military reservation (Gilluly, 1932, p. 117-118) that subsequently (1858) had its headquarters at Camp Floyd in adjacent Cedar Valley. Early use of water continued with the need for water for mining in the Oquirrh Mountains and with the arrival of farmers and stockmen. The larger perennial streams—Soldier, Ophir, Clover, and Vernon Creeks—and other smaller streams were the sources of water for early irrigated farming and are still (1968) the main supply. According to Richards, Davis, and Griffin (no date, p. 85-86), surface water in Rush Valley was used in 1963 by the following organizations:

Company	Acres irrigated
Clover Creek:	
Upper Clover Creek Irrigation Co.	200
Lower Clover Creek Irrigation Co.	200
St. John Irrigation Co.	300
Ophir Creek:	
Ophir Creek Water Co.	600
Harker and Oak Brush Creeks (Vernon area):	
Harker Creek Irrigation Co.	550
Vernon Creek:	
Vernon Irrigation Co.	700
Total	2,550

Dug wells presumably were installed early in the history of the valley. By the first decade of the 1900's, a 1,004-foot well had been jetted near Clover, and by the second decade, a number of wells had been drilled in both the St. John and Vernon areas. Large-diameter wells for irrigation supplies were not drilled until after World War II.

Carpenter (1913, p. 77) noted that in 1911, 600 acres were under cultivation at Clover and St. John and 800 acres near Vernon. J. H. Maughan (written commun., May 1944) estimated that the valley contained about 2,000 acres of irrigated hay and small grains in 1944. The Soil Conservation Service reported that in 1966 (M. W. Lewis, oral commun., 1966) northern Rush Valley from Soldier Creek to Clover Creek contained 3,600 acres of irrigated land, 1,400 acres of which were subirrigated. Irrigated lands near Vernon in 1966 (Soil Conserv. Service, written commun., February 1967) were reported to amount to 2,200 acres, of which 920 acres were sprinkler irrigated. Alfalfa was grown on 85 percent of the land and small grains were grown on 15 percent of the land. An additional 1,500 acres reportedly were dry cropped.

Future

Although all dependable supplies of surface water appear to be utilized, Rush Valley can support some additional development of ground water. The best potential for future ground-water development from the unconsolidated rocks is in the western half of the valley where the water levels are relatively shallow and the water-bearing deposits are relatively coarse grained and yield large quantities of water to wells. The consolidated rock aquifer in the Vernon area also should be able to support additional development, but considerable well interference could occur in closely spaced wells. Other possible areas for ground-water development are the edges of the Ophir Canyon fan, the area north of the fan along the edge of the valley floor, the western side of the Rush Lake bottom land, and the middle slopes of the alluvial apron along the bases of the Stansbury and Onaqui Mountains.

An accurate estimate of the quantity of ground water available for potential development in Rush Valley cannot be made, owing both to the need for additional hydrologic data and the complicated subsurface geologic conditions. Exploratory drilling would be necessary before such an estimate could be made. It can be stated with certainty, however, that ground-water levels ultimately will decline in areas where pumping is increased substantially. Such a decline would be desirable in major areas of evapotranspiration because the declines would result in a savings of water now lost by nonbeneficial consumptive use.

PROPOSALS FOR ADDITIONAL STUDIES

Rush Valley has a potential for additional development of its ground-water resources. Because interest in the valley is increasing, a detailed water-resources investigation is needed immediately to refine the estimates given in this report. Such a study should include the following considerations:

1. A comprehensive inventory of the water resources—wells, springs, and streams—in the drainage basin should be made to complete the coverage given by this reconnaissance. Detailed

data are needed on the hydraulic characteristics of existing wells and the aquifers they tap, the discharge characteristics of springs, the use of water in the valley, and the availability of surface-water supply at various times of the year and at various points along the streams.

2. A systematic study should be made of the unconsolidated rocks and of the consolidated rocks near the valley edge and beneath the valley to aid in evaluating the aquifer framework.

3. The drilling of test holes is needed to aid geologic and hydrologic analysis. At least one test hole should be drilled to a depth of 500-700 feet in the Rush Lake bottom land at the foot of the Stockton bar in the SE¼SW¼ sec. 23, T. 4 S., R. 5 W. One test hole is needed west of Topliff Hill to confirm old data for well (C-8-3)6aad-1. Test holes are also needed in the central part of the valley, as in sec. 35, T. 6 S., R. 5 W., in the vicinity of the ground-water divide, and in areas where water has been reported to be scarce or of poor chemical quality.

4. Streamflow records should be accumulated by expanding the crest-stage gage program in the valley and concurrently installing temporary gaging stations. Such gaging stations would have to be operated several years in order to provide adequate records. The flow of the perennial surface streams should be measured, particularly those streams heading in the Oquirrh Mountains; the flow from large springs should also be measured.

5. Additional chemical analyses should be made in order to determine the effects of increased withdrawals of water and reuse of irrigation water on the quality of existing water supplies.

SELECTED REFERENCES

Ashcroft, G. L., and Derksen, W. J., 1963, Freezing temperature probabilities in Utah: Utah State Univ. Agr. Expt. Sta. Bull. 439.

Bagley, J. M., Jeppson, R. W., and Milligan, C. H., 1964, Water yields in Utah: Utah Agr. Expt. Sta. Spec. Rept. 18.

Bissell, H. J., ed., 1959, Geology of the southern Oquirrh Mountains and the Fivemile Pass-northern Boulter Mountain area, Tooele and Utah Counties, Utah: Utah Geol. Society Guidebook to the Geology of Utah No. 14.

Carpenter, Everett, 1913, Ground water in Boxelder and Tooele Counties, Utah: U. S. Geol. Survey Water-Supply Paper 333.

Cohenour, R. E., 1959, Sheeprock Mountains, Tooele and Juab Counties: Utah Geol. and Mineralog. Survey Bull. 63.

Connor, 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.

Cook, K. L., and Berg, J. W., Jr., 1961, Regional gravity survey along the central and southern Wasatch Front: U. S. Geol. Survey Prof. Paper 316-E.

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

Disbrow, A. E., 1957, Preliminary geologic map of the Fivemile Pass quadrangle, Tooele and Utah Counties, Utah: U. S. Geol. Survey Map MF-131.

........................1961, Geology of the Boulter Peak quadrangle: U. S. Geol. Survey Map GQ-141.

Eakin, T. E., and other, 1951, Contributions to the hydrology of eastern Nevada: Nevada State Engineer Water Resources Bull. 12.

Feltis, R. D., 1967, Ground-water conditions in Cedar Valley, Utah County, Utah: Utah State Engineer Tech. Pub. 16.

Gates, J. S., 1963a, Selected hydrologic data, Tooele Valley, Tooele County, Utah: U. S. Geol. Survey open-file rept. (duplicated as Utah Basic-Data Report No. 7).

........................1963b, Hydrogeology of Middle Canyon, Oquirrh Mountains, Tooele County, Utah: U. S. Geol. Survey Water-Supply Paper 1619-K.

........................1965, Reevaluation of the ground-water resources of Tooele Valley, Utah: Utah State Engineer Tech. Pub. 12.

Gilbert, G. K., 1890, Lake Bonneville: U. S. Geol. Survey Mon. 1.

Gilluly, James, 1932, Geology and ore deposits of the Stockton and Fairfield quadrangles, Utah: U. S. Geol. Survey Prof. Paper 173.

Harris, DeVerle, 1958, The geology of the Dutch Peak area, Sheeprock Range, Tooele County, Utah: Brigham Young Univ. Research Studies, Geology Ser., v. 5, no. 1.

Heylmun, E. B., 1965, Reconnaissance of the Tertiary sedimentary rocks in western Utah. Utah Geol. and Mineralog. Survey Bull. 75.

Hood, J. W., and Waddell, K. M., 1968, Hydrologic reconnaissance of Skull Valley, Tooele County, Utah: Utah State Engineer Tech. Pub. 18.

Johnson, A. I., 1963, Application of laboratory permeability data: U. S. Geol. Survey open-file rept.

Kohler, M. A., Nordenson, T. J., and Baker, D. R., 1959, Evaporation maps of the United States: U. S. Weather Bur. Tech. Paper 37.

Mahoney, J. R., 1953, Water resources of the Bonneville Basin, Part 1, The water crop and its disposition: Utah Econ. and Business Rev., v. 13, no. 1-A.

Morris, H. T., 1964, Geology of the Tintic Junction quadrangle, Tooele, Juab, and Utah Counties, Utah: U. S. Geol. Survey Bull. 1142-L.

Peck, E. L., and Brown, M. J., 1962, An approach to the development of isohyetal maps for mountainous areas: Jour. Geophys. Research, v. 67, no. 2, p. 681-694.

Richards, S. H., Davis, L. H., and Griffin, R. E., (no date), Irrigation and canal companies of Utah: Utah State Univ. Agr. Expt. Sta. Ext. Circ. 331.

Rigby, J. K., ed., 1958, Geology of the Stansbury Mountains, Tooele County, Utah: Utah Geol. Soc. Guidebook to the Geology of Utah No. 13.

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

Snyder, C. T., 1963, Hydrology of stock-water development on the public domain of western Utah: U. S. Geol. Survey Water-Supply Paper 1475-N.

Stokes, W. L., ed., 1964, Geologic map of Utah: Utah Univ., Salt Lake City.

Teichert, J. A., 1959, Geology of the southern Stansbury Range, Tooele County, Utah: Utah Geol. and Mineralog. Survey Bull. 65.

Thomas, H. E., 1946, Ground water in Tooele Valley, Tooele County, Utah, *in* Utah State Engineer 25th Bienn. Rept.: Utah State Engineer Tech. Pub. 4, p. 91-238.

U. S. Geological Survey, 1967, Water resources data for Utah, 1966, Part 1, Surface-water records: Water Resources Div.

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

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

U. S. Weather Bureau, 1937, Climatic summary of the United States, climatic data from the establishment of stations to 1930, inclusive: Sec. 20-western Utah.

........................1951-67, Climatological data, Utah, 1950-66: v. 52-68, no. 1-13.

........................1957, Climatic summary of the United States - Supplement for 1931 through 1952: Climatography of the United States No. 11-37, Utah.

........................1963a, Normal annual and May-September precipitation (1931-60) for the State of Utah: Map of Utah, scale 1:500,000.

........................1963b, Normal October-April precipitation (1931-60) for the State of Utah: Map of Utah, scale 1:500,000.

U. S. Weather Bureau, 1965, Climatic summary of the United States - Supplement for 1951 through 1960, Climatography of the United States No. 86-37, Utah.

Vallentine, J. F., (no date), Important Utah range grasses: Utah State Univ. Agr. Expt. Sta. Ext. Circ. 281.

Waddell, K. M., 1967, Reconnaissance of the chemical quality of water in western Utah, Part I, Sink Valley area, drainage basins of Skull, Rush, and Government Creek Valleys, and the Dugway Valley-Old River Bed area: Utah Geol. and Mineralog. Survey Water-Resources Bull. 9.

White, D. E., 1957, Thermal waters of volcanic origin: Geol. Soc. America Bull., v. 68, p. 1637-1657.

Table 11.—Discharge of streams at miscellaneous sites in the Rush Valley drainage basin

Site location: See text for description of location-numbering system.
Stream and site description: Number is U.S. Geological Survey station number.
Drainage area: a, approximate.
Discharge: Dash indicates unmeasured flow in ephemeral stream on date visited; e, estimated.

Site location	Stream and site description	Drainage area (square miles)	Date	Discharge (cfs)	Remarks
(C-4-6)25bab	10-1727.8 Hickman Creek, near St. John. Crest-stage gage 0.1 mile upstream from road crossing and 6.5 miles north of St. John	12.8	10-17-60	-	Discharge not determined.
			9-17-61	-	Do.
			2-11-62	-	Do.
			3-27-62	-	Do.
			6-17-63	9.9e	
			9-13-63	18e	
			1964	-	No evidence of flow during year.
			3-13-65	7e	
			5-10-66	3e	
			8-29-66	-	Discharge not determined.
(C-4-7)36daa	Bear Fork of East Hickman Canyon	-	9-21-64	.02e	Chemical analysis in table 17.
(C-5-4)22bbc	10-1727.7 Dry Canyon near Stockton. Crest-stage gage at end of trail from Ophir Canyon road	1.42	1961-65	-	No evidence of flow except once in 1962 when discharge was not determined.
28cdb	Ophir Creek at mouth of Ophir	-	9-25-64	4e	Chemical analysis in table 17.
			5-29-65	6e	Do.
			9-15-65	15e	
(C-5-6)6bbd	Stream in Morgan Canyon	-	9-21-64	.02e	Chemical analysis in table 17.
6bbd	East flowing tributary of Morgan Canyon stream		9-21-64	.02e	Do.
32add	10-1727.6 Clover Creek near Clover. Crest-stage gage, 4.3 miles west of Clover and below Clover Springs	4.45	-		Listing of measurements and estimates in table 6.
(C-6-3)32bda	10-1727.4 Rush Valley tributary near Fairfield. Crest-stage gage, 0.9 mile northeast of State Highway 73	.26	9-17-61	-	Discharge not determined.
			2- -62	-	Do.
			9-19-63	-	Do.
			1964	-	No evidence of flow during year.
			9- 6-65	17e	
			1966	-	No evidence of flow during year.
(C-8-5)20cdb	Vernon Creek. 3-inch Parshall flume, north of Vernon	-	7-24 to	.97	Measurements reported by Soil Conservation Service. Highest flow during 1-day period.
			7-25-65	.85	Lowest flow. Flow of creek shows diurnal fluctuations and probable effects of diversion or regulation.
32bab	Vernon Creek. 6-inch Parshall flume, 100 feet south of Vernon	-	7-20 to	1.10	Highest flow during 5-day period.
			7-25-65	.76	Lowest flow during 5-day period.
			5-18-66	1.28	Measurements reported by Soil Conservation Service. Flow is subject to diversion; diurnal effect.
			5-20-66	1.12	
			5-24-66	1.23	
			6- 2-66	1.62	
			6-16-66	.92	
			6-30-66	.78	
			7-14-66	.47	
			8-15-66	.65	
			9-12-66	.58	
			9-30-66	.43	
(C-8-6)17dcc	10-1727.2 East Government Creek tributary near Vernon	.98a	2- 9-62	6	No evidence of any other flow in 1961-65.
(C-9-5)5bda	Vernon Creek ditch. 9-inch Parshall flume at end of concrete ditch	-	7-20 to	1.32	Measurements reported by Soil Conservation Service. Highest flow during 3-day period.
			7-23-65	.97	Lowest flow during 3-day period.
			7-26 to	1.37	Highest flow during 1-day period.
			7-27-65	1.05	Lowest flow during 1-day period.
			8- 3 to	1.63	Highest flow during 1-day period.
			8- 4-65	1.25	Lowest flow during 1-day period.
27b	Vernon Creek	-	9- 5-14	2.2	
27cdd	Vernon Creek ditch. 6-inch Parshall flume	-	7-26 to	1.79	Measurements reported by Soil Conservation Service. Highest flow during 1-day period.
			7-27-65	1.53	Lowest flow during 1-day period.
			8- 3 to	1.88	Highest flow during 1-day period.
			8- 4-65	1.64	Lowest flow during 1-day period.
28ada	Bennion Creek ditch. 6-inch Parshall flume at head of storage pond	-	7-16 to	.51	Measurements reported by Soil Conservation Service. Highest flow during 1-day period.
			7-17-65	.29	Lowest flow during 1-day period.
			7-19 to	.34	Highest flow during 1-day period.
			7-20-65	.26	Lowest flow during 1-day period.
29ddc	Bennion Creek. 9-inch Parshall flume 100 feet above Forest Service diversion	-	7-15 to	.84	Measurements reported by Soil Conservation Service. Highest flow during 5-day period.
			7-20-65	.47	Lowest flow during 5-day period.
32a	Bennion Creek	-	9- 5-14	.5	

Table 11.—Continued

Site location	Stream and site description	Drainage area (square miles)	Date	Discharge (cfs)	Remarks
(C-9-6)35d	Harker Creek	-	9- 5-14	0.5	
36bdc	Harker Creek. 3-inch Parshall flume, at diversion in mouth of canyon	-	7-13 to	.39	Measurements reported by Soil Conservation Service. Highest flow during 3-day period.
			7-16-65	.16	Lowest flow during 3-day period.
	Harker Creek. 90° V-notch weir, just below diversion	-	11-10-65	.30	Only 5-10 gpm reaches first farm on Harker Creek at head of distribution system.
(C-10-5)2cca	10-1727. Vernon Creek near Vernon	0.25a	-	See remarks	Gaging station. Summary record of monthly and annual discharges in table 5. Chemical analysis in table 17.
6ddc	Dutch Creek. 90° V-notch weir below confluence of forks	-	5-12-66	.40	All measurements reported by Soil Conservation Service.
			5-16-66	.28	
			5-18-66	.30	
			5-20-66	.24	
			5-24-66	.23	
			5-26-66	.21	
			6- 2-66	.21	
			6-10-66	.11	
			6-16-66	.05	
			6-22-66	.03	
			6-30-66	.02	
			7- 7-66	0	
8dbb	Bennion Creek. 9-inch Parshall flume at bridge on road to Little Valley	-	5-12-66	2.61	All measurements reported by Soil Conservation Service.
			5-16-66	2.02	
			5-18-66	1.94	
			5-20-66	1.78	
			5-24-66	1.55	
			5-26-66	1.40	
			6- 2-66	1.06	
			6-10-66	1.00	
			6-16-66	.81	
			6-22-66	.67	
			6-30-66	.56	
			7- 7-66	.56	
			7-14-66	.37	
			7-21-66	.35	
			8-15-66	.28	
			9-12-66	.37	
			9-30-66	.51	
11dcc	Little Valley Creek	-	3-29-65	1.5e	Chemical analysis in table 17.
(C-10-6)12dad	Tributary to Dutch Creek. 3-inch Parshall flume; at end of road	-	5-16-66	.26	All measurements reported by Soil Conservation Service.
			5-18-66	.23	
			5-20-66	.20	
			5-24-66	.18	
			5-26-66	.18	
			6- 2-66	.13	
			6-10-66	.12	
			6-16-66	.09	
			6-23-66	.08	
			6-30-66	.05	
			7- 7-66	.04	
			7-21-66	.03	
			8-15-66	.02	

Table 12.—Records of selected wells in Rush Valley

Well No.: See text for description of well-numbering system.
Type of well: B, bored or augered; C, cable tool; D, dug; H, hydraulic rotary; J, jetted; Z, drilled, but method not known.
Water-bearing zone: Character of material - B, boulders; C, conglomerate; G, gravel; HP, "hardpan" (a dense lime-cemented zone); JF, fractured shale; L, limestone; N, quartzite; P, clay; S, sand; Z, cobbles.
Altitude above mean sea level: Surveyed altitudes given in feet and tenths; altitudes interpolated from topographic maps given in feet.
Water level: Levels measured by the U.S. Geological Survey given in feet and tenths; levels reported by owner, driller, or other data source given in feet; F, water level unknown at time of report, but well was flowing.
Method of lift: B, bucket; N, none; P, piston pump (plunger or cylinder); S, submersible pump; T, turbine pump. Number in parentheses indicates horsepower.
Well performance: Yield - Reported by owner, operator, or driller; B, bailed; E, estimated by U.S. Geological Survey; F, yield by natural flow; M, measured by U.S. Geological Survey.
Use of water: H, domestic; I, irrigation; N, industrial; S, stock; U, unused.
Remarks and other data available: C, chemical analysis in table 16; H, hydrograph of water levels in figure 5; L, driller's log of well in table 13; Perf., casing perforated with Mills knife or with cutting torch; Temp., temperature of well water in degrees Fahrenheit; W, water-level measurements in table 14.

Well No.	Owner or name	Utah State Engineer application or claim No.	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Water-bearing zone: Depth to top (feet)	Water-bearing zone: Thickness (feet)	Water-bearing zone: Character of material	Altitude above sea level (feet)	Water level: Above(+) or below(-) land-surface datum (feet)	Water level: Date of measurement	Method of lift	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use of water	Remarks and other data available
(C-4-5)																	
13bbd-1	Combined Metals Reduction Co.	C-10978	1953	C	535	14	320 440	65 5	S,G,P B	4,970	-260	3-14-53	S	4	212	U	In Tooele Valley north of Stockton bar. Perf. 340-365, 400-450, 460-480 ft. Temp. 58. L.
32ddc-1	Hogan Bros.	A-28985 A-28986	1959	C	96	12	42	54	G,P	4,980	-	-	T (60)	718M	-	I,S	Perf. 42-96 ft. Temp. 54. C, L.
33aaa-1	Martell Russell	A-33811	1961	C	173	6	130	4	G,HP	5,030	-60	12- -61	-	-	-	S	Perf. 120-173 ft. L.
33bdc-1	Hogan Bros.	A-28985 A-28986	1959	C	55	12	25	30	P,S,G	4,988	-	-	N	100	35	U	Casing removed and well abandoned. L.
33cca-1	do	A-28985 A-28986	1959	C	43	12	35	8	G	4,970	-6.9	8- 4-61	T (75)	970M	-	H,S,I	Reportedly flows in winter. Perf. 36-43 ft. Temp. 53. C.
34bbd-1	-	-	-	-	-	8	-	-	-	4,960	-1	5-17-67	N	-	-	U	At edge of Rush Lake flat.
36daa-1	S. B. Bengerter	A-35206	1963	H	254	6,4	150 216	13 14	G,B JF	5,290	-200	10-15-63	-	158	-	H,S,I	Casing: 6 inch to 164 ft, perf. 150-163 ft; 4 inch 164-234 ft, perf. 186-234 ft. L.
(C-4-6)																	
35bdd-1	Joe Sandino	A-18315	1947	C	147	6	-	-	-	5,560	-	-	-	-	-	U	Well reportedly uncompleted because boulder bed could not be penetrated. Open-end casing. L.
(C-5-4)																	
28cdb-1	Snyder Mines Inc.	A-12696	1937	Z	90	12	67	19	G,JF	5,660	-62	5-17-37	N	178	15	U	Perf. 67-88 ft. L.
28cdb-2	do	A-12696	1937	Z	86	12	71	9	G,JF	5,650	-62	5-18-37	N	146	15	U	Perf. 68-85 ft.
(C-5-5)																	
1ccb-1	-	A-21890	1951	Z	296	16	-	-	-	5,260	-92	1951	-	<10	25	U	
2bcc-1	A. N. Young	C-19882	1902	D	34	60	-	-	-	5,010	-28.2	8-22-63	P	<50	-	H,S	C, H.
2bcc-2	A. L. Young	A-35682	1963	C	75	6	45	30	S,G,P	5,010	-31	12- 2-63	-	25	-	H,S	Perf. 33-75 ft. C, L.
4baa-1	Joe Sandino	A-32974	1963	C	300	8	164 282	23 8	G G	4,975	F	9- -63	-	650F	-	H,I,S	Quality of water reportedly good. Perf. 164-249, 282-290 ft. L.
10add-1	J. P. Quinn	A-24536	-	C	530	-	-	-	-	4,990	-	-	N	0	-	-	Well deepened in 1954 from 170 to 530 ft. Casing removed and well abandoned in 1966. L.
15aad-1	Warren Penny	-	1954	Z	180	6	-	-	-	5,025	-20	12- -64	-	-	-	H	Cased to 120 ft. C.
15add-1	Martell Russell	A-19899	1951	C	100	8	3	47	G	5,030	-3	11- -51	-	-	-	H	Perf. 10-100 ft.
15add-2	do	A-23557	1953	C	53	10	29 37	5 9	G G	5,030	-4	3- -53	T	373M	10	I	Perf. 5-53 ft. L.
15bbd-1	Warren Penny	A-24096	1953	C	150	6	68 90	2 1	HP HP	4,990	-15	1- -53	-	-	-	-	Perf. 54-? ft. L.
17aad-1	Martell Russell	-	1935	B	20	6	-	-	-	4,995	-10	9-22-64	-	50	-	H	C.
19ccd-1	J. W. Neilsen	A-32860	1961	C	86	6	25	13	P,S	5,065	-20	10-26-61	-	-	-	H	Cased to 81 ft. Perf. 20-81 ft. L.
19cdb-1	D. G. Bracken	A-25469	1954	C	40	6	36	4	S,G	5,065	-14	3- -54	-	-	-	H	
21dcb-1	Union Pacific Railroad Co.	-	1916	C	342	3	335	4	Z	5,020	-25	1916	N	<1	77	U	Well penetrated bedrock and reportedly yielded salty water. L.
30acc-1	Reid Caldwell	A-28313	1956	C	60	6	32	3	G	5,048	-30	8-13-56	-	-	-	-	Perf. 30-? ft.
30bab-1	R. G. Sager	A-34328	1962	C	74	6	18	1	HP	5,068	-13	7-21-62	-	-	-	H	Cased to 70 ft. Perf. 15-70 ft.
30bac-5	R. D. Sager	A-27167	1955	C	62	6	30	58	P,G	5,060	-28	10-10-55	-	-	-	-	Perf. 30-? ft.
30bca-1	William Ahlstrom	-	-	D	-	-	-	-	-	-	-12.7	4- 6-54	P	-	-	-	W.
30bcb-1	Willard Sager	C-8286	1934	D,C	62	8	20	30	S	5,100	-11.4	4- 6-54	-	10	-	U	Cased to 53 ft. Perf. 9-43 ft. H.
30cab-1	Frank Caldwell and Mervin Russell	A-31819	1960	C	572	10	125 276 323 375 492	2 4 2 59 13	S,G S,G S,G S,P S	5,075	-24	7-25-60	-	40	8	I	Perf. 115-513 ft. L.
30cbb-1	Willard Sager	C-8287	1934	D,C	107	8	60 84	14 20	S,G S,G	5,110	-24.0	10-23-35	J (½)	10	-	P	Cased to 90 ft, open end. L, W.
31cca-1	W. E. Harding	A-30164	1958	C	65	6	50	5	G	5,150	-50	10-25-58	-	8	2	-	Perf. 48-65 ft. L.
31dad-1	F. N. Maxwell	A-31018	1961	C	55	6	25	30	P,Z	5,070	-25	10-28-61	-	5B	-	H	Perf. 21-55 ft.
31dbd-1	R. H. Orr	C-18781	1910	D,C	60	60,6	-	-	-	5,100	-20.7	12-21-51	N	-	-	U	Dug well deepened in 1941 from 25 to 60 ft. H.
32adb-1	Stookey Bros.	-	1904	J	1,004	2	-	-	-	-	-1.9	3-21-50	N	-	-	U	Water reported hard and a little salty. Well reportedly had weak flow. Destroyed in 1950. W.
32add-1	do	-	-	D	36	30x60	-	-	-	5,026	-23.6	4-10-52	-	-	-	-	W.
32cac-1	C. T. Anderson	-	1944	J	750	2	-	-	-	5,050	-	-	N	-	-	U	All material penetrated fine grained--mostly clay. Well flows in some seasons. Water reportedly salty.
32cac-2	D. H. Russell	C-18776	1962	C	145	8	38	-	P	5,048	-29	12-10-62	-	-	-	H	Cased to 115 ft. Perf. 77-115 ft. L.
32dbb-1	do	A-32382	1961	C	112	8	35 97	32 15	S,G G	5,035	-18	4-20-61	-	250	44	I	Perf. 0-112 ft.
(C-5-6)																	
12aba-1	-	-	-	Z	-	6	-	-	-	5,250	-73.0	5-16-67	P (5)	-	-	S	
25aaa-1	Willard Sager	C-8288	1934	C	108	8	104	2	G	5,120	-19.8 -16.5	10-23-35 3-22-42	- (½)	15	-	P	Cased to 104 ft, open end. L, W.
35dba-1	M. M. Johnson	A-23045	1951	C	110	6	100	4	G	5,390	-37	7-21-51	-	-	-	-	Perf. 95-110 ft. L.
36cab-1	J. F. McDaniel	A-35212	1963	C	57	6	30	20	S,G	5,260	-23	5-18-63	-	30B	10	H	Perf. 30-57 ft.
36dc	Clover Irrigation Co.	-	1934	C	370	12, 15	315 339	10 4	S S	5,250	-14.6	5-17-37	N	20	90	U	Cased to 324 ft, open end; 15-inch casing to 80 ft. Water levels measured in both casings. Water level inside 15-inch casing was -12.6 on 5-17-37. L, W.

Table 12.—Continued

Well No.	Owner or name	Utah State Engineer application or claim No.	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Water-bearing zone: Depth to top (feet)	Water-bearing zone: Thickness (feet)	Water-bearing zone: Character of material	Altitude above sea level (feet)	Water level: Above(+) or below(-) land-surface datum (feet)	Water level: Date of measurement	Method of lift	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use of water	Remarks and other data available
(C-5-6)																	
36dbc-1	J. W. Russell	A-23065	1951	C	220	6	-	-	-	5,225	-18	9-26-51	-	-	-	-	Cased to 204 ft. Perf. 18-28, 182-204 ft. L.
(C-6-3)																	
5bac-1	Lewiston Peat Mine Co.	C-11815	-	D	65	48x72	-	-	-	-	-	-	-	-	-	S	In Oquirrh Mountains.
(C-6-4)																	
5bdb-1	U.S. Army Well 1	A-15128	1942	C	405	12	290	114	G	5,398.4	-284.6	12-21-51	T (60)	340	5.5	H	Perf. 290-404 ft. On 7-3-42, reported hardness was 268 ppm and dissolved solids was 365 ppm. C, L, W.
5bdd-1	U.S. Army Well 2	A-15128	1942	C	428	12	312	116	S,G,C	5,399.6	-287	9-28-42	T (60)	364	7	H	Perf. 312-412 ft. On 9-1-42, reported hardness was 343 ppm and dissolved solids was 458 ppm. C, L.
31acb-1	L. A. Stookey	A-35140	1963	C	50	6	25	20	S,G	5,050	-27.6	3- 3-67	P	30B	0	S	Perf. 25-45 ft. L.
35bac-1	U.S. Bureau of Land Management	A-26409	1954	C	365	6	210	155	P,S	5,150	-148.2	3- 3-67	T	18	5	S	"Gilmore well." Perf. 210-365 ft. L.
(C-6-5)																	
5bac-1	J. C. Zeutner	C-10602	-	D	33	48	-	-	-	5,059.9	-	-	-	8	-	S	
20acc-1	U.S. Bureau of Land Management	-	1936	C	377	-	195	5	S	5,110	-80	1936	N	2	-	U	Drilled for stock water. Reportedly yielded salty water and was abandoned. L.
22ddd-1	U.S. Army	C-10603	-	D	15	-	-	-	-	5,040	-	-	-	8	-	U	Formerly used for stock.
26cb	do	-	-	D	17	60	-	-	-	5,040	-14.7 -15.1	5-13-41 11-25-41	P	-	-	U	Do.
34aaa-1	L. A. Stookey	A-22393	-	D,C	35	6	20	15	G	5,045	-20	1-23-51	P	25B	10	U	Old dug well deepened in 1951. Perf. 19-30 ft. L.
34cab-1	do	A-35202	1963	C	50	5	20	2	S,G	5,070	-17.6	5-17-67	P	5B	4	S	Well gravel packed from 20 to 50 ft. Perf. 19-30 ft. L.
(C-6-6)																	
1aba-1	L. E. Orr	A-36485	1965	C	50	6	18	1	HP	5,225	-12	3-26-63	-	7B	0	-	Cased to 41 ft. Perf. 17-40 ft.
14bbb-1	O. A. Johnson	A-31280	1959	C	128	6	86 121	25 7	G G	5,465	-86	9- 5-59	-	10	14.5	-	Perf. 100-128 ft. L.
(C-7-3)																	
30acc-1	L. W. Fitzgerald	A-18903	1947	C	300	6	140 275	30 25	S,P S,P	5,090	-129.1 -131.1	12-11-58 3- 2-67	P (5)	15	0	S	Perf. 140-300 ft. Reported to yield slightly salty water. H, L.
(C-7-4)																	
14aac-1	U.S. Bureau of Land Management	A-19505	1935	C	875	8,6	735 860	15 15	S S	5,060	-92.1 -92.2	12-11-58 3-17-67	P (5)	40	-	S	Well deepened in 1958. Casing: 8 inch to 236 ft, 6 inch to 865 ft. C, L, W.
(C-7-5)																	
5cbb-1	Russell Bros.	A-36425	1964	C	159	6	90	-	P	5,275	-90	12-19-64	-	3B	-	S	Perf. 90-140 ft. L.
10c	L. A. Stookey	-	-	D	>8	-	8	1	C	5,175	-8	-	-	-	-	-	
10ccc-1	do	A-13289	1946	C	50	6	4	6	G	5,175	-	-	N	-	-	N	L.
27dbb-1	San Pedro, Los Angeles, and Salt Lake Railroad Co.	A-4989	1967	C	611	10	585	9	S,G,C	5,250	-80	2-10-67	N	100	60	H	Water reported warm and to contain some arsenic. Cased to 605 ft. Perf. 235-245, 386-390, 473-487, 585-594 ft. L.
28bbc-1	D. J. Atherly	A-34227	1962	C	150	4	31	2	G	5,220	-20	5-30-62	-	-	-	H	Cased to 145 ft. Perf. 20-40, 125-145 ft. C, L.
29dcd-1	Roy Davis	-	1917	J	260	2	-	-	-	5,250	+23.6	11-28-37	N	<1FM	-	H	Open-end casing. C, W.
32bdd-1	McFarland and Hullinger	A-23019	1952	C	360	12, 8	24 275	11 15	G S,G,C	5,255	-12 -12.1	6-12-52 12-15-65	T (15)	226M	10	I	Casing: 12 inch to 48 ft, perf. 20-40 ft; 8 inch to 360 ft, perf. 275-290 ft. Temp. 49. C, H, L.
(C-8-3)																	
6aad-1	San Pedro, Los Angeles, and Salt Lake Railroad Co.	C-4274	1907	C	654	15, 10	466	32	L,N	5,110	-595	-	N	20	-	U	Measured depth of well was 340 ft on 3-2-67. Casing: 15 inch to 126 ft; 10 inch 126-225 ft. Open hole in consolidated rock to 654 ft. Formerly supplied average of 10,400 gpd to railroad. L.
6cdc-1	E. H. Fitzgerald	A-24258	1952	C	290	6	270	10	P	5,128	-195.2	3- 2-67	N	10	50	U	Well reportedly can be pumped dry in 20 minutes. Formation not tested by perforated casing. L.
(C-8-4)																	
5caa-1	L. W. Fitzgerald	-	1934	D,C	160	16	-	-	-	5,260	-92.8	3-2-67	S	-	-	S	Old dug well appears to have been deepened. Well reportedly can be pumped dry in about 5 hours.
22aad-1	V. A. Mahoney	A-15855	1945	C	298	6	265	5	G	5,300	-252.9	3- 2-67	P	-	-	S	Perf. 260-298 ft. C, L.
30dcd-1	Clay Cummings	A-16444	1945	C	322	6	270	52	P,G	5,510	-260	4- -45	-	3M	-	S	Cased to 302 ft. Perf. 260-302 ft. Sandy loam to 7 ft, clay and gravel 7-322 ft. Temp. 54. C.
(C-8-5)																	
6ccd-1	McFarland and Hullinger	A-36904	1966	C	730	16	132	-	B,Z, S,C	5,350	-12	2- 9-66	-	700	-	I	Cased to 703 ft. Casing perforated opposite nearly all water-bearing zones. Perf. 132-142, 152-162, 197-207, 257-267, 290-300, 355-365, 530-540, 605-700 ft. Bottom of well may be finished in shattered consolidated rock. L.
6ddb-1	do	A-23018	1962	C	534	16	367 430	35 95	G G,B	5,301.1	+2.7	10-17-62	T (40)	4,100M	13	H,I,S	Cased to 532 ft. Perf. 387-530 ft. Flowed 1,450 gpm on completion. Temp. 61. C, L.
6ddb-2	do	-	1967	C	583	20	-	-	C,N	5,300	-	-	-	8,600	61	I	Incomplete report on recently drilled well. Part of yield is from brecciated quartzite.
6ddc-1	do	A-23018	1959	C	365	12	20 285	- 10	G C	5,300	-14	5- -59	N	280	86	U	Replaced by well (C-8-5)6ddb-1. Cased to 340 ft. Perf. 20-340 ft. Temp. 55. C, L.
7ddd-1	R. J. Walters	A-29903	1958	C	312	3	55 94 125 168 200	25 21 25 22 15	G,C G C C C	5,380	-8	7-15-58	-	25	7	H	Cased to 300 ft. Perf. 110-235 ft. L.
9c	Leo Fitzgerald	-	-	C	150	-	-	-	-	5,400	-85	-	-	-	-	S	
16bd	Diamond Oil Co. No. 4 State	-	1934	C	3,571	-	2,450 2,850 3,470	- - 12	- - S	5,345	-	-	N	-	-	U	Abandoned oil test. Casing was 5 inch to 3,550 ft.
19aaa-1	G. A. Ricks	A-32922	1961	C	156	12	30 80 130	15 15 6	S,G S,G S,G	5,450	-5	9- 7-61	-	135	90	I,S	Cased to 150 ft. Perf. 30-45, 80-95, 130-136 ft. L.
19aca-1	do	A-34856	1963	C	220	12	40	-	P,G	5,420	-13	11- 1-65	T (10)	60	115	U	Cased to 200 ft. Perf. 30-198 ft. L.
20cdc-1	Jay Fitzwater	A-33907	1966	C	250	6	116 215	2 17	HP S	5,510	-14	5-19-66	-	40	60	H	Perf. 116-118, 215-217, 220-223, 240-242 ft. L.
20cdd-1	William Snyder	-	1951	Z	65	6	-	-	-	5,510	-14.4	12-15-65	T (5)	150M	-	I	Water level while pumping 120 gpm was -47.5 ft. H.

Table 12.—Continued

Well No.	Owner or name	Utah State Engineer application or claim No.	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Water-bearing zone: Depth to top (feet)	Water-bearing zone: Thickness (feet)	Water-bearing zone: Character of material	Altitude above sea level (feet)	Water level: Above(+) or below(-) land-surface datum (feet)	Water level: Date of measurement	Method of lift	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use of water	Remarks and other data available
(C-8-5)																	
20dc	William Snyder	-	1934	D	13	60	-	-	-	5,510	-7.6	4- 5-57	B	-	-	H	H.
29baa-1	Pierre Castagno	-	1951	Z	300	6	-	-	-	5,520	-	-	-	20E	-	H	C.
29caa-1	Ambrose Shurtz	A-22823	1951	C	150	6	125	1	G	5,525	-40	10-27-51	-	-	-	H	Perf. 105-125 ft. L.
29caa-2	L. G. Fitzwater	A-35562	1964	C	114	4	110	2	G	5,520	-20	6-18-64	-	-	-	H	Cased to 112 ft. Perf. 90-112 ft. L.
30cac-1	H. T. and M. O. Yates	A-22902	1951	Z	53	12	-	-	-	5,497	-8.7	12- 7-56	-	-	-	-	W.
30ccc-1	H. T. Yates	C-1573	1934	D	16	60	-	-	-	5,525	-4.3	4- 1-55	P	-	-	U	W.
31aad-1	D. L. Fredrickson	C-19347	1934	Z	80	14	-	-	-	5,550	-18.8	11-25-52	-	-	-	U	W.
31abc-3	Peter Hansen	C-12660	1913	J	273	2	270	3	S,G	5,550	+29.2	4-30-40	-	20FM	-	I	Open-end casing. Temp. 52. L, W.
31ccd-1	W. O. Pehrson	C-19889	1918	J	310	2	-	-	-	5,575	+7.6	12-15-65	-	-	-	-	Temp. 54. C, W.
31ccd-5	Sidney Pehrson	A-22832	1951	Z	60	10	-	-	-	5,560	-18.0	12- 7-56	T (5)	250	-	I	W.
31dad-4	Laurence Sharp	A-19386	1951	J	214	2	194 211	3 3	S,G S	5,545	+14	11-10-51	-	6F	-	-	Open-end casing. L.
31dbc-1	Vernon Water Works	A-29868	1958	C	126	8	107	4	G	5,545	-30	5-18-58	T (5)	-	-	P	Perf. 104-117 ft. C, L.
(C-8-6)																	
10aaa-1	U.S. Bureau of Land Management	A-31245	1959	C	420	6	320	100	S,P	5,500	-170	8-30-59	-	30B	-	S	Perf. 340-415 ft. Temp. 54. C, L.
14baa-1	Layton Harris	A-31833	1960	H	700	5	-	-	-	5,400	-	-	-	-	-	U	Uncased test hole. L.
22ddd-1	J. E. Olson	C-18130	1917	-	300	3	-	-	-	5,460	-37.6	9- 7-66	-	>10	-	S	W.
23cd	-	-	-	-	-	2	-	-	-	5,420	+2.3	4- 5-57	-	-	-	U	W.
25acb-1	-	C-14203	1912	-	400	2	-	-	-	-	-	-	-	<10F	-	H	
26aaa-1	J. E. Olson	C-1415	1916	J	224	2	222	2	G	5,420	+17.0 +31.6	10-23-35 8-21-63	-	- 11FM	- -	H,S,I	Open-end casing. Temp. 52. C, H.
26aac-2	do	A-13292	1941	Z	445	7	52 140	- 5	- G,P	5,420	-6	10- 9-41	N	40	37	U	Well plugged and abandoned because of insufficient water. L.
26dad-1	Sidney Pehrson	A-25737	1954	-	124	2	123	<1	S	5,480	-	-	-	<1F	-	-	L.
35baa-1	-	C-19888	1935	-	324	2	-	-	-	5,500	-	-	-	<1F	-	S	
35bca-2	R. E. Pehrson	C-8500	-	C	150	12	-	-	-	5,560	-17	1- 2-60	-	80B	8	-	
35dab-1	-	C-7903	1918	-	200	4	-	-	-	-	-	-	-	<10F	-	H	
36dda-1	Robert Durrant	-	-	Z	68	10	-	-	-	5,550	-7	11- 2-65	-	200	-	I	
36ddc-1	W. O. Pendleton	A-22844	1951	C	186	12	90 177	1 5	G G	5,570	-17.7	12-15-65	T (10)	500 225M	70 -	I	Perf. 80-100, 162-182 ft. L, W.
(C-9-4)																	
2aa	Bill Jordan	-	-	Z	404	-	-	-	-	5,450	-270	-	P	<10	-	H,S	Old Scanton Mine well. Temp. 54. C.
32bbd-1	Union Pacific Railroad Co.	-	1913	Z	571	8	-	-	-	6,116	-	-	N	-	-	U	Uncased well; reportedly dry. L.
32bbd-2	do	-	1914	Z	90	8	21 26 50 77	4 8 24 5	G G S,G S,G,P	6,116.5	-	-	N	80F	-	H	Drilled in spring area. Perf. 21-34, 65-72, 79-82 ft. Temp. 51. Quality reported as good. L.
(C-9-5)																	
5bbc-1	Latter-day Saints Church, Tooele Stake Welfare Farm	A-29836	-	C	600	16, 12	176 195 241	5 11 15	G S,G G	5,580	-5	11- 4-65	T	575E	64	I	Well deepened in 1959 from 110 to 600 ft. Cased to 493 ft, open end. Water-bearing strata reportedly was cased off. L.
6aab-2	do	C-10609	1959	C	170	12	75 118 134	11 2 5	G G G	5,570	-46	6- 4-59	T (25)	430	31	I	Perf. 75-170 ft. L.
6bca-2	Harker Creek Irrigation Co.	C-8285	1935	C	90	16	70	20	S,G	5,590	-18.2	9-18-36	T (20)	200	-	-	Cased to 80 ft. H, L.
20ddd-1	U.S. Department of Agriculture	A-12462	1937	C	365	6,4	342	23	-	5,975	-295	7-21-37	-	15B	0	H,S	Casing: 6 inch to 340 ft, 4 inch to 358 ft. Perf. 347-358 ft. L.
29caa-1	A. S. Green	A-21636	1950	C	114	3	107	7	G,S	5,950	-	-	-	10	-	-	Open-end casing. L.
(C-9-6)																	
1bdc-1	R. E. Pehrson	A-13293	1940	C	75	16	-	-	-	5,605	-13	7-25-40	-	115	32	I	Perf. 15-75 ft.
1dab-1	Peter Hansen	C-12655	1922	J	338	3	-	-	-	5,600	-2.6	10-20-61	-	-	-	S	
10abd-1	U.S. Department of Agriculture	A-23802	1952	C	135	6	115	20	G,B	5,732	-95	5-29-52	-	-	-	-	Perf. 100-135 ft. L.
(C-10-4)																	
14acc-2	W. L. Hoyt	A-21887	1964	C	155	6	50	23	S,P	6,280	-58	6- 8-64	-	<1	-	S	Cased to 102 ft. Perf. 55-85 ft. L.

Table 13.—Drillers' logs of selected wells in Rush Valley

Altitudes are in feet above sea level for land surface at well.
Thickness in feet.
Depth in feet below land surface.

Material	Thickness	Depth
(C-4-5)13bbd-1. Log by I. C. Droubay. Alt. 4,970 ft.		
Clay and topsoil	25	25
Gravel, washed, and boulders	50	75
Sand, fine	5	80
Clay	5	85
Gravel and sand, washed and loose (water level 100 ft)	20	105
Sand, fine	10	115
Clay and gravel mixed	10	125
Clay, fine, light	25	150
Sand, coarse grained	10	160
Gravel, fine	15	175
Gravel and large rocks	30	205
Clay and gravel	30	235
Sand, coarse grained	5	240
Gravel and clay	25	265
Gravel, cemented, red	5	270
Gravel and clay, gray	10	280
Gravel, cemented, red	5	285
Gravel, cemented, gray	10	295
Gravel, cemented, red	5	300
Gravel; water bearing	10	310
Sand, fine, white (quicksand)	10	320
Sand, gravel, clay (mixed); water bearing	65	385
Clay and large boulders	15	400
Gravel and rock with clay mixed	25	425
Clay and lava (boulders)	15	440
Boulders, cemented; water bearing	5	445
Clay and large boulders (quartz and lava)	15	460
Lava, hard	5	465
Lava and quartz (boulders); water bearing	15	480
Lava, soft and fine	10	490
Lava and clay	10	500
Lava, hard	25	525
Lava and clay seams	10	535
(C-4-5)32ddc-1. Log by Robinson Drilling Co. Alt. 4,980 ft.		
Clay	34	34
Gravel	4	38
Sand	4	42
Clay and gravel	54	96
(C-4-5)33aaa-1. Log by H. C. Russell. Alt. 5,030 ft.		
Silt	2	2
Silt and cobbles	21	23
Hardpan	12	35
Hardpan, very, very hard	1	36
Clay, light	76	112
Clay, brown	18	130
Gravel and hardpan; water bearing	4	134
Clay, light	32	166
Clay, very soft	2	168
Clay	5	173
(C-4-5)33bdc-1. Log by Robinson Drilling Co. Alt. 4,988 ft.		
Clay, brown	15	15
Clay, blue	10	25
Clay and gravel	25	50
Clay, sand, and gravel	5	55
(C-4-5)36daa-1. Log by J. A. Nak Drilling Co. Alt. 5,290 ft.		
Topsoil	20	20
Gravel	1	21
Clay	9	30
Gravel	1	31
Clay	2	33
Gravel and cobbles	4	37
Clay	1	38
Gravel and cobbles	4	42
Clay	5	47
Cobbles and boulders	9	56
Boulders	4	60
Shale	7	67
Hardpan	1	68
Clay	2	70
Boulders	1	71
Shale	8	79
Clay	2	81
Limestone	8	89
Conglomerate	15	104
Clay	2	106
Conglomerate	3	109
Clay	2	111
Conglomerate	3	114
(C-4-5)36daa-1 - Continued		
Clay	3	117
Conglomerate	2	119
Conglomerate with gypsum	2	121
Conglomerate with clay	11	132
Clay	1	133
Conglomerate	2	135
Clay	1	136
Conglomerate	6	142
Clay	2	144
Conglomerate	3	147
Clay	1	148
Boulders	1	149
Clay	1	150
Conglomerate; water bearing	10	160
Boulders	1	161
Conglomerate with clay	2	163
Conglomerate	12	175
Clay	1	176
Conglomerate; water bearing	14	190
Clay	4	194
Conglomerate; water bearing	10	204
Clay	1	205
Conglomerate; water bearing	1	206
Shale	2	208
Conglomerate; water bearing	4	212
Gravel	1	213
Conglomerate; water bearing	2	215
Boulders	1	216
Shale, porous, fractured	14	230
Hardpan	1	231
Gravel	7	238
Boulders	7	245
Gravel	9	254
(C-4-6)35bdd-1. Log by L. E. Hale. Alt. 5,560 ft.		
Old well		85
Sand	15	100
Gravel	35	135
Boulders (driller could not penetrate)	12	147
(C-5-4)28cdb-1. Log by C. M. Erb Drilling Co. Alt. 5,660 ft.		
Topsoil	2	2
Clay, yellow and gravel	65	67
Gravel; water bearing	7	74
Shale, fractured, black	12	86
Shale, black	4	90
(C-5-5)2bcc-2. Log by H. C. Russell. Alt. 5,010 ft.		
Silt	5	5
Clay	13	18
Cobbles	10	28
Clay	14	42
No record, water at 45 ft.	31	73
Clay	2	75
(C-5-5)4baa-1. Log by H. C. Russell. Alt. 4,975 ft.		
Silt	5	5
Clay, white	11	16
Clay, dark, mushy	72	88
Sand; water bearing	8	96
Clay, dark	14	110
Sand	5	115
Clay, dark	6	121
Clay and sand	27	148
Sand	16	164
Gravel; water bearing	23	187
Clay	23	210
Gravel	4	214
Clay	2	216
Clay and cobbles	33	249
Clay, brown	21	270
Clay, gray	12	282
Gravel; water bearing	8	290
Clay	10	300
(C-5-5)10add-1. Log by Selby Drilling Co. Alt. 4,990 ft.		
Old well		170
Clay, light-gray, with small gravel	360	530
(C-5-5)15add-2. Log by H. C. Russell. Alt. 5,030 ft.		
Topsoil and large rocks	3	3
Gravel; water bearing	12	15
(C-5-5)15add-2 - Continued		
Clay, red	14	29
Gravel; water bearing	5	34
Mud, plain	3	37
Gravel; water bearing	5	42
Gravel, fine; water bearing	4	46
Hardpan	2	48
Mud	5	53
(C-5-5)15bbd-1. Log by J. F. O'Brien. Alt. 4,990 ft.		
Overburden	20	20
Clay, light brown	48	68
Hardpan; water bearing	2	70
Clay, brown	20	90
Hardpan; water bearing	1	91
Clay, brown	50	141
No record	9	150
(C-5-5)19ccd-1. Log by H. C. Russell. Alt. 5,065 ft.		
Silt	4	4
Clay	11	15
Hardpan	3	18
Clay; water at 25 ft.	7	25
Clay and sand; water bearing	13	38
Clay, blue	48	86
(C-5-5)21dcb-1. Log reported by Union Pacific RR Co. Alt. 5,020 ft.		
Clay, blue	19	19
Clay, white, and gravel	27	46
Clay and gravel	15	61
Clay, blue, and hardpan	249	310
Clay, gravel, sand	9	319
Cobblerock and clay	15	334
Clay, blue	1	335
Cobblerock; water bearing	4	339
Bedrock	3	342
(C-5-5)30cab-1. Log by I. Hale Alt. 5,075 ft.		
Topsoil	2	2
Conglomerate	18	20
Hardpan	.5	20.5
Clay, white	11.5	32
Conglomerate	2	34
Clay, gray	5	39
Gravel, coarse	4	43
Clay, yellow	2	45
Clay, white	39	84
Clay, blue	8	92
Sand	2	94
Clay, blue	19	113
Hardpan	1	114
Clay, gray	11	125
Sand and gravel; water bearing	2	127
Clay, black	46	173
Clay and sand; water bearing	5	178
Clay, white	76	254
Clay, blue	15	269
Clay, white, and sand	7	276
Sand and gravel; water bearing	4	280
Clay, white	12	292
Clay, gray	31	323
Sand and gravel; water bearing	2	325
Clay, gray	7	332
Hardpan	1	333
Clay, gray	7	340
Clay and sea shells	35	375
Clayand sand; water bearing	59	434
Clay, blue	6	440
Clay, white	52	492
Sand; water bearing	11	503
Clay, blue	55	558
Sand	2	560
Clay, blue	12	572
(C-5-5)30cbb-1. Log by St.John Irrigation Co. Alt. 5,110 ft.		
Gravel; water at 60 ft	64	64
Sand	10	74
Sand, clay, and gravel	10	84
Sand and gravel	20	104
Hardpan; water bearing	1	105
Sand and clay	2	107
(C-5-5)31cca-1. Log by I. Hale Alt. 5,150 ft.		
Topsoil	1	1
Gravel, coarse grained	9	10

Table 13.—Continued

Material	Thickness	Depth
(C-5-5)31cca-1 - Continued		
Hardpan	2	12
Sand and gravel	28	40
Hardpan	1	41
Sand and gravel	9	50
Gravel; water bearing	5	55
Clay	10	65
(C-5-5)32cac-2. Log by H. C. Russell. Alt. 5,048 ft.		
Silt	15	15
Gravel	10	25
Clay; water at 38 feet	28	53
Hardpan	7	60
Clay	85	145
(C-5-6)25aaa-1. Log by St. John Irrigation Co. Alt. 5,120 ft.		
Soil	2	2
Gravel	2	4
Clay	2	6
Gravel; water bearing	16	22
Clay	1	23
Gravel	15	38
Sand	3	41
Gravel; water bearing	4	45
Sand	6	51
Sand and clay	4	55
Clay, black	4	59
Hardpan, brown	6	65
Hardpan, white	6	71
Gravel	2	73
Sand, gravel, and clay	31	104
Gravel	2	106
Sand and clay	2	108
(C-5-6)35dba-1. Log by H. C. Russell. Alt. 5,390 ft.		
Topsoil	1	1
Clay, red	43	44
Hardpan	.5	44.5
Clay, red	40.5	85
Hardpan, thin layer		85
Mud	7	92
Hardpan	1	93
Mud, sandy	7	100
Gravel; water bearing	4	104
Mud, sandy	6	110
(C-5-6)36cd. Log by V. L. Crocheron. Alt. 5,250 ft.		
Soil	3	3
Gravel	7	10
Sand	18	28
Gravel	3	31
Sand	3	34
Clay and gravel	6	40
Sand and gravel	21	61
Gravel	2	63
Sand and clay	120	183
Hardpan	19	202
Sand	7	209
Gravel and sand	8	217
Gravel and clay	20	237
Hardpan	5	242
Gravel and sand	12	254
Hardpan	3	257
Sand	3	260
Sand and clay	20	280
Sand, coarse	1	281
Sand, clay, and gravel	19	300
Sand; water bearing	3	303
Gravel	1	304
Sand and clay	5	309
Sand; water bearing	4	313
Clay	2	315
Sand; water bearing	10	325
Clay	3	328
Sand; water bearing	11	339
Clay	4	343
Sand	1	344
Clay	3	347
Sand	1	348
Hardpan	4	352
Sand	18	370
(C-5-6)36dbc-1. Log by H. C. Russell. Alt. 5,225 ft.		
Rocks and gravel	9	9
Clay	4	13
Clay, mushy; water at 25 ft	17	30
Mud, sandy	55	85
Clay and small rocks	17	102
Hardpan	1	103
Clay, mushy	40	143
Clay and rock	1	144
Clay, white, soft	11	155
Clay, dark, with rock	40	195
Clay, white, sticky	14	209
Clay, gray, soft	11	220
(C-6-4)5bdb-1. Log by H. M. Robinson and Son. Alt. 5,398.4 ft		
Clay, brown	26	26
Clay and gravel	5	31
(C-6-4)5bdb-1 - Continued		
Clay, brown	5	36
Gravel	3	39
Clay, yellow	3	42
Gravel, muddy	44	86
Clay, gray	2	88
Gravel and yellow clay	9	97
Clay, yellow	5	102
Gravel and yellow clay	53	155
Clay, yellow, with little gravel	7	162
Gravel and clay	20	182
Gravel, fine	4	186
Gravel and yellow clay	104	290
Gravel, loose, and fine sand; water bearing	45	335
Gravel, coarse; water bearing.	4	339
Gravel, fine, and sand; water bearing	65	404
(C-6-4)5bdd-1. Log by H. M. Robinson and Son; finished by Rosco Moss. Alt. 5,399.6 ft.		
Sand, soft	20	20
Gravel and boulders	45	65
Clay, red	3	68
Gravel and boulders	143	211
Conglomerate	6	217
Gravel, loose, fine	7	224
Conglomerate	4	228
Gravel, loose, fine	3	231
Conglomerate, tight, and sandy gravel	197	428
(C-6-4)31acb-1. Log by E. W. Hale. Alt. 5,050 ft.		
Clay	25	25
Sand and gravel; water bearing	20	45
Clay	5	50
(C-6-4)35bac-1. Log by L. E. Hale. Alt. 5,150 ft.		
Sand	4	4
Gravel	28	32
Clay and traces of sand	333	365
(C-6-5)20acc-1. Log by H. M. Robinson. Alt. 5,110 ft.		
Gravel and clay	10	10
Clay, white; yields salt water	30	40
Clay, blue	155	195
Sand, fine; yields salt water.	5	200
Clay, blue	130	330
Clay, gray, dry	47	377
Remark: 3 mile N. at 750 ft depth similar dry clay.		
(C-6-5)34cab-1. Log by E. W. Hale. Alt. 5,070 ft.		
Clay	3	3
Clay and gravel	5	8
Clay	12	20
Sand and gravel; water bearing	2	22
Sand	3	25
Clay	25	50
(C-6-6)14bbb-1. Log by I. Hale Alt. 5,465 ft.		
Topsoil	12	12
Clay	23	35
Gravel	1	36
Clay	18	54
Hardpan; water bearing	4	58
Clay	27	85
Hardpan; water bearing	1	86
Gravel; water bearing	25	111
Clay	10	121
Gravel; water bearing	7	128
(C-7-3)30acc-1. Log by T. Woodhouse. Alt. 5,090 ft.		
Clay, brown	26	26
Gravel and clay	8	34
Clay, brown	106	140
Clay, granulated; water bearing.	50	190
Clay, brown	85	275
Clay, granulated; water bearing	25	300
(C-7-4)14aac-1. Log by Coxe and Clarkson. Alt. 5,060 ft.		
Clay, soft, brown	200	200
Clay, soft, blue	240	440
Clay, brown	295	735
Sand, brown; water bearing	15	750
Clay, brown	75	825
Clay and sand; water bearing	25	850
Clay, brown	10	860
Sand; water bearing	15	875
(C-7-5)5cbb-1. Log by H. C. Russell. Alt. 5,275 ft.		
Silt	4	4
Clay, sand, gravel, and cobbles	27	31
Clay, gray	29	60
Clay, brown; water bearing	45	105
Clay, white	34	139
Clay, blue	20	159
(C-7-5)10ccc-1. Log by L. E. Hale. Alt. 5,175 ft.		
Topsoil	4	4
Gravel; water bearing	6	10
Clay	40	50
(C-7-5)27dbb-1. Log by Eldon Comer. Alt. 5,250 ft.		
Soil	2	2
Clay, white	25	27
Clay, tan	13	40
Clay, gray	33	73
Clay and sand	7	80
Clay, white	15	95
Clay, green	19	114
Clay, tan	16	130
Clay and silt, tan	9	139
Clay and hardpan, tan, stratified	49	188
Sand and clay, gray, cemented	46	234
Clay, tan	13	247
Clay, green	53	280
Clay, gray	99	379
Clay rock (claystone?)	6	385
Clay, tan	10	395
Clay, gray	78	473
Hardpan, very hard	14	487
Sand and clay, gray	43	530
Clay, tan	55	585
Sand and fine gravel, soft, and hardpan	9	594
Sand, tan	8	602
Hardpan	2	604
Clay, tan	7	611
(C-7-5)28bbc-1. Log by H. C. Russell. Alt. 5,220 ft.		
Silt	30	30
Hardpan; water bearing	1	31
Gravel; water bearing	2	33
Sand	77	110
Clay	40	150
(C-7-5)32bdd-1. Log by J. F. O'Brien. Alt. 5,255 ft.		
Clay, brown	24	24
Gravel; water bearing	11	35
Clay, white	10	45
Clay, brown, soft	15	60
Clay, hard, brown, sandy	42	102
Clay, gray	19	121
Clay, blue	14	135
Clay, brown, sandy	70	205
Clay, light green	45	250
Clay, brown	25	275
Conglomerate; water bearing	10	285
Sand and gravel; water bearing	5	290
Clay, brown	70	360
(C-8-3)6aad-1. Log by San Pedro, Los Angeles and Salt Lake RR Co. Alt. 5,110 ft.		
Clay, yellow	10	10
Clay, yellow, and gravel	10	20
Clay, yellow, and boulders	106	126
Clay, gravel, and sand	78	204
Limestone fragments and clay	11	215
Limestone	10	225
Limestone, broken	10	235
Limestone quartzite, solid	40	275
Limestone quartzite and yellow clay	38	313
Lime quartzite, honey combed	49	362
Lime quartzite, solid	28	390
Lime quartzite, crevices	3	393
Lime quartzite, solid	43	436
Lime quartzite	149	585
Lime quartzite, stratified with porphyry; water bearing	13	598
Lime quartzite, stratified crevices filled with water.	56	654
(C-8-3)6cdc-1. Log by T. Woodhouse. Alt. 5,128 ft.		
Clay	22	22
Clay and gravel	43	65
Clay	205	270
Clay, granulated; water bearing.	10	280
Clay	10	290
(C-8-4)22aad-1. Log by U.S. Bureau of Land Management. Alt. 5,300 ft.		
Loam, sandy	10	10
Gravel and clay	275	285
Rock, hard, white; water formation	5	290
Gravel and clay	8	298
(C-8-5)6ccd-1. Log by B. B. Gardner. Alt. 5,350 ft.		
Topsoil	6	6
Gravel and boulders	10	16
Gravel; water bearing	2	18
Clay, white	67	85

Table 13.—Continued

Material	Thickness	Depth
(C-8-5)6ccd-1 - Continued		
Clay, brown	47	132
Conglomerate; water bearing	4	136
Clay, light red	10	146
Clay, blue	6	152
Sand; water bearing	3	155
Clay, blue	20	175
Clay, gray	20	195
Sand and cobbles; water bearing	5	200
Clay, gray, and sand	57	257
Sand; water bearing	3	260
Clay, blue	30	290
Sand and boulders; water bearing	4	294
Clay, blue	61	355
Sand; water bearing	3	358
Clay, blue, sticky	52	410
Clay, gray, sandy	45	455
Clay, blue, sandy	20	475
Clay, gray, sticky	55	530
Conglomerate; water bearing	5	535
Clay, brown, sticky	13	548
Clay, white	22	570
Clay, gray	18	588
Clay, gray	17	605
Sand; water bearing	10	615
Clay, blue	15	630
Sand; water bearing	3	633
Clay, blue	7	640
Hardpan and brown clay; water bearing	8	648
Clay, brown	12	660
Clay, red	18	678
Gravel, large; water bearing	22	700
Bedrock	30	730
(C-8-5)6ddb-1. Log by B. B. Gardner. Alt. 5,301.1 ft.		
Silt	2	2
Boulders	6	8
Conglomerate	1	9
Sand and gravel; water bearing	3	12
Clay, red	68	80
Clay, white	30	110
Clay, blue	52	162
Clay, red	30	192
Clay, gray	53	245
Clay, blue	70	315
Clay, blue, and gravel	15	330
Sand and gravel; water bearing	3	333
Clay, gray, and sand	33	366
Sand and gravel; water bearing	4	370
Clay, blue	10	380
Clay, gray, and sand	7	387
Gravel; water bearing	35	422
Conglomerate, white	8	430
Gravel and boulders; water bearing	95	525
Gravel, boulders, and white clay; water bearing	9	534
(C-8-5)6ddc-1. Log by J. F. O'Brien. Alt. 5,300 ft.		
Gravel; water bearing	20	20
Clay, brown	90	110
Clay, white	25	135
Clay, green	13	148
Clay, light blue	28	176
Clay, dark brown	6	182
Clay, light green	21	203
Clay, hard, brown	12	215
Gravel; water bearing	1	216
Clay, brown	69	285
Conglomerate; water bearing	10	295
Gravel, sand, and clay	5	300
Clay, green	38	338
Gravel and clay	3	341
Clay, brown	13	354
Gravel and clay	2	356
Conglomerate	4	360
Clay, brown	5	365
(C-8-5)7ddd-1. Log by Robinson Drilling Co. Alt. 5,380 ft.		
Clay, gray	2	2
Conglomerate	23	25
Gravel, cemented	10	35
Clay, brown	20	55
Gravel; water bearing	10	65
Gravel, cemented	15	80
Clay, brown	14	94
Gravel; water bearing	21	115
Clay, gray	10	125
Gravel, cemented; water bearing	25	150
Clay, gray	18	168
(C-8-5)7ddd-1 - Continued		
Gravel, cemented; water bearing	22	190
Clay, gray	10	200
Gravel, cemented; water bearing	15	215
Clay, gray	35	250
Shale, blue	62	312
(C-8-5)19aaa-1. Log by E. Comer Alt. 5,450 ft.		
Clay, tan	30	30
Clay, tan, and gravel	10	40
Gravel	5	45
Clay	35	80
Clay and gravel; water bearing	15	95
Clay	35	130
Sand and gravel; water bearing	6	136
Clay, tan	20	156
(C-8-5)19aca-1. Log by E. Comer Alt. 5,420 ft.		
Soil	3	3
Clay, tan	7	10
Clay and gravel	8	18
Hardpan	6	24
Clay and gravel	8	32
Clay, yellow	8	40
Clay and gravel mixed	16	56
Clay, yellow	23	79
Hardpan	4	83
Clay, yellow	15	98
Gravel, dirty	6	104
Clay, yellow	56	160
Clay and gravel	60	220
(C-8-5)20cdc-1. Log by E. Hale Alt. 5,510 ft.		
Topsoil	2	2
Gravel and cobbles; water bearing	12	14
Clay, white	4	18
Hardpan	1	19
Clay, white	49	68
Hardpan	1	69
Clay, blue	47	116
Hardpan; water bearing	2	118
Clay, gray, and gravel	47	165
Clay, gray	50	215
Sand; water bearing	2	217
Clay, gray	3	220
Sand; water bearing	3	223
Clay, gray	17	240
Sand; water bearing	2	242
Clay, gray	8	250
(C-8-5)29caa-1. Log by J. F. O'Brien. Alt. 5,525 ft.		
Overburden	37	37
Clay, red	30	67
Gravel and clay	2	69
Clay, red	11	80
Hardpan	2	82
Clay, red	5	87
Hardpan	3	90
Clay, red	35	125
Sand and gravel; water bearing	1	126
Clay, red	24	150
(C-8-5)29caa-2. Log by H. C. Russell. Alt. 5,520 ft.		
Silt	5	5
Gravel	7	12
Clay	37	49
Hardpan	1	50
Clay and sand	5	55
Hardpan	1	56
Clay and sand	4	60
Hardpan	1	61
Clay	12	73
Sand	5	78
Clay	32	110
Gravel; water bearing	2	112
Clay	2	114
(C-8-5)31abc-3. Log by Peter Hansen. Alt. 5,550 ft.		
Topsoil	12	12
Gravel with streaks of clay and hardpan	88	100
Clay and hardpan	95	195
Sand	1	196
Clay and hardpan	14	210
Sand and gravel	2	212
Clay and hardpan	58	270
Sand and gravel	3	273
(C-8-5)31dad-4. Log by Yates and Pehrson. Alt. 5,545 ft.		
Soil	11	11
Gravel	10	21
Gravel, coarse grained	10	31
Clay and gravel	18	49
Gravel, clay, and hardpan	28	77
Gravel and sand	10	87
Clay and hardpan	32	119
Hardpan	1	120
Clay, gravel, and sand	74	194
Sand and gravel; water bearing	3	197
Clay	14	211
Sand, fine; water bearing	3	214
(C-8-5)31dbc-1. Alt. 5,545 ft.		
Topsoil	12	12
Clay, sandy	13	25
Gravel, coarse; water bearing	6	31
Clay, yellow	29	60
Hardpan; water bearing	2	62
Clay, sandy	41	103
Clay, sandy, and gravel	4	107
Gravel, coarse; water bearing	4	111
Clay and gravel	15	126
(C-8-6)10aaa-1. Log by I. Hale Alt. 5,500 ft.		
Clay and rock	45	45
Clay	125	170
Clay and sand; water bearing	170	340
Sand, fine and coarse	18	358
Clay and sand; water bearing	42	400
Sand, coarse and fine; water bearing	20	420
(C-8-6)14baa-1. Log by United Drilling Co. Alt. 5,400 ft.		
Silt	12	12
Gravel	4	16
Clay, soft, yellow	274	290
Lime, hard, black	10	300
Clay, soft, yellow	150	450
Shale, hard, gray	35	485
Clay and shale	115	600
Clay, brown	100	700
(C-8-6)26aac-2. Log by A. H. Milligan, Soil Conservation Service. Alt. 5,420 ft.		
Clay, sandy; water at 52 ft	90	90
Clay, red	5	95
Clay, sandy	40	135
Clay, sandy, and small gravel	5	140
Clay and gravel; water bearing	5	145
Clay, sandy	5	150
Clay, sandy, and gravel	15	165
Clay, sandy	40	205
Clay	35	240
Clay and gravel	45	285
Clay	160	445
(C-8-6)26dad-1. Log by R. Pehrson and H. I. Yates. Alt. 5,480 ft.		
Topsoil	4.5	4.5
Gravel	4.5	9
Clay and hardpan	34	43
Hardpan	2.5	45.5
Clay	6	51.5
Clay, extra hard	1	52.5
Clay	4.5	57
Clay, blue, soft	3	60
Sand and gravel	2	62
Hardpan	1	63
Clay	6	69
Hardpan	.5	69.5
Clay and hardpan	20.5	90
Clay, soft	6	96
Hardpan	1	97
Clay	4	101
Hardpan	1	102
Clay	12	114
Hardpan	1	115
Clay and hardpan	8	123
Clay, soft	.5	123.5
Sand; water bearing	.5	124
(C-8-6)36ddc-1. Log by J. F. O'Brien. Alt. 5,570 ft.		
Overburden	20	20
Gravel	1	21
Clay, red	17	38
Hardpan	2	40
Gravel and clay	44	84

Table 13.–Continued

Material	Thickness	Depth
(C-8-6)36ddc-1 - Continued		
Hardpan.	6	90
Gravel; water bearing.	1	91
Clay, red.	29	120
Hardpan	2	122
Clay, red.	55	177
Gravel; water bearing.	5	182
Clay, brown.	4	186
(C-9-4)32bbd-1. Log reported by Union Pacific RR Co. Alt. 6,116 ft.		
Clay, brown.	34	34
Sand and gravel.	4	38
Clay, white, and boulders. . . .	10	48
Clay, sandy, blue, and boulders.	39	87
Sandstone.	7	94
Clay, blue, and boulders	15	109
Clay, yellow, and boulders . . .	25	134
Sand	2	136
Clay, blue	5	141
Sand	1	142
Clay, yellow	14	156
Clay, blue, and boulders	68	224
Clay, brown, sandy	24	248
Clay, blue, and boulders	124	372
Clay, yellow	57	429
Clay, brown, and boulders. . . .	60	489
Clay, brown, and sand and boulders	22	511
Gravel, cemented	2	513
Clay, blue	16	529
Clay, yellow	9	538
Clay, blue, and boulders	7	545
Clay, brown.	26	571
(C-9-4)32bbd-2. Log (from claim). Alt. 6,116.5 ft.		
Clay, yellow	21	21
Gravel, coarse	4	25
Clay, yellow	1	26
Gravel, coarse	8	34
Gravel and clay, yellow.	16	50
Gravel and coarse sand	24	74
Gravel, cemented	3	77
Gravel and coarse sand	2	79
Gravel and clay, yellow.	3	82
Gravel, cemented	8	90
(C-9-5)5bbc-1. Log by E. Comer Alt. 5,580 ft.		
Old well.		110
Clay, tan	66	176
Gravel; water bearing	5	181
Clay.	14	195
Sand and gravel; water bearing. .	11	206
Clay and gravel	35	241
Gravel; water bearing	15	256
Clay.	29	285
Clay and gravel	15	300
Clay.	20	320
Clay and gravel	10	330
Clay.	60	390
Clay and small gravel	71	461
Hardpan	2	463
Clay	51	514
Hardpan	3	517
Clay	83	600
(C-9-5)6aab-2. Log by E. Comer Alt. 5,570 ft.		
Soil.	2	2
Gravel, cemented.	53	55
Clay, tan	20	75
Gravel; water bearing	11	86
Clay, tan	32	118
Gravel; water bearing	2	120
Clay, tan	14	134
Gravel; water bearing	5	139
Clay, tan	31	170
(C-9-5)6bca-2. Log by Harker Creek Irrigation Co. Alt. 5,590 ft.		
Clay and gravel	16	16
Gravel, coarse; water bearing . .	6	22
Hardpan and clay.	3	25
Gravel, fine, and sand.	6	31
Gravel, coarse	5	36
Sand and gravel	24	60
Clay, hardpan, and rock	10	70
Sand, coarse, and gravel.	20	90
(C-9-5)20ddd-1. Log by H. M. Robinson. Alt. 5,975 ft.		
Soil	2	2
Gravel.	58	60
(C-9-5)20ddd-1 - Continued		
Gravel and clay	30	90
Clay, sandy	30	120
Gravel and clay	85	205
Clay, yellow, and gravel.	10	215
Gravel and clay	75	290
No record	75	365
(C-9-5)29caa-1. Log by R. E. Pehrson. Alt. 5,950 ft.		
Topsoil	3	3
Sand and gravel	12	15
Clay.	44	59
Sand.	4	63
Clay.	4	67
Sand and clay	13	80
Sand, fine.	4	84
Sand, coarse.	2	86
Clay.	21	107
Gravel and fine sand.	7	114
(C-9-6)10abd-1. Log by J. F. O'Brien. Alt. 5,732 ft.		
Overburden (boulders)	30	30
Clay, light brown	10	40
Gravel and clay	30	70
Clay, brown	13	83
Hardpan, gray	4	87
Gravel and clay	13	100
Clay, brown	10	110
Gravel and clay	5	115
Gravel; water bearing	2	117
Gravel and boulders; water bearing.	15	132
Gravel; water bearing	3	135
(C-10-4)14acc-2. Log by C. and C. Stephenson Drilling Co. Alt. 6,280 ft.		
Topsoil	15	15
Clay and gravel	15	30
Clay, brown	20	50
Clay and sand; water bearing. . .	23	73
Clay, light brown, sandy	13	86
Clay, gray	14	100
Porphyry, green	1	101
Porphyry, brown	26	127
Porphyry, light gray.	7	134
Porphyry, light brown	21	155

Table 14.—Water levels in selected observation wells in Rush Valley

Water levels in feet below land-surface datum are designated by a minus (-) sign immediately before the first entry in each column in the table, those above land-surface datum are designated similarly by a plus (+) sign.

(C-5-5)30bca-1.

Mar.	21, 1950	-12.94	Dec.	21, 1951	-13.45	Mar.	26, 1953	-13.15
Dec.	6	13.72	Apr.	10, 1952	12.40	Apr.	6, 1954	12.71
Mar.	30, 1951	13.72	Dec.	31	14.24			

(C-5-5)30cbb-1. Records available 1935-39

Oct.	23, 1935	-23.99	Feb.	25, 1937	-22.65	June	21, 1938	-21.96
Feb.	6, 1936	22.92	Mar.	23	22.24	Dec.	3	22.47
Apr.	14	22.24	May	17	21.97	Feb.	18, 1939	21.84
June	13	22.07	Sept.	15	22.90	Mar.	31	22.74
July	28	22.56	Nov.	28	22.72	Apr.	27	22.47
Sept.	18	23.23	Feb.	22, 1938	22.43	June	9	22.85
Nov.	12	23.35	Apr.	20	22.12			

(C-5-5)32adb-1. Records available 1944-50

Apr.	8, 1944	- 2.32	Sept.	9, 1946	- 2.16	Dec.	20, 1948	- 2.52
Dec.	31	2.20	Mar.	20, 1947	1.57	Mar.	14, 1949	.88
Mar.	12, 1945	1.61	Dec.	4	1.63	Dec.	13	2.72
Dec.	18	1.37	Mar.	24, 1948	.82	Mar.	21, 1950	1.89

(C-5-5)32add-1. Records available 1941-54

May	13, 1941	-31.87	Mar.	12, 1945	-29.59	Dec.	13, 1949	-25.85
Nov.	25	33.18	Dec.	18	29.22	Mar.	21, 1950	24.84
Mar.	23, 1942	31.76	Mar.	5, 1946	28.35	Dec.	6	25.27
Oct.	20	33.52	Dec.	19	28.23	Mar.	30, 1951	24.62
Dec.	19	32.06	Mar.	20, 1947	27.10	Apr.	10, 1952	23.61
Mar.	31, 1943	30.73	Dec.	4	27.11	Dec.	31	22.70
Dec.	28	31.42	Mar.	24, 1948	25.55	Mar.	26, 1953	21.19
Apr.	8, 1944	29.92	Dec.	20	26.28	Nov.	25	21.15
Dec.	31	30.52	Mar.	14, 1949	24.88	Apr.	6, 1954	18.91

(C-5-6)25aaa-1. Records available 1935-42

Oct.	23, 1935	-19.77	Sept.	15, 1937	-19.30	Apr.	27, 1939	-14.02
Feb.	6, 1936	14.95	Nov.	28	19.46	June	9	15.22
Apr.	14	9.49	Feb.	22, 1938	18.84	Aug.	10	18.82
June	13	17.28	Apr.	20	13.38	Dec.	20	18.70
July	28	19.09	June	21	17.35	Apr.	30, 1940	14.63
Sept.	18	20.58	Aug.	23	19.67	Nov.	27	15.49
Nov.	12	19.65	Oct.	25	19.19	May	12, 1941	14.76
Feb.	25, 1937	16.45	Dec.	3	18.95	Nov.	25	18.44
Mar.	23	14.17	Feb.	18, 1939	18.55	Mar.	22, 1942	16.49
May	17	9.65	Mar.	21	14.28	Oct.	20	17.62

(C-5-6)36cd. Water level inside 12-inch casing. Records available 1935-37

Oct.	23, 1935	-17.34	July	28, 1936	-15.75	Feb.	25, 1937	-14.60
Feb.	6, 1936	16.53	Sept.	18	15.93	Mar.	23	14.39
Apr.	14	16.07	Nov.	12	15.11	May	17	14.62
June	13	15.72						

(C-5-6)36cd. Water level inside 15-inch casing. Records available 1935-37

Oct.	23, 1935	-14.68	June	13, 1936	-12.30	Feb.	25, 1937	-14.04
Feb.	6, 1936	13.42	July	28	12.60	Mar.	23	12.92
Apr.	14	10.91	Nov.	12	13.17	May	17	12.60

(C-6-4)5bdb-1. Records available 1946-51, 1954

Mar.	20, 1946	-282.12	Dec.	14, 1949	-291.88	Mar.	30, 1951	-287.45
Mar.	20, 1947	283.53	Mar.	21, 1950	286.35	Dec.	21	284.64
June	24, 1948	282.68	Dec.	5	281.28	Dec.	10, 1954	298.00

(C-7-4)14aac-1. Records available 1958-67

Dec.	11, 1958	-92.10	Oct.	20, 1961	-92.16	Nov.	5, 1964	-92.18
Apr.	30, 1959	91.09	Apr.	13, 1962	92.08	Aug.	2, 1965	92.13
Jan.	21, 1960	92.29	Oct.	17	92.01	Oct.	12	92.08
May	13	92.30	Apr.	18, 1963	92.14	Dec.	15	92.11
Oct.	20	92.09	Aug.	21	92.10	Mar.	16, 1966	92.13
Jan.	26, 1961	92.07	Dec.	5	92.21	Sept.	7	92.25
Apr.	28	92.20	Mar.	23, 1964	92.13	Mar.	17, 1967	92.21
July	27	92.17						

(C-7-5)29dcd-1. Records available 1936-37

Sept.	8, 1936	+23.0	Mar.	23, 1937	+23.4	Sept.	15, 1937	+23.4
Nov.	12	23.0	May	17	23.1	Nov.	28	23.6
Feb.	25, 1937	23.4						

(C-8-5)30cac-1. Records available 1956-62

Dec.	7, 1956	- 8.70	May	1, 1959	- 8.68	Jan.	26, 1961	-11.38
Apr.	5, 1957	8.22	Jan.	21, 1960	11.17	Apr.	28	16.07
Dec.	20	8.65	Oct.	20	14.48	Apr.	3, 1962	11.45
Dec.	11, 1958	9.55						

(C-8-5)30ccc-1. Records available 1941-53, 1955

May	13, 1941	- 5.47	Mar.	12, 1945	- 7.19	Dec.	14, 1949	- 8.85
Nov.	25	8.30	Dec.	18	8.08	Mar.	21, 1950	[illegible]
Mar.	23, 1942	5.82	Mar.	5, 1946	6.68	Mar.	30, 1951	6.19
Oct.	20	9.78	Dec.	19	7.65	Dec.	21	7.90
Dec.	19	8.60	Mar.	20, 1947	5.25	Apr.	10, 1952	1.61
Mar.	31, 1943	6.53	Dec.	4	7.63	Nov.	25	6.00
Dec.	28	9.52	Mar.	24, 1948	5.90	Mar.	26, 1953	5.08
Apr.	8, 1944	6.66	Dec.	20	8.41	Apr.	1, 1955	4.31
Dec.	31	8.91	Mar.	14, 1949	5.63			

(C-8-5)31aad-1. Records available 1941-52

Apr.	13, 1941	-18.18	Dec.	31, 1944	-19.92	Dec.	20, 1948	-20.58
Nov.	25	19.88	Mar.	12, 1945	19.79	Dec.	14, 1949	19.76
Mar.	23, 1942	19.61	Dec.	18	19.73	Mar.	21, 1950	18.83
Oct.	20	19.94	Mar.	5, 1946	19.64	Dec.	5	18.84
Dec.	19	19.82	Dec.	19	20.05	Mar.	20, 1951	19.22
Mar.	31, 1943	19.31	Mar.	20, 1947	19.72	Dec.	21	19.26
Dec.	28	19.97	Dec.	4	19.26	Nov.	25, 1952	18.82
Apr.	8, 1944	19.73	Mar.	24, 1948	19.45			

(C-8-5)31abc-3. Records available 1935-40

Oct.	23, 1935	+22.3	May	17, 1937	+25.5	Dec.	3, 1938	+25.1
Feb.	6, 1936	24.2	Sept.	15	23.6	Feb.	18, 1939	27.4
Apr.	14	24.4	Nov.	28	24.3	Mar.	31	27.6
June	13	23.2	Feb.	22, 1938	25.4	Apr.	27	27.6
July	28	23.1	Apr.	20	24.4	June	9	25.1
Sept.	18	23.0	June	21,	24.5	Aug.	10	25.5
Nov.	12	23.0	Aug.	23	24.8	Dec.	20	25.8
Feb.	25, 1937	26.2	Oct.	25	25.1	Apr.	30, 1940	29.2
Mar.	23	26.8						

(C-8-5)31ccd-1. Records available 1960-67

May	13, 1960	+16.5	Oct.	17, 1962	+15.0	Aug.	2, 1965	+10.5
Jan.	26, 1961	15.6	Aug.	21, 1963	12.0	Oct.	12	9.8
Apr.	28	15.2	Dec.	5	13.7	Dec.	15	7.6
July	27	13.8	Mar.	23, 1964	14.2	Mar.	17, 1966	7.4
Oct.	20	13.2	Nov.	5	13.0	Sept.	7	7.2
Apr.	18, 1962	10.1	Mar.	10, 1965	12.9	Mar.	17, 1967	8.0

(C-8-5)31ccd-5. Records available 1956-67

Dec.	7, 1956	-18.53	Oct.	20, 1961	-21.93	Nov.	5, 1964	-21.90
Dec.	20, 1957	18.40	Apr.	13, 1962	18.96	Mar.	10, 1965	19.84
Dec.	11, 1958	18.23	Oct.	17	21.69	Aug.	2	21.02
Apr.	29, 1959	19.69	Apr.	18, 1963	19.32	Dec.	15	20.39
Oct.	20, 1960	21.28	Dec.	5	22.54	Mar.	17, 1966	19.83
Jan.	26, 1961	19.26	Mar.	24, 1964	19.78	Mar.	17, 1967	22.96
Apr.	28	18.80						

(C-8-6)22ddd-1. Records available 1949-51, 1953-55, 1957-67

Dec.	14, 1949	-38.89	Jan.	21, 1960	-34.31	Aug.	21, 1963	-38.03
Mar.	21, 1950	38.37	May	13	34.33	Dec.	5	38.36
Mar.	30, 1951	38.45	Oct.	20	35.42	Nov.	5, 1964	40.31
Mar.	26, 1953	36.87	Jan.	26, 1961	35.81	Mar.	10, 1965	38.26
Dec.	10, 1954	36.42	Apr.	28	35.98	Aug.	2	38.24
Apr.	1, 1955	35.42	July	27	36.26	Oct.	12	37.85
Dec.	7,	36.42	Oct.	20	36.20	Dec.	15	38.05
Apr.	5, 1957	36.90	Apr.	13, 1962	35.85	Mar.	17, 1966	36.99
Dec.	20	37.21	Oct.	17	37.10	Sept.	7	37.60
Dec.	11, 1958	36.00	Apr.	18, 1963	36.20	Mar.	17, 1967	33.48
May	1, 1959	36.53						

(C-8-6)23cd. Records available 1941-47, 1950, 1953-55, 1957

May	13, 1941	+ 1.98	Dec.	31, 1944	+ 1.77	Dec.	6, 1950	+ 1.30
Nov.	25	1.70	Mar.	12, 1945	1.98	Mar.	26, 1953	2.02
Oct.	20, 1942	1.75	Dec.	18	1.93	Dec.	10, 1954	1.94
Dec.	17	1.75	Dec.	19, 1946	1.69	Apr.	1, 1955	1.26
Mar.	31, 1943	1.93	Mar.	20, 1947	2.07	Dec.	7	2.15
Dec.	28	1.98	Dec.	4	1.45	Apr.	5, 1957	2.25
Apr.	8, 1944	1.75	Mar.	21, 1950	1.95			

(C-8-6)36ddc-1. Records 1959-63

Apr.	29, 1959	-16.21	Oct.	20, 1961	-19.45	Aug.	2, 1965	-19.77
Jan.	21, 1960	17.24	Apr.	13, 1962	16.45	Oct.	12	19.33
May	13	15.78	Oct.	17	18.84	Dec.	15	17.72
Oct.	20	19.54	Apr.	18, 1963	16.80	Mar.	17, 1966	18.47
Jan.	26, 1961	17.15	Nov.	5, 1964	18.88	Mar.	17, 1967	18.73
Apr.	28	16.52	Mar.	10, 1965	17.22			

Table 15.—Records of selected springs in the Rush Valley drainage basin

Location number: See text for explanation of numbering system.
Altitude of land surface: Interpolated from U.S. Geological Survey and Army Map Service topographic maps.
Discharge: > means more than; < means less than; R, reported by owner or in source document.
Use: H, domestic; I, irrigation; S, stock.
Remarks: C, chemical analysis in table 16.

Location number	Owner or name	Altitude of land surface (feet)	Geologic source	Estimated discharge: Gallons per minute	Estimated discharge: Temperature (°F)	Estimated discharge: Date	Use	Remarks
(C-4-4)33bb-S	-	-	Paleozoic limestone	>100R	-	-	S	State Engineer file No. A-03764.
(C-4-5)35cba-S1	A. L. and N. M. Young	4,990	Alluvial fan	60	56	9-22-64	I,S	Flows into pond. C.
(C-4-7)25dcb-S1	U.S. Bureau of Land Management	-	-	50	40	9-21-64	S	In streambed. C.
(C-4-7)36daa-S1	do	7,400	Paleozoic limestone(?)	<10	40	9-21-64	-	Spring outlet not seen; discharge probably largely overland runoff.
(C-5-3)30dbb-S1	do	7,850	Paleozoic limestone	<5	47	9-25-64	S	C.
30dcd-S1	do	7,290	Manning Canyon Shale	1.25	45	9-25-64	S	Flows into trough. C.
(C-5-5)3ada-S1	Young Ranch	4,970	Alluvial fan	<1	56	9-22-64	S	C.
9cba-S1	Flying G Ranch	4,990	Valley fill	1,000	75	9-22-64	I	Water has turquoise color from distance; known as Warm Spring. C.
9cba-S2	do	4,990	do	2	56	9-22-64	H	C.
17aaa-S1	Martell Russell	5,000	do	-	57	9-22-64	I	Flows into large pond. C.
(C-5-6)20bba-S1	Chokecherry Spring	6,590	Manning Canyon Shale	1	55	9-21-64	S	Flows from a pipe into a small concrete trough. C.
32bba-S1	Clover Creek Spring	5,900	Fault trace across contact of Manning Canyon Shale and Great Blue Limestone	4,500	45	9-21-64	I	Flows from two large and several small orifices; forms base flow of Clover Creek (measurements in table 6). C.
(C-6-6)1bbc-S1	Orson Johnson	5,305	Valley fill	1	57	9-21-64	S	Flows from pipe into trough. C.
1cba-S1	do	5,290	do	<10	55	9-21-64	S	Flows into 50-foot square reservoir. C.
14daa-S1	U.S. Bureau of Land Management Clover Bench Spring	5,310	do	.5R 1	- -	5-10-59 5-16-67	S	Improved by installation of horizonal perforated pipe in alluvial deposits in low fault scarp.
24bac-S1	-	5,305	do	2	52	5-16-67	S	do
(C-7-5)28b-S	Dan Atherly	5,300	do	-	-	12-22-64	I,S	Flows from several orifices into 500-foot diameter reservoir. C.
32aba-S1	Roy Davis	5,300	do	600	68	12-22-64	I,S	C.
(C-7-6)4cb-S	U.S. Bureau of Land Management Hell Hole Spring	7,100	Paleozoic limestone	20R	-	7- -62	S	
4d-S	U.S. Bureau of Land Management Two Spring	6,700	do	4	-	7-15-64	S	
8ad-S	U.S. Bureau of Land Management East Faust Spring	7,200	do	15R	-	11-30-66	S	Developed spring. Replaces nearby spring that dried up.
(C-8-5)5ccd-S1	Vandybarker Spring	5,300	Quaternary alluvium	450R	-	-	H,I	Artesian spring. Formerly supplied Faust railroad station and irrigated lands. Reportedly dried up at end of the first summer that nearby large-yield well was pumped. Reportedly yielded 2 cfs when temporarily enlarged and pumped.
(C-9-4)15c-S	-	5,700	Tertiary-Quaternary terrace deposits	-	45	12-21-64	H	Water used at nearby store. C.
20dd-S	Union Pacific Railroad Co.(?)	6,220	Quaternary alluvium	-	42	12-21-64	H	Water piped from spring site to Lofgreen station. C.
35bbb-S1	U.S. Bureau of Land Management Boulter Spring	5,790	Quaternary alluvium and colluvium	1	55	3-29-65	-	Opening is buried under highway and discharges through a pipe. C.

Table 16.--Chemical analyses of water from selected wells and springs in the Rush Valley drainage basin

Discharge: Estimated unless indicated by m, measured, or r, reported.
Sodium and potassium: Where no potassium value is shown, sodium plus potassium is calculated and reported as sodium.
Dissolved solids: Residue on evaporation at 180°C unless indicated by c (sum of determined constituents).

Location No.	Date of collection	Temperature (°F)	Discharge (gpm)	Parts per million																	Percent sodium	Sodium-adsorption ratio	Specific conductance (micromhos/cm at 25°C)	pH
				Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$				
(C-4-5)																								
32ddc-1	9-25-64	54	900	16	0.00	0.00	83	21	35	1.7	254	0	29	99	0.2	1.2	0.05	416	293	85	20	0.9	713	7.9
33cca-1	9-25-64	53	1,100	14	.43	.01	76	24	41	2.2	242	0	33	106	.2	2.8	.05	452	290	92	23	1.0	769	7.9
35cba-S	9-22-64	56	60	18	.52	.01	62	23	23	1.2	232	0	38	52	.3	.9	.04	368	250	60	17	.6	570	7.6
(C-4-7)																								
25dcb-S1	9-21-64	40	50	10	.34	.03	69	16	13	2.6	276	0	14	23	.2	1.2	.04	283	238	12	11	.4	490	7.9
(C-5-3)																								
30dbb-S1	9-25-64	47	1-5	8.0	.10	.03	67	14	15	.4	211	0	68	13	.2	2.4	.06	291	227	54	12	.4	491	7.9
30dcd-S1	9-25-64	45	1.2m	9.3	.02	.01	52	20	21	.4	223	0	33	26	.2	9.0	.05	274	212	29	18	.6	479	7.9
(C-5-5)																								
2bcc-1	9-22-64	51	40-50	16	.32	.10	69	46	47	2.0	226	0	92	130	.4	3.0	.06	531	360	175	22	1.1	876	7.7
2bcc-2	9-22-64	-	25m	17	.00	.02	59	32	22	1.5	212	0	62	58	.4	1.9	.03	380	280	106	15	.6	605	7.7
3ada-S1	9-22-64	56	0-1	17	.15	.01	34	48	28	2.1	215	0	62	74	.4	2.5	.05	388	280	103	18	.7	647	7.9
9cba-S1	9-22-64	75	1,000	20	.88	.02	58	24	110	11	174	0	90	179	1.0	.4	.17	594	242	99	48	3.1	981	8.0
9cba-S2	9-22-64	56	2m	42	.00	.18	69	52	176	17	164	6	172	330	1.1	.3	.42	1,040	384	240	49	3.9	1,600	8.4
15aad-1	12-22-64	-	-	17	.21	.04	66	42	78	1.8	299	0	66	142	.4	1.0	.05	561	335	90	33	1.9	947	7.9
17aaa-S1	9-22-64	57	-	18	.53	.01	52	20	74	14	176	0	59	135	1.3	.4	.14	463	211	67	41	2.2	789	7.8
17aad-1	9-22-64	-	50m	50	.06	.06	73	44	106	28	314	0	107	176	2.8	3.6	.25	762	364	107	37	2.4	1,210	7.9
(C-5-6)																								
20bba-S1	9-21-64	55	1	12	.00	.00	75	12	27	.8	272	0	38	30	.3	.0	.04	338	235	12	20	.8	551	7.6
32bba-S1 1/	9-21-64	45	4,500	7.6	.00	.02	63	10	8.7	.3	238	0	8.2	11	.2	.2	.03	223	200	5	9	.3	393	7.8
	5-29-65	-	5,000	4.6	.44	.01	63	5.8	10		213	0	7.4	14	-	.2	-	203	180	5	11	.3	373	7.9
	3-18-66	46	2,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	391	-
(C-6-4)																								
5bdb-1	5- 5-48	49	360r	14	-	-	85	35	17		398	0	38	12	.1	11	.00	399	356	30	9	.4	686	7.9
	11- 7-49	49	360r	12	-	-	94	36	21	2.9	420	0	40	23	.1	9.0	.04	440	382	38	11	.5	761	7.7
	10- 4-50	51	360r	12	-	-	96	38	21	1.3	417	0	40	34	.3	9.1	.03	453	396	54	10	.5	781	7.2
	8- 2-51	54	360r	13	-	-	97	38	23	3.5	412	0	40	46	.2	9.7	-	484	398	60	11	.5	815	7.6
	9-24-52	50	-	11	-	-	98	39	25	1.3	406	0	38	58	.1	9.4	-	486	405	73	12	.5	844	7.3
	9- 8-53	50	335r	13	-	-	102	41	22	.9	396	0	43	62	.1	12	-	496	423	98	10	.5	863	7.3
	10-11-54	50	335r	12	-	-	103	41	25	1.0	398	0	41	64	.1	12	-	497	426	100	11	.5	850	7.3
	2-11-57	50	335r	11	-	-	96	37	26	1.1	395	0	40	53	.1	9.2	-	479	392	68	13	.6	823	7.3
	4-15-60	50	335r	13	-	-	87	33	19	1.3	387	0	35	17	.1	12	-	404	352	35	11	.4	700	7.3
	5- 2-62	50	335r	11	-	-	89	29	23		391	0	44	14	.1	8.9	-	398	343	22	13	.5	670	7.3
5bdd-1	5- 6-48	49	360r	13	-	-	87	34	27		408	0	39	24	.1	8.7	.00	421	357	22	14	.6	739	7.8
	11- 6-49	49	360r	12	-	-	89	34	34	2.9	406	0	44	37	.1	8.3	.02	451	362	30	17	.8	787	7.6
	10- 5-50	51	360r	13	-	-	90	36	34	1.3	399	0	40	46	.3	9.3	.03	458	372	46	17	.8	794	7.2
	8- 2-51	54	360r	12	-	-	86	35	37	2.6	399	0	40	46	.2	9.2	-	462	358	32	18	.8	806	7.5
	9-24-52	50	350r	11	-	-	94	36	32	1.3	394	0	41	57	.1	9.6	-	472	382	60	15	.7	834	7.4
	9- 8-53	50	335r	11	-	-	92	37	30	1.4	338	0	43	57	.4	9.7	-	482	382	64	14	.7	830	7.3
	9-29-54	50	335r	11	-	-	90	35	32	1.0	332	0	41	45	.1	9.2	-	446	368	56	16	.7	774	7.2
	2-11-57	-	335r	10	-	-	83	31	26	1.1	369	0	36	29	.1	9.7	-	411	336	33	14	.6	716	7.2
	4-15-60	50	350r	12	-	-	86	31	18	.9	357	0	42	21	.1	10	-	398	340	47	10	.4	682	7.3
	5- 2-62	50	350r	11	-	-	97	28	34		392	0	52	31	.1	14	-	425	356	35	17	.8	744	7.4
	6-10-63	50	335r	11	-	-	96	27	12		374	0	40	14	.1	11	-	382	350	43	7	.3	666	7.2
(C-6-6)																								
1bbc-S1	9-21-64	57	1m	17	.90	.01	75	25	139	.7	260	0	149	158	.3	4.6	.05	717	292	79	51	3.6	1,150	7.7
1cba-S1	9-21-64	55	5-10	15	.33	.03	83	17	23	.8	282	0	20	52	.2	.0	.03	378	278	46	15	.6	602	7.9
(C-7-4)																								
14aac-1 2/	3-30-65	-	-	50	.15	.04	20	24	145	9.2	334	0	113	61	1.4	2.1	.35	600	148	0	66	5.2	894	8.2
(C-7-5)																								
28b-S 3/	12-22-64	-	-	23	.19	.03	116	115	235	7.8	384	0	165	555	.6	.3	.22	1,490	762	448	40	3.7	2,430	7.6
28bbc-1	12-22-64	-	-	22	.15	.01	63	54	129	3.5	298	0	81	238	.6	1.3	.09	767	378	134	42	2.9	1,290	8.1
29dcd-1 4/	12-22-64	-	1-5	15	.40	.01	64	41	52	7.4	309	0	34	120	.3	.5	.07	503	330	77	25	1.2	845	7.7
32aba-S1	12-22-64	68	600	14	.12	.07	46	38	47	2.8	237	0	35	106	.3	1.4	.06	412	270	76	27	1.2	725	7.8
32bdd-1	4-22-59	49	-	50	-	-	184	178	354		415	0	216	988	-	1.0	-	2,180c	1,190	850	39	4.5	3,770	7.4
(C-8-4)																								
22aad-1	4-28-59	55	-	66	-	-	44	26	55		300	0	49	25	-	4.2	-	417c	216	0	36	1.6	603	7.7
30dcd-1	3-29-65	54	3m	40	.00	.00	117	54	58	5.4	394	0	25	325	.5	8.0	.12	868	515	356	19	1.1	1,330	7.6
(C-8-5)																								
6ddb-1 2/	12-22-64	-	4,500r	13	.33	.01	40	27	36	2.8	192	0	28	70	.6	.0	.09	344	210	53	27	1.1	558	7.6
6ddc-1	5-11-59	55	250r	28	-	-	49	32	71		232	0	47	120	-	.3	-	461c	254	64	38	1.9	795	7.9
29baa-1	12-22-64	-	20m	16	.31	.01	91	30	35	1.8	188	0	38	171	.2	2.3	.05	559	350	196	18	.8	848	7.7
31ccd-1	12-11-58	54	-	16	-	-	47	16	24		178	0	14	52	-	2.3	-	259c	183	37	22	.8	466	7.8
	1-26-61	53	5	13	-	-	49	15	23	1.3	172	0	18	50	.2	1.5	.05	258	183	42	21	.7	459	7.3
31dbc-1 5/	12-22-64	-	50	16	.40	.01	67	18	29	1.5	198	0	29	80	.2	2.4	.04	386	242	80	20	.8	602	7.6
(C-8-6)																								
10aaa-1	3-30-65	54	20m	5.0	.18	.07	59	39	29	3.4	124	0	19	177	.5	.2	.09	513	305	203	17	.7	782	7.9
26aaa-1	12-11-58	52	-	16	-	-	37	17	25		156	0	14	50	-	2.3	-	238c	160	32	25	.9	433	7.7
	1-26-61	-	11m	16	-	-	38	16	25	.9	149	0	18	51	.3	.4	.07	238	160	38	25	.9	420	7.5
(C-9-4)																								
2aa	4-28-59	55	-	60	-	-	40	26	77		232	0	40	100	-	1.2	-	458c	206	16	45	2.3	740	7.6
	12-21-64	54	5-10	56	.71	.01	38	29	72	8.0	226	0	39	115	1.0	.5	.14	460	216	31	41	2.1	737	8.0
15c-S	12-21-64	45	-	65	-	.00	51	44	71	9.2	222	0	29	184	.8	1.4	.14	610	308	126	33	1.8	956	7.6
20dd-S	12-21-64	42	-	12	.33	.00	55	19	34	1.2	226	0	36	47	.2	.7	.04	342	218	32	25	1.0	538	7.8
35bbb-S1	3-29-65	55	1	31	.29	.09	81	39	42	3.5	274	0	32	140	.6	1.0	.11	614	362	138	20	1.0	891	8.2

1/ Forms base flow of Clover Creek.
2/ Sample collected from storage tank.
3/ Several springs flow into reservoir; sample collected from edge of reservoir.
4/ Reported as (C-7-5)32a-1 in Utah Geological and Mineralogical Survey Water-Resources Bulletin 9, Part I.
5/ Sample collected from tap at U.S. Post Office in Vernon.

No. 12. Reevaluation of the ground-water resources of Tooele Valley, Utah, by Joseph S. Gates, U.S. Geological Survey, 1965.

*No. 13. Ground-water resources of selected basins in southwestern Utah, by G. W. Sandberg, U.S. Geological Survey, 1966.

No. 14. Water-resources appraisal of the Snake Valley area, Utah and Nevada, by J. W. Hood and F. E. Rush, U.S. Geological Survey, 1966.

No. 15. Water from bedrock in the Colorado Plateau of Utah, by R. D. Feltis, U.S. Geological Survey, 1966.

No. 16. Ground-water conditions in Cedar Valley, Utah County, Utah, by R. D. Feltis, U.S. Geological Survey, 1967.

No. 17. Ground-water resources of northern Juab Valley, Utah, by L. J. Bjorklund, U.S. Geological Survey, 1968.

No. 18. Hydrologic reconnaissance of Skull Valley, Tooele County, Utah, by J. W. Hood and K. M. Waddell, U.S. Geological Survey, 1968.

No. 19. Appraisal of the quality of surface water in the Sevier Lake basin, Utah, by D. C. Hahl and J. C. Mundorff, U. S. Geological Survey, 1968.

No. 20. Extensions of streamflow records in Utah, by J. K. Reid, L. E. Carroon, and G. E. Pyper, U. S. Geological Survey, 1969.

No. 21. Summary of maximum discharges in Utah streams, by G. L. Whitaker, U. S. Geological Survey, 1969.

No. 22. Reconnaissance of the ground-water resources of the upper Fremont River Valley, Wayne County, Utah, by L. J. Bjorklund, U. S. Geological Survey, 1969

WATER CIRCULAR

No. 1. Ground water in the Jordan Valley, Salt Lake County, Utah, by Ted Arnow, U.S. Geological Survey, 1965.

BASIC-DATA REPORTS

No. 1. Records and water-level measurements of selected wells and chemical analyses of ground water, East Shore area, Davis, Weber, and Box Elder Counties, Utah, by R. E. Smith, U.S. Geological Survey, 1961.

No. 2. Records of selected wells and springs, selected drillers' logs of wells, and chemical analyses of ground and surface waters, northern Utah Valley, Utah County, Utah, by Seymour Subitzky, U.S. Geological Survey, 1962.

No. 3. Ground-water data, central Sevier Valley, parts of Sanpete, Sevier, and Piute Counties, Utah, by C. H. Carpenter and R. A. Young, U.S. Geological Survey, 1963.

No. 4. Selected hydrologic data, Jordan Valley, Salt Lake County, Utah, by I. W. Marine and Don Price, U.S. Geological Survey, 1963.

No. 5. Selected hydrologic data, Pavant Valley, Millard County, Utah, by R. W. Mower, U.S. Geological Survey, 1963.

*No. 6. Ground-water data, parts of Washington, Iron, Beaver, and Millard Counties, Utah, by G. W. Sandberg, U.S. Geological Survey, 1963.

No. 7. Selected hydrologic data, Tooele Valley, Tooele County, Utah, by J. S. Gates, U.S. Geological Survey, 1963.

No. 8. Selected hydrologic data, upper Sevier River basin, Utah, by C. H. Carpenter, G. B. Robinson, Jr., and L. J. Bjorklund, U.S. Geological Survey, 1964.

No. 9. Ground-water data, Sevier Desert, Utah, by R. W. Mower and R. D. Feltis, U.S. Geological Survey, 1964.

No. 10. Quality of surface water in the Sevier Lake basin, Utah, by D. C. Hahl and R. E. Cabell, U.S. Geological Survey, 1965.

No. 11. Hydrologic and climatologic data, collected through 1964, Salt Lake County, Utah by W. V. Iorns, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1966.

No. 12. Hydrologic and climatologic data, 1965, Salt Lake County, Utah, by W. V. Iorns, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1966.

No. 13. Hydrologic and climatologic data, 1966, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1967.

No. 14. Selected hydrologic data, San Pitch River drainage basin, Utah, by G. B. Robinson, Jr., U.S. Geological Survey, 1968.

No. 15. Hydrologic and climatologic data. 1967, Salt Lake County, Utah, by A. G. Hely, R. W. Mower, and C. A. Horr, U.S. Geological Survey, 1968.

INFORMATION BULLETINS

*No. 1. Plan of work for the Sevier River Basin (Sec. 6, P.L. 566), U.S. Department of Agriculture, 1960.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES

TECHNICAL PUBLICATION NO. 2
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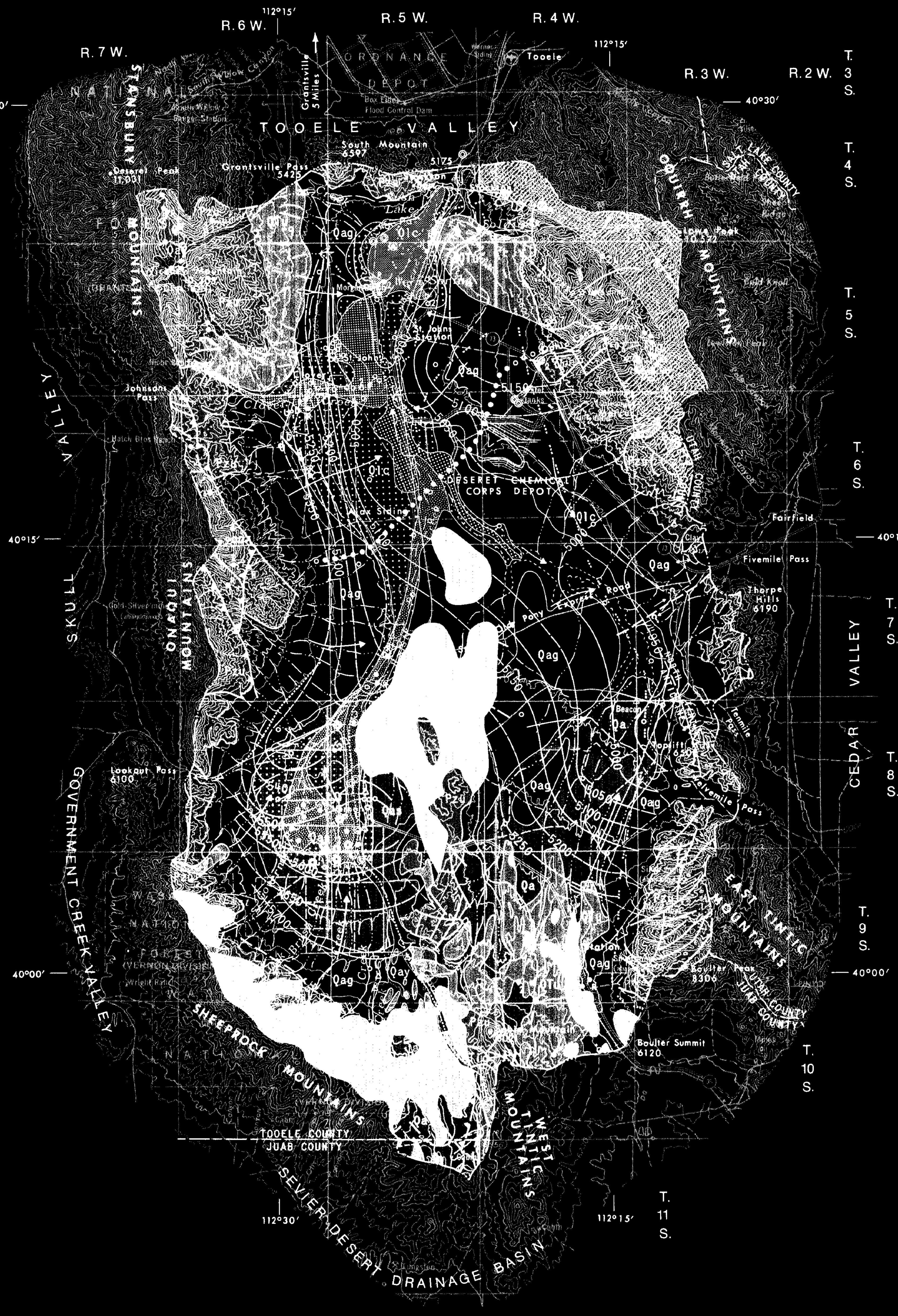


5 0 5 MILES
5 0 5 KILOMETERS
CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL

Generalized geology and hydrology

Base from Army Map Service 1:250,000 series:
Tooele (1962) and Delta (1962)

Hydrogeology by J. W. Hood and Don Price (1966-67). Geology adapted from Stokes (1964), Gilluly (1932), Heylmun (1965), and others (see text).

EXPLANATION

GEOLOGY

UNCONSOLIDATED ROCKS

Qay
Younger alluvium
Clay, silt, sand, and gravel; chiefly along active streams; moderate to high permeability

Qa, Qas
Older alluvial deposits and surfaces
Clay, sand, and gravel; mostly sloping, well drained, and generally not stony; moderate permeability

Qlc
Lakebed sediments
Mostly clays; part of area poorly drained; and most clays generally saline; low to moderate permeability

Qag
Colluvium and alluvium
Sand, gravel, conglomerate(?), and some clay; includes veneer of windblown sand southwest of Oquirrh Mountains; forms recharge area; yields water freely to wells where saturated

QTu
Deposits and surfaces of uncertain age
Generally brownish and conglomeratic; low to high permeability

QUATERNARY

CONSOLIDATED ROCKS

Salt Lake Formation
Continental sandstone, claystone, limestone, silt, and tuff and other pyroclastic rocks; generally low permeability

Tig
Igneous rocks
Porphyritic intrusives in Oquirrh Mountains; rhyolite-dacite-quartz and andesite-trachyte-latite extrusive flows of early Tertiary age in southern end of basin; generally low permeability

TERTIARY

Cenozoic

Pzu
Sedimentary rocks
Mainly carbonate rocks; generally low in permeability, but locally high in permeability along joints, faults, and cavernous zones

Paleozoic — MIDDLE CAMBRIAN to PERMIAN

Tintic Quartzite and Precambrian rocks
Tintic Quartzite: relatively pure quartzite, sandstone, and some conglomerate. Precambrian rocks: include Sheeprock Group (or Series) of Harris (1958), argillite, tillite, and metaconglomerate; and Mutual Formation, chiefly quartzite having distinctive purple color. Low in permeability, but may be high in permeability along faults and shattered zones

Precambrian and Cambrian — UPPER PRECAMBRIAN to MIDDLE CAMBRIAN

Approximate contact

Highest recognized Lake Bonneville shoreline

U
D
Fault
Solid where exposed; dashed where inferred from general data; triple-dot pattern where inferred from geophysical data; dotted where concealed. U, up; and D, down, indicate relative movement

Thrust fault
Barbs are on side of thrust sheet

Inferred strike-slip fault
Arrows show relative movement

Anticline
Showing trace of plane, direction of plunge of axis, and overturn of plane. Dashed where approximately located

Syncline
Showing trace of plane and direction of plunge of axis. Dashed where approximately located

Strike and dip of beds

HYDROLOGY

5050
Water-level contour
Shows altitude of water level. Dashed where approximate. Contour interval 50 feet. Datum is mean sea level. Arrows indicate direction of ground-water movement

R2
Spring
R, *indicates record in table 15*

2 3
Nonflowing *Flowing*
Well
Double circle indicates large-diameter drilled well (see table 12)
Number by spring or well symbol indicates the number of springs or wells in the same 10-acre tract

Stream-gaging station
(see table 5)

Partial record or miscellaneous stream discharge data site
(see tables 6 and 11)

Site sampled for chemical analysis of surface water
(see table 17)

Ground-water divide
Open symbol indicates where approximately located

Area excluded from estimate of ground-water recharge in table 8

Boundary of surface drainage basin

MAIN AREAS OF EVAPOTRANSPIRATION
(see also table 9)

Boundary of evapotranspiration area

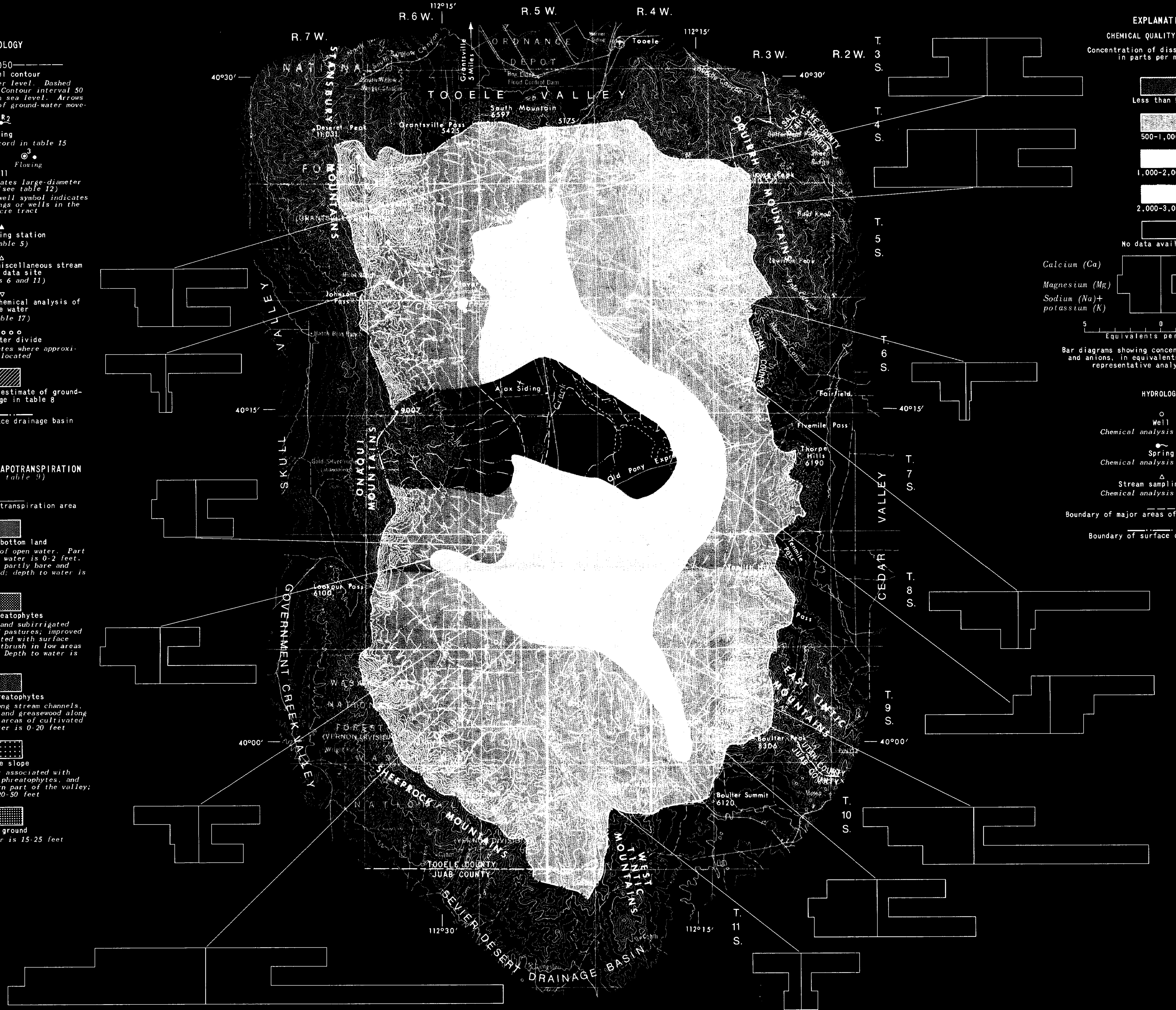
Rush Lake bottom land
Contains small areas of open water. Part is marshy; depth to water is 0-2 feet. Part is moist land, partly bare and partly grass covered; depth to water is 0-10 feet

Mixed phreatophytes
Rabbitbrush, meadow, and subirrigated cultivated land and pastures; improved lands partly irrigated with surface water. Dense rabbitbrush in low areas where not cleared. Depth to water is 5-20 feet

Mixed phreatophytes
Dense rabbitbrush along stream channels, sparse rabbitbrush and greasewood along edges of area, and areas of cultivated lands; depth to water is 0-20 feet

Middle slope
Mainly greasewood but associated with rabbitbrush, other phreatophytes, and sage in the southern part of the valley; depth to water is 20-50 feet

Bare ground
Depth to water is 15-25 feet



EXPLANATION

CHEMICAL QUALITY OF WATER

Concentration of dissolved solids, in parts per million

Less than 500

500-1,000

1,000-2,000

2,000-3,000

No data available

Calcium (Ca) *Bicarbonate (HCO_3)*
Magnesium (Mg) *Sulfate (SO_4)*
Sodium (Na)+ potassium (K) *Chloride (Cl)*

5 0 5
Equivalents per million

Bar diagrams showing concentrations of cations and anions, in equivalents per million, for representative analyses of water

HYDROLOGY

Well
Chemical analysis in table 16

Spring
Chemical analysis in table 16

Stream sampling site
Chemical analysis in table 17

Boundary of major areas of evapotranspiration

Boundary of surface drainage basin

5 0 5 MILES
5 0 5 KILOMETERS
CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL

Hydrology by K. M. Waddell

Generalized distribution of dissolved solids in ground and surface waters and the chemical character of representative water samples

HYDROGEOLOGIC MAPS OF THE RUSH VALLEY DRAINAGE BASIN, TOOELE COUNTY, UTAH