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HYDROLOGIC RECONNAISSANCE OF GROUSE CREEK VALLEY, BOX ELDER COUNTY, UTAH

by

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ABSTRACT

Grouse Creek valley is a trough-shaped depression that extends about 30 miles southward from T. 13 N. in the Grouse Creek and Goose Creek Mountains to the Great Salt Lake Desert in T. 7 N. The drainage basin extends a short distance into Nevada and includes about 430 square miles. The known ground-water reservoir in the valley is in unconsolidated and consolidated sedimentary rocks of Quaternary and Tertiary age and underlies at least 110 square miles.

The source of water in Grouse Creek valley is precipitation on its drainage area, which is estimated to average 276,000 acre-feet annually. All but about 1 percent of the precipitation ultimately is consumed within the drainage basin. Most runoff and ground-water recharge to the valley is derived from precipitation on lands above an altitude of about 6,000 feet. The estimated average annual runoff from the uplands is 7,000 acre-feet. A very small part leaves the valley, mainly as ephemeral flow after summer storms.

The estimated average annual recharge to the ground-water reservoir is about 14,000 acre-feet, and the corresponding discharge is about 15,000 acre-feet. About 11,000 acre-feet of water is discharged by evapotranspiration, about 2,000 acre-feet by pumping and flow from wells (1967), and 2,000 acre-feet by subsurface outflow into the Great Salt Lake Desert. The difference in estimated recharge and discharge indicates that a part of the pumpage is being withdrawn from ground-water storage, and declining water levels in Tps. 9 and 10 N. confirm this conclusion.

The amount of ground water available annually for salvage from nonbeneficial discharge in Grouse Creek valley is estimated to be about 3,000 acre-feet. Additional withdrawals by wells in excess of 3,000 acre-feet would be entirely from storage and would result in accelerated and more widespread water-level declines. If 100 feet of saturated deposits in the ground-water reservoir were dewatered, the estimated minimum volume of water recovered would be 160,000 acre-feet.

The water in Grouse Creek valley generally is of suitable chemical quality for domestic, stock, and irrigation use. In water samples analyzed the range in dissolved solids is 207-1,100 mg/l (milligrams per liter). The freshest water sampled was from streams and upland springs. The highest observed concentration of dissolved solids was in water from shallow wells near the confluence of Grouse and Etna Creeks and probably is the result of evapotranspiration.

Of 26 water sources sampled, all but three yielded water of the calcium bicarbonate type. Three ground-water samples from the south end of the valley were of the sodium bicarbonate type.

In most years, about 2,000 acres of land reportedly is irrigated from streams and springs and not all that land receives a full water supply. Wells have been used since 1948 to supplement other water supplies to a part of the irrigated land. Approximately 400 acres is irrigated from wells alone.

The total annual supply of surface and ground water in the valley is estimated to be 21,000 acre-feet, but the average annual amount that can be readily diverted is estimated to be 17,000 acre-feet. This amount could be augmented by ground water pumped from storage, but the withdrawal from storage would cause a change in the hydrologic regimen and locally could affect existing water rights.

INTRODUCTION

This report is the seventh in a series by the U. S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights, which describes water resources of the western basins of Utah. Its purpose is to present available hydrologic data on Grouse Creek valley, to provideanevaluation of the potential water-resource development of the valley, and to identify studies that would help provide a better understanding of the valley's water supply.

The reconnaissance of Grouse Creek valley was made during 1967-68 and consisted largely of a study of available data on climate, geology, streams, wells, springs, and water use. These data were supplemented with data collected during 1 week of fieldwork in April and May 1968. The fieldwork included rapid examination of landforms, vegetation, geology, and distribution and use of water. Geological data were supplemented by data from aerial photographs. Selected basic data are presented in tables 2, 3, 5, 6, and 11-14; and locations of wells, springs, and surface-water data sites are shown on plate 1.

Grouse Creek valley is near the northwestern corner of Utah, and a part of the drainage basin extends into Elko County, Nev. (pl. 1). The drainage basin includes about 430 square miles.

Grouse Creek valley is an agricultural area and the population is small. A part of the population is scattered among ranches in the central and northern parts of the drainage basin and part lives in the communities of Grouse Creek and Etna. The historic Lucin townsite at the south end of the valley now is only a siding on the Southern Pacific Co. railroad. The Utah Highway Department reports about 300 persons in the vicinity of Grouse Creek and 45 persons in and near Etna (based on the 1960 census).

The water available to the residents of Grouse Creek valley has been the subject of considerable study, but little has been published that specifically describes the water resources of the valley. The two principal sources of hydrologic information are a U. S. Geological Survey water-supply paper by Carpenter (1913), which supplies some early data, and a master's thesis by Packer (1967) that is largely a compilation of hydrologic data.

The geologic map of Utah (Stokes, 1964) and the work of Granger and others (1957) in Nevada are the main sources for the geologic mapping shown on plate 1. Other sources of geologic data include Heylmun (1965) who described some of the rocks of Tertiary age in the valley, and Felix (1956) who described for the Raft River Mountains some of the rocks that also crop out in the Grouse Creek Mountains. These and other sources that provide specific data or useful background material on the region are given in the list of selected references.

A description of the system of numbering wells, springs, and other hydrologic sites and an explanation of the use of metric units in this report are included in the appendix.

GENERAL HYDROLOGIC ENVIRONMENT

In the following discussion of the water-resources system in Grouse Creek valley, the interpretation of the system and the quantitative estimates are based not only on specific hydrologic data available, but also on consideration of the general effects of physiographic, geologic, and climatic factors.

Physiography

Grouse Creek valley is in the northeastern part of the Great Basin subprovince of the Basin and Range physiographic province (Fenneman, 1931, 1946). The valley is a trough-shaped depression about 30 miles long and is bounded on the east by the Grouse Creek Mountains and on the west and north by the crescent-shaped Goose Creek Mountains. (See pl. 1.) Grouse Creek valley is open to the south and drains to the Great Salt Lake Desert.

The mountains that bound the valley have moderate to high relief. Altitudes along the drainage divide are generally between 7,000 and 8,000 feet in the Goose Creek Mountains and between 7,000 and 9,000 feet in the Grouse Creek Mountains. The highest point on the drainage divide is Ingham Peak (altitude 9,046 ft.) in the northern Grouse Creek Mountains. The lowest altitude on the valley floor, southeast of Lucin, is about 4,400 feet; thus, the total relief in the project area is about 4,600 feet.

Grouse Creek valley consists of a flood plain or bottom land along Grouse Creek and moderately steep side slopes that rise rather abruptly to the edges of the bounding mountains. The flood plain is less than 1 mile wide and is bounded by low bluffs. The west side of the valley is narrowest and abuts rugged volcanic terrain and escarpments of the Goose Creek Mountains. The broader east side has a relatively smooth, rolling topography and merges with the lower slopes of the Grouse Creek Mountains. In the upper parts of the valley, above the confluence of Grouse Creek and Etna Creek (west fork of Grouse Creek), the flood plain is less than half a mile wide and is bounded by steep bluffs of relatively resistant sedimentary and volcanic rocks.

Below an altitude of about 5,180 feet, the surface of the valley has been modified by the wave and current action of Pleistocene Lake Bonneville. Most of the lake features are subdued landforms, but along the mouth of the valley wave-cut terraces are strongly developed at several levels on consolidated rocks, and many old shorelines are visible on the slopes above the desert floor. Gravel bars and spits link many of the outliers of consolidated rocks near the valley mouth or extend outward from them.

Most of the landforms in Grouse Creek valley appear to be relatively old. The flood plain of Grouse Creek, for example, appears to be the work of an ancestral stream much larger than modern Grouse Creek. In Pleistocene time the large stream carved a trench 30-60 feet deep which has been backfilled with alluvium.

The valley contains no large alluvial fans such as are common in many of the basins of western Utah. Their absence is due partly to lack of deposition and partly to erosion. Erosion currently is being renewed in many places in the drainage basin. Along the lower reaches of Grouse Creek from T. 9 N. to the Great Salt Lake Desert, for example, most stream channels are narrow, steep-walled cuts in unconsolidated and semiconsolidated rocks.

Grouse Creek is the master stream draining the valley. It has a total fall from the Grouse Creek community to Lucin of about 870 feet (about 30 ft. per mile). The creek is intermittent below the Grouse Creek community and streamflow reaches the lower end of the valley only during severe floods. Deep gullies and washed-out bridges along the stream channel are evidence of the severity of such floods.

Geology

Rocks ranging in age from Precambrian to Triassic and from early (?) Tertiary to Holocene are exposed or have been penetrated by wells in the Grouse Creek valley drainage basin. The pre-Tertiary rocks consist of consolidated metasedimentary and sedimentary rocks. The consolidated rocks of Tertiary age consist of both igneous and sedimentary rocks, including appreciable quantities of pyroclastic deposits.

Grouse Creek valley, a structural depression created by the deformation of consolidated Tertiary and older rocks, is partly filled with unconsolidated and semiconsolidated rocks of Cenozoic (Tertiary and Quaternary) age. These Cenozoic rocks contain the main ground-water reservoir in the valley.

In this report, geologic units having similar water-bearing characteristics were mapped as single units to emphasize the relation of geology to hydrology. Plate 1 shows the distribution of the rock units and table 1 gives a general description of their lithology and general water-bearing properties.

Climate

The climate in Grouse Creek valley is arid to semiarid. The average annual precipitation is less than 6 inches in the south end of the valley and about 12 inches in the north end (pl. 1). Data from selected climatologic stations in the Grouse Creek region (fig. 1 and table 10, appendix) show that most of the precipitation falls during the period December-June (table 2). Precipitation generally is least during the summer and fall and results mainly from sporadic, intense thunderstorms.

Total annual precipitation at the low-altitude stations (4,221-5,620 feet) varies considerably from year to year. The precipitation at Lucin ranged from 1.88 inches in 1908 to 12.83 inches in 1941, and the annual precipitation at Grouse Creek ranged from 6.06 inches in 1895 to 17.10 inches in 1913. The intermittent records of annual precipitation at three stations in Grouse Creek valley, together with the cumulative departure from average annual precipitation at four long-term stations in the region, are shown in figure 2. These data indicate the relation of annual precipitation in the valley to long-term trends.

The climate in the mountains that surround Grouse Creek valley is semiarid to humid. The average annual precipitation generally ranges from 12 inches on the lower slopes to more than 20 inches on the highest slopes of the Grouse Creek Mountains (pl. 1). The snowpack that accumulates at high altitudes during winter and spring is the principal source of water in the drainage basin. Records from a snow course at Vipont (table 3) north of the Grouse Creek drainage basin provide an indication of the amount of winter and spring precipitation at high altitudes.

The valley has a wide annual range of air temperatures as indicated in the following tabulation:

Station	Period of record	Years	Average monthly temperature, in degrees Fahrenheit												
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Lucin (combined record)	1905-55	36	22.7	29.4	38.4	47.5	55.4	64.7	73.8	71.3	61.1	47.9	35.2	24.3	47.6
Grouse Creek (Kimber Ranch)	1959-65	5	18.5	27.7	32.3	42.4	51.4	62.2	70.2	67.0	58.2	48.3	34.4	24.3	44.7

Table 1.—Age, character, and water-bearing properties of major lithlogic units in the Grouse Creek drainage basin.

Age	Geologic unit and map designation	Character of material	Water-bearing properties
Quaternary	Younger alluvium Qay	Channel fill along Grouse Creek and larger tributaries. Consists chiefly of alternating strata of clay, clay and gravel, and sand and gravel. Maximum aggregate thickness is a few feet near the upper end of the valley and more than 100 feet near the lower end, but in most places where full penetrated by wells, thickness is between 50 and 70 feet.	Sand and gravel strata are moderately to highly permeable and, where saturated, form the most productive aquifers in the valley; they generally yield moderate to large volumes (several hundred gallons per minute) of water to wells.
	Alluvium and colluvium Qa	Surficial deposits of clay, silt, sand, and gravel that probably are less than 50 feet thick in most places; on steeper slopes, the deposits consist chiefly of colluvium and form gravelly and rubbly surfaces; on the gentler slopes, they consist chiefly of clay and silt which is well drained and form a well-developed soil profile. Include local sand dunes in south end of valley.	Deposits generally of low permeability and not water bearing, but are moderately permeable adjacent to steeper slopes and act as an intake area for recharge near margins of the valley. Some water also is discharged through them locally by evapotranspiration.
	Lake-bottom deposits Qlc	Underlie a major part of the main valley floor below an altitude of about 5,180 feet. Consist chiefly of clay, silt, and fine sand; maximum thickness is less than 100 feet in most places.	Poorly to moderately permeable and generally not water bearing; inhibit recharge. Part of precipitation that falls on these deposits is retained as soil moisture; the rest runs off and collects in ponds and drainage channels where it evaporates.
	Lakeshore deposits Qlts	Underlie several small areas between altitudes of 4,600 and 4,900 feet in southern part of the valley. Consist chiefly of sand and gravel in spits, bars, and terrace deposits; generally less than 50 feet thick.	Moderately to highly permeable, but too limited in extent to constitute an important aquifer. Probable source of water that is discharged from Owl Spring and from springs in the Rabbit Spring group; some water is discharged from the deposits by evapotranspiration.
Tertiary and Quaternary	Older alluvial deposits QTu	Unconsolidated and semiconsolidated deposits of sand and gravel in terraces on the east side and upper reaches of the valley. May also extend beneath main valley floor locally; maximum thickness not known.	Poorly to moderately permeable; may be too limited in extent to constitute an important aquifer but may support the flow of several small springs and act as a local intake area for recharge. Probably extend beneath younger valley-fill deposits locally and serve as part of the main ground-water reservoir. Well (B-8-17)31ccc-1 probably taps these rocks.
Tertiary	Extrusive igneous rocks Te	Underlie a major part of the Goose Creek Mountains east of the mountain crest; also crop out locally in the lower part of Grouse Creek valley. Consist mainly of rhyolite, dacite, and quartz latite flows; include some basalt. Highly fractured, faulted, and jointed locally.	Permeability highly variable; yield water to numerous springs; many of the springs occur along contacts between these rocks and less permeable underlying sedimentary rocks; yields of individual springs range from less than 1 to more than 200 gpm. Well (B-9-18)16aaa-1 probably penetrated part of these flows.
	Salt Lake Formation Tsl	Widely exposed in the drainage basin between altitudes of 5,200 and 7,800 feet; extends beneath younger alluvial and lacustrine deposits of the valley fill, and probably interfingers with and extends beneath the extrusive igneous rocks. Consists chiefly of tuffaceous shale, siltstone and sandstone, limestone and marlstone with some carbonaceous strata, and some thin layers of sand and gravel. Has undergone considerable deformation, especially around margins of valley.	Unit as a whole is of generally low permeability, but some thin interbeds of sand and gravel deposits yield small to moderate quantities of water; supports the flow of many small springs and seeps which generally occur along fault and contact zones. Several wells that tap the formation in the vicinity of the Grouse Creek community flow and have yields ranging from less than 1 gpm to more than 100 gpm. Well (B-10-17)4cbc-1, which taps the formation, was abandoned owing to insufficient yield; but well (B-11-18)33bdc-1, which apparently taps the formation, has measured pumping yield of 705 gpm.
	Intrusive igneous rocks Ti	Crop out in 10 square mile area in the southern Grouse Creek Mountains but only a small part (about 1 sq mi) is exposed within the Grouse Creek valley drainage divide. Consist mostly of gray and red quartz monzonite; some quartz diorite.	Generally of low permeability, but yield water to several small springs and seeps along zones of faulting, jointing, and fracturing.
Triassic	Thaynes(?) Formation TRt	Crops out locally in the southern Grouse Creek Mountains and in the upper reaches of Joe Dahar Creek. Consists of brownish to reddish sandy to shaly limestone with some dolomite; lenses of chert are common throughout formation.	Generally of low permeability but may yield water to several small seeps and springs along bedding planes, faults, and fractures.
Ordovician to Permian	Sedimentary and metasedimentary rocks undivided POu	In the Grouse Creek Mountains consist mostly of limestone, dolomite, quartzite, and shale; in the Goose Creek Mountains mostly limestone, cherty limestone, dolomite, chert, and cherty mudstone; also contain some phosphate rock locally.	Permeability highly variable depending on degree of secondary porosity; unit as a whole has low permeability. Various strata support the flow of numerous springs and seeps, most of which occur along zones of fracturing, contacts, and bedding planes. Discharge of individual springs generally less than 10 gpm.
Precambrian	Metamorphic rocks p€	Form the core of the Grouse Creek Mountains and crop out over a large area in the highest segment of the range. Consist chiefly of quartzite, schist, and limestone of the Dove Creek Formation of Stringham (1961) and of Stokes (1964); and of quartzite, schist, and dolomite of the Albion Range Group (Precambrian[?]).	Generally of low permeability but yield water to many small seeps and springs which occur chiefly along zones of faults and fractures at or near the heads of small ravines. Most of the discharge of Grouse Creek results from runoff from these rocks.

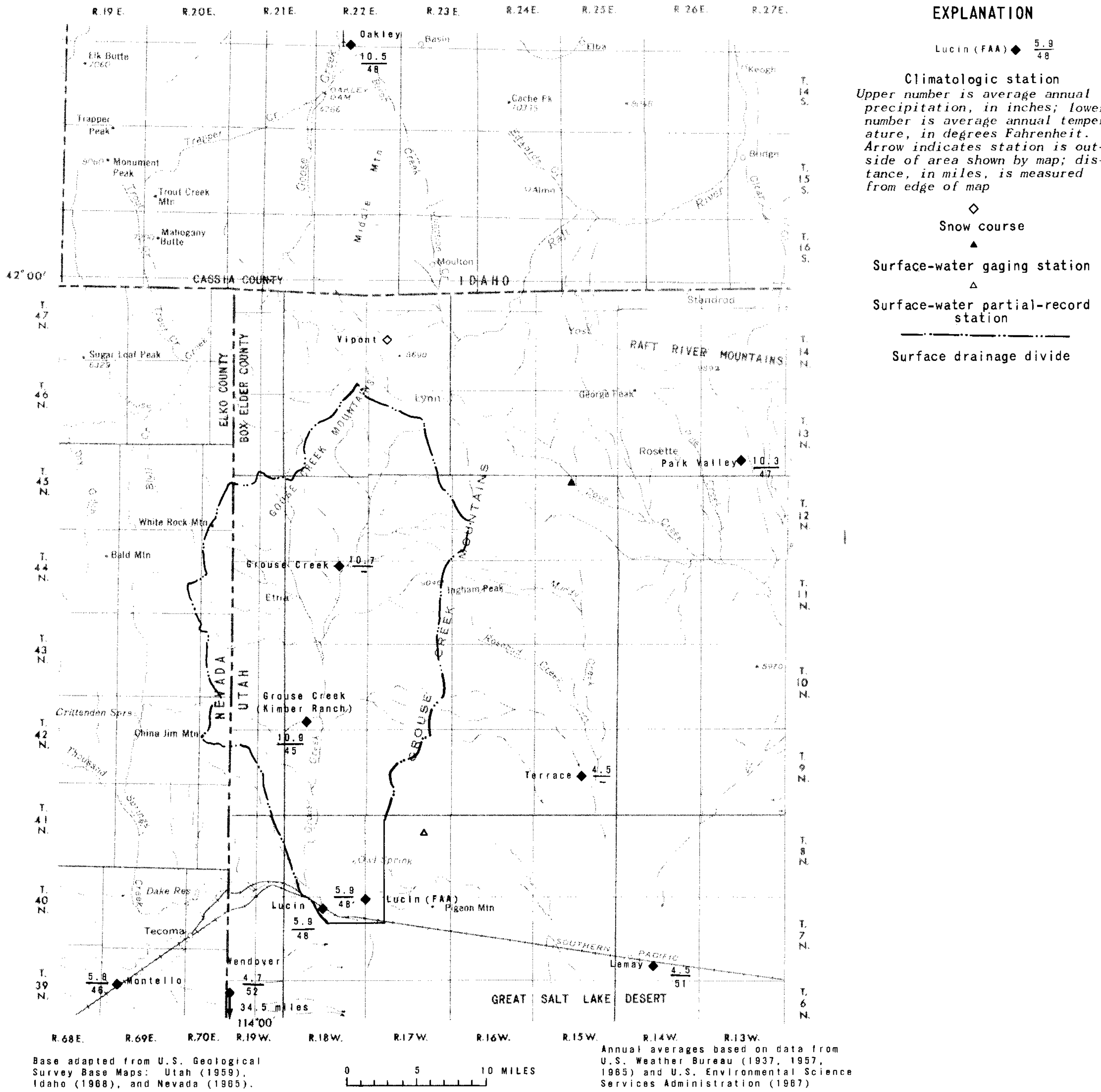


Figure 1.—Locations of selected climatologic stations in the Grouse Creek region.

Table 2.—Average monthly and annual precipitation, in inches, at climatologic stations in Grouse Creek valley

(Data from U. S. Weather Bur., 1937, 1951-66, 1957; Environmental Sci. Services Adm., 1967. Numbers in parentheses show number of years of record.)

Month	Station and period of record		
	Grouse Creek 1890-1966	Kimber Ranch 1959-65	Lucin (combined record) 1905-55
January	1.31(12)	0.62(5)	0.57(41)
February	.91(12)	.83(5)	.43(39)
March	.74(11)	.80(5)	.36(39)
April	1.06(12)	.65(6)	.52(40)
May	.90(12)	1.69(6)	.76(39)
June	1.32(14)	1.65(5)	.58(40)
July	.58(14)	.74(5)	.47(40)
August	.51(14)	1.01(5)	.46(39)
September	.60(14)	1.32(5)	.40(37)
October	.68(14)	.50(5)	.56(40)
November	.80(14)	.56(5)	.34(38)
December	1.06(14)	.49(5)	.47(38)
Year	10.70	10.94	5.92

Midwinter nighttime temperatures often fall far below freezing and midsummer daytime temperatures often exceed 90°F (32°C).

The length of the growing season is of particular importance in assessing evapotranspiration and is defined as the number of days between the last killing frost in the spring and the first killing frost in the fall; the definition of killing frost differs with the type of plant. A summary of freeze data for the period 1950-67 is shown in table 4 for three stations in and near the Grouse Creek drainage basin.

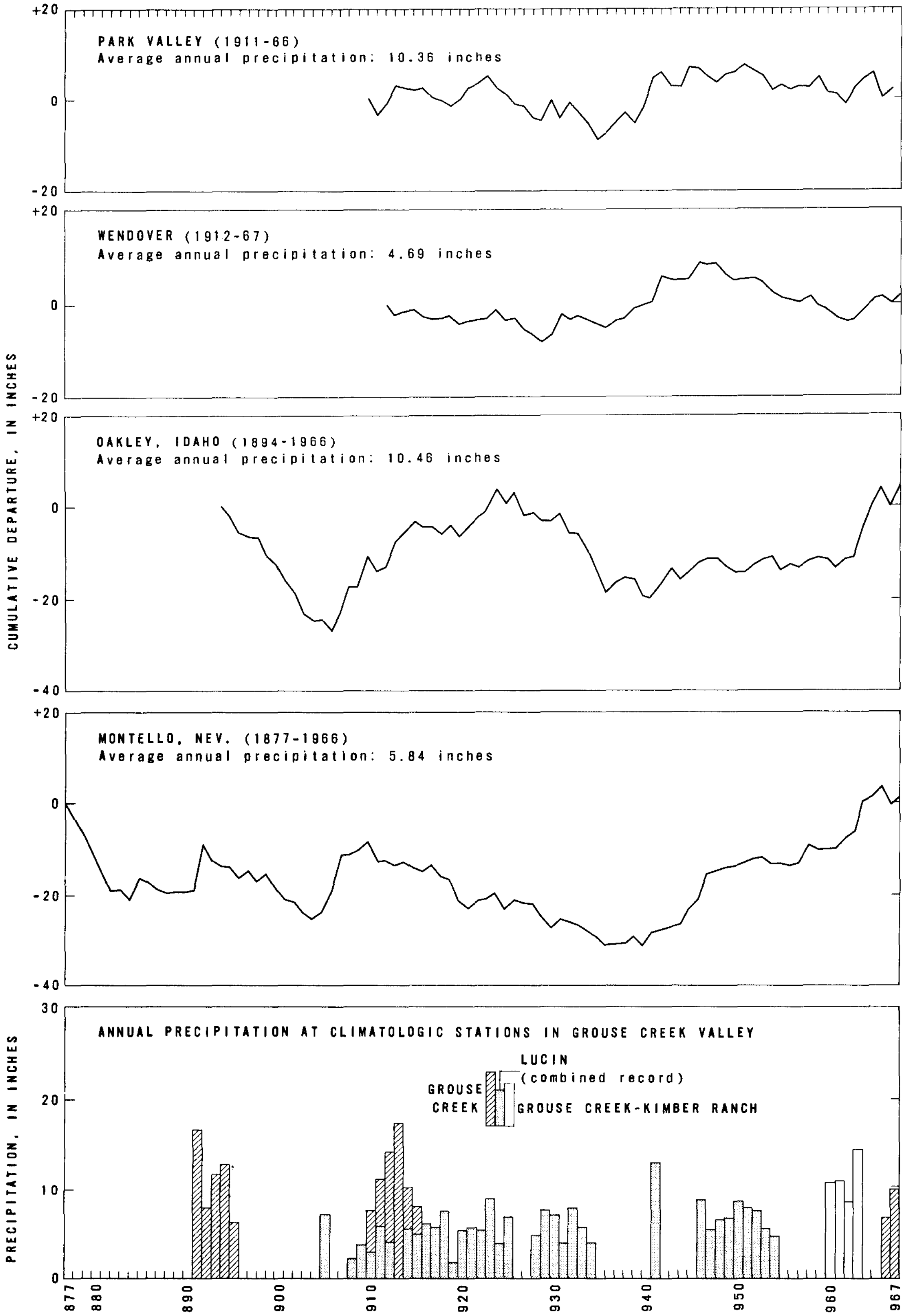


Figure 2.—Cumulative departure from average annual precipitation at four climatologic stations in the Grouse Creek region and annual precipitation at climatologic stations in the valley.

Table 3.—Depth and water content of snow at Vipont (alt. 7,670 feet) in the Goose Creek Mountains, sec. 17, T. 14 N., R. 17 W.

(Data from U. S. Soil Conservation Service)

Date	Snow depth (inches)	Water content (inches)	Date	Snow depth (inches)	Water content (inches)
Water year 1962			Water year 1964 (Cont.)		
12-29-61	37	11.9	1-29-64	36	10.7
1-30-62	42	14.2	2-29	32	9.0
3-5	56	18.8	3-29	44	13.0
3-26	56	21.3	4-29	27	10.7
Water year 1963			Water year 1965		
12-31-62	8	1.8	2- 1-65	43	16.5
2- 5-63	17	3.9	3-30	48	16.0
2-28	24	5.8	4-29	35	16.4
3-29	27	8.3			
4-30	21	7.0	Water year 1966		
Water year 1964			1-26-66	35	9.3
			3-29	33	10.0
12-30-63	21	4.5			

HYDROLOGY

Volume of precipitation

The physiographic and geologic environment of the Grouse Creek drainage basin indicates that the only source of water for Grouse Creek valley is precipitation, which is estimated to average 276,000 acre-feet annually on its drainage area; therefore, the volume of precipitation is the basis for estimating runoff and ground-water recharge. Most of the precipitation is consumed by evapotranspiration, and only about 1 percent of it flows from the drainage basin. The average annual volume of precipitation was estimated from the precipitation data shown on plate 1, and the computation is shown in table 7.

Surface water

The estimated average annual runoff in the Grouse Creek drainage basin is 7,000 acre-feet. Direct runoff of rainfall and snowmelt is not perennial. Summer thunderstorms result only in ephemeral flow that may be intense and occasionally destructive. Runoff from snowmelt

Table 4.—Number of days between the last spring freeze and the first fall freeze at three stations in and near the Grouse Creek drainage basin, 1950-67

(Data from U. S. Weather Bur. (1951-66); U. S. Environmental Sci. Services Adm. (1967). Year of occurrence given in parentheses.)

	Grouse Creek, Utah	Park Valley, Utah	Montello, Nevada
	Number of days between the last spring and the first fall temperatures of:		
	32°F (0°C) or below		
Average	109	125	86
Maximum	152 (1963)	179 (1963)	150 (1963)
Minimum	63 (1960)	82 (1962)	9 (1959)
	28°F (-2°C) or below		
Average	132	150	123
Maximum	164 (1963)	206 (1952)	174 (1963)
Minimum	114 (1960)	111 (1966)	65 (1960)
	24°F (-4°C) or below		
Average	152	178	147
Maximum	190 (1962)	211 (1956)	190 (1952)
Minimum	116 (1960)	134 (1965)	120 (1959)

is the main supply for irrigation, and generally extends from March or April into June, although it may begin as early as February. The base runoff is sustained by springs and seeps and is perennial in a few of the streams in the northern half of the drainage basin, but most of the streams are intermittent and most of the streams that head in the valley or lower mountains are ephemeral.

Water is diverted from Grouse Creek and its larger tributaries for irrigation of lands in the upper and central parts of the valley. Dams have been built on several streams for storage and for diversion works. The two largest dams impound water in reservoirs on Etna Creek (NW¼ sec. 6, T. 11 N., R. 18 W.) and on Death Creek (SE¼ sec. 21, T. 11 N., R. 19 W.). The reservoir capacities are 1,500 and 250 acre-feet, respectively (Packer, 1967, p. 49).

Available records

No continuous records of streamflow in the Grouse Creek drainage basin are available, but several measurements and estimates of discharge are shown in table 5 and a partial record for a crest-stage gage (station 10-1729.20) maintained by the Geological Survey on Cotton Creek since 1958 is shown in table 6. Daily measurements of discharge during parts of several years have been reported by the U. S. Soil Conservation Service for sites on Pine, Kimbell, and Cotton Creeks (table 5 and fig. 3). A few measurements and estimates of stream discharge were made during the field work for this report. Locations of the sites at which discharge measurements were made are shown on plate 1.

To aid analysis of conditions in Grouse Creek valley, records from two stations in nearby areas were studied: station 20-1729.4, Dove Creek near Park Valley, Utah, and station 10-1729.25 (crest-stage gage), Great Salt Lake Desert Tributary No. 3, near Park Valley, Utah (U. S. Geol. Survey, 1961-67; 1963, p. 136). The Dove Creek station provides an essentially continuous record since December 1958 for a part of the Grouse Creek Mountains similar to the headwater area of Cotton Creek, and the crest-stage gage on the Great Salt Lake Desert tributary indicates runoff for a area similar to southern Grouse Creek valley.

Runoff characteristics

Streamflow in Grouse Creek valley varies both seasonally and annually. Generally streamflow at the beginning of the water year is low, and modest increases in streamflow occur in the winter due to rain and low-altitude snowmelt. Subsequently, streamflow due to spring snowmelt begins abruptly and rises rapidly to an annual peak. In the larger tributaries, such as Pine Creek (fig. 3), snowmelt may be sustained for 8-10 weeks, but once melting ceases, the streamflow dwindles rapidly to the base flow, which in turn dwindles through summer and fall. For example, measurements by the U. S. Soil Conservation Service show that Pine Creek in 1962 increased from about 2 cfs (cubic feet per second) in late March to an annual peak of nearly 19 cfs in mid-April, and by late July had dwindled to less than 0.5 cfs (fig. 3). Similar characteristics are indicated in figure 3 for Cotton Creek and in figure 4 for Dove Creek.

The only perennial streams are those supplied by relatively large springs or groups of springs such as those in Morse Canyon and Death Creek canyon; some of the streams are perennial in some reaches and intermittent in others. Cotton Creek at the gage, for example, was dry at least a part of the summer of 1959, when the upland springs presumably had diminished in response to the drought during the 1950's. Figure 4 shows the effect of a dry year on the flow of Dove Creek.

Estimated average annual runoff

An estimate of the average annual runoff to the valley was made from the isogram worksheets for Utah described by Bagley and others (1964, p. 54-56) and from an extrapolation of the lines of mean annual runoff from the Utah part into Nevada. The average annual runoff from the uplands was estimated from the worksheets as about 12,000 acre-feet. Comparison of the partial record for the crest-stage gage on Cotton Creek with the Dove Creek gaging station record shows, however, that figures for runoff based on the worksheets are too high.

An approximate correlation of available simultaneous daily discharges in Dove and Cotton Creeks (fig. 5) was prepared. The measured annual runoff at the Dove Creek gaging station and the derived figure for runoff at the Cotton Creek crest-stage gage are shown in the tabulation on page 15.

Table 5.—Discharge of streams at sites in and near the Grouse Creek drainage basin.

Site location: See appendix for description of numbering system for hydrologic sites.
Stream and site description: Number is U.S. Geological Survey station number for partial-record station.
Discharge: Measured, unless indicated by e, estimated, or r, reported.

Site location	Stream and site description	Date	Discharge (cfs)	Remarks and other data available
			UTAH	
(B-8-17)11b	10-1729.25 Great Salt Lake Desert Tributary No. 3 near Park Valley	5-24-63 6- 4-63 6- 7-64	75.3 15.8 25	Crest-stage gage on State Highway 30, 3 miles southeast of Grouse Creek drainage basin divide and about 6.8 miles east of junction of Highway 30 with road to Grouse Creek community. Drainage area, approximately 0.4 square mile. Altitude, 5,010 feet. Flow recorded is only evidence of flow during period March 1962 to the fall of 1967.
(B-11-18)6b	Big Canyon [Morse Canyon(?)] Creek above Etna Reservoir site	4- -53 5- 2-53 6-19-53	2.58r 2.48r 2.53r	Location approximate. Measurements by U.S. Soil Conservation Service. Reported to be springflow only, which fluctuates little. Site probably close to (B-11-18)6bcb listed below.
6b	Straight Fork Creek above Etna Reservoir site	4- -53 5- 2-53 6-19-53	.56r .56r .57r	Location approximate. Measurements by U.S. Soil Conservation Service. Reported to be springflow only.
6bcb	Morse Canyon Creek	4-12-68	2.41	Water temperature was 16°C. See chemical analysis in table 14.
(B-12-17)6a	Cotton Creek above Tanner Diversion	5-11-65	3.12r	Location approximate. Measurements by U.S. Soil Conservation Service. See figure 3 for hydrograph of measurements during the spring of 1965.
6aac	10-1729.20 Cotton Creek near Grouse Creek	5-11-65	2.1e	Crest-stage gage 2 miles above mouth and 50 feet downstream from tributary entering on right bank. Drainage area, 18.4 square miles. See table 6 for separate listing of measurements and estimates.
17b	Kimbell Creek above Tanner meadow	5-11-65	4.64r	Location approximate. Measurements by U.S. Soil Conservation Service. See figure 3 for hydrograph of measurements during the spring of 1965.
29bda	Pine Creek	4-12-68	.6e	Water temperature was 10°C. See chemical analysis in table 14.
30a	do	5-11-62	6.70r	Location approximate. Measurements by U.S. Soil Conservation Service. See figure 3 for hydrograph of measurements during the spring and summer of 1962 and the spring of 1965.
(B-13-17)29aac	Little Pole Creek at mouth	4-12-68	.2	Measured immediately above confluence with Cotton Creek. Water temperature was 9°C. Specific conductance measured in field was 231 micromhos per cm at 25°C.
29acc	Cotton Creek	4-12-68	.4e	Flow estimated immediately below confluence with Little Pole Creek. Water temperature was 10°C. See chemical analysis in table 14.
(B-13-18)34acc	Joe Dahar Creek	4-12-68	.09	Discharge was probably springflow. No discharge observed downstream. Water temperature was 11°C. See chemical analysis in table 14.
			NEVADA	
44/70-33bac	Death Creek at road crossing, near the Nevada-Utah State line	5-17-68	0.5e	Discharge was probably springflow. Water temperature was 19°C. Specific conductance measured in field was 280 micromhos per cm at 25°C.

Table 6.—Discharges obtained from the crest-stage gage record for station 10-1729.20, Cotton Creek near Grouse Creek, Utah

Location.—(B-12-17)6aac.
Altitude.—5,660 feet. (See also table 5.)
Date.—That given is for periodic gage inspection except p, probable date of flood peak.
Discharge (in cubic feet per second).—Flow estimated, except m, measured; most estimates for shallow water in which cross section was measured and velocity carefully estimated: †, flood peak, discharge not determined.

Date	Discharge	Date	Discharge	Date	Discharge
12-17-58	0.8	10-19-60	0.05	9-19-63	0.15
4- 2-59	.5	11- 9	.2	p 6- 7-64	†
4-21	.4	p 4- 1-61	†	6-24	3.0
5-12	.4	7-26	<.05	7-22	.1
5-16	1.0	8-29	.2	8-19	.5
5-26	.3	9-22	.15	5-11-65	2.1
6-23	.2	p 2-11-62	†	6-29	1.8
7-22	(1)	3-28	1.66m	8-11	.75
8- 6	.1	4- 5	1.35m	p 2-25-66	†
9-15	.1	7-10	.36	3-25	.9
9-24	.15	8- 1	.75	5- 5	.75
10-13	.1	8-21	.2	5-23	.7
4-27-60	.3	9-13	.07	6-17	.5
5-10	(2)	9-26	(2)	7-12	.5
7- 6	.2	10-16	.15	8-12	.1
8- 3	.05	2- 5-63	.5	9-15	.25
8-12	.05	5-14	.6	10-13	.2
8-19	.1	6-14	1.48	4-14-67	.3
8-25	.2	7- 9	.4	6-14	1.95m
9-21	.14m	8- 7	.18	10- 5	.25
10- 5	.09m	8-28	.1	3-21-68	.5

[1] Channel had been dry for some time.

[2] Flow too small to estimate.

Water year	Runoff (acre-feet) Measured at 10-1729.4 (Dove Creek)	Derived for 10-1729.20 (Cotton Creek)
1960	187	130
1961	167	120
1962	914	640
1963	203	140
1964	309	220
1965	597	420
1966	563	390
1967	381	270
Average (rounded)	420	290

The average of 290 acre-feet of water per year at the Cotton Creek gage is the runoff from 18.4 square miles of mountain upland, or about 0.3 inch per year. Runoff estimated from the isogram worksheets for the same area is on the order of 0.5 inch. Because the figure of 0.3 inch is of the same order as that indicated in the general study by Busby (1966), and because the Cotton Creek drainage is believed to represent the average upland in terms of runoff, the estimated average annual runoff to Grouse Creek valley is adjusted downward to 0.6 (0.3/0.5) of the 12,000 acre-feet per year, or to about 7,000 acre-feet per year.

About 5,000 acre-feet of the total runoff is estimated to be readily available for diversion. The estimates are deliberately conservative because of the many unknowns. All the stream and spring flow has been claimed for use, but the supply possibly could be used to better advantage by improving management.

Ground water

Ground water occurs in all the geologic units in the Grouse Creek drainage basin (table 1). The principal sources of ground water in Grouse Creek valley are (1) the saturated part of the younger alluvium that forms channel fill along Grouse Creek and its tributary valleys and (2) the more extensive and thicker sedimentary rocks of Quaternary and Tertiary age (including the Salt Lake Formation) that underlie the entire valley. The two ground-water reservoirs are hydraulically connected, but they have greatly different characteristics. The younger alluvium will yield moderate to large quantities of water to wells but has a small volume of water in storage relative to the older rocks. The older rocks generally have low to moderate permeability and generally yield small quantities of water to wells, but owing to their thickness and areal extent, they contain most of the water in storage in the valley.

Ground water in Grouse Creek valley is used mainly for irrigation. Most of the ground water is obtained from wells finished in the younger alluvium, but some irrigation water comes from springs that issue from extrusive igneous rocks.

The younger alluvium is generally thin, and several wells finished at the base of the younger alluvium are too shallow to provide a pump setting deep enough for sufficient drawdown during pumping; the pumps in these wells break suction when operated and yields have

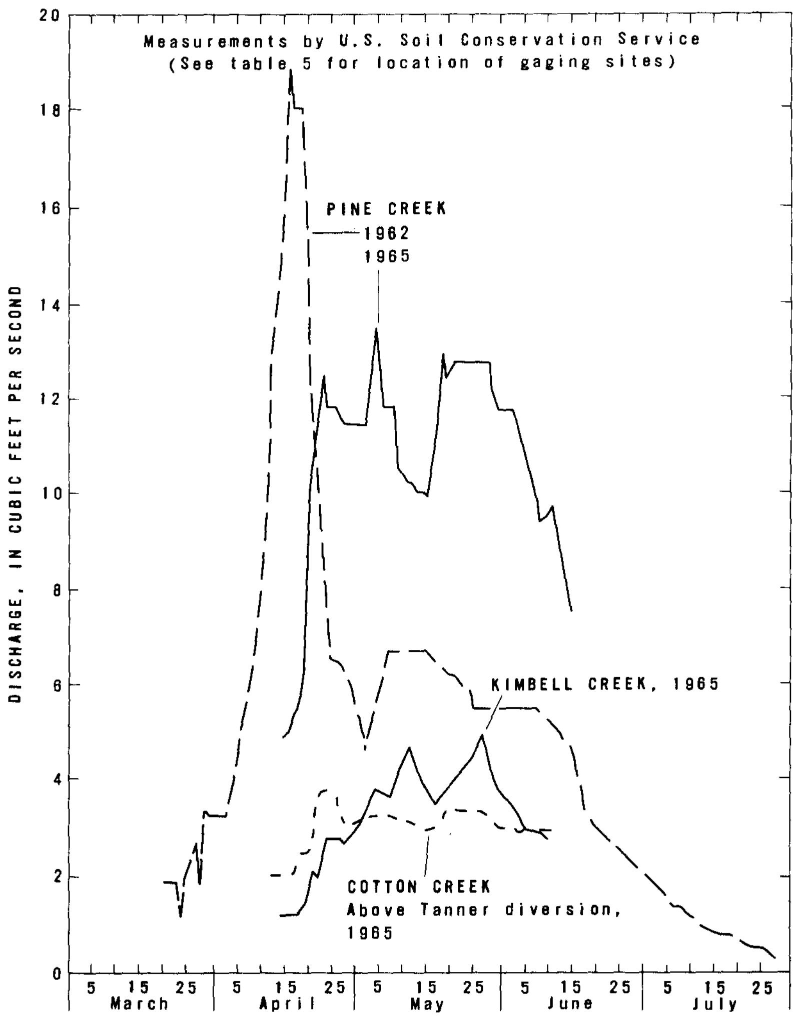


Figure 3.—Daily discharge during snowmelt season for three streams in Grouse Creek valley.

diminished. Deeper wells that penetrate both the younger alluvium and the underlying older rocks have greater and better sustained yields. Wells (B-11-18)27baa-1 and 33bdc-1 (tables 11 and 12) have the largest sustained yields of all wells in the valley. The record of well (B-11-18)33bdc-1 shows that a deep well carefully logged, fully perforated in all potential water-bearing zones, and equipped with a pump and motor that match the yield of the well can produce more water than the shallow wells.

Recharge

The estimated average annual recharge to the ground-water reservoir in Grouse Creek valley (table 7) is 14,000 acre-feet, or about 5 percent of the estimated 276,000 acre-feet of average annual precipitation in the drainage basin. The recharge estimate was made using a method described by Hood and Waddell (1968, p. 22-23).

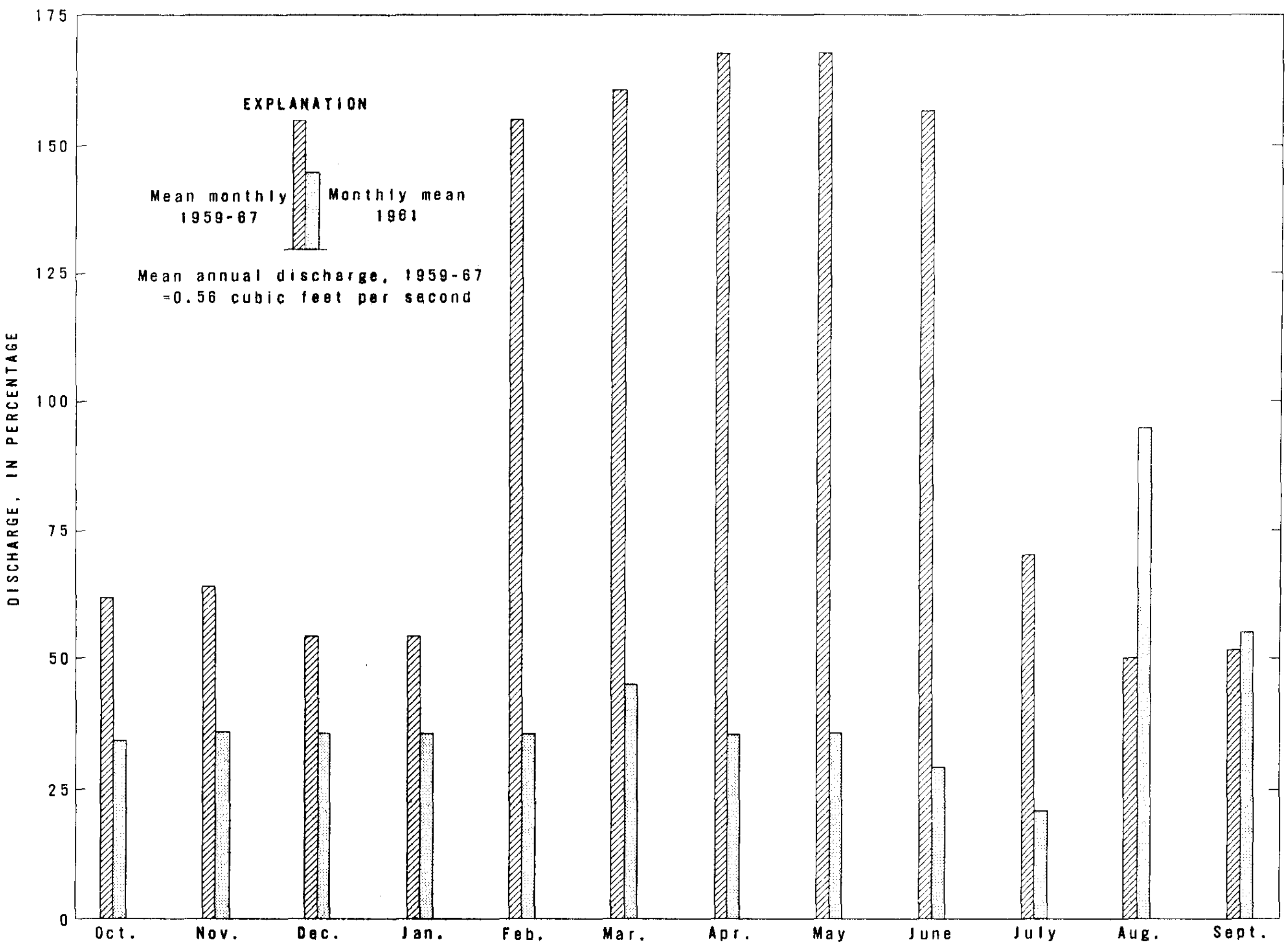


Figure 4.—Mean monthly discharge and monthly mean discharge during driest year (1961), in percentage of mean annual discharge, of Dove Creek near Park Valley, Utah.

Ground-water recharge is derived mainly from precipitation that falls on lands above 6,000 feet. A part of the recharge percolates directly to the ground-water reservoir through the rocks on which it falls, and a part percolates down through the beds of streams that flow over permeable rocks at lower altitudes. The ground-water reservoir receives only a very small part of the precipitation that falls on land below 6,000 feet because the precipitation there is light and the surficial rocks retain most of the water.

Occurrence and movement

Water in the younger alluvium beneath the flood plain of Grouse Creek is under water-table (unconfined) conditions. Water in the older Quaternary and Tertiary aquifers that underlie the valley floor and slopes is under both water-table and artesian (confined) conditions. Several wells that tap deep aquifers in the westward-dipping Salt Lake Formation near the community of Grouse Creek flow under artesian heads of several feet above land surface, but wells in other parts of the valley apparently tap unconfined aquifers in the older Quaternary and Tertiary rocks.

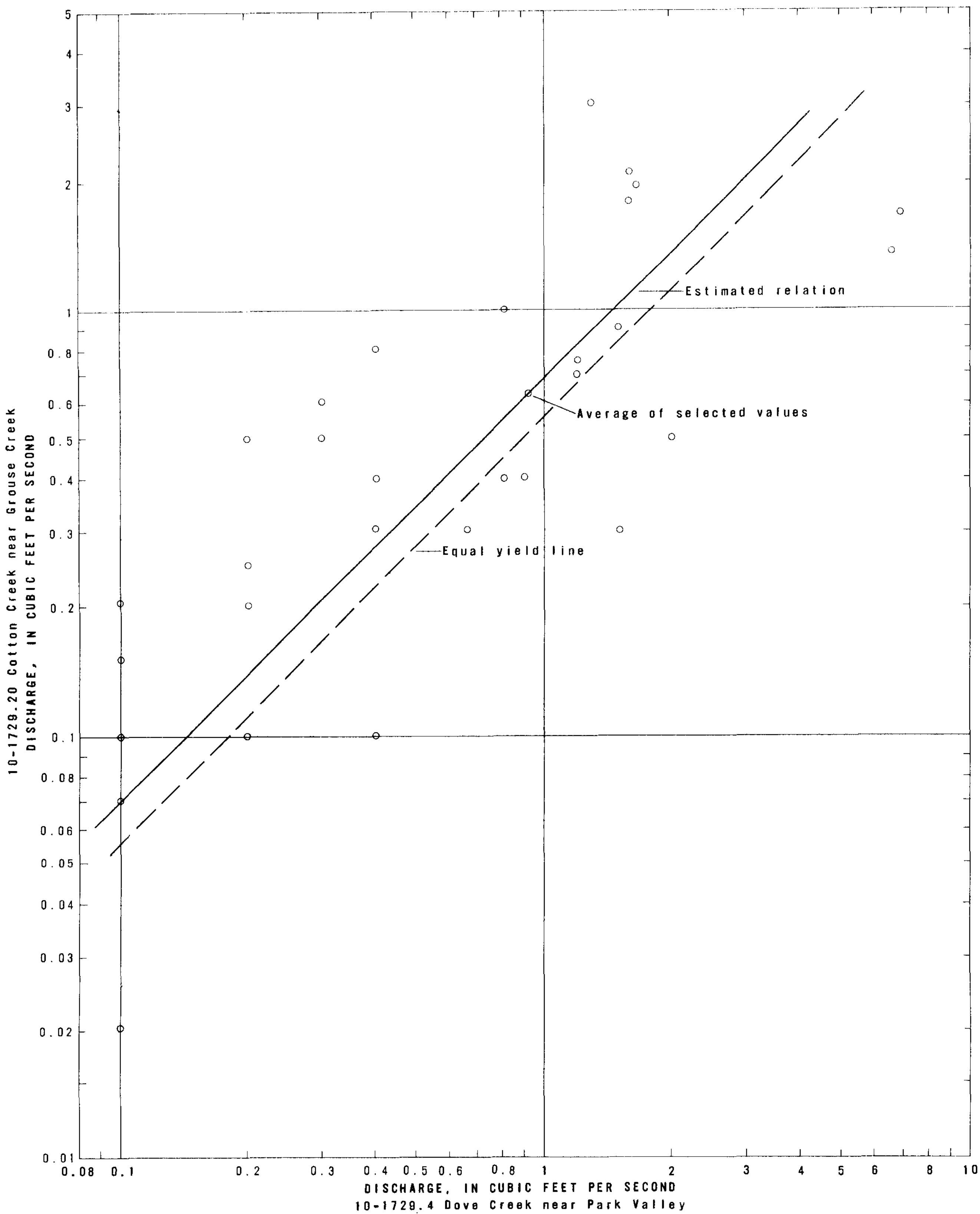


Figure 5.—Approximate correlation of streamflow at stations 10-1729.20 and 10-1729.4.

Table 7.—Estimated average annual volumes of precipitation and ground-water recharge in the Grouse Creek drainage basin

(Areas of precipitation zones measured from geologic and isohyetal maps (pl. 1). Estimates of average annual precipitation are weighted for steeply sloping areas.)

Precipitation zone (inches)	Area (acres)	Estimated annual precipitation: Feet	Estimated annual precipitation: Acre-feet	Estimated annual recharge: Percent of precipitation	Estimated annual recharge: Acre-feet
Areas underlain by Quaternary and Tertiary rocks					
Less than 8	35,100	0.60	21,000	0	0
8-12	97,000	.82	79,500	2	1,600
12-16	99,700	1.15	114,700	4	4,600
16-20	12,800	1.46	18,700	10	1,900
Subtotal (rounded)	245,000		234,000		8,000
Areas underlain by Precambrian and Paleozoic rocks					
12-16	6,400	1.15	7,400	10	700
16-20	15,300	1.46	22,300	15	3,300
More than 20	6,600	1.79	11,800	20	2,400
Subtotal (rounded)	28,000		42,000		6,000
Totals (rounded)	273,000		276,000		14,000

Confined ground-water conditions in the igneous and pre-Tertiary rocks are evident from several springs that discharge along faults and fractures in and adjacent to the mountains. The largest springs are the thermal springs, (B-10-18)30bad-S1 and (B-11-19)11dad-S1 (table 13).

Ground water in the younger alluvium moves in the same general direction as the surface streamflow—that is, toward the confluence of Grouse and Etna Creeks, and thence southward toward Lucin (pl. 1). The gradient of the water table beneath Grouse Creek northeast of the Grouse Creek community is about 50 feet per mile, and immediately south of the confluence of Grouse and Etna Creeks and gradient is about 30 feet per mile. At the south line of T. 10 N., R. 18 W., the water-table gradient again steepens and the depth to water increases rapidly with distance from that line. The net gradient from well (B-9-18)16aaa-1 to well (B-8-17)31ccc-1 is about 50 feet per mile.

The direction of ground-water movement in the Quaternary and Tertiary aquifers in most of the valley cannot be determined from existing wells because of their distribution. However, it is assumed that the general direction of movement is toward the axis of the valley and southward toward the mouth of the valley. The assumption is partly confirmed by water levels in wells near the edge of the Grouse Creek flood plain (table 11 and pl. 1).

Storage

Under natural conditions, a ground-water system is in dynamic equilibrium; long-term average annual recharge and discharge are equal, and the amount of ground water in transient storage remains nearly constant. Withdrawal of water from wells has locally altered this natural balance in Grouse Creek valley.

Water-level fluctuations.—Year-to-year changes in ground-water storage are indicated by the corresponding changes in the water levels in wells. Water levels rise when recharge exceeds discharge, and conversely the water levels decline when discharge is greater than recharge. Water levels in observation wells that have been measured in Grouse Creek valley since 1935 are plotted in figure 6. These graphs indicate that prior to the period 1952-54 water-level trends generally followed precipitation trends. In the wells with long records of water levels small but general rises occurred during 1936-52 when annual precipitation was generally above average. The graphs show, moreover, that water levels in the upper parts of the valley, as in T. 12 N., apparently have not been affected by subsequent pumping in downstream areas. The seasonal fluctuations of the water levels in the upper valley are interpreted as direct and rapid response to seasonal changes in streamflow. For example, note the rapid spring rise and subsequent summer and fall decline of the water level during 1952 in well (B-11-18)22acb-1. A similar example is the annual high levels in the spring and low levels in the fall that produce a saw-tooth graph in the hydrograph for well (B-12-18)35daa-1. Both of these wells are close to Grouse Creek.

Near the confluence of Etna and Grouse Creeks an intermediate condition exists. Wells have been pumped in the area since 1948, but the quantity of water pumped depends in part on the quantity of surface water available for irrigation. The water level in well (B-11-18)33adb-1 declined during some years in response to pumping, but during 1964-65 when precipitation and runoff were above average, water levels rose.

The effects of greater precipitation on water levels downvalley during 1964-65 also are evident on the hydrographs, as for well (B-10-18)33aaa-1; but there the effect is superimposed on a general decline of water levels in Tps. 9 and 10 N., caused by pumping that started in the early 1950's. The recorded net decline in this area ranges from about 5 feet to about 30 feet. The hydrographs for wells in T. 10 N. also show that little or no local recharge to the aquifer occurs. Spring and fall levels do not show a seasonal trend because streamflow and diversions to the area are relatively insignificant. Rises of water level in the heavily pumped area are related to cessation of pumping during periods of increased precipitation.

Estimated storage.—The estimate of recoverable ground water in storage is based on conditions inferred from the water-level fluctuations and from well logs, and it is made only for the lower areas of the valley because the subsurface geologic conditions are not well enough known to provide a basis for estimating storage in the entire valley. For the purpose of the estimate, the water-bearing material included (1) saturated younger alluvium (channel fill) and (2) staurated older sedimentary rocks of Quaternary and Tertiary age that are adjacent to the channel fill.

The volume of saturated channel fill was calculated by assuming three segments, one in upper Grouse Creek, one in Etna Creek, and one in the main valley below the confluence of the two creeks. The total estimated volume of saturated channel fill is 4.3 billion cubic feet, and its estimated average specific yield is 15 percent. Therefore, the estimated volume of recoverable water in storage is about 15,000 acre-feet which probably is conservative.

The saturated older beds adjacent to and beneath the channel fill occupy an area of at least 110 square miles. The thickness is not known. The specific yield of the older beds is estimated to be about 2 percent. Within the 110 square miles (70,400 acres) dewatering 100 feet of the older beds would yield 70,400 x 100 x 0.02 = 140,800 acre-feet of water.

The estimated recoverable ground-water in storage in the younger alluvium and the adjacent rocks is about 160,000 acre-feet (rounded). The figure probably is conservative because the total ground-water reservoir in Grouse Creek valley is far thicker that 100 feet and greater in areal extent than the figure used for the estimate. However, the estimate demonstrates that the easily recovered water in the channel fill is only a small part of the ground water in storage.

The recovery of 160,000 acre-feet of water, however, would require an extensive network of wells to accomplish the required dewatering, and during a period of 25 years would yield 6,400 acre-feet per year. This yield from storage assumes a steady withdrawal of water during the period. In times of drought, a larger draft on ground-water storage could be made to offset deficiencies of streamflow, and in periods of above-normal precipitation the ground-water draft could be diminished. This system already is practiced to some extent where both wells and streamflow are used.

Discharge

Ground water is discharged from the aquifers in Grouse Creek valley by evapotranspiration, by wells, and by subsurface outflow to the Great Salt Lake Desert area. Of the estimated 15,000 acre-feet discharged in 1967, 11,000 acre-feet was consumed by evapotranspiration, 2,000 acre-feet was withdrawn by wells, and 2,000 acre-feet was discharged by subsurface outflow. The figure for evapotranspiration includes all the water discharged by springs; the spring water is entirely consumed by evapotranspiration and a separate determination of spring discharge was not practicable for this reconnaissance. About one-half of the withdrawal from wells (1,000 acre-feet) is believed to be water diverted from natural discharge; the remaining 1,000 acre-feet presumably came from storage in the aquifer.

Evapotranspiration.—An estimated average of 11,000 acre-feet of ground water is discharged annually by transpiration from native and cultivated vegetation, by evaporation from small open bodies of water, and by evaporation from soils in Grouse Creek valley. The approximate area of ground-water discharge by ET (evapotranspiration) is shown on plate 1. The area is divided into four parts (table 8) based on the depth to water and the type and relative density of phreatophytic vegetation.

Ground-water discharge by ET is greatest in the bottom land along Grouse and Etna Creeks near and upstream from their confluence. Much of this area is agricultural land that is used mainly to produce fodder from meadowgrasses and the cultivated phreatophyte alfalfa *(Medicago sativa)*. The principal native phreatophytes are meadowgrass, greasewood *(Sarcobatus vermiculatus)*, which grows along margins of fields and on adjacent slopes, and willow *(Salix* sp.), which grows in dense thickets in meadows and along waterways where cultivation is

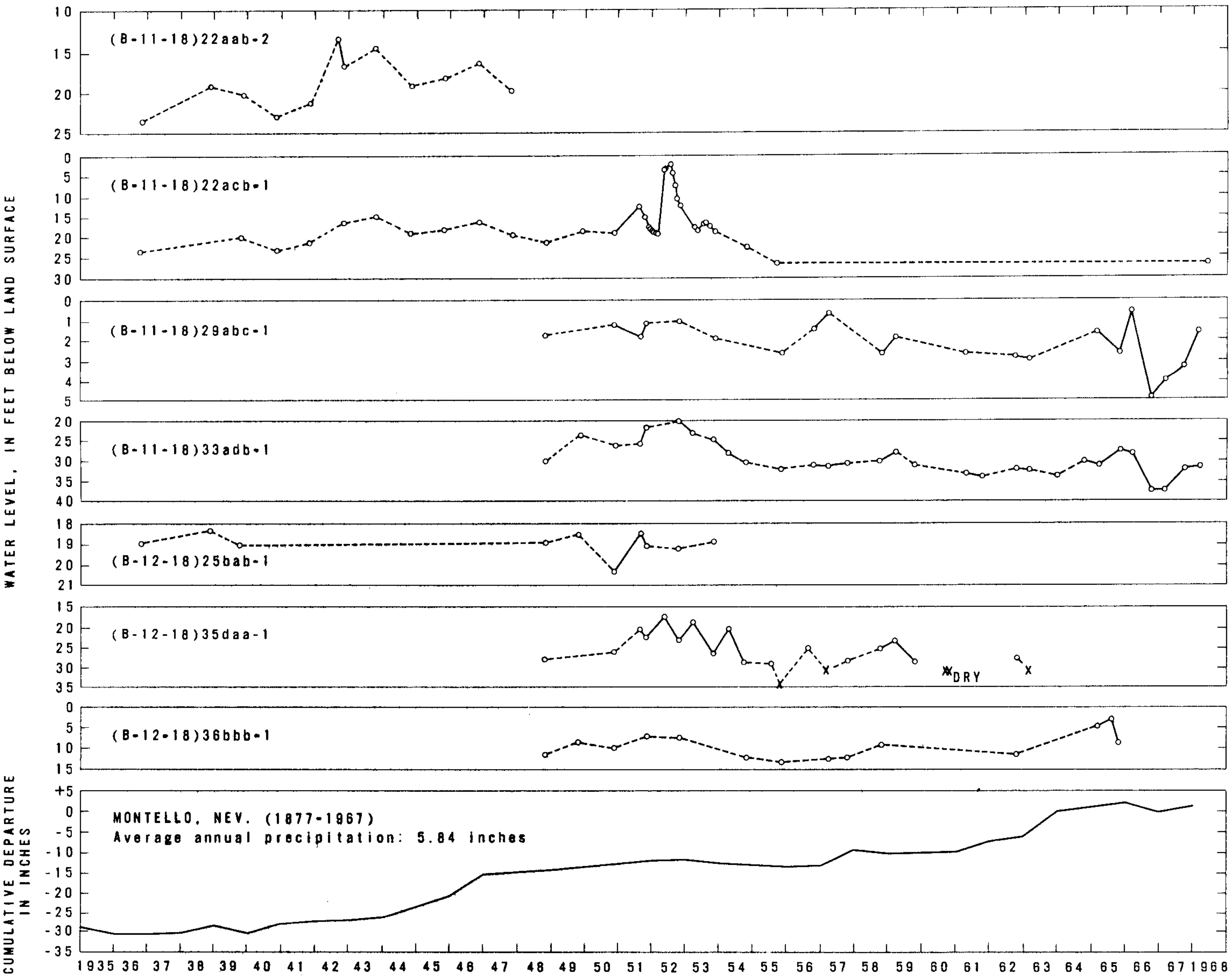


Figure 6.—Water levels in selected observation wells in Grouse Creek valley and the cumulative departure from the 1877-1966 average annual precipitation at Montello, Nev.

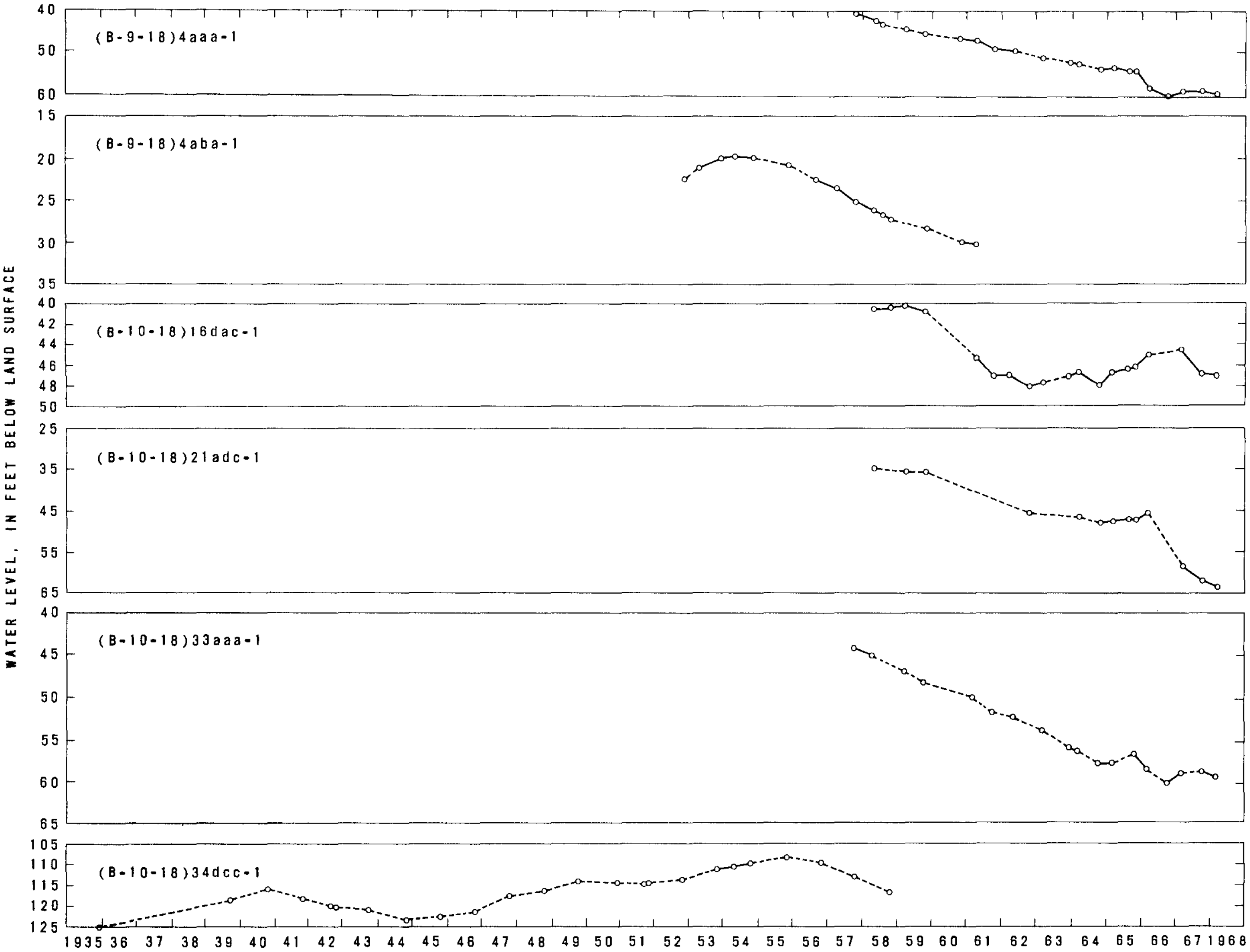


Figure 6.—Water levels in selected observation wells in Grouse Creek valley and the cumulative departure from the 1877-1966 average annual precipitation at Montello, Nev. cont.

Table 8.—Estimated average annual ground-water discharge by evapotranspiration in Grouse Creek valley

Terrain and phreatophytes (see pl. 1.)	Area (acres)	Depth to water (feet)	Average annual evapotranspiration	
			Acre-feet per acre	Acre-feet (rounded)
Bottom land in north end of valley, in both Grouse and Etna Creeks. Meadowgrass supplied by both ground water and streamflow. Cultivated fields of alfalfa with surface-water irrigation. Local dense thickets of willow and concentrations of greasewood and (?) rabbitbrush.	9,900	0-30	0.80	7,900
Bottom land in central part of valley and small tributary valleys. Moderate to sparse greasewood. Some areas cleared for irrigation, where some alfalfa is grown. Small upland tributary valleys contain willow and grasses sustained (?) by springflow.	5,900	20-50	.20	1,200
Western slope of main valley. Sparse greasewood growing among moderate to dense sage. Locally dense vegetation in small areas adjacent to larger tributary streams.	7,200	20?- more than 50	.10	700
Owl and Rabbit Springs area. Sparse to locally dense growth, mainly greasewood.	2,300	0- (?)	.50	1,200
Total (rounded)	25,000			11,000

impracticable. The water table in most of this area is shallow, and surface water is diverted for irrigation. The maximum rate of discharge by ET occurs where the water table is near the land surface, as at well (B-11-18)29abc-1, where the water level was 1.5 feet below the land surface in March 1968 (table 11) and at the land surface during part of the irrigation season.

The estimated quantities and rates given in table 8 are for actual evapotranspiration; the PE (potential evapotranspiration) is greater. The PE is the quantity of water that would be used if adequate water were continuously available and is a function of several natural factors. The PE for Grouse Creek valley was estimated using the Blaney-Criddle method (Cruff and Thompson, 1967, p. M15-M16, M26-M27) and the mean monthly temperature at Kimber Ranch; the PE is 41 inches, or nearly four times the average annual precipitation at Grouse Creek.

The estimated 11,000 acre-feet of ground-water discharged by ET accounts for 80 percent of the estimated recharge. The average ET in the 25,000 acres of area shown on plate 1 amounts to 5.3 inches per acre; this amount is 13 percent of the PE, and together with the average annual precipitation at Grouse Creek amounts to only 40 percent of the PE.

Subsurface outflow.—Ground-water outflow from Grouse Creek valley to the Great Salt Lake Desert is estimated to be 2,000 acre-feet per year. This computed amount probably discharges through the Salt Lake Formation and is based on an estimated coefficient of transmissibility of 5,000 gallons per day per foot, a section 7 miles wide, and the water-table gradient of 50 feet per mile between wells in the central part of the valley and well (B-8-17)31ccc-1.

Withdrawal from wells.—The estimated average withdrawal of water from wells during the 3-year period 1964-66 was 1,500 acre-feet per year, and the withdrawal in 1967 is estimated to have been about 2,000 acre-feet.

More than 60 wells have been dug or drilled in Grouse Creek valley. About one-half of the wells, including 17 irrigation wells, were used in 1968. At least two of several reported flowing wells still flowed in 1968.

The largest withdrawal of ground water in Grouse Creek valley is for irrigation. The estimated annual rate of withdrawal, based on partial records of power consumption and well discharge, fluctuated between 1,300 and 2,000 acre-feet during the 4-year period 1964-67.

An estimated 200 acre-feet of ground water is required annually for domestic and stock use. About 50 acre-feet is withdrawn from wells and about 150 acre-feet, including water used by the Grouse Creek community, is discharged by springs.

Ground-water budget

The ground-water budget for Grouse Creek valley is summarized in table 9. The difference of 1,000 acre-feet between discharge and recharge is believed to be due to withdrawal of water by wells from storage in the aquifer.

Perennial yield

In this report series the perennial yield of a ground-water reservoir is defined as the maximum amount of water of suitable chemical quality that can be withdrawn economically each year for an indefinite period of years without causing a continuing depletion of storage. The perennial yield cannot exceed the natural discharge; moreover, the yield will be limited by the amount of natural discharge that can be economically salvaged for beneficial use.

The maximum amount of ground water available for use on a perennial basis is 14,000 acre-feet. Of this amount, very little of the 2,000 acre-feet of subsurface outflow (table 9) could be salvaged economically. The perennial yield, therefore, is approximately 12,000 acre-feet, of which 8,000 acre-feet is used beneficially in cultivated fields and pastures. In 1967, an additional 1,000 acre-feet was diverted to wells. The remaining 3,000 acre-feet might be salvaged by lowering water levels in the valley. A planned network of wells would be needed to achieve the lowering, and the pumping of the wells would to some extent affect supplies now being used beneficially in the valley bottom land.

Chemical quality of the water

All natural water contains dissolved mineral matter. Water which falls as precipitation contains minute amounts, and additional mineral matter is dissolved as the water moves across

Table 9.—Ground-water budget for Grouse Creek valley

Item	Estimated quantity of water, in acre-feet per year
Recharge (table 7)	14,000
Discharge	
Evapotranspiration (table 8)	11,000
Subsurface outflow (p.25)	2,000
Withdrawal from wells (1967, p. 25)	2,000
Total discharge (rounded)	15,000

the land surface or percolates through the ground. The amount and chemical character of the minerals dissolved by the water depend upon the nature of materials it contacts and the duration of contact. The water is further mineralized or changed chemically as the result of its use by man (consumptive use for irrigation and soil leaching), its use by natural vegetation (evapotranspiration), or by chemical interaction with minerals in the soils (ion-exchange). The total concentration of dissolved minerals and the concentrations of individual ions will determine the usefulness of the water for various purposes.

Chemical analyses (table 14) were obtained for water from 14 wells, seven springs, and five streams in the Grouse Creek drainage basin. The specific conductance of water from two other streams, one well, and three springs are given in tables 5, 11, and 13, respectively. Locations of the water-sampling sites and the general chemical quality of water in its source area are shown on plate 1.

All the samples were calcium bicarbonate water, except three ground-water samples from the south end of the valley, which were sodium bicarbonate water. All but one sample were fresh and the concentration of dissolved solids ranged from 208 to 933 mg/l (milligrams per liter); the one sample contained 1,100 mg/l and is classified as slightly saline.

All the water sampled in Grouse Creek valley was chemically suitable for stock use. Concentrations of the major constituents in all but one sample are within the maximum limits recommended by the U. S. Public Health Service (1962) for domestic use; in the one sample of slightly saline water, the concentration exceeded the maximum recommended for dissolved solids. All the water, however, was moderately hard to very hard according to the following classification used by the U. S. Geological Survey.

Hardness range (mg/l)	Adjective rating
0-60	Soft
61-120	Moderately hard
121-180	Hard
181-	Very hard

All the water samples analyzed were suitable for irrigation of crops that have a moderate to high salt tolerance. According to the U. S. Salinity Laboratory Staff (1954, p. 69), the characteristics most important in determining the suitability of water for irrigation of plants are: (1) the concentration of boron (B) and other toxic elements; (2) the concentration of dissolved solids, as indicated by the specific conductance (conductivity), which determines the salinity hazard; and (3) the relative proportion of sodium (Na) to other cations in the water, as indicated by the SAR (sodium-adsorption ratio), which determines the sodium hazard.

According to Wilcox's classification (1948), the most boron-sensitive plant can withstand concentrations of 0.33 mg/l of boron. None of the six samples for which boron was determined (table 14) contained more than 0.33 mg/l of boron.

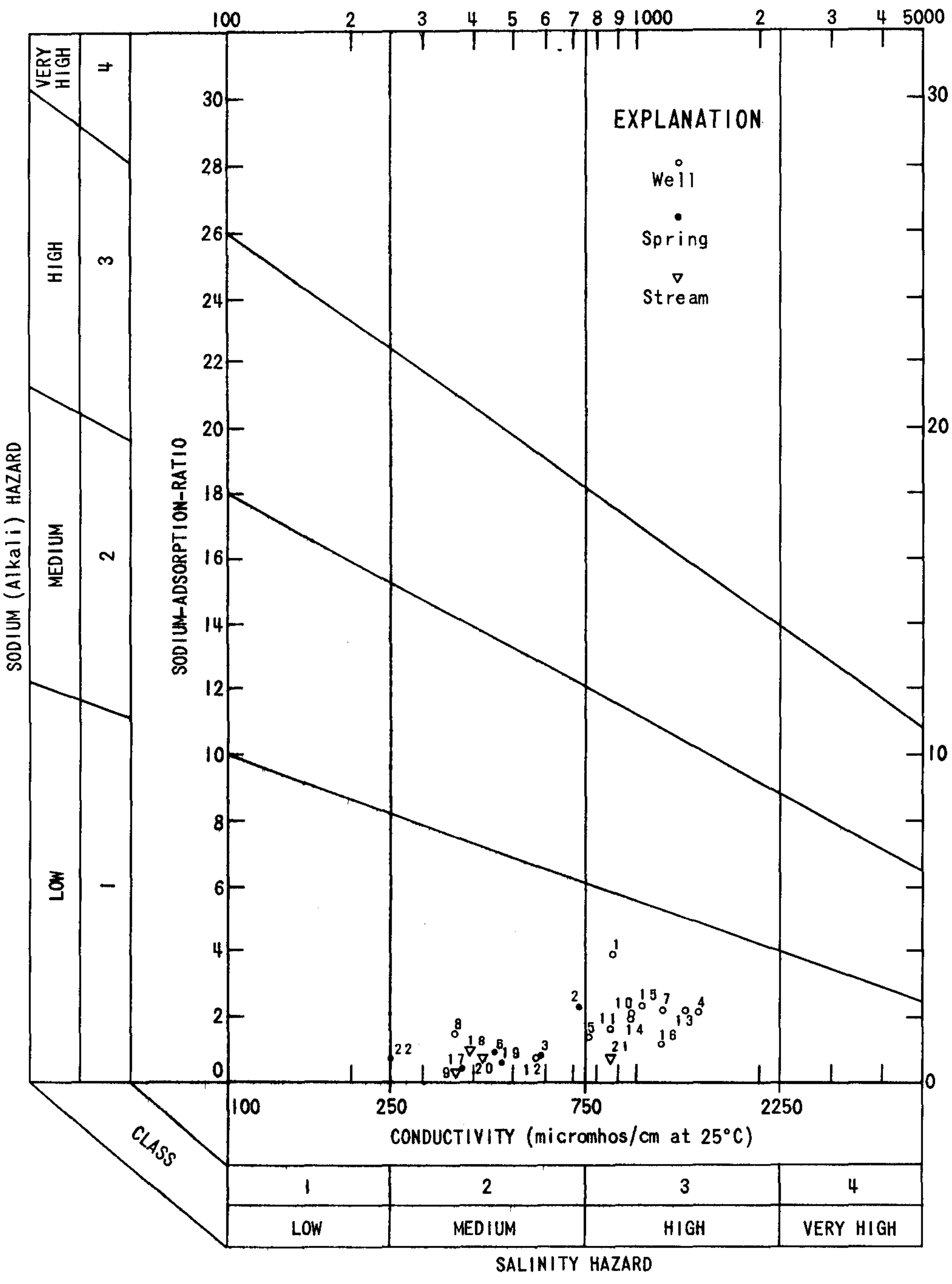
The salinity hazard and sodium hazard are judged by plotting the values for specific conductance and SAR on a diagram (fig. 7) developed by the U. S. Salinity Laboratory Staff (1954, p. 79-81). Water with low salinity and sodium hazards can be used on nearly all soils with little harmful effect on either the soil or the crops, whereas water with high salinity and solium hazards is unsuitable for any soil or crop except under special conditions. The classification is based on "average conditions" with respect to soil texture, climate, drainage, and salt tolerance of crops.

The samples having the lowest specific conductances were from Little Pole Creek (table 5) near the crest of the Grouse Creek Mountains and Dairy Valley Springs (point 22 in fig. 7). These samples show that direct runoff from the mountain areas and many upland springs yield water with low to moderate salinity hazard.

Water from wells and springs in the valley have a moderate to high salinity hazard. Water samples having the highest specific conductances were obtained from wells finished in the younger alluvium near and below the confluence of Grouse and Etna Creeks. The relatively large mineral content of water in the shallow aquifer is due mainly to increase in mineral concentration as a result of removal of pure water by evapotranspiration, leaving minerals behind. In the southern part of T. 10 N., a part of the mineral content may be due to the leaching of soils that have been irrigated since 1952.

All water samples from the drainage basin had a low sodium hazard (fig. 7). The SAR, however, indicates that the sodium concentration relative to other cations increases from the source areas in the mountains downgradient to the valley and thence to the Great Salt Lake Desert. The sodium bicarbonate waters sampled at the south end of the valley represent in part water moving out of the valley and probably have derived a part of their sodium concentrations by base exchange in the ground-water aquifers.

The temperature of water within the Grouse Creek drainage basin is related to the air temperature. The annual average air temperature in the valley ranges from 44.7°F (7°C) to 47.6°F (9°C), and most wells and springs in the valley yield water a few degrees warmer. Two springs, however, are thermal according to the definition by White (1957). Kimber Spring, (B-10-18)30bad-S1, has a water temperature of 20°C (68°F) and spring (B-11-19)11dad-S1 has a water temperature of 42°C (107°F). Both springs issue from or near structurally deformed igneous rocks. The source of heat in the thermal waters may be residual heat from the igneous rocks, heat generated by faulting, or both.



No.	Location of sampling site
1	(B-8-17)31ccc-1
2	(B-8-18)14dbb-S1
3	(B-10-17)15ccb-S1
4	(B-10-18)9abb-1
5	28ddd-1
6	30bad-1
7	33aaa-1
8	(B-11-18)2ccd-2
9	6bcb
10	10aac-1
11	22aab-1
12	27baa-1
13	33ada-1
14	33ada-1
15	33adb-1
16	33bdc-1
17	(B-11-19)11dad-S1
18	(B-12-17)29bda
19	(B-12-18)32aad-1
20	(B-13-17)29acc
21	(B-13-18)34acc
22	43/70-20acc1

(See table 14 for analytical data)

Figure 7.—Classification of water fro irrigation in Grouse Creek valley.

SUMMARY OF WATER SUPPLY

The total supply of water in the Grouse Creek drainage basin is derived from precipitation, which is estimated to average 276,000 acre-feet annually. Of this total amount, all but an estimated 1 percent ultimately is consumed by evapotranspiration. The water that is not consumed consists of a small quantity of runoff and about 2,000 acre-feet of ground-water outflow.

The estimated average annual supply of water in Grouse Creek valley is 21,000 acre-feet (average annual runoff plus average annual ground-water recharge). The estimated average annual yield that can readily be diverted to man's use is 17,000 acre-feet (5,000 acre-feet of runoff, 8,000 acre-feet of beneficially used evapotranspiration, 3,000 acre-feet of nonbeneficial evapotranspiration subject to salvage, and 1,000 acre-feet of well water that probably was diverted from evapotranspiration in 1967).

The available water supply could be augmented with about 6,000 acre-feet per year of ground water pumped from storage, but at the end of 25 years water-level declines might amount to 100 feet or more locally. Such withdrawals would affect existing beneficial uses to an extent presently unknown.

SUMMARY OF WATER USE

The Grouse Creek drainage basin contains about 273,000 acres of land, of which about 270,000 acres are grazing lands. Water needs in this large area are relatively small and are satisfied from streams and springs and a few wells. The largest use of water is for irrigation of farms and pastures that have been developed in the valley bottom lands.

Past and present development

The continuous use of the waters of Grouse Creek valley for domestic and agricultural purposes began when the first permanent settlers moved to the vicinity of Etna in 1875 and established ranches on the natural meadows (Fosgren, no date, p. 298-300). Cookesville (now called Grouse Creek) was established in 1877, and the first (?) well was dug there in 1878. In 1909, a water company began delivering water from Buckskin Springs to the homes of 30 farmers in the Grouse Creek community; the system still is in use and is the only public-supply system in the valley.

The earliest farming development was a wheat crop in 1877 (Fosgren, p. 298-300). By the early 1900's a small rock dam on Etna Creek was used to divert streamflow (Packer, 1967, p. 48-49). Richards, Davis, and Griffin (no date, p. 4-6) list two formally organized irrigation companies in operation in Grouse Creek valley. The West Fork Grouse Creek Irrigation Co. uses the Etna Reservoir north of Etna and in 1963 supplied water to 1,103 acres. The present dam was completed in 1959. The East Grouse Creek Water Co. was incorporated in 1905 and in 1963 supplied 1,200 acres of land with water diverted from Pine, "Middle," and Cotton Creeks.

The irrigation supplies for the valley thus were obtained from streamflow for many years. Distribution was made mainly through unlined ditches, with consequent conveyance losses, that locally accounted for as much as 80 percent of the water diverted into the ditch (Packer, 1967, p. 46). Not all of the land irrigated receives a full supply of water every year; and in years of heavy precipitation, these lands are heavily watered until the stored supply is used.

In order to supplement the supply from streamflow, large-diameter wells were drilled. The effort started in 1948 near the confluence of Etna and Grouse Creeks and near the Grouse Creek community (table 12), but some of the wells were drilled in the 1950's in the area extending as far south as T. 9 N., R. 18 W. The conditions found led to the construction mainly of shallow wells, some of which are overpumped with the result that they "break suction" or surge.

The lands that are irrigated (1967-68) in Grouse Creek valley extend from the south end of T. 10 N., northward into T. 12 N. Most lands in T. 10 N. are irrigated with water from wells. Lands in the southern part of T. 11 N. are irrigated with water from both streams and springs and on some farms from wells. Lands in T. 12 N. are mainly small tracts along stream bottoms and are supplied with stream and spring flow. Some lands in Tps. 12 and 13 N. are hay meadows and pastures that are naturally supplied with very shallow ground water.

In 1966, the Utah State Engineer completed a hydrographic survey of the valley preparatory to the adjudication of water rights. This survey is based on field mapping in 1958; the maps show the following acreages (rounded) in use or claimed:

Part of valley	Cultivated areas (acres)	
	Claimed as actively used	Dry [1]
Grouse Creek above confluence with Etna Creek	1,980 [2]	350
Etna Creek above confluence	1,060 [2]	270
Main stem of Grouse Creek below confluence	420	210
Totals	3,460	830

[1] Includes lands no longer having water rights and probably some land that was unused in 1958.

[2] Includes some tracts of pasture and hay lands that have natural shallow ground-water supplies in the upper parts of the valley.

Packer (1967, p. 46) indicates that about 750 acres along Etna Creek and about 1,300 acres along Grouse Creek receive surface-water supplies during most years. These lands, together with about 400 acres irrigated from wells, amount to about 2,400 acres.

Future development

Further development of wells in presently (1968) irrigated areas in Grouse Creek valley will add to the local depletion of ground-water storage. Large parts of the valley, however, are untested; these areas, along the slopes above the Grouse Creek bottom land, are underlain by the Salt Lake Formation and older rocks, and they appear to be areas for the potential development of additional water supplies. Records of two wells, (B-11-18)27baa-1 and (B-11-18)33bdc-1, indicate that the Salt Lake Formation in some areas contains productive aquifers and that large yields are possible.

None of the valley south of T. 10 N. has been sufficiently explored by drilling to evaluate the water-bearing formations. The meager available data suggest, however, that the southern part of the valley also is an area of potential development, but that initial pumping lifts would be more than 100 feet, and individual well yields probably would be 400 gallons per minute or less. At the southern end of the valley, on the edge of the Great Salt Lake Desert, water of fair chemical quality for irrigation is available at least locally, but the soils may not be suitable for farming and should be evaluated.

DATA NEEDED FOR ADDITIONAL STUDIES

A detailed water-resources investigation is needed to refine the estimates given in this reconnaissance. Such a study should include the following considerations:

1. Completion of detailed geologic mapping. A systematic study of the rocks is needed to evaluate the hydrologic framework.

2. Field and laboratory tests to determine the hydrologic properties of the principal aquifers.

3. Records of streamflow. Recording gages should be installed above diversions or impoundments on all major tributaries to Grouse Creek. Partial-record stations are needed on large ephemeral streams, such as Grouse Creek near Lucin, to aid evaluation of runoff. Periodic measurements are needed during the snowmelt period and during the low-water period to determine stream losses into the alluvium and other rocks. Detailed analysis of the diversion and delivery of water in the existing irrigation systems is needed to provide part of a firm water budget.

4. A detailed inventory of the ground-water sources. An inventory of springs, including chemical analyses of the water, is especially important. Detailed data are needed on the hydraulic characteristics of the springs and existing wells. Annual and seasonal pumpage data should be accumulated.

5. Supplemental data for analysis of the hydrology. These include climatologic data in both valley and mountains, botanic mapping to aid in evaluating evapotranspiration, and soil studies.

6. Test drilling. After study and analysis of existing records and surface conditions, the drilling of several test holes may be justified to aid in geologic and hydrologic analysis, particularly of the Salt Lake Formation.

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APPENDIX

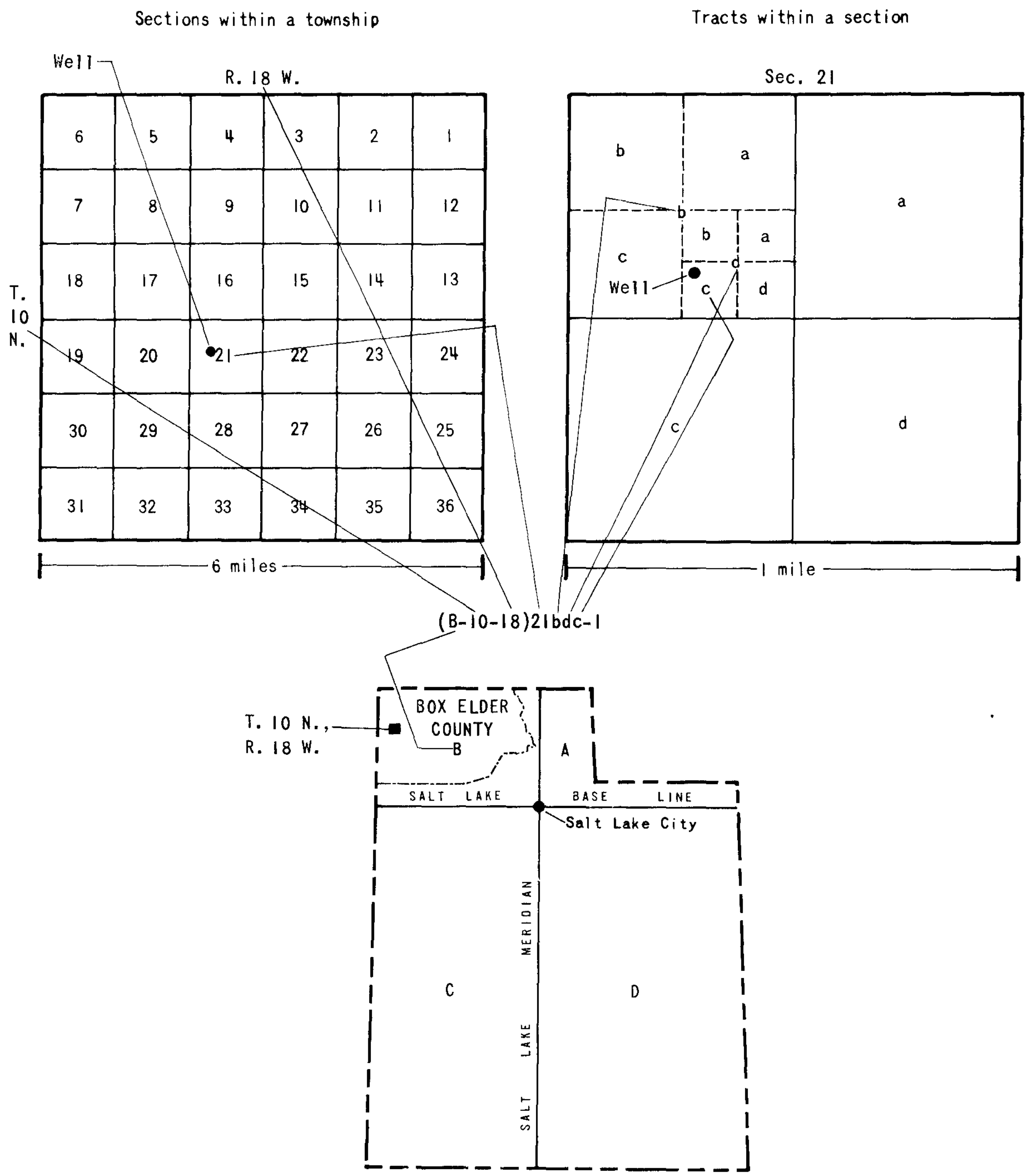

Figure 8.—Well- and spring-numbering system used in Utah.

Well- and spring-numbering system

In this report the number assigned to a well or spring is both an identification number and a location number. The number is based on the common method of subdividing Federal Lands of the western United States. In Utah, the numbers are referenced to the Salt Lake Base Line and Meridian, and in Nevada to the Mount Diablo Base Line and Meridian.

Utah is divided into four quadrants by the Salt Lake Base Line and Meridian (see fig. 8). These 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 (B-10-18)21bdc-1, in Box Elder County, is in the SW¼SE¼NW¼ sec. 21, T. 10 N., R. 18 W., and is the first well constructed or visited in that tract.

When the serial (final)number is preceded by an "S" the number designates a spring; for example, Owl Spring is (B-8-18)14dbb-S1 (table 13). In this report, when no serial number is suffixed to a location for a 10-acre tract, the number designates the location of a surface-water data or sampling site; for example, see (B-11-18)6bcb, Morse Canyon Creek (table 5).

A typical Nevada number consists of three elements. The first is the township north of the Mount Diablo Base Line; and the second element, separated from the first by a slant line, is the range east of the Mount Diablo Meridian. The third element, separated from the second by a dash, is the section in the township, and the section number is followed by three lowercase letters that indicate the section subdivisions in the same manner as for those in Utah; finally the letters are followed by a number that indicates the order in which the well or spring was recorded in the 10-acre tract.

Use of metric units

In this report, the units which indicate concentrations of dissolved solids and individual ions determined by chemical analysis and the temperatures of water are reported in metric units rather than English units. This change has been made a part of a gradual change to the metric system that is in general use by the scientific community. The change is intended to promote greater uniformity in reporting of data.

Concentrations of chemical constituents are reported in milligrams per liter (mg/l). For concentrations less than 7,000 mg/l the numbers reported are the same as for concentrations in parts per million (ppm), the units used in earlier reports in this series.

Water temperature is reported in degrees Celsius (centigrade or °C), but the customary English unit, in degrees Fahrenheit (°F), follows in parentheses. The following conversion table will help to clarify the relation between degrees Fahrenheit and degrees Celsius.

Water temperature is reported in degrees Celsius (centigrade or °C), but the customary English unit of degrees Fahrenheit (°F) follows in parentheses in the text. Air temperature is reported in °F, but the equivalent temperature in °C follows in parentheses in the text for easier comparison with water temperature in tables. The reporting of temperatures in both metric and English units is done to assist those readers who are not familiar with the Celsius temperature scale. The following conversion table will also help to clarify the relation between degrees Fahrenheit and degrees Celsius:

TEMPERATURE-CONVERSION TABLE

For conversion of temperature in degrees Celsius (°C) to degrees Fahrenheit (°F). Conversions are based on the equation, $°F = 1.8°C + 32$; Temperatures in °F are rounded to nearest degree. Underscored equivalent temperatures are exact equivalents. For temperature conversions beyond the limits of the table, use the equation given, and for converting from °F to °C, use $°C = 0.5556\ (°F - 32)$. The equations say, in effect, that from the freezing point (0°C, 32°F) the temperature rises (or falls) 5°C for every rise (or fall) of 9°F.

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
-20	-4	-10	14	0	32	10	50	20	68	30	86	40	104
-19	-2	-9	16	+1	34	11	52	21	70	31	88	41	106
-18	0	-8	18	2	36	12	54	22	72	32	90	42	108
-17	+1	-7	19	3	37	13	55	23	73	33	91	43	109
-16	3	-6	21	4	39	14	57	24	75	34	93	44	111
-15	5	-5	23	5	41	15	59	25	77	35	95	45	113
-14	7	-4	25	6	43	16	61	26	79	36	97	46	115
-13	9	-3	27	7	45	17	63	27	81	37	99	47	117
-12	10	-2	28	8	46	18	64	28	82	38	100	48	118
-11	12	-1	30	9	48	19	66	29	84	39	102	49	120

Table 10.—Selected stations at which climatological data have been collected in the Grouse Creek region

Station	Location		Altitude (feet)	Period of record	Type of record	Remarks
	Lat	Long				
Grouse Creek, Utah	41°43'	113°52'	5,324	5- -90 to 10 -95	P, T	No description available.
Do.	41°43'	113°52'	5,324	5- -10 to 12 -15	P, T	About one quarter of a mile northeast of Grouse Creek Post Office.
Do.	41°45'	113°52'	5,350	5-19-35 to 4-14-38	P, T	About 3½ miles north of Post Office.
Do.	41°43'	113°52'	5,324	6-17-38 to 7-29-39	P, T	At Post Office.
Grouse Creek-Kimber Ranch	41°33'	113°56'	5,050	4- -59 to 5- -65	P, T	At Kimber Ranch 12 miles south-southwest of Post Office.
Grouse Creek	41°41'	113°53'	5,270	5- -65 to -	P, T	Near Post Office (300 ft southwest). Station reporting in 1967.
LeMay, Utah	41°18'	113°31'	4,221	3- -11 to 3- -31	P, T	North of Post Office 50 ft; record incomplete.
Lucin, Utah	41°21'	113°55'	4,478	4- 1-05 to 5- -20	P, T	Near railroad station; discontinuous record to 1913.
Do.	41°21'	113°55'	4,478	5- 20 to 5-17-35	P	North of railroad station (100 ft); partial record 1919.
Lucin CCC Camp	41°25'	113°53'	4,500	12-16-40 to 6-30-42	P	Northeast of railroad station 6 miles.
Lucin AP	41°22"	113°50'	4,413	6-24-44 to 6-30-55	P, T	At airport (old CAA station) about 3½ miles northeast of Lucin railroad station.
Montello, Nev.	41°19'	114°05'	4,812	7- -77 to 8-22-21	P, T	Northeast of Montello 7 miles; known as Tacoma station.
Do.	41°16'	114°12'	4,877	9- 1-21 to -	P, T	Near Montello Post Office (270 ft southeast). Station reporting in 1967.
Oakley, Idaho	42°15'	113°54'	4,533	8- -93 to 5- -34	P, T	About 1 mile north of Oakley.
Do.	42°14'	113°54'	4,600	6- -34 to -	P, T	About 0.1 mile southwest of Oakley. Station reporting in 1967.
Park Valley, Utah	41°49'	113°21'	5,613	1- -11 to 5- -51	P, T	Record intermittent, 1913.
Do.	41°49'	113°20'	5,620	5- -51 -	P, T	Record intermittent, 1951. Station reporting in 1967.
Terrace, Utah	41°30'	113°38'	4,544	1- -70 to 8- 04	P	Record intermittent 1873, 1888, 1904. At station on Southern Pacific Co. railroad.
Wendover WBAP, Utah	40°44'	114°02'	4,237	6- -11 to -	P, T	Weather Bureau station at airport. At west edge of Great Salt Lake Desert, 1 mile southeast of Post Office. Record combines data from more than one location. Detailed data for station available from U.S. Weather Bureau. Station reporting in 1967.

BASIC DATA

Table 11.—Records of selected wells in Grouse Creek valley

Well No.: See appendix for description of well-numbering system.
Utah State Engineer numbers: A, application; C, claim; WDR, well driller's report.
Type of well: C, drilled with cable-tool (percussion) equipment; D, dug.
Water-bearing zone: Character of material - B, boulders; C, conglomerate; G, gravel; 4G, coarse gravel; JF, fractured shale; R, sand and gravel; S, sand; V, sandstone; Z, other.
Altitude above mean sea level: Interpolated from U.S. Geological Survey and Army Map Service topographic maps and from Coast and Geodetic Survey benchmark records.
Water level: Levels measured by the U.S. Geological Survey or the Utah State Engineer given in feet and tenths; reported levels given in feet.
Type of pump: C, centrifugal; N, none; P, piston (plunger or cylinder); S, submersible; T, turbine. Where pump type is given, power is electric motor except H, hand, or W, wind. Number in parentheses indicates horsepower.
Well performance: Yield - E, estimated; M, measured by U.S. Geological Survey or Utah State Engineer personnel; R, reported by owner or driller; F, yield by natural flow. Drawdown - accuracy is same as for yield.
Use of water: H, domestic; I, irrigation; S, stock; U, unused.
Remarks and other data available: Miscellaneous observations by U.S. Geological Survey personnel and general information reported by owner or driller. C, chemical analysis in table 14; H, hydrograph of water levels in figure 6; L, driller's log of well in table 12; Perf., casing perforated; Temp., temperature of water in degrees Celsius; UERA, Utah Emergency Relief Administration.

Well No.	Owner or name	Utah State Engineer numbers	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	Type of pump	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use of water	Remarks and other data available
(B-8-17)																	
31ccc-1	Federal Aviation Administration	A-15131 WDR 3423	1944	C	200	8	160	40	S	4,414	-145	6-5-44	T	10R	0	H	Well used very little in 1967-68. Perf. 160-200 ft. Temp. 14. C,L.
(B-9-18)																	
4aaa-1	R. E. Reddon	A-23993	1957	C	-	12	-	-	-	4,935	-40.7	10-18-57	N	-	-	U	Drilled for irrigation. H.
4aba-1	do	A-23993 WDR 9623	1952	C	190	8	51	7	S	4,925	-22 -20.8	11- 8-52 3-31-53	-	515R	23	H	Originally drilled for irrigation. Perf. 48-58 ft. H,L.
4dab-1	do	A-23993	1960	C	112	14	60	47	R	4,895	-	-	-	-	-	U	Casing perforated. L.
16aaa-1	S. Fonnesbeck	A-25711 WDR 11610	1955	C	202	16	96	-	G	4,870	-76 -81	7- 5-55 4-12-68	N	725R	38	U	Perf. 50-? ft. L.
34caa-1	C. J. Eman	A-24208	1952	C	100	-	-	-	-	4,825	-	-	-	-	-	-	Dry hole, abandoned. L.
(B-10-17)																	
4cbc-1	U.S. Bureau of Land Management	-	1935	C	262	6	-	-	V (?)	5,800	-90	2-20-35	N	2R	-	S	UERA well 72. Originally reported to yield insufficient water. Water quality reported "fair." Cased to 82 ft, open end. L.
(B-10-18)																	
9abb-1	M. T. Thompson	A-24238	-	C	65	12	32	28	G	5,050	-	-	T (10)	630R	-	I,S	C,L.
16aba-1	J. B. and Dorothy Kitt	A-19193 WDR 9622	1952	C	52	16	29	23	G	5,000	-29 -47.3	10-20-52 3-21-68	N	500R	9	U	Perf. 29-50 ft. L.
16dac-1	do	A-19194 WDR 12830	1956	C	60	14	42	18	G	5,000	-34	9- 1-56	T	-	-	U	Perf. 40-? ft. Temp. 18. H.
21aab-1	Merlin Tanner	A-19195 WDR 12831 WDR 12772	1956	C	62	14	40	22	R,B	4,980	-36 -38.4	9- 5-56 10-16-57	T (20)	350M	20	I	Perf. 38-? ft. Temp. 20. L.
21adc-1	B. J. G. Wirthlin	A-19195 WDR 13383	1957	C	63	14	36	27	R	4,985	-34 -62.0	6-23-57 10- 5-67	N	-	-	U	Perf. 32-63 ft. H.
21bdc-1	George Farrell	A-19195 WDR 11702	1955	C	66	12	30	34	G,C	5,000	-26	6-14-55	N	700R	24	U	Perf. 26-64 ft. L.
28add-1	-	-	-	D	38	-	-	-	-	4,990	-38	1911	-	-	-	U	Dug before 1911. C.
28baa-1	J. O. Kimber	A-24280 WDR 10832	1954	C	120	16, 12	32 80 112	28 7 3	R R R	4,975	-25 -51	5-15-54 10- 9-65	-	194R	-	I	Originally drilled to 68 ft; deepened to 140 ft in 1965; no water reported below 115 ft; backfilled to 120 ft. Casing: 16 inch to 60 ft, 12 inch from 60 to 120 ft. Perf. 32-118 ft.
28bac-1	do	A-24280 WDR 10557	1953	C	67	16	41	16	G,C	4,980	-35	12-23-53	-	130R	20	I	Perf. 35-? ft. L.
28dab-1	Urban Puyuelo	A-25459 WDR 10833	1954	C	72	16	35	35	R	4,975	-23.6	10-13-54	T (25)	400R 665M	37	I	Perf. 35-? ft.
28dbb-1	do	A-26349 WDR 11608	1955	C	83	12	55	27	G	4,970	-25 -26.4	7-23-55 10-17-57	-	600R	50	I	Casing perforated. Temp. 8.
28ddd-1	do	A-29222 WDR 13136	1957	C	63	10	28	15	G	4,985	-	-	S	12M	-	H,S	Drilled for irrigation. Perf. 0-40 ft. Temp. 12. C.
29cac-1	W. C. Kimber	A-23852 WDR 9694	1952	C	130	16	20	6	B	5,075	-14 -15.6 -14.6	11-15-52 10-13-54 10-17-57	T	70R	-	-	Perf. 15-24 ft. L.
33aaa-1	B. C. Kimber	A-24977 WDR 12771	1956	C	84	12	40	44	R,B	4,980	-38 -44.4 -59.6	9-20-56 10-16-57 3-21-68	T (15)	200M 400E	- -	I	Breaks suction with pump set at 80 ft. Perf. 4-84 ft. Temp. 10. C,H,L.
33aba-1	do	A-24978 WDR 12698	1956	C	92	12	36	51	R	4,975	-24	9-20-56	T (25)	1,130M	-	I	Perf. 0-92 ft. Temp. 20
33acd-1	do	A-24978	1956	C	94	12	30	58	R,B	4,975	-22 -25.5	9-22-56 10-17-57	T (30)	420M	-	I	Perf. 30-? ft.
34dcc-1	U.S. Bureau of Land Management	A-13796	1935	C	252	6	110	42	S	4,990	-125 -118.6	12- -35 9-29-39	P	30R	-	S	UERA well 72-A. Cased to 210 ft. H,L.
(B-11-18)																	
2ccd-1	A. R. Tanner	C-8121 WDR 303	1934	C	369	10, 8	-	-	R,V	5,300	+1.45 +2.35 +2.33 +2.09 +2.64	10-31-35 8-15-36 10- 9-36 10-12-38 9-28-39	N	147RF 10EF	-	S	UERA well. Drilled for Grouse Creek Irrigation Co. Casing: 10 inch to 34 ft, 8 inch 31-369 ft. Perf. 172-180, 190-196, 226-231, 235-245, 280-290, 300-340 ft. L.
2ccd-2	Harold Paskett	A-12757 WDR 7224	1949	C	605	8	285	30	G (?)	5,300	+16	9-19-49	N	25RF	-	-	Perf. 280-310 ft. Temp. 16. C,L.
3aad-1	Sidney Paskett	-	1936	C	665	8, 6	400	5	G	5,330	-31.8 -9.2	10-10-36 10-12-38	N	-	-	-	Drilled to 405 ft in 1936; deepened to 665 ft in 1938. Casing: 8 inch to 278 ft, 6 inch to 665(?) ft; open end. L.
10aac-1	George Paskett	A-19216	1952	C	190	16	17	33	R	5,290	-12 -19.3 -22.7	7-12-52 10-12-54 5-17-68	T (10)	600R 200E	38 -	I	Pump was set at 60 ft with 10 ft of suction; in 1953 and 1954 the pumping level was near end of pump and it was "breaking suction." Owner had to close valve partly to hold discharge steady. Perf. 15-50 ft. Temp. 10. C,L.

Table 11.–Records of selected wells in Grouse Creek valley cont.

Well No.	Owner or name	Utah State Engineer numbers	Year drilled	Type of well	Depth of well (feet)	Diameter of well (feet)	Water-bearing zone: Depth to top (feet)	Water-bearing zone: Thickness (feet)	Water-bearing zone: Charater of material	Altitude above sea level (feet)	Water level: Above(+) or below(-) land-surface datum (feet)	Water level: Date of measurement	Type of pump	Well performance: Yield (gpm)	Well performance: Drawdown (feet)	Use of water	Remarks and other data available
(B-11-18)																	
10aad-1	George Paskett	A-12218	1936	C	300	10,8, 6	50 290 374	16 20 6	G JF (?) G (?)	5,290	+16	9-12-49	N	25RF	-	S	Drilled to 380 ft in 1936; backfilled to 300 ft in 1949; salt water reported in zone 330-337 ft. Specific conductance was 310 micromhos per cm at 25°C on 5-17-68 when well was found flowing. Cased to 290 ft, open end. L.
22aab-1	David Paskett	A-19205	1952	C	34	12	10	22	4G	5,195	-7 -19.8	9-30-52 10-13-54	T (10)	500R	23	I,S	Breaks suction with pump set near bottom of well. Perf. 10-32 ft. Temp. 10. C,L.
22aab-2	Annie L. Paskett	-	-	D	24	48	-	-	4G	5,195	-23.6	10-10-36	-	-	-	U	Gravel is well sorted and round; up to 4 inches in diameter; under 16 ft of clay. Water level in 1946 rose to about 3 ft due to nearby surface-water irrigation. Open-end casing. H.
22aca-1	R. Kimber, Sr.	C-5775	1931	D	28½	54	-	-	-	5,160	-	-	-	-	-	S	Open-end casing.
22acb-1	do	-	1934	D	26½	48	-	-	-	5,160	-23.7	10-10-36	P	-	-	H,S	Open-end casing. H.
27baa-1	W. S. Thomas	A-19557	1955	C	367	16	52	12	R	5,150	-52	10- 7-55	T (75) S	755M	-	I,S	Perf. 77-? ft. C,L.
29abc-1	R. D. Warburton and sons	A-18088 WDR 6234	1948	C	60	16, 12	12	10	4G	5,112	-1.8 -1.5	10-23-48 3-21-68	T (5)	670R 345M	33 -	I	Casing: 16 inch to 42 ft, 12 inch 32-60 ft. Perf. 0-60 ft. H,L.
29abd-1	do	A-18088 WDR 9487	1952	C	25	16	13	9	G	5,110	-2 -4.0	8-15-52 10-13-54	T (7½)	-	-	I	Perf. 9-? ft.
32adb-1	do	A-24164 WDR 9697	1952	C	284	8	25	10	4G	5,080	-20	9-20-52	P,W	-	-	H,S	Open-end casing. L.
32b-1	James Douglas	-	-	D	20	-	-	-	-	-	-12	1911	-	-	-	-	C.
33aaa-1	R. D. Warburton and sons	A-18016 WDR 9485 WDR 9415	1952	C	47	14	26	13	4G	5,100	-22 -34.2	7-20-52 5-17-68	T (10)	-	-	I	Perf. 23-? ft.
33aaa-2	E. M. Dunn	A-18016a WDR 9800	1952	D,C	39	14	20	18	R	5,100	-20	11-22-52	N	-	-	U	Drilled into bottom of existing 18-foot dug well. Intended for irrigation. Perf. 17½-39 ft.
33abd-1	R. D. Warburton and sons	A-18061 WDR 9483	1952	C	45	16	33	10	4G	5,090	-22 -32.7	8-10-52 5-17-68	N	-	-	U	Perf. 23-43 ft.
33ada-1	do	A-18061 WDR 6237	1948	C	59	16	19	33	4G,B	5,100	-32.4 -35.2	10-23-48 5-17-68	T (10)	80E 250M	- -	I	East well of three in line. Casing perforated. Temp. 11. C.
33ada-2	do	A-18061 WDR 6351	1948	C	60	16	20	29	G	5,098	-30.7	10-23-48	T (10)	400R 30E	8	I	Perf. 15-60 ft. L.
33ada-3	do	A-18061 WDR 9484	1952	C	43	16	22	18	R	5,098	-22 -33.4	7-12-52 5-17-68	N	-	-	U	Perf. 19-? ft.
33adb-1	do	A-18061 WDR 6398	1948	C	200	16	28	19	G	5,095	-30.4 -33.1	10-23-48 3-21-68	T (10)	450R 292M	12 -	I	Drilled to 90 ft in 1948; deepened to 200 ft in 1960. Little water reported below 47 ft. Perf. 27-? ft. C,H.
33bdc-1	do	A-18061 a-3961	1963	C	232	16	40	-	R	5,100	-39	10-13-63	T (50)	850R 220M 490M 705M	161	I	Drilled to 551 ft. Total length of 8-inch column and suction, 208 ft. Many thin beds of sand and gravel. Perf 60-225 ft. Temp. 16. C,L.
33cbc-1	do	A-32212	1960	C	38	14	20	8	G	5,078	-20.0	5-17-68	N	-	-	I,S	Cased to 30 ft, perforated. L.
33cbd-1	do	A-32212	1960	C	55	14	24	31	R,B	5,075	-18	8-24-60	C	-	-	H,S	Casing perforated. Pump is in small pit.
(B-12-17)																	
19bbc-1	R. Kimber, Sr.	A-21764 WDR 10826	1953	C	77	7	26	22	-	5,510	-21	7-15-54	-	6R	16	H	Drilled to 48 ft in 1953; deepened to 77 ft in 1954. Cased to 48 ft; perf. 24-? ft. L.
(B-12-18)																	
12dad-1	East Grouse Creek Water Co.	A-35158	1965	C	605	16	-	-	-	5,540	-2 -1.3	3- 2-65 5-17-68	N	-	-	U	Cased to 379 ft; perf. 0-370 ft. Well not used owing to insufficient yield. L.
13aab-1	Tanner	-	-	D	15	30	-	-	-	5,560	-13.9 -14.3 Dry	10-12-38 9-28-39 10- 9-40	N	-	-	U	
13acd-1	Elmer Kimber	-	-	D	18	60	-	-	-	5,520	-16.4	10- 9-36	P,H	-	-	S	
24aaa-1	O. L. Kimber	C-8123	1934	-	29	-	9 19	1 10	G Z	5,478	-	-	-	136R	-	H,S	UERA well. Constructed for Grouse Creek Water Co. Used only a short time.
24ada-1	A. L. Toyn	A-25891 WDR 11568	1955	C	37	7	11	18	G,Z	5,482	-11	6- 8-55	-	2.5R	10	H	Temp. 10. L.
25bab-1	Elmer Kimber	-	-	D	28	54, 8	-	-	-	5,390	-18.9 -18.9	10- 9-36 11- 5-53	-	-	-	H	Dug well deepened by drilling 8-inch hole in bottom. H.
25cbb-1	Grant Kimber	A-24314	1953	C	58	7	33	25	-	5,380	-	-	S	26M	-	H	Perf. 24-49 ft. Temp. 12. C,L.
35ada-1	Bryan Blanthorn	C-12922	1933	-	50	6	-	-	-	5,365	-29.9 -27.8 -19.6 -24.3 -36.7	8-15-36 10- 3-36 10- 2-38 9-28-39 10- 9-40	P,W	3R	-	H,S	Former community supply well. Drawdown reported to be appreciable. Perf. 44-? ft.
35daa-1	Ted Betridge	A-19211 WDR 6228	1948	C	37	12	18	19	G	5,360	-28.0	10-22-48	-	300R	20	I	Perf. 15-? ft. H.
36bbb-1	George Blanthorn	A-19303 WDR 6141	-	D,C	30	12	17	13	G	5,360	-11.9	10-23-48	-	250R	23	-	Clay to 17 ft; water-bearing gravel 17-30 ft. Perf. 17-? ft. H.
36bcb-1	East Grouse Creek Water Co.	A-19213 WDR 6230	1948	C	508	12	15 270 380	8 15 60	G S C	5,360	-13	4-16-48	-	300R	10	I	Cased to 56 ft, perf. 13-? ft. L.

Table 12.–Selected drillers' logs of wells in Grouse Creek valley

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

Material	Thickness	Depth
(B-8-17)31ccc-1. Log by L. W. Dalton. Alt. 4,414 ft.		
Clay, gray	25	25
Gravel; some water	32	57
Clay, gray	46	103
Sand and gravel	6	109
Clay	3	112
Gravel	9	121
Clay	3	124
Gravel	4	128
Clay	32	160
Sand; fresh water	40	200
(B-9-18)4aba-1. Log by J. F. O'Brien. Alt. 4,925 ft.		
Soil and clay	14	14
Clay, sand, and gravel	8	22
Clay, tan	2	24
Sand and silt	27	51
Sand, blue gray; water	7	58
Sand and gravel, cemented	39	97
Clay (or) shale, tan	2	99
Clay (or) shale, brown	15	114
Clay (or) shale, brownish gray to gray	76	190
(B-9-18)4dab-1. Log by Waymon Yarbrough. Alt. 4,895 ft.		
Clay	18	18
Gravel, dry	6	24
Clay, brown, sandy, and sand	16	40
Sand and blue sandy muck	10	50
Clay, blue	10	60
Sand and gravel, blue	10	70
Gravel, cemented	8	78
Sand and gravel	29	107
Clay, red	5	112
(B-9-18)16aaa-1. Log by F. A. Cagle. Alt. 4,870 ft.		
Soil	6	6
Gravel	17	23
Clay, blue	30	53
Clay, sand, and gravel	13	66
Rock, gray	6	72
Sand and large gravel	2	74
Rock, gray	46	120
Cobbles, large	4	124
Rock, gray	17.5	141.5
Gravel	3.5	145
Rock, gray	57	202
(B-9-18)34caa-1. Log by J. F. O'Brien. Alt. 4,825 ft.		
Clay	10	10
Sand, fine	55	65
Shale, "lava washed"	23	88
Clay (or) shale	12	100
(B-10-17)4cbc-1. Log by E. E. Bailey. Alt. 5,800 ft.		
Sandstone	22	22
Clay, blue	16	38
Shale, brown	30	68
Clay, red	28	96
Sandstone	15	111
"Talc"	17	128
Clay or shale, blue	18	146
Lime and talc	11	157
Conglomerate	26	183
Sandstone and limestone, alternating	39	222
Clay, blue and brown	27	249
Lime, black, and quartz	13	262
(B-10-18)9abb-1. Alt. 5,050 ft.		
Loam	6	6
Clay, loam	10	16
Sand and fine gravel	2	18
Gravel, dry	14	32
Gravel; water bearing	28	60
Clay	5	65
(B-10-18)16aba-1. Log by J. F. O'Brien. Alt. 5,000 ft.		
Soil and clay	22	22
Clay, sand, and gravel; no water	7	29
Gravel; water bearing	23	52
(B-10-18)21aab-1. Log by Waymon Yarbrough. Alt. 4,980 ft.		
Soil	2	2
Clay	12	14
Gravel	6	20
Gravel, clean	4	24
Clay and gravel	7	31
Gravel and sand, dry	9	40
Gravel, washed	15	55
Gravel and boulders	7	62
(B-10-18)21bdc-1. Log by J. F. O'Brien. Alt. 5,000 ft.		
Topsoil	3	3
Clay, brown	6	9
Gravel and clay	26	35
Gravel	27	62
Conglomerate	2	64
Clay	2	66
(B-10-18)28bac-1. Log by J. F. O'Brien. Alt. 4,980 ft.		
Topsoil	3	3
Hardpan	3	6
Clay	15	21
Conglomerate	4	25
Clay	16	41
Gravel and conglomerate	14	55
Shale	12	67
(B-10-18)29cac-1. Log by J. F. O'Brien. Alt. 5,075 ft.		
Overburden	20	20
Boulders	6	26
Shale, gray	94	120
Shale, white, fine	10	130
(B-10-18)33aaa-1. Log by Waymon Yarbrough. Alt. 4,980 ft.		
Soil	2	2
Clay	28	30
Gravel	8	38
Sand and gravel	22	60
Gravel, clean	10	70
Clay and silt	5	75
Boulders	5	80
Clay	4	84
(B-10-18)34dcc-1. Log by H. M. Robinson. Alt. 4,990 feet		
Clay, light	40	40
Gravel, coarse	10	50
Clay, light	60	110
Sand and clay, alternating; water	142	252
(B-11-18)2ccd-1. Log by C. A. Holland. Alt. 5,300 ft.		
Surface soil	28	28
Gravel	7	35
Clay, white, sandy	25	60
Gravel, sandy; some water	4	64
Shale, red	41	105
Clay, yellow, sandy	15	120
Gravel; water	5	125
Gravel and clay	15	140
Gravel and sand	10	150
Clay or shale, gray	22	172
Gravel and sand; water	8	180
Clay, light green	10	190
Gravel and sand; water	6	196
Clay, light green	30	226
Gravel; water	5	231
Sandstone, green	1	232
Sand, shale, and gravel; streaks of water in zone 232-250 feet	44	276
Sand and shale, green	5	281
Gravel; water, strong flow 281-291 feet	15	296
Sandstone	2	298
Sand, coarse	1	299
Shale and gravel	1	300
Gravel; 25 gpm of water	2	302
Gravel, fine	1	303
Sand and gravel, fine	5	308
Shale and sand, blue	1	309
Sandstone, green	28	337
Sandstone; strong flow of water	11	348
Shale and sand, green	12	360
Shale, green, sandy	35	395
(B-11-18)2ccd-2. Log by A. J. Diehl. Alt. 5,300 ft.		
Topsoil	20	20
Boulders and gravel	15	35
Clay	140	175
Gravel; little water	5	180
Shale	105	285
Gravel; flowing water	30	315
Shale	30	345
Silt	8	353
Shale	52	405
Gravel; water	6	411
Shale	194	605
(B-11-18)3aad-1. Log by F. H. Hughes. Alt. 5,330 ft.		
Sandstone	40	40
Shale, soft black	10	50
Sand; water bearing	5	55
Shale, soft green	81	136
Sand; water bearing	6	142
Shale, soft green	258	400
Gravel, black; cuttings are sharp-edged and possibly indicate fractured rock	5	405
No record	260	665
(B-11-18)10aac-1. Log by J. F. O'Brien. Alt. 5,290 ft.		
Clay, brown	17	17
Gravel and sand	33	50
Shale, brown, hard	5	55
Shale, gray, hard	135	190
(B-11-18)10aad-1. Log by F. H. Hughes. Alt. 5,290 ft.		
Surface soil	16	16
Gravel, coarse; water bearing	50	66
Clay, blue-gray	104	170
Clay and fine gravel	10	180
Gravel, coarse; small flow of water	10	190
Shale, sandy, green, some gravel; flows of water at 210 and 270 feet	100	290
Gravel and sand, black; flow of water at 310 feet	20	310
Shale, sandy, green, some gravel	20	330
Sand, loose, green; salty water	7	337
Shale, sandy, green, small gravel	33	370
Limestone, hard	4	374
Gravel; fresh flowing water	6	380
(B-11-18)22aab-1. Log by J. F. O'Brien. Alt. 5,195 ft.		
Clay, brown	10	10
Gravel, coarse; water bearing	22	32
Shale, gray	2	34
(B-11-18)27baa-1. Log by F. A. Cagle. Alt. 5,150 ft.		
Gravel, sand, and clay	66	66
Limestone and quartz	4	70
Sand, reddish, and clay	5	75
Shale, white, hard	1	76
Sand with clay	6	82
Shale, white, very hard	2	84
Clay and sand	6	90
Shale, white, hard	1	91
Sand and clay	4	95
Sandstone	15	110
Gravel and fine sand	65	175
Sand, white	3	178
Sand, red	32	210
Sand and gravel	30	240
Sand	20	260
Sandstone	5	265
Sand	1	266
Sandstone	84	350
Sand, clay, and hardpan	17	367
(B-11-18)29abc-1. Log by A. J. Diehl. Alt. 5,112 ft.		
Soil; a little water at 5 feet	5	5
Clay, blue	7	12
Gravel, coarse; water	10	22
Gravel, cemented	37	59
Shale	1	60

Table 12.—Selected drillers' logs of wells in Grouse Creek valley cont.

Material	Thickness	Depth
(B-11-18)32adb-1. Log by J. F. O'Brien. Alt. 5,080 ft.		
Clay, brown	25	25
Gravel, coarse	10	35
Conglomerate	3	38
Shale, gray	25	63
Shale, blue	12	75
Shale, brown	25	100
Clay, brown, sandy	17	117
Clay, light brown, sandy	6	123
Sandstone, dark gray	12	135
Sandstone, light brown	9	144
Sandstone, dark gray	54	198
Shale, brown	7	205
Shale, gray, sandy	79	284
(B-11-18)33ada-2. Log by A. J. Diehl. Alt. 5,098 ft.		
Soil, clay, and boulders	18	18
Gravel; water at 29 feet	18	36
No record	8	44
Clay, sandy	3	47
Gravel; water	5	52
Shale	8	60
(B-11-18)33bdc-1. Log by R. D. Warburton and Sons. Alt. 5,100 ft.		
Clay, blue when wet	12	12
Clay, brown	27	39
Gravel and sand. Static level	1	40
Sandstone, gray	6	46
Gravel, rock, and sand; water	3	49
Sandstone, gray	13	62
Gravel, rock, and sand	2	64
Sandstone, brown	4	68
Sandstone, white	5	73
Clay, soft, brown	5	78
Gravel and sand; water	5	83
Sandstone, brown	12	95
Sandstone, hard, white	2	97
Gravel, pea [size] and larger	6	103
Sandstone, soft, brown	7	110
Sandstone, hard, brown	11	121
Gravel; water	2	123
Sandstone, soft, brown	7	130
Clay, white	1	131
Gravel; water	1	132
Sandstone, brown	3	135
Clay, brown, and pea gravel	4	139
Sandstone, white	1	140
Gravel and sand; water	1	141
Sandstone, soft, brown	5	146
Clay, soft, brown	7	153
Sand and gravel; water	1	154
Sandstone, brown	5	159
Clay, white	2	161
Sandstone, hard, brown	1	162
Sand	1	163
Sandstone	2	165
Sandstone, soft, light brown	5	170
Clay, white	2	172
Gravel, pea [size]	1	173
Sandstone, hard brown	2	175
Clay, soft, brown	4	179
Gravel, pea; water	1	180
Sand and clay	7	187
Sandstone, hard, brown	1	188
Clay, white, and sand	8	196
Clay, soft, brown	4	200
Gravel; water	1	201
Sandstone, hard	2	203
Clay, white	1	204
Gravel	1	205
Clay, brown	7	212
Clay, white	2	214
Clay, light brown, and sandstone	2	216
Sandstone, hard, brown	6	222
Clay, soft, brown	8	230
Sandstone, hard	1	231
(B-11-18)33bdc-1 - continued		
Clay, white	.5	231.5
Gravel; water	.5	232
Clay, brown and red. Hole size, 14 inches	3	235
Sandstone, hard	3	238
Sandstone, very hard	2	240
Sand and pea gravel; water	.5	240.5
Clay, brown and two boulders	5.5	246
Sandstone, very hard	1	247
Sand and gravel; water	1	248
Clay, soft, brown	7	255
Sandstone	1	256
Clay	4	260
Sandstone, hard	2	262
Gravel, pea	.5	262.5
Sandstone, hard	1.5	264
Sand and pea gravel; water	1	265
Sandstone, hard	1	266
Sand and pea gravel	1	267
Sandstone, layers of light brown	13	280
Sand and pea gravel	1	281
Sandstone, brown	8	289
Sand and pea gravel	3	292
Sandstone, light brown, hard	1	293
Sand and large pea gravel	1	294
Sandstone, layer of brown	3	297
Gravel and sand	1	298
Sandstone, light brown, hard	2	300
Sand and pea gravel; water	2	302
Sandstone, light brown	3	305
Sand and pea gravel; water	1	306
Sandstone layers	3	309
Sandstone, hard	7	316
Sand; water	2	318
Sandstone layers	12	330
Sandstone, hard, blue	1	331
Sandstone	5	336
Clay	3	339
Sandstone, light gray, hard	1	340
Sandstone layers	15	355
Sandstone, layers of dark brown	4	359
Silt and sandstone, in layers	6	365
Sandstone, layers of gray	9	374
Sandstone, hard, white	1	375
Clay, soft, white	1	376
Sandstone, hard, white	9	385
Sandstone, hard, gray	1	386
Gravel and sand; trace of water	1	387
Sandstone, soft, white	3	390
Sandstone, hard, white	1	391
Sand, fine; water	8	399
Sandstone	1	400
Sand	4	404
Sandstone, light gray, soft	45	449
Sandstone, blue-gray, soft	6	455
Gravel and sand; water	1	456
Sandstone, layers, dark gray	22	478
Sandstone, layers, light gray hard	3	481
Sand; trace of water	2	483
Sandstone, layers of gray	2	485
Sandstone, layers of brown	14	499
Sandstone, white	2	501
Gravel and sand in layers; trace of water	4	505
Sandstone, very hard, gray	5	510
Sandstone, soft, gray	9	519
Sandstone, soft, brown	11	530
Clay, brown	8	538
Sandstone, hard, gray, specks of lava	4	542
Sand	1	543
Sandstone, gray	8	551
(B-11-18)33cbc-1. Log by Waymon Yarbrough. Alt. 5,078 ft.		
Clay, adobe	12	12
Gravel	2	14
Gravel and clay	4	18
(B-11-18)33cbc-1 - continued		
Gravel; water	10	28
Sandstone	8	36
Clay, blue	2	38
(B-12-17)19bbc-1. Log by E. O. Kimber. Alt. 5,510 ft.		
Soil and rock	9	9
Conglomerate	13	22
Shale	4	26
Rock type not recorded; water bearing	22	48
"Granite"	6	54
Sandstone	5	59
Clay, or soft shale	18	77
(B-12-18)12dad-1. Log by C. D. Bishop Drilling Co. Alt. 5,540 ft.		
Clay, black	10	10
Clay, gray	8	18
Clay and gravel, gray	57	75
Clay, cobbles, and boulders, black	31	106
Clay and sand, black	42	148
Clay and silt, gray	10	158
Clay, sand, and gravel, gray	62	220
Clay and silt, gray	6	226
Clay and gravel, black	42	268
Silt and gravel, gray	5	273
Clay and gravel, dark gray	22	295
Clay and gravel, black	20	315
Clay and gravel, gray	30	345
Clay, silt, and gravel, gray	13	358
Clay, silt, and gravel, black	40	398
Clay and gravel, black	42	440
Clay, black	35	475
Sandstone, black	13	488
Sandstone, gray	22	510
Clay and hardpan	15	525
Sand, gravel, and clay, gray	23	548
Clay and gravel, brown	21	569
Clay and gravel, gray	36	605
(B-12-18)24ada-1. Log by E. O. Kimber. Alt. 5,482 ft.		
Soil	11	11
Gravel and rock, mixed with clay	6	17
Conglomerate	12	29
Clay and sand	8	37
(B-12-18)25cbb-1. Log by E. O. Kimber. Alt. 5,380 ft.		
Clay, loam	14	14
Clay and gravel	15	29
Sandstone	4	33
Rock type not recorded; water bearing	25	58
(B-12-18)36bcb-1. Log by J. S. Lee and Sons. Alt. 5,360 ft.		
Clay, brown	15	15
Gravel; water	8	23
Shale, gray	114	137
Conglomerate	14	151
Shale, sandy	26	177
Shale and gravel	3	180
Shale, gray	90	270
Sand; water	15	285
Conglomerate	25	310
Shale, gray	70	380
Conglomerate; with soft spots carrying water	60	440
Shale, sandy	10	450
Bentonite, light gray	25	475
Bentonite, dark gray	33	508

Table 13.—Records of selected springs in the Grouse Creek drainage basin

Location number: See appendix for explanation of numbering system.
Altitude of land surface: Interpolated from U.S. Geological Survey and Army Map Service topographic maps.
Discharge: Rate - e, estimated; m, measured; r, reported.
Use: H, domestic, I, irrigation, S, stock. These uses are made at or near the springs. Flow from many of the springs is claimed for irrigation downstream.
Remarks and other data available: C, chemical analysis of water in table 14; specific conductance of water, in micromhos per cm at 25°C, measured with portable conductivity meter.

Location number	Name or owner	Altitude of land surface (feet)	Geologic source	Discharge			Use	Remarks and other data available
				Rate (gpm)	Temperature (°C)	Date		
				UTAH				
(B-8-18)14dbb-S1	Owl Spring	4,600	Lakeshore deposits	5m	9	4-11-68	H,S	Flows into 5-foot square concrete sump from which water is pumped for domestic and other use. Overflow diverted to nearby stock pond. C.
24bdc-S1	Rabbit Spring	4,525	do	20m	10	4-11-68	S	Flows from 3-inch plastic pipe into large stock pond. C.
(B-9-17)10abb-S1	Mud Springs	6,550	Paleozoic rocks	12r	-	-	S	Flows into small reservoir.
(B-10-17)15ccb-S1	Keg Spring	6,175	Alluvium in narrow canyon	2r 1m	- 10	- 4-12-68	S	Flows from 3-inch pipe into stock pond; some water probably seeps unseen into pond. C.
(B-10-18)30bad-S1	Kimber (Rose) Spring	5,200	Extrusive igneous rocks	900r 215m	- 20	- 4-11-68	H,I,S	Flows into large reservoir. C.
(B-10-19)28bac-S1	Big Spring	6,380	do	110r	-	-	S	
(B-11-17)30dc-S	Bedke Spring	5,580	Salt Lake Formation	20r	-	-	S	
(B-11-18)18cca-S1	M. V. Tanner	5,200	Extrusive igneous rocks	45r	-	-	H,S	
19daa-S1	Warburton Ranch	5,200	do	-	15	5-17-68	I	At west side of pond. Formerly used also for domestic supply. Discharges near contact between volcanic rocks and Salt Lake Formation. Specific conductance 560.
(B-11-19)11dad-S1	Mark Warburton	5,350	Paleozoic rocks	225r 75e	- 42	- 5-16-68	I	Total discharge from several openings in area. Flows directly into Death Creek. Estimate made for opening nearest road. C.
12dd-S	do	5,300		14r	-	-	-	
26add-S1	P. E. Bohon	5,500	Salt Lake(?) Formation	43r	-	-	H,I,S	
(B-12-17)31ccd-S1	North Cook Spring	5,600	do	2r .12m	- 9	- 4-11-68	S	Flows from 1½-inch pipe into small stock-watering trough. C.
(B-12-18)9bbb-S1	Dry Canyon Spring	6,160	do	35r	-	-	S	
32aad-S1	Buckskin Springs	5,650	Alluvium in small canyon	110r -	- 6	- 4-12-68	H,S	Discharge from large spring area to central collection gallery. Alluvium overlies Salt Lake Formation. Domestic supply for Grouse Creek community. On 4-12-68, 4 gpm was overflowing into stock tank below spring area. C.
(B-12-19)10cd-S	Rock Spring	-	Paleozoic(?) rocks	14r	-	-	S	
11ca-S	Upper Roman Spring	-	do	31r	-	-	S	
14cd-S	Ern Spring	-	do	14r	-	-	S	
				NEVADA				
43/70-7ddd1	Unnamed spring	6,275	Slope wash in narrow canyon	<1e	-	5-17-68	S	Slope wash immediately overlies Paleozoic rocks. Specific conductance 400.
8cab1	Dinner Springs	6,280	Paleozoic rocks	15e	12	5-17-68	S	North spring of two, at contact between Paleozoic rocks and Salt Lake Formation. Specific conductance 390.
20aaa1	Dairy Valley Springs	6,150	Alluvium in upland meadow	10e	8	5-17-68	S	One of several spring openings in spring area at head of flow in branch of Dairy Valley Creek. Alluvium overlies Salt Lake Formation. C.

Table 14.—Chemical analyses of water from selected wells, springs, and streams in the Grouse Creek drainage basin

Calcium and magnesium: Where no magnesium value is shown, calcium plus magnesium is calculated and reported as calcium.
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 calculated).

Location No.	Source, or depth of water-bearing zone (feet)	Date of collection	Temperature (°C)	Milligrams per liter															Percent sodium	Sodium-adsorption ratio	Specific conductance (micromhos/cm at 25°C)	pH
				Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$				
UTAH																						
(B-8-17)																						
31ccc-1	160-200	4-11-68	14	50	49	14	119		249	0	54	126	-	0.3	-	543	178	0	59	3.9	875	7.7
(B-8-18)																						
14dbb-S1	Owl Spring	4-11-68	9	52	57	14	75		248	0	44	80	-	.6	-	463	199	0	45	2.3	722	7.8
24bdc-SI	Rabbit Spring	1911?	-	-	60		150		290	0	<30	120	-	-	-	540c	145	0	69	5.4	-	-
		4-11-68	10	-	-	-	-	-	-	-	-	75	-	-	-	-	198	-	-	-	756	-
(B-10-17)																						
15ccb-S1	Keg Spring	4-12-68	10	-	64	18	29		204	0	37	64	-	1.6	-	338	234	67	21	.8	589	7.6
(B-10-18)																						
9abb-1	32-60	4-12-68	10	38	143	42	112		438	0	164	173	-	6.1	-	933	534	175	31	2.1	1,430	7.7
28add-1	38±	1911?	-	-	95		180		315	0	<30	215	-	-	-	700c	235	0	62	5.1	-	-
28ddd-1	28-43	4-11-68	10	40	75	21	55		276	0	53	75	-	4.4	-	483	272	46	30	1.4	761	7.6
30bad-S1	Kimber (Rose) Spring	1911	-	-	55		110		195	0	<30	120	-	-	-	460c	140	0	63	4.0	-	-
		4-11-68	20	47	50	8.3	25	5.7	154	0	18	50	0.4	2.5	0.02	304	158	32	25	.9	441	7.6
33aaa-1	40-84	7-16-58	10	39	87	21	85		331	0	77	97	-	3.3	-	572c	306	35	38	2.1	934	7.7
		10-15-58	11	44	87	22	85		336	0	72	97	-	3.2	-	575c	306	30	38	2.1	926	7.8
		1/5-24-61	-	43	85	17	71	6.1	300	0	72	84	.4	.3	.16	530	281	35	35	1.8	854	7.5
		7-28-64	10	33	102	28	94	6.7	350	0	112	128	.2	1.8	.23	685	370	83	35	2.1	1,100	7.7
		7-11-67	9	-	-	-	101		348	0	127	152	-	-	-	-	412	127	35	2.2	1,180	7.6
(B-11-18)																						
2ccd-2	285-315	4-12-68	-	55	37	5.8	36		192	0	22	10	-	.4	-	263	116	0	41	1.5	367	7.7
6bcb	Morse Canyon Creek	4-12-68	16	13	40	20	9.4		196	0	22	14	-	.3	-	207	183	22	10	.3	367	8.0
10aac-1	17-50	7-16-58	10	38	90	27	86		370	0	88	82	-	13	-	606c	333	30	36	2.0	974	7.4
22aab-1	10-32	4-12-68	10	37	79	29	71		388	0	59	64	-	1.2	-	542	316	0	33	1.7	865	7.8
27baa-1	52-64	7-29-64	13	38	72	14	25	3.7	214	0	21	73	.3	.3	.01	370	236	60	18	.7	575	7.5
		4-11-68	12	37	76	14	29		233	0	21	68	-	2.9	-	392	248	57	20	.8	613	7.6
32b-1	20±	1911?	-	-	80		340		675	0	145	135	-	-	-	1,100c	205	0	78	1.0	-	-
33ada-1	19-52	5-14-56	-	-	116	33	101	10	423	-	77	116	-	-	-	790	424	77	34	2.2	1,310	-
		10-15-58	10	45	78	23	90		360	0	68	80	-	6.8	-	568c	288	0	41	2.3	908	8.0
		2/10-27-60	10	37	114	28	96	6.6	402	0	125	106	.3	.9	.24	725	398	68	34	2.1	1,120	7.9
		7-29-64	11	40	84	29	81		382	0	79	78	-	1.1	-	599	330	17	35	1.9	954	7.6
33adb-1	28-47	7-16-58	-	37	92	26	95		372	0	98	94	-	5.1	-	630c	336	31	38	2.3	1,030	7.8
33bdc-1	40-225	5-17-68	16	64	128	37	61	17	321	0	152	141	-	.3	-	844	474	211	21	1.2	1,170	7.5
(B-11-19)																						
11dad-S1	Thermal spring	5-16-68	42	24	44	14	13		184	0	29	9.1	-	.2	-	248	166	15	14	.4	373	7.5
(B-12-17)																						
29bda	Pine Creek	4-12-68	10	-	43	10	26		169	0	18	35	-	-	-	239	150	11	27	.9	391	8.0
31ccd-S1	North Cook Spring	4-11-68	9	-	-	-	-	-	-	-	-	158	-	-	-	-	377	-	-	-	898	-
(B-12-18)																						
25cbb-1	33-58	4-12-68	10	-	82	37	-	-	421	0	-	81	-	-	-	-	359	14	-	-	1,050	7.6
32aad-S1	Buckskin Springs	3/ 1911	-	-	47	18	13		160	13	22	31	-	-	-	266	-	-	-	-	-	-
		4/8-31-54	-	20	41	13	27	-	166	0	32	30	.2	2.1	-	249	157	21	27	.9	-	7.8
		4-12-68	6	19	52	18	19	2.6	188	0	46	30	.5	.2	.06	291	202	48	17	.6	463	7.9
(B-13-17)																						
29acc	Cotton Creek	4-12-68	10	22	49	12	22		180	0	28	31	-	.2	-	261	172	24	22	.7	420	8.0
(B-13-18)																						
34acc	Joe Dahar Creek	4-12-68	11	26	84	40	35		346	0	95	49	-	.2	-	551	376	92	17	.8	850	8.1
NEVADA																						
43/70-20aaa1	Dairy Valley Springs	5-17-68	8	52	26	5.4	15		90	0	9.9	24	-	0.9	-	209	86	12	28	.7	250	7.2

1/ Analysis includes 0.01 mg/l iron.
2/ Analysis includes 0.00 mg/l iron.
3/ Sample apparently collected at tap in community, 2 miles southeast of spring. Analysis includes 0.40 mg/l iron.
4/ Sample apparently collected at tap in community, 2 miles southeast of spring. Analysis includes 0.88 mg/l iron.

PUBLICATIONS OF THE UTAH DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER RIGHTS

(*)—Out of Print

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