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# HYDROLOGIC RECONNAISSANCE OF THE PARK VALLEY AREA, BOX ELDER COUNTY, UTAH

by

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# HYDROLOGIC RECONNAISSANCE OF THE PARK VALLEY AREA, BOX ELDER COUNTY, UTAH

by J. W. Hood

## ABSTRACT

The Park Valley area consists of the drainage basins of Muddy and Dove Creeks, a part of the Indian Creek drainage basin, and the northernmost part of the Great Salt Lake Desert. The area includes about 1,050 square miles and extends from T. 7 N. to T. 14 N. and from R. 11 W. to R. 17 W.

The main ground-water reservoir is in unconsolidated and semiconsolidated sedimentary rocks of Quaternary age and semiconsolidated to consolidated sedimentary rocks of Tertiary age. The reservoir underlies at least 90,000 acres in the northern half of the area; the area of the ground-water reservoir in the southern half of the drainage area is not known.

The source of all water in the Park Valley area is precipitation, which is estimated to average 520,000 acre-feet annually. Most runoff and ground-water recharge is derived from precipitation on lands above an altitude of 6,000 feet.

Runoff from the mountains in the western and northern parts of the area supplies part of the water used for irrigation in the valleys. The average annual runoff from the mountain areas is an estimated 5,000 acre-feet, of which an estimated 3,000 acre-feet is readily diverted to man's use. A part of the remaining precipitation is consumed by evapotranspiration in the areas in which it falls, and a part recharges the ground-water reservoir.

Use of ground water in the area has not affected the recharge-discharge balance to any appreciable extent; average annual recharge and discharge, therefore, are equal and amount to an estimated 24,000 acre-feet each. Ground water is discharged from the Park Valley area by evapotranspiration, by subsurface outflow, and by wells. The estimated average evapotranspiration (16,000 acre-feet annually) consumes most of the ground water discharge from the reservoir, but a part of the water consumed is used beneficially. Subsurface outflow from the area is estimated to be about 8,000 acre-feet annually. In 1968, wells discharged only an estimated 500 acre-feet of water.

An estimated 6,000 acre-feet of ground water is consumed by beneficial evapotranspiration in crop and pasture lands, and an additional 8,000 acre-feet is estimated to be available annually for salvage from nonbeneficial evapotranspiration in the Park Valley area. Water for development in excess of this 14,000 acre-feet a year would have to be withdrawn from storage by dewatering the ground-water reservoir. Dewatering the upper 100 feet of the reservoir would yield an estimated 500,000 acre-feet of water. About half of this water is stored in the northern part of the area. Water obtained from storage in the southern part of the area may not all be of chemical quality suitable for domestic, stock, and irrigation use.

The chemical quality of water limits potential development in a part of the Park Valley area. The observed range of concentration of dissolved solids in the drainage basin is from 111 to more than 26,000 milligrams per liter. The freshest water is from streams and springs in the Raft River and Grouse Creek Mountains and the alluvial slopes adjacent to them. The quality of ground water in the central area ranges from fresh to moderately saline, and very saline water occurs along the edge of Great Salt Lake and probably along the edge of the Great Salt Lake Desert.

Past and present development of water in the Park Valley area has depended mainly on stream and spring flow. Only about 1 percent of the area is used for farming and the remainder is used for grazing. Of the nearly 6,000 acres of irrigated lands, only about 500 acres were irrigated with supplemental well water.

The total annual supply of surface and ground water in the Park Valley area is estimated to be 29,000 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 beneficial uses.

## INTRODUCTION

This report is the eighth in a series prepared by the U. S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights, that describes the water resources of the western basins of Utah. (See fig. 1.) Its purpose is to present available hydrologic data on the Park Valley area, to provide an evaluation of the potential water-resource development of the area, and to identify needed studies that would improve understanding of the area's water supply.

The investigation on which this report is based consisted largely of a study of available data for geology, streams, wells, springs, climate, and water use in the Park Valley area. These data were supplemented with field data on landforms, vegetation, geology, and water sources, particularly in remote parts of the area, which were collected during a 1-week reconnaissance in November 1968. Basic data for the area are presented in tables 2, 4-6, and 9-14.

The Park Valley area is in northwestern Box Elder County, Utah. The area, as depicted in figure 1, extends from T. 7 N. to T. 14 N. and from R. 11 W. to R. 17 W. The 1,050 square-mile area includes the drainage basins of Muddy and Dove Creeks, a part of the Indian Creek drainage basin, and the northernmost part of the Great Salt Lake Desert.

The Park Valley area is used for agricultural purposes, primarily for stock raising. Only about 1 percent of the area is farmed; most of the area is Federal, State, and private grazing land. The population of the area is small and is concentrated mainly in and near the communities of Park Valley and Rosette, which had populations of 162 and 72 persons, respectively, according to the 1960 census. A few residents are at ranches on Dove, Muddy, and Rosebud Creeks near State Highway 30. The total population probably does not exceed about 250 persons.

The water available to the residents of the Park Valley area has been the subject of some study, but little has been published that specifically describes the water resources of the valley. The principal source of information is a U. S. Geological Survey Water-Supply Paper by Carpenter (1913) which supplies some early data. The principal sources of basic data are the files of the Geological Survey and those of the Utah State Engineer, who made a hydrographic survey of the area in 1965. The hydrographic survey, together with files of claims of water use in the valley, provides a comprehensive listing of the water sources in the area, but few of the sources were individually checked for this investigation.

Descriptions of the geology of the area, which provide data on the hydrogeologic framework of the water-resources system, include the geologic map of Utah (Stokes, 1964), which is the main source of the geology on plate 1, Felix (1956), who described the geology of part of the Raft River Mountains, and Heylmun (1965), who briefly described a part of the Tertiary rocks in the area. Data also were obtained from theses (on file at the University of Utah) by W. H. Baker, who described the southern Grouse Creek Mountains in 1959, and by P. B. Stifel, who described the Hogup and Terrace Mountains in 1964.

## GENERAL HYDROLOGIC ENVIRONMENT

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

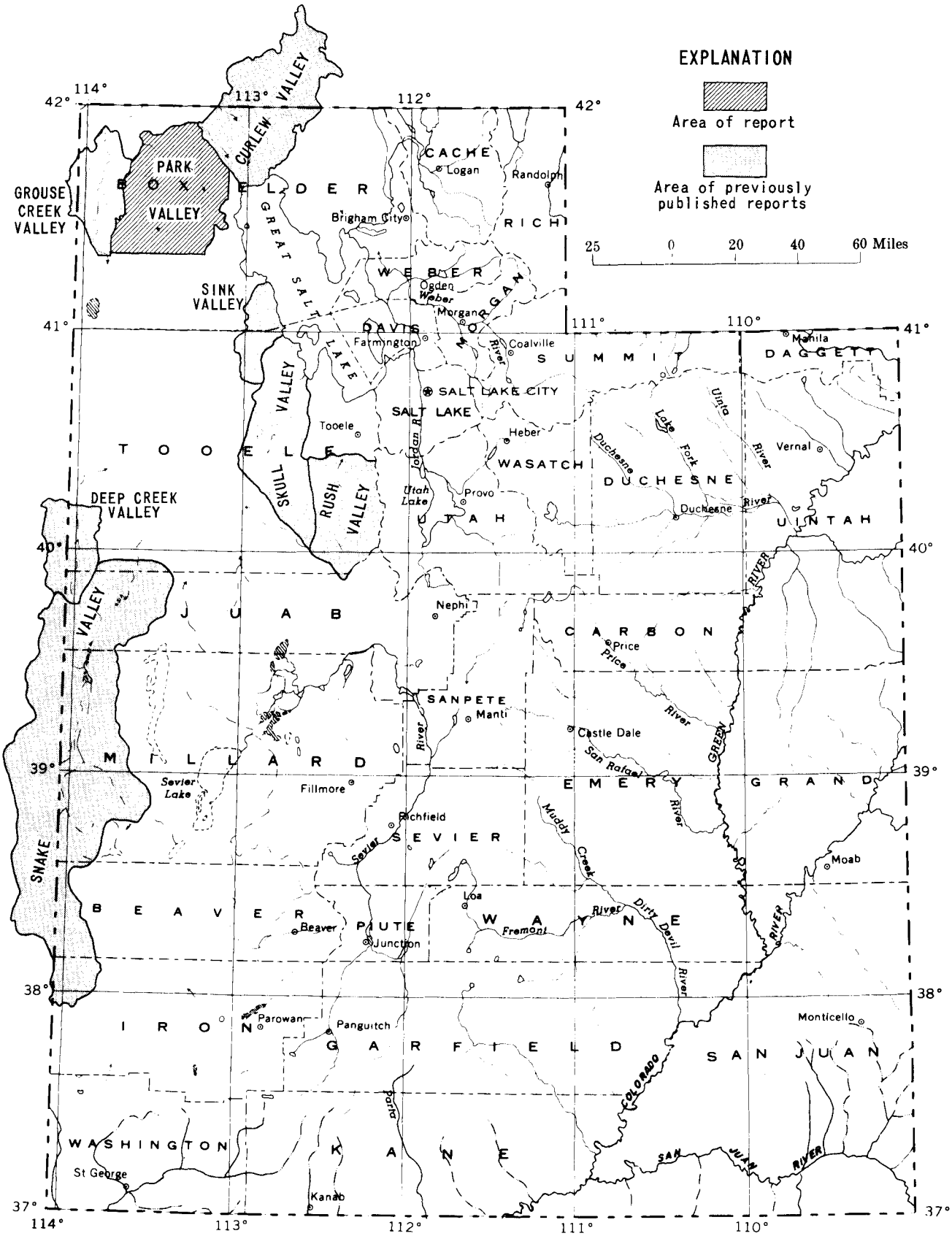


Figure 1.—Location of the Park Valley area and other areas described in previously published reports in this reconnaissance series.

## Physiography

The Park Valley area is near the edge of the northeastern part of the Great Basin section of the Basin and Range physiographic province (Fenneman, 1931, 1946). The project area (pl. 1) includes the Muddy Creek and Dove Creek drainage basins and part of the Indian Creek drainage basin. The area contains some internal upland areas such as the Matlin Mountains, which are part of the drainage divide between Dove and Muddy Creeks.

The total relief in the Park Valley area is about 5,700 feet. The mountains that bound the valley on the west and north have moderate to high relief. Altitudes along the drainage divide in the Grouse Creek Mountains generally are 7,000-9,000 feet; the highest point on the drainage divide in the range is Ingham Peak (alt. 9,046 ft). In the Raft River Mountains, the altitudes of the drainage divide generally are 7,200-9,800 feet; the highest point on the divide, at the head of Dunn Canyon, is 9,931 feet. High points on the drainage divides in the Hogup and Matlin Mountains are 6,487 and 5,970 feet, respectively. The lowest altitudes in the area shown on plate 1 are about 4,220 feet on the shore of Great Salt Lake and about 4,240 feet in the Great Salt Lake Desert.

In the Muddy Creek drainage basin, the Grouse Creek Mountains are a narrow, steep cuesta-shaped ridge that overlooks a broad, steep alluvial slope. Outliers of consolidated rock and spurs of the mountain range rise above the interrupt the continuity of the alluvial slope. The main tributaries of Muddy Creek, such as upper Muddy Creek (called Birch Creek by Carpenter, 1913) and Rosebud Creek head in the mountains and flow eastward through narrow, steep canyons. Some of these tributaries are perennial in their upper reaches. Minor tributaries from the east are ephemeral and their channels have been shaped mainly by floods. The main stem of Muddy Creek occupies a broad, relatively smooth valley that is floored with lake-bottom deposits.

The upper part of Dove Creek heads at the western end of the Raft River Mountains. Eastward-flowing tributaries to the creek head on the steep escarpment of an eastern spur of the Grouse Creek Mountains; this area is similar in character to the upper Muddy Creek basin.

The principal tributaries to Dove Creek head on a relatively smooth, glaciated upland surface in the Raft River Mountains and descend steeply through canyons in consolidated rock. The streams debouche through narrow canyon mouths onto small alluvial fans and thence onto a moderately steep, gently undulating slope that is underlain by a veneer of coarse-grained alluvium. This alluvial slope contains most of the cultivated land in the Park Valley area and is both a recharge area and a discharge area for ground water in the central part of the Dove Creek drainage basin.

Other tributaries to Dove Creek head in the Hogup Mountain area and in the Matlin Mountains. These tributaries are small and intermittent; in their lower reaches most of the streams are incised sharply into relatively soft rocks, but some occupy broad flat channels.

Indian Creek, which is outside the boundary of the study area, and its tributary stream channels head on the southeastern end of the Raft River Mountains and the adjacent alluvial slopes. Most of these stream channels are youthful in appearance; they occupy deep canyons or gullies and go almost straight to the mudflats of Great Salt Lake.

Below an altitude of 5,185-5,200 feet (Crittenden, 1963, p. E6, fig. 3) the surface of the entire Park Valley area has been modified by the wave and current action of Pleistocene Lake

Bonneville. (See Gilbert, 1890.) The shoreline of the Bonneville stage, the highest level of the ancient lake, appears prominently in aerial photographs of the area south of the Park Valley community. The shoreline, as seen on the ground, is marked by a substantial amount of coarse-grained beach deposits where the wave action removed the fine-grained fraction of alluvium. In parts of the area that face Great Salt Lake and Great Salt Lake Desert, wave-cut terraces are strongly developed on consolidated rocks at several levels and numerous old shorelines are marked on the alluvial slopes. Gravel bars and spits deposited in the lake link or extend from many of the outliers of consolidated rocks. The gravel in some of these lake features is sufficiently well sorted to provide local intake areas for ground-water recharge from precipitation and local flooding.

The general physiographic framework of the Park Valley area appears to predate the humid part of the Pleistocene Epoch. The shapes of the modern valleys do not appear to have been appreciably altered since the end of the Pleistocene Epoch. The broad alluvial slopes appear to be mainly pediments that were cut on older rocks and later covered with a few tens of feet of alluvium. The few true alluvial fans in the area are small.

## Geology

The geologic formations in the Park Valley area are shown on plate 1, and table 1 gives a general description of their lithology and general water-bearing properties.

Rocks ranging in age from Precambrian to Holocene are exposed or have been penetrated by wells in the Park Valley area. The pre-Tertiary rocks consist of consolidated metasedimentary, sedimentary, and intrusive igneous rocks. The consolidated rocks of Tertiary age are igneous and sedimentary rocks and include appreciable quantities of pyroclastic deposits.

The Park Valley area is a composite structural depression that was created by the deformation of consolidated rocks of Tertiary and earlier age and is partly filled with unconsolidated and semiconsolidated rocks of Tertiary and Quaternary age.

The area south of T. 11 N. is interpreted as typical of the Basin and Range province, in which the Grouse Creek Mountains to the west and the Hogup Mountains to the east are deformed mainly by northward-trending high angle faults. Between these two mountain masses the consolidated rocks are faulted down and are partly covered with unconsolidated rocks. In both the lower Muddy Creek and Dove Creek drainage basins, the main ground-water reservoir is in clay, silt, sand, and gravel that has a maximum known thickness of about 300 feet.

In T. 11 N. and northward, however, the northward-trending faults have not been instrumental in providing deep depressions for the accumulation of unconsolidated debris. Much of the northern part of the Park Valley area is undergoing active dissection, and unconsolidated deposits in most places are a veneer that partly covers consolidated rocks. Interpretation of drillers' logs (table 12) indicates that the maximum thickness of unconsolidated deposits is about 150 feet in well (B-12-14)21cad-1. The main ground-water reservoir in T. 11 N. and northward includes both unconsolidated clay, sand, and gravel and the semiconsolidated alluvium that lie on the Salt Lake Formation. Some strata in the Salt Lake Formation are sufficiently permeable to yield water to wells, and detailed study probably will confirm that the formation is part of the ground-water reservoir.

## Table 1.—Age, character, and water-bearing properties of major lithologic units in the Park Valley area

| | Age | | Geologic unit | Character of material | Water-bearing properties |
|---|---|---|---|---|---|
| CENOZOIC | Quaternary | Pleistocene and Holocene | Alluvium and colluvium | Surficial deposits of clay, silt, sand, and gravel on steep slopes below and around outcrops of consolidated rock. Generally has appearance of being very coarse-grained, but in most areas is a mixture of both fine and coarse materials. Includes alluvial apron along bases of Hogup, Raft River, and southern Grouse Creek Mountains and upland deposits around outliers in central and eastern parts of area. In most areas may be 50 feet or less in thickness and lies upon either consolidated rocks or older unconsolidated rocks. | Moderately to highly permeable. In steep slopes at edge of mountains, act as intake for recharge from mountain streams. Probably not water bearing in most of upland parts of central and eastern area. Some water probably is discharged through this unit locally by evapotranspiration. Water from these deposits in most parts of area probably is fresh. |
| | | Pleistocene | Lakeshore deposits | Consist chiefly of gravel and sand in spits, bars, and terrace deposits, and probably are less than 50 feet thick. Underlie several small areas between altitudes of 4,220 and 5,180 feet in central and eastern parts of area. | Moderately to highly permeable, but too small in extent to be an important aquifer. Probable source of water discharged from several small springs in Muddy Creek drainage basin and possibly the source for water discharged from a spring and seepage areas near Great Salt Lake. Where water bearing, probably derives water from local precipitation and runoff in ephemeral streams. |
| | | | Lake-bottom deposits | Chiefly clay, silt, and fine sand; maximum thickness is less than 100 feet in most places. Underlies a major part of the area below an altitude of 5,180 feet. | Low permeability; not water bearing in many parts of area; inhabits recharge. Part of precipitation that falls on these deposits is retained as soil moisture; the rest runs off to the Great Salt Lake and Great Salt Lake Desert. Water bearing in parts of Muddy and Dove Creek drainage basins and in the lowest parts of the area, along the edges of Great Salt Lake. In this area, the fine-grained deposits cause a capilliary rise to near land surface and water is discharged from them by evapotranspiration. Water in the deposits ranges in chemical quality from fresh in the northwestern parts of the area to briny in the lakeshore. |
| | | | Alluvium | Chiefly clay, silt, sand, and gravel. Surface is sloping and well drained; soil profile well developed in some parts of area. May be as thick as 150 feet, but in most areas probably is a veneer, 50 feet or less in thickness, on a pediment cut on older rocks. Upper part, near mountains, may be equivalent to alluvium and colluvium (Qa) but parts of alluvial apron clearly lie upon this unit; this unit also predates Lake Bonneville; wave action along highest shoreline has reworked the alluvium. | Moderately permeable in most areas; highly permeable along upper edges near alluvial aprons; acts both as recharge and discharge medium for ground water. Unit is the source of water in most shallow wells near the Park Valley and Rosette communities. Water from this unit is fresh. |
| | Tertiary and Quaternary | Late (?) Pliocene (?) to Pleistocene | Older alluvial deposits | Conglomeratic deposits of clay, sand, and gravel deposited on cut surfaces in upland areas of western Matlin Mountains. Similar cut surfaces occur on outcrops of older rocks near Indian Creek. Deposits are unconsolidated to well cemented with calcium carbonate and may include some pyroclastic rocks. Deposits of equivalent age are thought to underlie alluvial and lacustrine deposits in both the Muddy Creek and Dove Creek drainage basins, where the unit includes sandstone, boulders mixed with clay, and thick beds of hard clay. | Low to moderate permeability; probably are the main ground-water reservoir in southern Park Valley area. In northern part of area these deposits are part of main reservoir together with both overlying and underlying rocks. The ground-water reservoir as a whole has yielded from less than 50 to more than 1,000 gpm to irrigation and irrigation test wells in the Dove Creek bottom land in T. 12 N., R. 14 W. Ground-water from wells that probably are finished in this unit ranges in chemical quality from fresh in the northern area to moderately saline in the southern half of the area. |
| | Tertiary | | Extrusive igneous rocks | Exposed rocks are mainly basalt in eastern side of area; dark vesicular rocks have been exposed and eroded by wave action of Lake Bonneville; includes small exposures of rhyolite and pyroclastic rocks of earlier Tertiary age. | Permeability probably is highly variable; rock basically has low permeability, but probably transmits water through fractures, joints, and vesicular or rubbly zones between flows. Where saturated, similar rocks in adjacent Curlew Valley have high permeability. |

| Age | | Geologic unit | Character of material | Water-bearing properties |
|---|---|---|---|---|
| CENOZOIC | Tertiary | Salt Lake Formation | Unaltered to partly altered vitric and pumice lapilli tuffs, claystone, and limestone (Heylmun, 1965, p. 18). Drillers' logs indicate formation also contains sandstone and loosely consolidated sand and (?) gravel. Formation has been strongly deformed and subsequently eroded. Underlies much (?) of Dove Creek valley near Park Valley and Rosette communities where pediment cut on this formation is veneered with alluvium. Formation also is believed to underlie much of lower Dove Creek and Muddy Creek drainage basins and the Great Salt Lake Desert where formation probably was penetrated between 470 and 1,690 feet in Southern Pacific Co. test well at Lemay (Heylmun, 1965, p. 27-28.) | Unit as a whole probably has low permeability, but some interbeds of sand and gravel probably can yield small to moderate quantities of water to wells. Well (B-12-14)2abb-1 yielded 2 gpm and flowed under a low artesian head (Carpenter, 1913, p. 66). Other wells in Dove Creek drainage basin are believed to be finished partly in this formation, which is inferred to be part of the main ground-water reservoir. Water from the formation in the northern part of the Park Valley area probably is fresh. |
| | | Intrusive igneous rocks | Chiefly gray and red quartz monzonite; some quartz diorite. Crops out in southern Grouse Creek Mountains and adjacent eastern slopes. | Unit has low bulk permeability, but probably transmits some water through joints and through fractures in zones of faulting. Water from such zones of secondary permeability should be fresh. |
| MESOZOIC | Triassic | Thaynes Formation | Brown to reddish and maroon sandy to shaly limestone, some dolomite and siltstone; gray-green shale. Chert common in formation. Crops out on west flank of Hogup Mountains. | Low permeability. |
| PALEOZOIC | Devonian to Permian | Sedimentary and metasedimentary rocks, undivided | In Grouse Creek Mountains and outcrops within the area, consist of limestone, dolomite, sandstone, quartzite, and shale. In Hogup Mountains consist of quartzite, limestone, dolomite, sandstone, some phosphate rock, shale, chert, and cherty shale, mudstone, and siltstone. Much of the rock is deformed, mainly by faulting. The relatively small outcrops in the northern Grouse Creek Mountains and the Raft River Mountains are remanents of a thrust plate that places the rocks in contact with rocks of Precambrian age. Felix (1956, p. 82-85) reports that in the Raft River Mountains rocks of Paleozoic age below the Oquirrh Formation are metamorphosed. | Unit as a whole has low permeability, but locally the permeability is highly variable depending on the amount of secondary porosity. Supports the flow of some springs in the Grouse Creek Mountains and adjacent slopes, most of which come from zones of fracturing; contacts, and bedding planes. Most individual springs have discharges of less than 10 gpm, but at least one, (B-10-15)6cdbS-1, had a measured yield of 386 gpm, and several, such as (B-11-16)1dbdS-1, have discharges in the range 10-100 gpm. Water from this unit in most of the Grouse Creek Mountains and the Raft River Mountains probably is fresh but hard; in the central Park Valley area and near the Great Salt Lake and desert, it is inferred that the water is slightly saline to briny. |
| PRECAMBRIAN | | Intrusive igneous rocks | Mainly granite; locally pegmatitic. Some small areas of amphibolite. Crops out in central Grouse Creek and Raft River Mountains. | Low permeability, but supports flow of some springs in both mountain ranges. |
| | | Metamorphic and sedimentary rocks | Quartzite, schist, limestone, and dolomite; exposed throughout Raft River Mountains and northern Grouse Creek Mountains; rocks are strongly deformed. | Primary permeability is low, but deformation and solution have created substantial secondary permeability locally. Supports flow of numerous springs in mountains and adjacent slopes. Most springs have low rates of discharge, but where secondary permeability is well developed, large yields to springs are possible; fractured quartzite yields about 340 gpm at spring (B-12-15)9aabS-1. Spring discharge from these rocks sustains the low flow of most of the perennial streams in the area. Water from these rocks is fresh and probably is soft in most outcrop areas. |

## Climate

The climate in the Park Valley area is arid to semiarid in valleys below an altitude of about 6,000 feet and semiarid to cold and humid in the mountain areas above 6,000 feet. The cold–snowy forest climate (Trewartha, 1954, p. 383) in the mountains is one in which snow cover is present several months a year.

The average annual precipitation in the valley (pl. 1) ranges from less than 6 inches in the northern part of the Great Salt Lake Desert to 12 inches at the base of the Raft River Mountains. Data from climatologic stations in and near the area (see table 10) show that the average monthly precipitation fluctuates moderately through the year (table 2). Precipitation at most stations is substantially greater in the months of December through May than during the summer and fall, when it results mainly from sporadic thunderstorms.

**Table 2.–Average monthly and annual precipitation, in inches, at four climatologic stations in and near the Park Valley area**

[See table 10 for station records.]

| Station | Period of record | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kelton | 1878-1929 | 0.67 | 0.64 | 0.52 | 0.62 | 0.76 | 0.51 | 0.41 | 0.29 | 0.51 | 0.57 | 0.43 | 0.70 | 6.63 |
| Lemay | 1911-30 | .33 | .34 | .38 | .37 | .53 | .60 | .23 | .26 | .40 | .49 | .25 | .33 | 4.51 |
| Park Valley | 1931-60[1] | 1.05 | .87 | .73 | .94 | 1.11 | .85 | .91 | .82 | .63 | .62 | .82 | .99 | 10.34 |
| Terrace | 1870-1904 | .61 | .44 | .44 | .38 | .68 | .25 | .10 | .15 | .27 | .24 | .36 | .62 | 4.54 |

[1]Period used by U. S. Weather Bureau for computing normal precipitation. Average annual precipitation for period 1911-68 is 10.45 inches.

Total annual precipitation at the low-altitude stations (4,221-5,620 feet) varies considerably from year to year. For example, the precipitation at Park Valley was 5.08 inches in 1966 (record minimum) and 12.50 inches in 1967 (U. S. Environmental Sci. Services Adm., 1967-69). The maximum annual precipitation recorded at the station was 17.64 inches in 1941 (U. S. Weather Bur., 1957). The variation in annual amounts of precipitation is demonstrated in the graph of the cumulative departure from the 1931-60 normal annual precipitation for the period 1936-68. This graph is given in figure 2 where it may be compared with data for other hydrologic parameters that respond to changes in precipitation. In the graph, the cumulative-departure curve declines in years of below-normal precipitation and rises in years of above-normal precipitation.

The average annual precipitation in the Raft River Mountains ranges from 12 inches at the base of the range to more than 30 inches near the crest (pl.1). The maximum average annual precipitation in the Grouse Creek Range is more than 20 inches. In the lower and less extensive Hogup Mountain area, the maximum average annual precipitation is about 10 inches.

The mountain areas have two general effects on precipitation in the Park Valley area. First, the Grouse Creek Mountains cast a "rain shadow" on the western part of the area. Winter

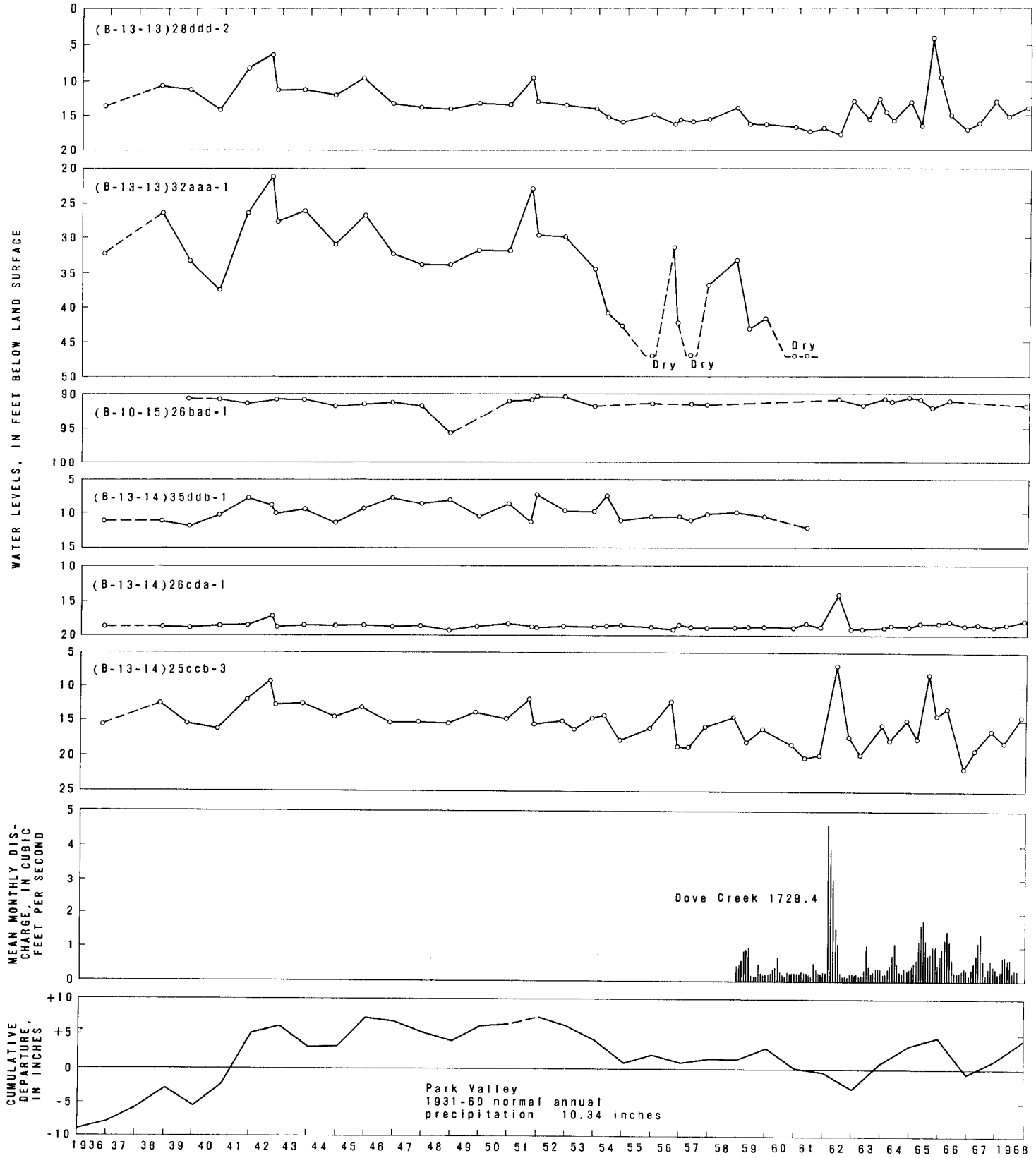


Figure 2.—Water levels in observation wells, monthly mean discharge of Dove Creek at station 10-1729.4, and the cumulative departure from the 1931-60 normal annual precipitation at Park Valley.

and spring storms come mainly from the west and because of orographic lifting, the moisture-laden air masses deposit most of their local precipitation on the western slopes of the Grouse Creek Mountains. The eastern slopes receive less precipitation than those on the west. The second general effect is that of storage of the winter precipitation at high altitudes. The snowpack that accumulates in the mountains is the main source of water in the drainage basin both for streamflow and for ground-water recharge.

Air temperatures in the Park Valley area have a wide annual range as indicated for the three low-altitude stations in the following tabulation:

| Station | No. of years of record[1] | Temperature, in degrees Fahrenheit | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. | Feb. | Mar. | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
| Kelton | 25 | 21.5 | 28.0 | 37.5 | 45.1 | 54.0 | 63.5 | 71.4 | 69.9 | 58.0 | 47.2 | 35.2 | 23.5 | 46.2 |
| Lemay | 19 | 24.5 | 32.0 | 41.0 | 50.0 | 60.0 | 69.9 | 77.8 | 74.5 | 62.8 | 49.5 | 37.5 | 27.1 | 50.6 |
| Park Valley | 36[2] | 24.5 | 28.7 | 35.6 | 44.7 | 53.5 | 61.6 | 74.9 | 70.0 | 60.8 | 49.6 | 35.5 | 27.3 | 47.2 |

[1]See table 10 for periods of record.

[2]Based on intermittent record of monthly averages, 1931-68.

Midwinter nighttime temperatures often fall far below freezing and have been as low as −26°F (−32°C) in January at Park Valley and in December at Lemay and −30°F (−34°C) in December at Kelton. Midsummer daytime temperatures often exceed 90°F (32°C); the highest recorded temperature at Park Valley was 100°F (38°C) in June and July.

The length of the growing season is of particular importance in assessing evapotranspiration; it is defined as the number of days between the last spring and first fall killing frosts and differs with the type of vegetation. A summary of freeze date for the period 1950-68 is given in the following tabulation for the Park Valley station:

| Parameter | [1]Number of days between the last spring and the first fall temperature of: | | |
|---|---|---|---|
| | 32°F or below | 28°F or below | 24°F or below |
| Average | 126 | 149 | 178 |
| Maximum[2] | 179 (1963) | 206 (1952) | 211 (1956) |
| Minimum[2] | 82 (1962) | 111 (1966) | 147 (1950) |

[1]Data from U. S. Weather Bureau (1951-66) and U. S. Environmental Science Services Administration (1967-68).

[2]Years of occurrence given in parentheses.

## HYDROLOGY

### Volume of precipitation

The physiography and geologic environment of the Park Valley area indicate that the only probably source of water for the area is precipitation on its drainage area; the precipitation is estimated to average 520,000 acre-feet annually. The volume of precipitation, therefore, is the basis for estimating runoff and ground-water recharge. The average annual volume of precipitation was estimated from the precipitation data shown on plate 1, and the computation is shown in table 3.

**Table 3.—Estimated average annual volumes of precipitation and ground-water recharge in the Park Valley area**

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

| Precipitation zones (inches) | Area (acres) | Estimated annual precipitation | | Estimated annual recharge | |
|---|---|---|---|---|---|
| | | Feet | Acre-feet | Percent of precipitation | Acre-feet (rounded) |
| | | Area of no recharge | | | |
| Less than 8 | 316,000 | 0.56 | 177,000 | 0 | 0 |
| | | Areas underlain by most Quaternary and Tertiary rocks | | | |
| 8-12 | 233,000 | 0.83 | 193,000 | 3 | 5,800 |
| 12-16 | 19,900 | 1.12 | 22,300 | 7 | 1,600 |
| Subtotal | 252,900 | | 215,300 | | 7,400 |
| | | Areas underlain by Tertiary intrusive, Paleozoic, and Precambrian rocks | | | |
| 8-12 | 38,200 | 0.83 | 31,700 | 5 | 1,600 |
| 12-16 | 24,400 | 1.12 | 27,300 | 10 | 2,700 |
| 16-20[1] | 28,900 | 1.46 | 42,200 | 15 | 6,300 |
| 20-25 | 6,900 | 1.83 | 12,600 | 20 | 2,500 |
| 25-30 | 4,000 | 2.25 | 9,000 | 25 | 2,200 |
| More than 30 | 2,300 | 2.58 | 5,900 | 30 | 1,800 |
| Subtotal | 104,700 | | 128,700 | | 17,100 |
| Total (rounded) | 674,000 | | 520,000 | | 24,000 |

[1] Includes small areas of thin alluvial veneer in stream channels and high mountain slopes.

### Surface water

The estimated average annual runoff from the mountains of the Park Valley area is 5,000 acre-feet. This water is derived from both overland runoff and ground-water discharge. Runoff from snowmelt is the main supply for irrigation and generally extends from March through May, although it may begin in February and end in June of some years. Summer thunderstorms result only in ephemeral flow that may be intense and occasionally destructive. The base runoff,

sustained by springs and seeps, is perennial in the upper reaches of at least 13 small streams, but most of the streams are intermittent in their lower reaches. Most of the streams that head in the lower mountain areas and in the valleys are ephemeral.

Water is deverted by ditch from Indian, Dove, and Muddy Creeks. Both ditches and pipelines are used to divert water from some of the other streams (pl. 1). The Southern Pacific Co. collects water in the Rosebud Creek drainage basin both from streamflow and directly from some springs and pipes it out of the project area. Pipelines head in the mouths of Dunn (Marble Creek), Fisher Creek, and Pine Creek Canyons (pl. 1) and convey much of the streamflow directly to lands along the slope south of the Raft River Mountains. Small privately owned reservoirs impound water from Rosebud Creek and from the group of springs around sec. 19, T. 12 N., R. 15 W. Water from the springs is diverted by ditch from its natural stream course to lands also watered by diversions from Dove Creek.

#### Available records

Continuous records of streamflow in the Park Valley area are available for gaging station 10-1729.4 Dove Creek near Park Valley, Utah. Partial records are available from two crest-stage gages: Station 10-1729.25 Great Salt Lake Desert tributary No. 3 near Park Valley, Utah, which is near the southwestern corner of the Park Valley area, and station 10-1729.3 Right Hand Fork Dove Creek near Park Valley, Utah. Several measurements and estimates of stream discharge at various sites, made during fieldwork for this report, are listed in table 4, together with a summary of records for station 10-1729.25. A summary of the records for stations 10-1729.4 and 10-1729.3 is given in tables 5 and 6, respectively. Locations of the sites listed are shown on plate 1, and the monthly mean discharge at station 10-1729.4 is shown in figure 2.

#### Runoff characteristics

Streamflow in the Park Valley area varies both seasonally and annually. Usually streamflow is lowest in late summer and early fall, and modest increases in streamflow occur in late fall and early winter due to rain and low altitude snowmelt; midwinter flow is low. Streamflow due to seasonal snowmelt begins fairly abruptly in February or March, and the annual peak may occur in April, May, or June, depending on conditions during the individual year. On the larger streams, such as Dove Creek (table 5 and fig. 2), snowmelt may be sustained for 8 to 16 weeks, but once melting ceases, the streamflow dwindles rapidly to the base flow.

The only perennial streams are those supplied by springs such as those in the upper reaches of Dove Creek; and because the discharge of the springs responds slowly to changes in precipitation, the base flow of the streams can be low but remarkably uniform. In Dove Creek, during the driest water year, 1961, the mean daily discharge remained constant at 0.2 cfs for a period of several months; these months were preceded by periods when the discharge varied slowly from 0.1 to 0.3 cfs (U. S. Geol. Survey, 1961-68, 1963).

#### Estimated average annual runoff

The runoff from the mountainous parts of the Park Valley area above about 6,000 feet is a source of water for use in the cultivated parts of the valleys. The precipitation on the lower mountains and the valley areas yields ephemeral runoff that can produce destructive floods, but the average annual amount of water produced by such floods is believed to be negligible. Most of the water comes from streams that are perennial or have intermittent flow sustained for appreciable parts of the year.

## Table 4.—Discharge of streams at sites in the Park Valley area

Site location: See appendix for description of numbering system for hydrologic sites.
Stream and site description: Number is U. S. Geological Survey station number.
Drainage area: Measured with planimeter on 15-minute topographic quadrangle sheets.
Discharge: Measured, unless indicated by e, estimated. Streams were at low flow in November 1968.

| Site location | Stream and site description | Drainage area (square mi.) | Date | Discharge (cfs) | Remarks and other data available |
|---|---|---|---|---|---|
| | *Dove Creek* | | | | |
| (B-12-15)32abd | 10-1729.3, Right Hand Fork Dove Creek, near Park Valley, Utah | 12.2 | 11- 5-68 | 0.18 | Crest-stage gage site. Period of record 1958-68. See table 6 for record of estimated and measured discharge. See chemical analysis and temperature in table 14. |
| (B-12-15)4dab | 10-1729.4. Dove Creek near Park Valley. Utah | 33.2 | 11- 5-68 | .41 | Gaging station. See table 5 for summary of monthly and annual discharge. |
| | | | 11- 7-68 | .41 | |
| 13adb | At State Highway 30 | - | 11- 7-68 | 0 | See chemical analysis in table 14. |
| (B-11-13)10bab | Near County road | - | 11- 6-69 | 0 | At constriction in narrow flood plain along main stem, and below most tributaries; above old reservoir with washed-out dam. Channel indicates that floods occasionally reach this site. Dense patches of willow in this reach. |
| (B-10-12)8db | At Grazing Service road | - | 11- 6-68 | 0 | Creek flows into "Sinks of Dove Creek", a back-bar area; road (old railroad grade) crosses the creek via a large constructional bar (from old Lake Bonneville) that has been breached; water drains from back-bar area to the Great Salt Lake Desert only during floods. |
| | *Muddy Creek* | | | | |
| (B-11-15)18bb | At James Ranch road | - | 11- 7-68 | 0 | Channel is small and passes through dense willow and grass. Water is diverted above this site for irrigation during runoff season. |
| 27cab | At State Highway 30 | - | 11- 7-68 | 0 | Small flood plain heavily covered with grass; small channel incised in plain. See chemical analysis in table 14. |
| (B-9-15)14cda | At Grazing Service road | - | 11- 6-68 | 0 | Road (old railroad grade) crosses multiple channels cut in fine-grained lake deposits; little vegetative cover in immediate area. |
| | *Miscellaneous sites* | | | | |
| (B-13-13)14ad | Creek at mouth of Cove Canyon | - | 11- 7-68 | 0 | Immediately below diversion; no water in ditch; streambed deeply incised in gravel fan. |
| 14dcc | Creek below mouth of Quaking Aspen Canyon | - | 11- 7-68 | 0 | Streambed incised in gravel fan. |
| 15bbb | Creek at diversion in mouth of Dunn Canyon | 8.73 | 11- 7-68 | .7e | Estimated flow over 12-foot rectangular sharp crested weir. Diversions into two pipelines from concrete box below weir. See specific conductance and temperature in table 9. |
| 17baa | Fisher Creek at road crossing above diversion in mouth of canyon | 4.24 | 11- 8-68 | .49 | Road crossing about 100 feet above diversion; creek bed very bouldery; flow turbulent. Diversion is pipeline from concrete box. See specific conductance and temperature in table 9. |
| 18acb | Creek at road crossing in Rock Canyon | 2.77 | 11- 8-68 | .20 | Road crossing is in quarry storage area. Flow very turbulent on boulders and bedrock. See specific conductance and temperature in table 9. |
| (B-13-14)14bdc | Pine Creek at diversion near mouth of canyon | 7.78 | 11- 8-68 | .60 | Diversion is pipeline from concrete box immediately below marshy spring area. Inspection of stream at location (B-13-14)11ccc indicates most of flow comes from left-hand fork of canyon. See specific conductances and temperatures for main stem and for Left Hand and Right Hand Forks in table 9. |
| (B-8-17)11b | 10.1729.25, Great Salt Lake Desert tributary No. 3 near Park Valley, Utah | 10.1 | 5-24-63 | 75.3 | Crest-stage gage on State Highway 30, approximately 3 miles west of Park Valley area drainage divide and about 40 road miles southwest of Park Valley, Utah. Alt. 5,010 feet. Flow recorded is only evidence of flow during period March 1962 through September 1968 and is ephemeral discharge after thunderstorms. |
| | | | 6- 4-63 | 15.8 | |
| | | | 6- 7-64 | 25 | |
| | | | 10-28-67 | 135 | |
| | | | 8-22-68 | 126 | |

## Table 5.—Mean monthly discharge at gaging station 10-1729.4 Dove Creek near Park Valley, water years, 1959-68

Location: Lot 41° 47′, long 113° 34′, in SE¼ sec. 4, T.12N., R.15W., on left bank 6 miles upstream from Black Hill Creek and 12 miles west of Park Valley.

Drainage area: 33.2 sq mi.

Records available: October 1958 to September 1968 (discontinued). Monthly discharge only for October and November 1958.

Gage: Digital water-stage recorder and timber weir. Altitude of gage is 5,600 ft. (from topographic map). Prior to Oct. 14, 1966, graphic water-stage recorder at same site and datum.

Average discharge: 10 years, 0.55 cfs (398 acre-feet per year).

Extremes: Maximum discharge, 275 cfs on Feb. 10, 1962 (gage height, 4.65 ft.), from rating curve extended above 75 cfs on basis of logarithmic plotting and slope-area measurement at gage height 3.91 ft. Minimum, 0.09 cfs on several days in January, February, and August 1966.

Remarks: Records good. No diversion above station. Annual mean discharge is calculated from sum of daily mean discharges. Average discharge is calculated from sum of annual mean discharges.

**Monthly and annual mean discharge, in cubic feet per second**

| Water year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1959 | 0.4 | 0.4 | 0.4 | 0.44 | 0.57 | 0.86 | 0.93 | 0.95 | 0.36 | 0.14 | 0.10 | 0.12 | 0.47 |
| 1960 | .22 | .14 | .20 | .20 | .20 | .29 | .34 | .69 | .33 | .13 | .11 | .23 | .23 |
| 1961 | .19 | .20 | .20 | .20 | .20 | .25 | .20 | .20 | .16 | .12 | .53 | .31 | .23 |
| 1962 | .20 | .20 | .24 | .23 | 4.61 | 3.93 | 3.00 | 1.54 | 1.10 | .22 | .11 | .10 | 1.26 |
| 1963 | .10 | .18 | .20 | .14 | .20 | .14 | .16 | .32 | 1.03 | .41 | .23 | .27 | .28 |
| 1964 | .36 | .38 | .36 | .20 | .21 | .31 | .45 | .77 | 1.10 | .55 | .25 | .24 | .43 |
| 1965 | .38 | .29 | .35 | .42 | .51 | .60 | 1.15 | 1.66 | 1.79 | 1.19 | .76 | .80 | .83 |
| 1966 | 1.01 | 1.04 | .47 | .72 | .96 | 1.20 | 1.45 | 1.18 | .66 | .25 | .19 | .24 | .78 |
| 1967 | .30 | .38 | .30 | .15 | .33 | .52 | .74 | 1.12 | 1.36 | .58 | .20 | .33 | .53 |
| 1968 | .58 | .42 | .37 | .23 | .23 | .63 | .69 | .65 | .63 | .25 | .28 | .30 | .44 |
| Average | .37 | .36 | .31 | .29 | .80 | .87 | .91 | .91 | .85 | .38 | .28 | .29 | .55 |
| Maximum | 1.01 | 1.04 | .47 | .72 | 4.61 | 3.93 | 3.00 | 1.66 | 1.79 | 1.19 | .76 | .80 | 1.26 |
| Minimum | .10 | .14 | .20 | .14 | .20 | .14 | .16 | .20 | .16 | .12 | .10 | .10 | .23 |

**Monthly and annual discharge, in acre-feet**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1959 | 25 | 24 | 25 | 27 | 32 | 53 | 55 | 58 | 22 | 8.5 | 6.3 | 7.3 | 343 |
| 1960 | 13 | 8.5 | 12 | 12 | 12 | 18 | 20 | 43 | 20 | 7.9 | 6.9 | 14 | 187 |
| 1961 | 12 | 12 | 12 | 12 | 11 | 15 | 12 | 12 | 9.3 | 7.3 | 33 | 19 | 167 |
| 1962 | 12 | 12 | 15 | 14 | 256 | 241 | 179 | 94 | 66 | 13 | 6.5 | 6.0 | 914 |
| 1963 | 6.1 | 11 | 12 | 8.7 | 11 | 8.7 | 9.5 | 20 | 61 | 25 | 14 | 16 | 203 |
| 1964 | 22 | 23 | 22 | 12 | 12 | 19 | 27 | 47 | 65 | 31 | 15 | 14 | 309 |
| 1965 | 24 | 17 | 21 | 26 | 29 | 37 | 68 | 102 | 106 | 73 | 47 | 47 | 597 |
| 1966 | 62 | 62 | 29 | 44 | 53 | 74 | 86 | 73 | 39 | 15 | 12 | 14 | 563 |
| 1967 | 18 | 23 | 19 | 9.2 | 18 | 32 | 44 | 69 | 81 | 35 | 12 | 19 | 381 |
| 1968 | 36 | 25 | 23 | 14 | 13 | 39 | 41 | 40 | 38 | 15 | 17 | 18 | 319 |
| Average | 23 | 22 | 19 | 18 | 45 | 54 | 54 | 56 | 51 | 23 | 17 | 17 | 398[1] |

[1]Annual average given is sum of monthly averages.

**Table 6.—Discharges obtained from the crest-stage gage record for station 10-1729.3 Right Hand Fork Dove Creek near Park Valley**

Location: (B-13-15)31abd.
Altitude: 5,850 feet.
Date: That given is for periodic gage inspection except p, probable date of flood peak.
Discharge: Flow estimated except m, measured; most estimates for shallow water in which cross section was measured and velocity estimated; z, stream frozen.

| Date | Discharge (cfs) | Date | Discharge (cfs) | Date | Discharge (cfs) |
|---|---|---|---|---|---|
| 12-17-58 | z | 7- 9-62 | 0.15 | 3- 8-66 p | 16m |
| 4- 1-59 | 0.5 | 8- 1 | .3 | 3-25 | 1.17 |
| 4-21 | .3 | 8-21 | .1 | 4-11 | .75 |
| 5-12 | .3 | 9-12 | < .1 | 5-23 | .5 |
| 5-16 | .4 | 9-26 | 0 | 6-17 | .35 |
| 5-26 | .3 | 10-16 | < .1 | 7-12 | .5 |
| 6-23 | .2 | 2- 1-63p | 13m | 8-12 | .2 |
| 7-22 | .2 | 2- 4 | 0 | 9-15 | .2 |
| 8- 7 | .1 | 2-20 | .1 | 10-13 | .2 |
| 9-16 | .15 | 4-24 | .1 | 4-14-67 | .25 |
| 9-25 | .1 | 5-14 | .3 | 5-15 | .75 |
| 10-14 | .2 | 5-28 | .16 | 6-14 | 1.5m |
| 4-27-60 | .4 | 6- 4 | .8 | 8- 8 | .2 |
| 6- 1 | .3 | 6-14 | .8 | 4-19-68 | .5 |
| 7- 6 | .2 | 7- 9 | .15 | 5-14 | .6 |
| 8- 3 | .1 | 8- 7 | .15 | 6- 6 | .7 |
| 8-12 | <.1 | 8-28 | .1 | 8- 8 | .75 |
| 8-19 | .1 | 9-19 | .15 | 9- 7 | .35 |
| 8-25 | .15 | 10-18 | .27 | 11- 5 | .18 |
| 9- 6 | .17 | 11-14 | .27 | | |
| 9-21 | .19m | 4-23-64 | .75 | | |
| 10- 6 | .19m | 5-13 | .75 | | |
| 10-19 | .18 | 6-24 | 1.28m | | |
| 11-10 | .1 | 7-22 | .2 | | |
| 7-25-61 | .2 | 8-19 | .2 | | |
| 8- 6 | 16m | 4-22-65 | .75 | | |
| 8-16 | .5 | 5-11 | 1.2m | | |
| 9-22 | .16m | 6-29 | 1.0 | | |
| 3-25-62p | 32.3m | 8-11 | .70 | | |
| 3-26 | 26.9m | 9- 6 | .75 | | |
| 4- 4 | 1.98m | | | | |

*Runoff in measured streams.*—The average annual discharge of Dove Creek at station 10-1729.4 during the 1959-68 water years was 398 acre-feet (table 5). This amount should be about the long-term average discharge because average precipitation during this period (10.64 inches) was close to both the long-term average (10.45 inches during 1911-68) and the 1931-60 normal annual (10.34 inches) at Park Valley.

The recorded flow at station 10-1729.4 was extrapolated to four other streams on the south flank of the Raft River Mountains where miscellaneous estimates and measurements were made (table 4); the method of extrapolation was that used by Moore (1968, p. 33-36), using the equation

$$Qm = QM \frac{Qa}{Qb}$$

in which *Qm* is the unknown long-term annual mean flow at the ungaged stream, *QM* is the long-term annual mean flow at the gaged stream, *Qa* is the measured streamflow at the ungaged station, and *Qb* is the daily streamflow at the gaged station on the same day as *Qa*. The results are given in the following table:

| Stream | Date | Cubic feet per second QM = 0.55 *Qa* | *Qb* | *Qm* | Acre-feet per year (rounded) |
|---|---|---|---|---|---|
| Dunn Canyon creek | 11-7-68 | 0.7[1] | 0.41 | 0.94 | 680 |
| Fisher Creek | 11-8-68 | .49 | .37 | .73 | 530 |
| Rock Canyon creek | 11-8-68 | .20 | .37 | .30 | 220 |
| Pine Creek | 11-8-68 | .64 | .37 | .95 | 690 |
| Dove Creek | - | - | - | - | 400 |
| Total (rounded) | | | | | 2,500 |

[1]Estimate.

*Estimated runoff from the uplands.*—The average annual runoff from the uplands of the Park Valley area is estimated to be 5,000 acre-feet, of which about 3,500 acre-feet originates in the Raft River Mountains and about 1,500 acre-feet in the Grouse Creek Mountains. Of the 5,000 acre-feet, about 3,000 acre-feet is estimated to be readily diverted to man's use.

The average annual runoff was estimated by comparing the estimated average annual runoff in Dove Creek, Pine Creek, Rock Canyon creek, Fisher Creek, and Dunn Canyon creek directly with the average annual precipitation in those canyons and to the total precipitation on all the uplands of the Park Valley area. Runoff in the five canyons originates mainly on lands above the trace of the 16-inch isohyet shown on plate 1. The average annual precipitation on the area drained by the five canyons, above the 16-inch isohyet, is 43,300 acre-feet. The observed and extrapolated runoff in the five canyons is about 6 percent of this amount; 6 percent of the estimated 69,700 acre-feet of precipitation that falls on all lands in the area, above the 16-inch isohyet is about 4,000 acre-feet. A smaller amount of runoff originates in uplands below the trace of the 16-inch isohyet. This amount is estimated to be about 1,000 acre-feet; the estimated average annual runoff from the uplands of the Park Valley area, thus, amounts to about 5,000 acre-feet.

The proportions of runoff derived from the Raft River and Grouse Creek Mountains are based on the proportions of land area inside the 16-inch isohyet in the two mountain areas, as applied to the estimated total runoff. The estimate of readily diverted runoff is based both on the distribution of precipitation and on topographic considerations.

## Ground water

All the geologic formations in the Park Valley area contain ground water and can yield it to wells and springs. (See table 1.) The principal source of ground water is the reservoir in sedimentary rocks of Cenozoic age that underlie the central and lower Dove Creek and Muddy Creek drainage basins. This reservoir consists of (1) the saturated parts of the sedimentary rocks of Quaternary age and (2) at least a part of the thicker and extensive sedimentary rocks of Tertiary age. The saturated section probably functions as a single reservoir, but the rocks of different ages have different hydrologic characteristics. The younger rocks have moderate to high

permeability and can yield moderate to large quantities of water to wells, but these saturated rocks are relatively thin. 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 a large quantity of water in storage.

In the sections that follow, the estimates of recharge, storage, and discharge apply mainly to the reservoir in the Cenozoic rocks. It should be kept in mind, however, that all the rocks are a part of the ground-water system and that ground and surface waters interchange in their movement through the hydrologic system in the Park Valley area.

#### Recharge

The estimated average annual ground-water recharge to the Park Valley area is 24,000 acre-feet (table 3), nearly 5 percent of the estimated 520,000 acre-feet of average annual precipitation in the area. The estimate was made using a method described by Hood and Waddell (1968, p. 22-23).

The ground-water recharge is derived mainly from precipitation on lands above 6,000 feet in altitude. A small amount of recharge, however, is derived from precipitation on coarse-grained alluvium in the zone from 5,000 to 6,000 feet; some recharge occurs where consolidated rocks at lower altitudes convey accumulated runoff to coarse-grained alluvium. Precipitation that falls on most of the unconsolidated deposits in the area does not reach the ground-water reservoir because the quantity of precipitation is small and the water that enters the ground is held as soil moisture. A part of the recharge percolates directly to the ground-water reservoir through the rocks on which it falls, and a part percolates down from the beds of streams that flow over permeable rocks at lower altitudes.

#### Occurrence and movement

Ground water in shallow alluvium along the slopes below the Raft River and Grouse Creek Mountains, and along the valley flats of Dove and Muddy Creeks is under water-table (unconfined) conditions. Probably most of the ground water in the thicker section of alluvium in the lower reaches of Dove and Muddy Creeks also is unconfined. Some of the water in the older Quaternary and Tertiary aquifers near the hills and mountains may be unconfined, but these aquifers are known to contain water under artesian (confined) conditions near the Park Valley and Rosette communities and near Dove Creek. For example, well (B-13-14)25ccb-2 reportedly discharges about 5 gpm by natural flow from sandstone in the Salt Lake Formation. The artesian head has not been measured, but it is assumed to be small.

Most of the springs that discharge from alluvium in the vicinity of the Park Valley and Rosette communities are gravity springs that flow because the land surface intersects the water table. A few springs, however, may be artesian and discharge from deeper aquifers. For example, the predominance of sodium among the anions, the higher concentration of dissolved solids, and higher temperature of water from springs (B-13-13)27dddS-1 and 35bbbS-1 indicate that water from these two springs probably passes through the Salt Lake Formation and moves upward along an inferred fault at the west side of Chicken Ridge (pl. 1).

Most ground water in the igneous and pre-Tertiary rocks in the mountain areas probably is unconfined, but at lower altitudes where these rocks are water bearing and extend beneath unconsolidated rocks, artesian conditions probably exist. Ground water probably is partly

confined near such springs as (B-10-15)6cdbS-1 and (B-12-15)19aabS-1 where deeply circulating ground water in highly permeable solution channels and fractures overflows into the alluvium that abuts the older consolidated rocks.

Ground water in the area moves downgradient from the mountain areas to the valleys of Dove and Muddy Creeks. Thus in the vicinity of the Park Valley and Rosette communities, the direction of movement is almost due south. Gradients near Park Valley range from 100 to more than 200 feet per mile, and in the upper slopes the gradient of the water surface approximates that of the land surface. In the upper part of Dove Creek and along the east slope of the Grouse Creek Mountains, ground water moves southeastward and eastward; the gradients are slightly lower than those near Park Valley. (See pl. 1) In the southern, central, and eastern parts of the Park Valley area, the control for constructing the water-level contours shown on plate 1 is very sparse, and the position of the contours is inferred. Sufficient control is available along the stream valleys to show that the ground water moves southward and eastward, and that the water-table gradient probably is 40-100 feet per mile. The lower gradient probably is due both to movement through a thicker section of permeable rock and to decreased flow through the section because a part of the water has been discharged upgradient.

### 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 storage remains nearly constant. The only known withdrawal of ground water in the Park Valley area for irrigation is from a few wells in the vicinity of Dove Creek. The withdrawal may have altered the natural balance, but such imbalance would be only local and the Park Valley area as a whole is under natural conditions.

*Water-level fluctuations.*—Year-to-year changes in ground-water storage are indicated by corresponding changes in the water levels in wells. When recharge exceeds discharge, water levels rise, and conversely, when discharge is greater, the water levels decline. Water levels in observation wells that have been measured in the Park Valley area since 1936 are plotted in figure 2, together with the monthly mean flow of Dove Creek at station 10-1729.4 and the cumulative departure from the 1931-60 normal annual precipitation at Park Valley.

The hydrographs show that in the areas of the observation wells the results of ground-water withdrawal has had little or no effect on storage; the water levels responded in varying degree to annual changes in precipitation and resulting runoff. Well (B-10-15)26bad-1 taps a 300-foot thick section of permeable unconsolidated rocks and is several miles from areas where recharge might occur. The water level changed little during the 33-year period 1936-68.

In the vicinity of the Park Valley and Rosette communities, the permeable, unconsolidated alluvium is relatively thin (50-100 feet) and is in an area where both recharge and discharge can occur. Most of the observation wells are shallow and water levels show quick response to changes in precipitation and therefore to the flow of streams, as indicated by the hydrographs for observation wells and record for Dove Creek. The most prominent example is shown in the hydrograph for well (B-13-13)31aaa-1; in this well, the water level changed through a relatively wide range and apparently reflected year-to-year changes in precipitation. The hydrograph, however, does show response to long-term changes in a general way; the water level was high during the period of above-normal and near-normal precipitation in the 1940's, but the water level declined and the well went dry several times during the periods of below-normal

precipitation in the early 1950's and early 1960's. If observations had been continued at this well, they probably would have shown sharp rises in response to increased streamflow in 1962 and 1965 as did wells (B-13-13)28ddd-2 and (B-13-14)25cbb-3.

*Estimated storage.*—An estimated minimum of about 500,000 acre-feet of ground water is stored in the Park Valley area. The storage figure is a minimum because it is based on the probable yield that would result from dewatering a part of the ground-water reservoir that underlies Dove Creek valley and does not include water in deeper zones or in adjacent pre-Tertiary rocks.

The estimate was made as follows. The ground-water reservoir underlies at least 90,000 acres in Dove Creek valley, from the foot of the Grouse Creek Mountains eastward to the vicinity of Indian Creek and from the foot of the Raft River Mountains southward to the north side of the Matlin Mountains. The reservoir includes unconsolidated rocks with an estimated average saturated thickness of 50 feet and an estimated specific yield of 5 percent. Below the unconsolidated rocks are semiconsolidated and consolidated sedimentary rocks that have an estimated specific yield of 1 percent. Dewatering 100 feet of this composite reservoir would yield an estimated 270,000 acre-feet of water. In the southern half of the Park Valley area, the character of the reservoir is not well known; but dewatering 100 feet of the reservoir in this area might yield as much ground water as in Dove Creek valley. The rounded total, therefore, is 500,000 acre-feet.

The recovery of 500,000 acre-feet of ground water, however, would require an extensive network of wells to accomplish the required dewatering. Dewatering in the vicinity of the Park Valley and Rosette communities, moreover, would affect the flow of springs that yield water appropriated for irrigation use. Some of the water available for withdrawal from storage in the southern half of the Park Valley area is not of suitable chemical quality for most uses, and dewatering near the southern and eastern edges of the area would cause the water quality to deteriorate further.

### Discharge

The estimated average annual discharge of ground water in the Park Valley area is 24,000 acre-feet. Water is discharged naturally by evapotranspiration and by subsurface outflow to the Great Salt Lake Desert area and to the lake. The quantity of water that discharges from springs is included in the figure for evapotranspiration because the spring water is consumed within the valley areas. Water discharged from wells increases the total discharge only slightly.

*Evapotranspiration.*—About 16,000 acre-feet of the ground water that leaves the Park Valley area is transpired by plants and is evaporated from soils where the water table is shallow. (See table 7.) The data used for the estimate of evapotranspiration were obtained from a rapid field examination of plant distribution and comparison of that distribution with a map of the depth to water in wells in the valley.

The plant species that grow in most of the Park Valley area reflect the generally small amount of precipitation that falls on the area. Both xerophytes and phreatophytes are those adapted to survival in specific environments. Xerophytes use available soil moisture, and grow anywhere that suitable soil exists. The phreatophytes, those plants that utilize ground-water supplies, generally are restricted to the areas where the depth to water is 40 to 60 feet or less.

Table 7.—Estimated average annual evapotranspiration of ground water

| Type | Area (acres) | Depth to water (feet) | Estimated evapotranspiration Acre-feet per acre | Acre-feet (rounded) |
|---|---|---|---|---|
| Grass, rabbitbrush, and patches of willow, mainly in and near spring areas. | 2,300 | 0-10 | 1.5 | 3,400 |
| Mainly greasewood, with areas of rabbitbrush; generally sparse, but locally dense and luxuriant. | 12,300 | 0-30 | .2 | 2,000 |
| Grass, rabbitbrush, and patches of willow; partly supplied with applied irrigation water from streams and local springs and with natural spread streamflow. | 7,500 | 5-30 | .4 | 3,000 |
| Locally observed as very sparse greasewood and rabbitbrush associated with sage. Designation as area of evapotranspiration based on depth to water. | 57,200 | 10-30 | .1 | 6,000 |
| Mainly sparse greasewood and bare ground; area along Dove Creek has locally dense greasewood (?) and patches of willow; area along Great Salt Lake Desert probably has sparse to very sparse greasewood, locally associated with pickleweed (Foster, 1968). | 23,900 | 10-60(?) | .1 | 2,000 |
| Totals (rounded) | 103,000 | | | 16,000 |

Observed phreatophytes include willow (*Salix* sp.), greasewood (*Sarcobatus vermiculatus*), rabbitbrush (probably *Chrysothamnus nauseosus*), and meadowgrasses.

Willow withdraws ground water in parts of the Park Valley area. Most growth of this species was observed in the northern and western parts where well-established stands line the edges of some stream channels and also occupy patches around spring areas that are not in channels. Growth along perennial and intermittent streams that flow most of the year probably subsist on water from streamflow, but most willow thickets along intermittent and ephemeral streams depend on ground water. An example is the willow growth in the Dove Creek channel due south of the Park Valley community (pl. 1), where precipitation averages less than 10 inches annually and is widely variable from year to year. With small amounts of streamflow and precipitation, water-loving willow must be sustained by ground water. This dependence is partly demonstrated by data from Robinson (1968a, p. A134), which show that willow grown in tanks in an area of low precipitation derived more than 82 percent of its water needs from ground water and that the consumption of water was almost independent of precipitation.

Greasewood in density and size indicating phreatophytic growth was observed during the reconnaissance as far north as sec. 22, T. 12 N., R. 13 W., along the road south from Park Valley. It also was observed in parts of the upper Muddy Creek drainage basin near State Highway 30. Detailed mapping doubtless would show that the phreatophyte is concentrated near streams and terraces in shallow water areas throughout the lower altitudes of the area.

Rabbitbrush was observed throughout the northern and western parts of the Park Valley area wherever the ground water is shallow and is of good chemical quality. Dense growth, for example, was observed along the road in sec. 27, T. 12 N., R. 13 W., where it grows in association with greasewood and locally with meadowgrasses on beach deposits of Lake Bonneville. Elsewhere, the phreatophyte was observed growing on fallow land and in spring areas high on the alluvial apron of the Raft River Mountains.

Meadowgrasses in areas of appreciable size were seen mainly along the valley bottoms of upper Muddy and Dove Creeks and in the vicinity of Park Valley. Much of the grassland is cultivated or harvested as a crop, and it is partly sustained with surface-water irrigation. In part of the observed areas, however, it is believed that grass is naturally sustained in part by ground water.

Along the shore of Great Salt Lake and the edge of the Great Salt Lake Desert, it is inferred that the phreatophyte pickleweed (*Allenrolfea occidentalis*) discharges saline ground water. Mapping by Foster (1968) confirms the presence of pickleweed in the shore area south-southeast of Kelton.

Parts of the Park Valley area are bare of vegetation. Small areas of the alluvial cover are bare, particularly in areas behind Lake Bonneville bar deposits, because the available precipitation is low, the soil is a tight lacustrine silt, and the soil probably is salty. The bareness of the Great Salt Lake shore and a part of the Great Salt Lake Desert obviously is due to high soil salinity.

Plate 1 shows the observed and inferred areas of phreatophytes in the Park Valley area. The areas shown were obtained by plotting observed occurrences of phreatophytes on aerial photographs and extending from those control points to other similar areas on the photographs. Extrapolation on the photographs was hampered by the many small cleared tracts, particularly in Dove Creek valley south of State Highway 30, that obscure the natural distribution. The areas of phreatophyte growth were further delimited by geologic and depth-to-water data. Areas of growth along the Great Salt Lake Desert were obtained from the photographs only. Delineation of areas of phreatophyte growth in the Park Valley area may be subject to substantial revision if detailed mapping is done.

*Subsurface outflow.*—An estimated 8,000 acre-feet of ground water discharges annually from the water-bearing formations of the Park Valley area into Great Salt Lake and the Great Salt Lake Desert. The water thus discharged is the residue of the water recharged to the formations that is not consumed by evapotranspiration or withdrawn by wells.

The estimate has a low accuracy because it is based on water-level contours (pl. 1) that have only a small amount of control and on hydraulic coefficients that are estimated from the lithology of the water-bearing formations. The subsurface flow was estimated for the area downgradient from most of the evapotranspiration, and in that area the shape and slope of the water table is inferred. A study of the drillers' logs of wells near the southern area and of the typical coefficients of permeability cited by Johnson (1963, p. 31) indicates that the upper 100 feet of the saturated alluvium has a relatively low hydraulic conductivity (see appendix)—probably 8 feet per day or less—and the alluvium and other rock below that zone have a very low hydraulic conductivity—in the range 0.000001-1.3 feet per day. The latter low values include the consolidated rocks which the contours cross. Judging from the large amounts of clay and other materials of low hydraulic conductivity and the steep water-table gradients, the gross transmissivity (see appendix) is estimated to be 670 $ft^2$ per day (equivalent to a coefficient of transmissibility of 5,000 gpd per ft).

An estimated average annual subsurface flow of 10,000 acre-feet of ground water was derived by use of the equation

$$Q = 0.00838\ TIL$$

in which $Q$ is the subsurface flow, in acre-feet per year; 0.00838 is a units conversion factor; $T$ is transmissivity, in $ft^2$ per day; $I$ is the average slope of the water table, in feet per mile; and $L$ is the length, in miles, of the contour across which the subsurface flow occurs. Using the inferred 4,800-foot contour on plate 1, $Q = 0.00838 \times 670 \times 57 \times 32 = 10{,}200$ acre-feet per year. About 2,000 acre-feet of evapotranspiration south of the 4,800-foot contour must be subtracted from the amount calculated; the quantity of subsurface outflow, therefore, rounds to 8,000 acre-feet.

*Wells.*—The estimated withdrawal of ground water through wells in the Park Valley area in 1968 was 500 acre-feet. Most stock and some domestic supplies are obtained from springs, and the remaining needs are satisfied from dug wells and small-diameter drilled wells. The total annual use for stock and domestic purposes probably is less than 50 acre-feet. According to available electric power records (1960-67), only two wells were supplied with power for irrigation, but as many as five wells may have been used. Most of the land to which the pumped water is applied (about 500 acres) also is supplied with water from streams and springs.

### Ground-water-budget

The average quantity of ground water recharged to and discharged from the Park Valley area is estimated to be 24,000 acre-feet per year. The quantities involved in the several processes are shown in table 8.

**Table 8.—Ground-water budget for the Park Valley area**

| Item | Estimated quantity of water, in acre-feet per year |
|---|---|
| Recharge (table 3) | 24,000 |
| Discharge: | |
| Evapotranspiration (table 7) | 16,000 |
| Subsurface outflow | 8,000 |
| Wells | 500 |
| Total (rounded) | 24,000 |

### 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 ground-water storage. The perennial yield cannot exceed the natural discharge; moreover, the yield will be limited by the amount of natural discharge that can be salvaged for beneficial use.

Of the estimated average annual discharge (24,000 acre-feet) very little of the 8,000 acre-feet of subsurface outflow could be salvaged economically. None of the 2,000 acre-feet of ground water discharged by evapotranspiration near the Great Salt Lake Desert could be salvaged, mainly because the water probably is not chemically suitable for most present uses. The perennial yield, therefore, is 14,000 acre-feet.

An estimated 6,000 acre-feet of the water consumed by evapotranspiration presently is beneficially used together with irrigation water in cultivated fields and pastures. The remaining water discharged by evapotranspiration, about 8,000 acre-feet, might be salvaged by concurrently lowering water levels and clearing of phreatophytes. To achieve the lowering of water levels a planned network of wells would be needed; the pumping of the wells would to some extent affect supplies now being used beneficially in the area.

#### Chemical quality of 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 the land surface or percolates into the ground. The amount and chemical character of the minerals dissolved by the water depend chiefly 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 rocks and soils (ion-exchange). The total concentration of dissolved minerals and the concentration of individual ions will determine the usefulness of the water for various purposes.

The available chemical analyses of water from the Park Valley area indicate that most water in streams, springs, and wells north of the Matlin Mountains and west of Muddy Creek is fresh (dissolved-solids concentration less than 1,000 mg/l). In the central part of the Muddy Creek and Dove Creek drainage basins, ground water probably is slightly saline (1,000-3,000 mg/l of dissolved solids) and near the Great Salt Lake Desert, the ground water probably is moderately saline (3,000-10,000 mg/l). Springs along the shore of Great Salt Lake yield very saline water (10,000-35,000 mg/l).

The freshest water, such as that from spring (B-13-16)23ccdS-1, is of the calcium bicarbonate type. Near the mountains, some of the ground and surface waters are of the calcium mangesium bicarbonate type. Water from deeper aquifers near the mountains are inferred to be of the sodium bicarbonate type, as at spring (B-13-13)27dddS-1. In the vicinity of the central and lower Muddy Creek and Dove Creek drainage basins, the ground water is of mixed types. Well (B-12-14)21cad-1 yielded a sample that is a calcium sodium bicarbonate chloride type water. The saline water from springs near the southern and eastern edges of the area all are sodium chloride type.

These types are based on chemical analyses of water from 20 springs, 12 wells, and 3 streams (table 14). The specific conductance and approximate dissolved-solids concentrations in water from 12 other sources are given in table 9. Locations of the sampling sites and the general chemical quality of water in its source area are shown on plate 2.

All water in the Park Valley area except the water from springs at the edges of both Great Salt Lake and the Great Salt Lake Desert is generally suitable for use by stock.

Most water in the areas where the population now resides is suitable for domestic consumption. For most samples the concentrations of the major constituents shown in table 14 are within the maximum limits recommended by the U. S. Public Health Service (1962, p. 6-7). Some water samples contained more than the maximum of 500 mg/l of dissolved solids the Public Health Service lists as desirable; in most of the same samples, the concentrations of

## Table 9.—Specific conductance and dissolved solids in water from miscellaneous wells, springs, and streams in the Park Valley area

Location: See appendix for description of numbering system for wells, springs, and other hydrologic sites.

Temperature: See appendix for discussion of relation of Celsius and Fahrenheit scales.

Specific conductance: Field determinations in micromhos per centimeter at 25°C.

Dissolved solids: In milligrams per liter, approximated from specific conductance, except R, reported.

| Location | Name or description | Date | Temperature (°C) | Specific conductance | Dissolved solids | Remarks |
|---|---|---|---|---|---|---|
| (B-9-12)9bbb-1 | Stock well | 1935 | - | - | 3,670R | Reported by Utah Emergency Relief Administration. |
| (B-10-15)6accS-1 | Water Cress Spring area | 11- 7-68 | 16 | 1,000 | 530 | Spring area at foot of low bluff is choked with dense vegetation. |
| 29dca | Pipeline | 5-18-68 | 13 | 250 | 130 | Measured at fountain at highway rest area. |
| | | 11- 6-68 | 11 | 300 | 160 | Pipeline gathers water from springs, and streams in the Rosebud Creek area and delivers it to Lemay siding on the Southern Pacific Co. railroad. |
| (B-11-15)4bbaS-1 | Developed spring area | 11- 7-68 | 10 | 740 | 390 | "Muddy Creek Water Development" of Bureau of Land Management. Area on both sides of State Highway 30 is boxed and water is piped to trough on west side. |
| (B-13-13)15bbb | Creek in Dunn Canyon | 11- 7-68 | 4 | 240 | 130 | At diversion works in mouth of canyon. |
| 17baa | Fisher Creek | 11- 8-68 | 2 | 238 | 130 | At road crossing 100 feet above diversion works in mouth of canyon. |
| 18acb | Creek in Rock Canyon | 11- 8-68 | 2 | 220 | 120 | At road crossing by quarry in canyon. |
| (B-13-14)10ddd | Left Hand Fork Pine Creek | 11- 8-68 | 2 | 200 | 120 | At confluence of forks of the creek. |
| 11ccc | Right Hand Fork Pine Creek | 11- 8-68 | 2 | 160 | 85 | Do. |
| 14bdaS-1 | Spring | 11- 8-68 | 13 | 320 | 170 | On slope above east side of canyon mouth. |
| 14bdbS-1 | do | 11- 8-68 | 14 | 220 | 120 | West of road and east of Pine Creek in mouth of canyon. Natural spring basin choked with water cress. |
| 14bdc | Pine Creek | 11- 8-68 | 3 | 204 | 110 | Main stem at diversion works; below spring area. |

chloride and sulfate were less than the recommended 250 mg/l for each. Most of the waters were 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 |

Of the 11 samples for which fluoride was determined and which are judged suitable for domestic use, only two, those from springs (B-13-13)27dddS-1 and 35bbbS-1, contained fluoride in excess of the recommended maximum listed by the U. S. Public Health Service (0.8 mg/l at mean daily maximum air temperatures of 59°F).

Water in the areas of saline water (in excess of 1,000 mg/l shown on pl. 2) generally is undesirable or not suitable for domestic use. Some of the slightly saline water could be used for domestic purposes without harmful effects, but most of the water would have an unpleasant taste and probably a cathartic effect.

Most of the water analyzed is suitable for irrigation use on 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 the concentration of boron and other toxic elements, the concentration of dissolved solids as indicated by the specific conductance (conductivity), and the relative proportion of sodium to other cations in the water as indicated by the sodium-adsorption ratio (SAR).

According to Wilcox's classification (1948), the most boron-sensitive plant can withstand concentrations of 0.33 mg/l of boron. Only 2 of the samples for which boron was determined (table 14) contained more than 0.33 mg/l of boron.

The suitability of water for irrigation is judged by plotting the values for specific conductance and SAR on a diagram (fig. 3) 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 sodium 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.

Most of the water samples except for those from the springs in the southern and eastern edges of the area had a low sodium hazard. The analyses indicate that the lowest sodium concentrations are in mountain streams and springs and shallow ground-water sources nearest the mountains. The sodium concentration increases southeastward and in water that is inferred to circulate deep within the reservoir. The increase probably is the result of base exchange in the aquifers.

Most water sampled has a medium to high salinity hazard. The water from streams and springs in and near the mountains has the lowest salinity hazard and water from sources in the lower Muddy Creek and Dove Creek drainage basins has the highest salinity hazard (except for the saline springs, which have a very high salinity hazard).

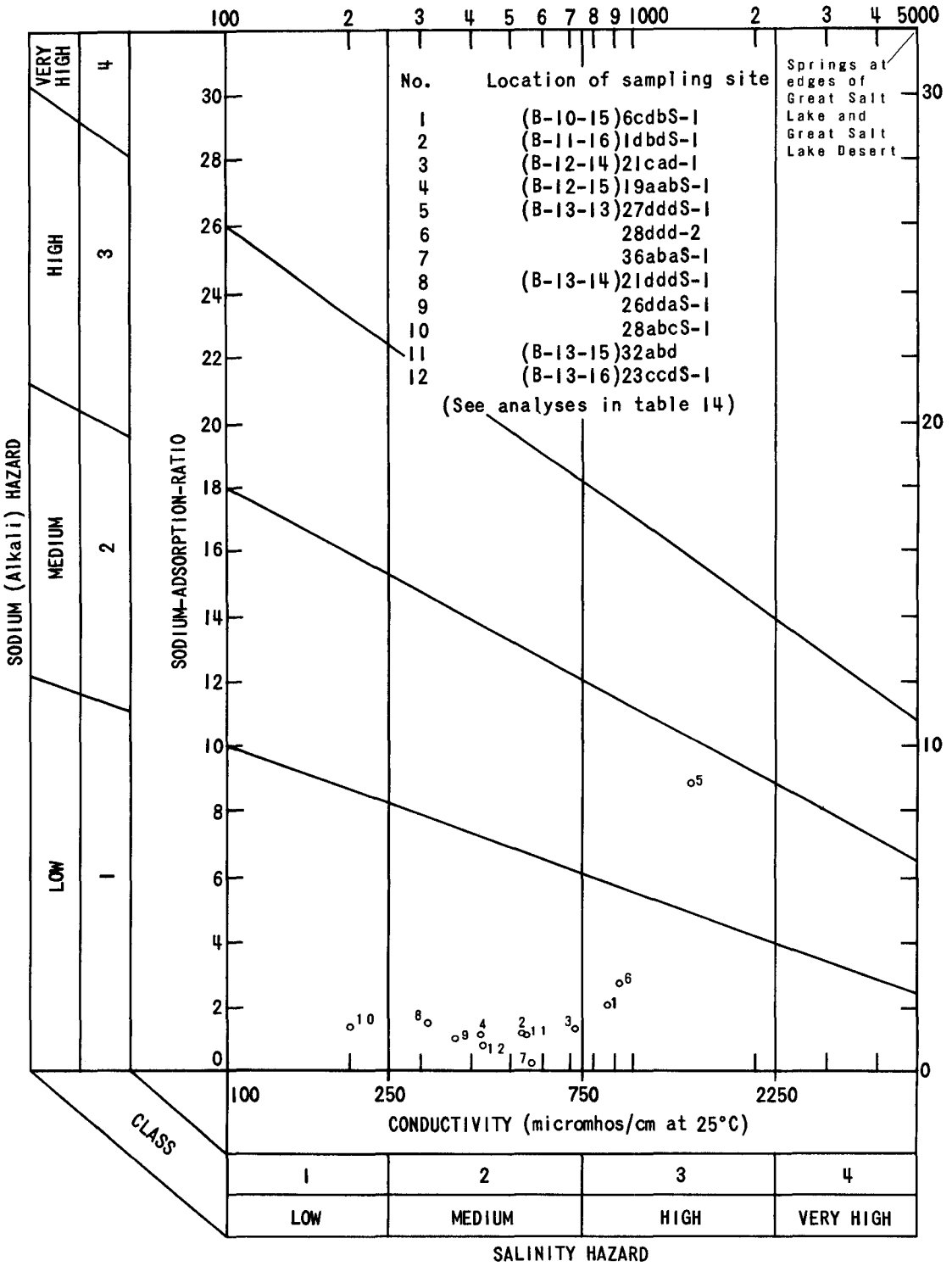


Figure 3.—Classification of representative well, spring, and stream water for irrigation in the Park Valley area.

The temperature of water in the Park Valley area is related to the average annual air temperature and the water generally is a few degrees warmer. However, two springs, (B-10-15)6cdbS-1 and (B-12-15)19aabS-1 (Warm Spring 2 and 1), have temperatures of 20°C (68°F) and 27°C (81°F), respectively. They issue from structurally distorted limestone and quartzite, respectively, and the source of heat may be due to depth of circulation or to residual heat along fault zones. The higher temperatures for some other water samples from springs listed in table 14 may be due mainly to conditions such as ponding at the collection point. (See footnotes, table 13.)

## SUMMARY OF WATER SUPPLY

The estimated average annual supply of water in the Park Valley area is 29,000 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 (3,000 acre-feet of runoff and 14,000 acre-feet of evapotranspiration). About 8,000 of the 17,000 acre-feet is used nonbeneficially and is subject to salvage.

The 17,000 acre-feet of water per year could be augmented with ground water pumped from storage. If 10,000 acre-feet per year were withdrawn from storage in the northern part of the area, at the end of 25 years the water-level decline might amount to 100 feet or more locally. The withdrawals and consequent decline of water level would affect existing beneficial uses to an extent presently unknown.

## SUMMARY OF WATER USE

The Park Valley area contains about 674,000 acres of land, of which about 668,000 acres are grazing lands, timberland in the high mountains, and some saltflats and mudflats in the northern part of the Great Salt Lake Desert. In this large area, water needs are small and are satisfied from streams and springs and a few wells. The largest use of water is on irrigated farms and pastures that have been developed on the slopes at the foot of the Raft River Mountains and along the courses of Indian, Dove, and Muddy Creeks.

### Past and present development

The continuous use of water in the Park Valley area began in 1868-69 when the Central Pacific Railroad (later called the northern route of the Southern Pacific Railroad) was being built through the area. The railroad towns of Terrace and Kelton came into being about 1869 and were supplied subsequently with water from Rosebud Creek (Carpenter, 1913, pl. 1) and springs, respectively. Both communities, as towns, no longer exist. The southern route (the Lucin Cutoff) was built in the early 1900's and when the northern route was abandoned, the railroad installed a pipeline from its Rosebud Creek water development of Lemay siding (pl. 1) and thence to other sidings to the east. Today, the pipeline still supplies the sidings, but the water also is used for some irrigation near the head of the pipeline, and taps along the line withdraw water for stock and domestic use.

Other parts of the Park Valley area were settled by farmers and ranchers. Most farming operations were and still are related to fodder production. The Rosette community was settled on the banks of Pine Creek in 1871 (Fosgren, p. 197) and the Park Valley community shortly

afterward. Ranches in the area from Kelton to Muddy (Birch) Creek were well established concerns by 1911 (Carpenter, 1913, p. 66-71, and pl. 1). Water for farming and ranching operations has always been derived mainly from streams and from springs near the points of use. Most early wells were dug to shallow depths, and well construction undoubtedly began soon after settlement began. In 1890 and later, deeper wells were drilled, but the construction of modern, deep irrigation wells was not started until 1946 (table 11).

The lands to which the available water supply is applied are mostly privately owned (U. S. Bur. of Land Management, 1969). Part of the land is supplied from privately claimed and operated diversions and partly by organized water companies. Richards and others (no date, p. 4-5) show the following organizations that supply irrigation water:

| Organization | Source | Date incorporated | Acres supplied in 1963 |
|---|---|---|---|
| Fisher Creek Irrigation Co. | Fisher Creek | 5-10-15 | 1,300 |
| Marble Creek Irrigation Co. | Marble (Dunn Canyon) Creek | 12-12-47 | 1,300 |
| Pine Canyon Creek Irrigation Co. | Pine Creek | 11-30-14 | 700 |
| Rosen Valley Irrigation Co. | Long Birch and Big Hollow Creeks | 7-26-25 | 200 |

The quantity of land irrigated in the Park Valley area has been relatively stable since the early 1900's, but it undoubtedly has fluctuated from year to year in response to changes in the available water supply. The following tabulation shows acreages reported in 1911, 1965, and 1968:

| Subarea | 1911 Carpenter (1911, p. 70) | 1965 Utah State Engineer hydrographic survey[1] | 1968 U.S. Soil Conservation Service[2] |
|---|---|---|---|
| Park Valley-Rosette | 5,700 | 5,410 | 4,200 |
| Indian Creek | - | 410[3] | 80 |
| Dove Creek | 150 | 860 | 680 |
| Muddy (Birch) Creek[4] | 150 | 660 | 550 |
| Totals (rounded) | 6,000 | 7,300 | 5,500 |

[1]Field mapping showed all cultivated acreages including fallow land.

[2]Estimated by D. Braithwaite, District Conservationist (oral commun., March 1969).

[3]May include a few acres in Curlew Valley area, just beyond boundary of Park Valley area.

[4]Muddy Creek drainage basin, including Rosebud Creek area.

The acreage listed for 1965 probably is greater than the amount actually cultivated in that year; the table, however, shows that the long-term average annual amount irrigated is about 6,000 acres.

The use of irrigation wells in the Park Valley areas has not been entirely successful. Wells intended for irrigation have been drilled near the Park Valley and Rosette communities and in the

flood plain of Dove Creek. Some of the wells reportedly had yields of several hundred gallons per minute, but over a period of several years the sustained yields have proven to be low and some of the wells were converted to stock and domestic supplies. Part of the reason for the low yields is the low to moderate permeability of part of the water-bearing formations, and part may be the method of drilling, finishing, or development of the wells. The most successful wells are in and near the Dove Creek flood plain.

The development of irrigated land has resulted in some small amendments to the hydrologic regimen. Loss of streamflow into the beds of the major streams apparently has occurred. Pipelines from Dunn (Marble) Creek, Fisher Creek, and Pine Creek canyons were observed; these pipelines transport the diverted water into the vicinity of the lands to be supplied. It seems probable that a part of the shallow-water conditions noted in the Park Valley-Rosette subarea results from this localized application of irrigation water. Shallow-water conditions near the Park Valley and Rosette communities have necessitated drains to maintain good growing conditions. These drains are short, as indicated on field maps of the State Engineer's hydrographic survey of 1965; the survey, moreover, indicates that water derived from the drains is used for additional irrigation downslope.

#### Future development

Ground water from wells is the main source of water for future development as most, if not all, reliable streamflow and spring discharge has been appropriated. The history of well development in the northern part of the area to date (1968) shows that widespread development of large-capacity wells in the area is improbable, because much of the ground-water reservoir has a low to moderate permeability. However, further exploratory drilling and experimentation with well-completion techniques should show that the ground-water reservoir locally is capable of yielding enough water to wells for limited irrigation. Wells with yields of several hundred gallons per minute probably can be developed where the saturated alluvium is thickest in a few small areas near and along Dove and Muddy Creeks.

General development of ground water in the northern Park Valley area probably should involve small-diameter deep wells that penetrate both the alluvium and permeable beds of the Salt Lake Formation. Where irrigation water is needed and no thick saturated section of alluvium is found, several small-diameter wells ultimately may provide more water economically than a single large-diameter well.

Large-capacity wells probably could be developed in part of the area south and east of the Matlin Mountains, but near these mountains the water levels are deep and pumping costs would be appreciable. Near the desert, the chemical quality of the ground water may prohibit its use for irrigation.

## 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 better evaluate the hydrologic framework. Geophysical mapping, such as a gravity survey, would greatly enhance subsurface interpretation.

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 Dove and Muddy Creeks. Partial-record stations are needed on large intermittent streams, such as lower Muddy Creek below Rosebud Creek, 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 system 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 analysis 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 for the hydrology. These include climatologic data in both valley and mountains, botanic mapping to aid in evaluating evapotranspiration, and soils 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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[1]Climatological data were published prior to 1967 by the U. S. Weather Bureau and from 1967 forward by the Environmental Data Service, Environmental Science Services Administration.

# APPENDIX

### Well- and spring-numbering system

Wells, springs, and other hydrologic-data sites are numbered in this report using the system of numbering wells and springs in Utah, and is based on the cadastral land-survey system of the Federal Government. The number, in addition to designating the well, spring, or other data site, locates the site to the nearest 10-acre tract in the land net. By this system the State is divided into four quadrants by the Salt Lake Base Line and Meridian. 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 following three letters give the location of the site 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 three letters are set in lower case in text, on illustrations and typeset tables; in tables reproduced from computer printouts, such as table 11, The letters are uppercase. The number that follows the letters indicates the serial number of a well within the 10-acre tract. Thus, well (B-10-15)26bad-1, in Box Elder County, is in the SE¼NE¼NW¼ sec. 26, T. 10 N., R. 15 W., and is the first well constructed or visited in that tract (see fig. 4).

Springs are designated by the letter S preceding the serial (final number at the end of the location number), for example, (B-8-13)36dddS-1. Other hydrologic-data sites are numbered similarly except that the serial number is not used, for example, (B-12-15)13adb. This numbering system when used for surface-water gaging sites supplements but does not supplant the established system of numbering in downstream order.

### Metric units and new hydrologic terms

In this report, the units which indicate concentrations of dissolved solids and individual ions determined by chemical analysis and the temperatures of air and water are metric units. This change from reporting in "English units" has been made as a part of a gradual change to the metric system that is underway within the scientific community. The change is intended to promote greater uniformity in reporting of data. Chemical data for concentrations are reported in milligrams per liter (mg/l) rather than in parts per million (ppm), the units used in earlier reports in this series. For concentrations less than 7,000 mg/l, the number reported is about the same as for concentrations in parts per million.

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:

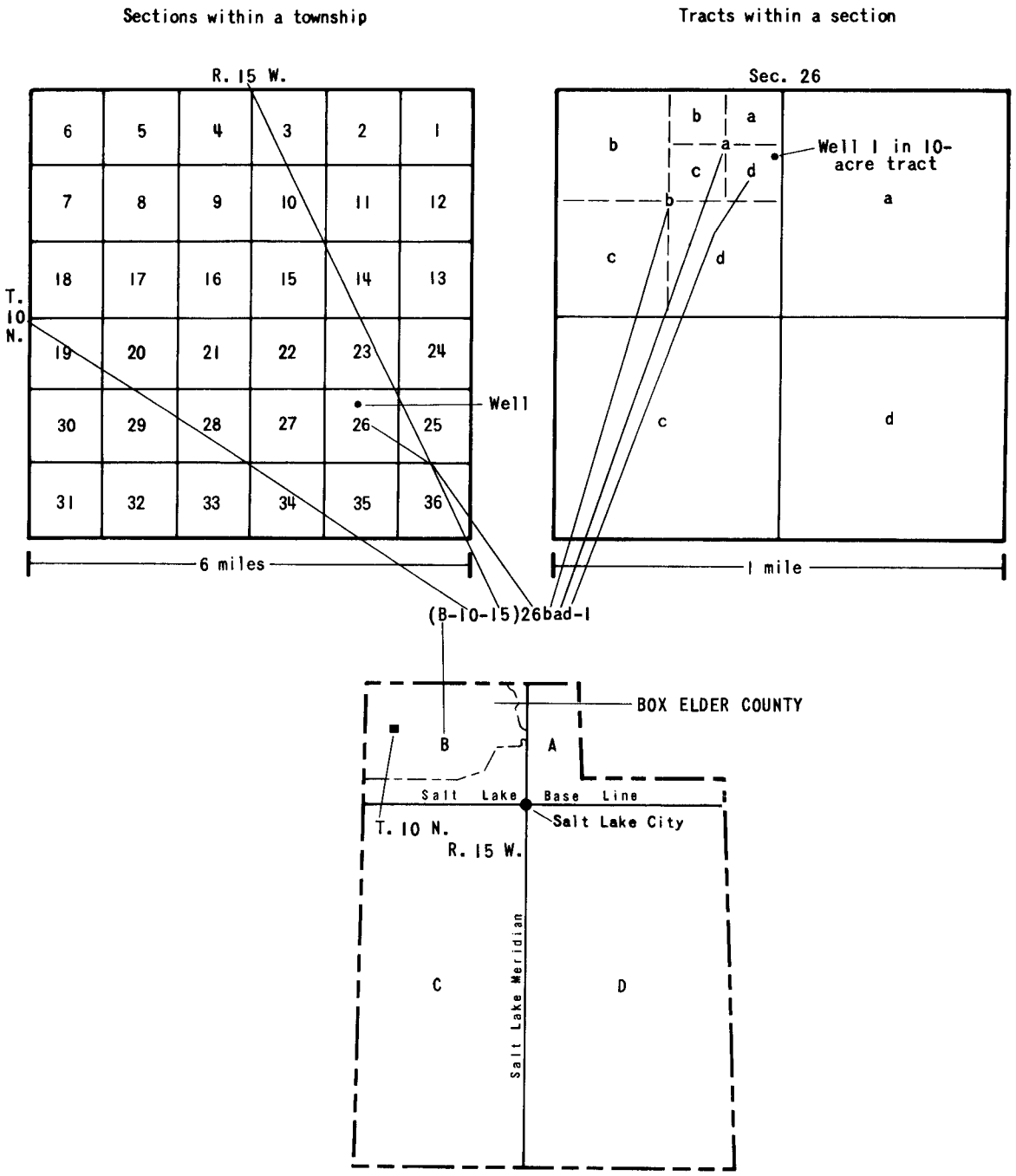


Figure 4.—Well- and spring-numbering system used in Utah.

## 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 |

Two new hydrologic terms are used in this report to describe properties of water-bearing formations. These terms, as provided by a U. S. Geological Survey committee of redefinition of hydrologic terms, express parameters in consistent units and have been assigned different symbols to avoid confusion with the older, previously used terms.

Hydraulic conductivity, $K$, replaces the long-used term, field coefficient of permeability, $Pf$. Units used in the definition are length and time, in feet and days (or any other units desired). $K = \frac{ft^3}{ft^2\ day\ ft\ ft^{-1}} = ft\ day^{-1}$, or ft per day and $K = \frac{Pf}{7.48}$, where $Pf$ is in gpd per $ft^2$.

Transmissivity replaces the term, coefficient of transmissibility, both being designated by the symbol, $T$. The coefficient of transmissibility $T = Pfm$, where $m$ is the thickness of the aquifer, in feet. Transmissivity $T = Kb = ft^2\ day^{-1}$, or $ft^2$ per day, the symbol, $b$, replacing $m$.

# BASIC DATA

## Table 10.—Stations at which climatologic data have been collected in and near the Park Valley area

(P, precipitation; T, temperature)

| Station | Location Lat. | Location Long. | Altitude (feet) | Period of record | Type of record | Remarks |
|---|---|---|---|---|---|---|
| Kelton | 41°45′ | 113°07′ | 4,225 | Mar. 1878-Dec. 1929 | P, T | At depot. No temperature record after 10-19-24. |
| Lemay | 41°18′ | 113°31′ | 4,221 | Mar. 1911-Mar. 1931 | P, T | At Post Office. Record intermittent. |
| Park Valley | 41°49′ | 113°20′ | 5,600 | Apr. 1911-July 1913 | P | At Post Office. |
| | 41°49′ | 113°25′ | 5,690 | Apr. 22, 1914-Apr. 1915 | P | Moved to Rosette Post Office. Record intermittent. |
| | 41°49′ | 113°20′ | 5,600 | July 20, 1915-Sept. 1927 | P | Returned to Park Valley Post Office. |
| | 41°49′ | 113°21′ | 5,613 | Dec. 15, 1927-Dec. 5, 1929 | P | Post Office moved 1 mile west. |
| | | | | Dec. 5, 1929-May 24, 1951 | P, T | In corral southeast of house. |
| | 41°49′ | 113°20′ | 5,620 | May 24, 1951-Dec. 1961 | P, T | Moved 1 mile east and across from new Post Office at Park Valley store. |
| | 41°48′ | 113°20′ | 5,570 | 1962-68 | P, T | Moved about 1.2 miles southwest. |
| Terrace | 41°30′ | 113°38′ | 4,550 | Feb. 1870-Aug. 1904 | P, T | At Library. Temperature data unreliable. |

# Table 11.—Records of wells in the Park Valley area.

LOCATION. SEE APPENDIX FOR DESCRIPTION OF WELL- AND SPRING-NUMBERING SYSTEM USED IN UTAH.

OWNER. BUR LAND MANAGE, U.S. BUREAU OF LAND MANAGEMENT; EST, ESTATE; VAL, VALLEY; LDS CHURCH, CHURCH OF JESUS CHRIST OF LATTER DAY SAINTS; CEN PACIFIC RR, CENTRAL PACIFIC RAILROAD CO.; STATE ROAD COMM, UTAH STATE ROAD COMMISSION.

TYPE OF WELL. C, DRILLED WITH PERCUSSION (CABLE TOOL) RIG; D, DUG; J, JETTED.

CASING DIAMETER IS THAT OF THE SMALLEST CASING THAT EXTENDS TO THE LAND SURFACE.

CASING FINISH. O, OPEN END UNPERFORATED CASING; P, PERFORATED CASING (GENERALLY DONE WITH A MILLS KNIFE); W, SHORED (IN DUG WELLS); X, OPEN HOLE (UNCASED) IN AQUIFER.

WATER-BEARING MATERIAL. A, ALLUVIUM; B, SEDIMENTARY ROCK (UNCLASSIFIED); BA, BOULDERY ALLUVIUM; BG, BOULDERY GRAVEL; G, GRAVEL; 4G, COARSE GRAVEL; 6G, CLAYEY GRAVEL; PG, POORLY SORTED GRAVEL; QL, CHERTY LIMESTONE; R, SAND AND GRAVEL; 6R, CLAYEY SAND AND GRAVEL; S, SAND; V, SANDSTONE; 5Y, VERY COARSE CLAYEY GRAVEL; ZI, WEATHERED IGNEOUS ROCKS.

AQUIFER. OA, UNCONSOLIDATED ALLUVIUM; OZ, SALT LAKE FORMATION (LATE MIOCENE-EARLY PLIOCENE AGE); 5X, UNDIFFERENTIATED ROCKS OF PALEOZOIC AGE.

ALTITUDE. IN FEET ABOVE MEAN SEA LEVEL. INTERPOLATED FROM MOST ACCURATE AVAILABLE TOPOGRAPHIC MAPS.

WATER LEVEL. IN FEET BELOW LAND SURFACE EXCEPT AS INDICATED BY +, WELL FLOWED BUT HEAD ABOVE LAND SURFACE NOT KNOWN. MEASURED LEVELS ARE INDICATED BY M, REPORTED LEVELS BY R.

TYPE OF LIFT. C, CENTRIFUGAL; J, JET; N, NONE; P, PISTON (CYLINDER); S, SUBMERGIBLE; T, TURBINE.

PRODUCTION. SOURCE OF YIELD AND DRAWDOWN DATA SHOWN BY M, MEASURED; D, FROM DRILLER'S REPORT; R, REPORTED BY OTHER THAN DRILLER.

USE OF WATER. H, DOMESTIC; I, IRRIGATION; S, STOCK; U, UNUSED. USE EITHER OBSERVED OR REPORTED IN STATE ENGINEER'S RECORDS OF CLAIMS. IN MULTIPURPOSE WELLS, THE USE LISTED IS THE PRINCIPAL USE ACCORDING TO CLAIM

OTHER DATA AVAILABLE. C, M, OR P, COMPLETE, MULTIPLE, OR PARTIAL ANALYSIS (SEE TABLE 14); D, DRILLER'S LOG (SEE TABLE 12 FOR SELECTED DRILLER'S LOGS); W, PERIODIC WATER-LEVEL MEASUREMENTS (SEE FIGURE 2 FOR HYDROGRAPHS).

| LOCATION | OWNER | DATE DRILLED (YEAR) | TYPE OF WELL | DEPTH OF WELL (FT) | CASING DIAMETER (IN) | CASING FINISH | WATER BEARING FORMATION MATERIAL | WATER BEARING FORMATION AQUIFER | ALTITUDE OF LAND SURFACE (FT) | WATER LEVEL (FT) | DATE MEASURED | PRODUCTION TYPE OF LIFT | PRODUCTION YIELD (GPM) | DRAWDOWN (FT) | USE OF WATER | OTHER DATA AVAILABLE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B- 8-13 | | | | | | | | | | | | | | | | |
| 12 - | BUR LAND MANAGE | 1935 | C | 150 | | | QL | 5X | 4,350 | | | N | 0 D | | U | |
| B- 9-12 | | | | | | | | | | | | | | | | |
| 9BBB-1 | BUR LAND MANAGE | 1935 | C | 346 | 6 | P | R | OA | 4,450 | 236 M | 11-68 | P | 20 D | | S | D |
| B-10-13 | | | | | | | | | | | | | | | | |
| 22CA - | | | D | 28 | 30 | W | ZI | | 4,650 | 24 M | 11-68 | J | | | S | |
| B-10-15 | | | | | | | | | | | | | | | | |
| 26BAD-1 | BUR LAND MANAGE | 1935 | C | 333 | 8 | | 4G | OA | 4,750 | 94 M | 9-39 | P | 35 D | | S | P D W |
| B-11-13 | | | | | | | | | | | | | | | | |
| 3CCB-1 | J JAMES | 1954 | | 136 | 16 | | | OA | 4,790 | 14 M | 11-68 | C | | | S | |
| 4BAC-1 | H J SANDALL | 1966 | C | 1/67 | 6 | P | 6G | OA | 4,850 | 30 R | 5-66 | | 28 D | 001 | S | D |
| 26ADA-1 | BUR LAND MANAGE | 1936 | C | 196 | 6 | P | G | OA | 4,700 | 100 R | 9-36 | T | 30 D | | S | P D |
| B-11-15 | | | | | | | | | | | | | | | | |
| 16CCC-1 | FRANK HIGHLAND 2/ | | D | 9 | | W | | OA | 5,100 | 7 M | 1911 | | | | | P |
| B-11-16 | | | | | | | | | | | | | | | | |
| 3/ 12AAB-1 | E C MOTT | | D | 10 | | | A | OA | 5,350 | | | N | | | U | |
| B-12-12 | | | | | | | | | | | | | | | | |
| 13DDD-1 | E R MORRIS | 1951 | C | 83 | 6 | | PG | OA | 4,300 | 75 R | 12-51 | | | | S | D |
| B-12-13 | | | | | | | | | | | | | | | | |
| 3BAC-1 | W R CARTER | 1961 | C | 145 | 8 | P | BG | OA | 5,355 | | | | | | S | D |
| 4BAA-1 | JESS JAMES | | | | | | | OA | 5,405 | 16 M | 1911 | | | | H | |
| 4BB - | CHAS CHADWICK 2/ | | D | 32 | 36 | W | | OA | 5,400 | 12 M | 9-11 | C | 31 M | | I | |
| 5AB - | | | D | | | | | OA | 5,400 | 13 M | 11 | | | | | |
| 8DB - | | | | 145 | | | (4/) | | 5,210 | | | | 0 R | | | |
| 10AA - | | | | | | | | | 5,235 | 48 M | 1911 | | | | | |
| 22BCC-1 | THOMAS STIRLAND 2/ | | D | 32 | | | A | OA | 5,030 | 27 M | 9-11 | | | | | P |
| B-12-14 | | | | | | | | | | | | | | | | |
| 2ABB-1 | H J SANDALL | 1890 | J | 206 | 4 | O | 4/V | OZ | 5,450 | 0 M | 10-35 | P | 2 M | | S | P |
| 2D - | | | | | | | | OA | 5,330 | 24 M | 1911 | | | | | |
| 5D - | | | | | | | | OA | 5,330 | 50 M | 9-11 | | | | | |
| 8BA - | | | | | | | | OA | 5,300 | 23 M | 9-11 | | | | | |
| 8BBA-1 | HENRY PETERSON 2/ | | D | 15 | | | | OA | 5,320 | 13 M | 9-11 | | | | | P |
| 8DC - | | | | | | | | OA | 5,240 | 20 M | 9-11 | | | | | |
| 18CAC-1 | J J KUNZLER EST | 1900 | | 50 | 3 | | G | OA | 5,265 | 2 M | 9-11 | N | | | S | |
| 18CAC-2 | J J KUNZLER EST | 1968 | C | 5/115 | 8 | P | G | OZ | 5,260 | 50 R | 1-68 | | 20 D | 3 | H | D |
| 18CBD-1 | J J KUNZLER EST | 1962 | C | 168 | 16 | P | | | 5,270 | | | T | 825 R | | I | |

## Table 11.—Records of wells in the Park Valley area

| LOCATION | OWNER | DATE DRILLED (YEAR) | TYPE OF WELL | DEPTH OF WELL (FT) | CASING DIAMETER (IN) | CASING FINISH | WATER BEARING FORMATION MATERIAL | WATER BEARING FORMATION AQUIFER | ALTITUDE OF LAND SURFACE (FT) | WATER LEVEL (FT) | DATE MEASURED | PRODUCTION TYPE OF LIFT | PRODUCTION YIELD (GPM) | PRODUCTION DRAWDOWN (FT) | USE OF WATER | OTHER DATA AVAILABLE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B-12-14 | | | | | | | | | | | | | | | | |
| 20AAA-1 | H L KUNZLER | 1959 | C | 200 | | | | OA | 5,140 | 90 R | 11-59 | N | | | 6/U | D |
| 21AC - | | | | | | | | OA | 5,100 | 7 M | 9-11 | | | | | |
| 21BBA-1 | M D KUNZLER | 1968 | C | 300 | 6 | | | | 5,125 | 31 R | 2-68 | | | | 6/U | D |
| 21CAB-1 | V L KUNZLER | 1961 | C | 7/250 | 16 | P | 4G | OA | 5,100 | 19 R | 1961 | | 100 D | 200 | S | D |
| 21CAD-1 | M W KUNZLER | 1946 | C | 225 | 6 | | | OA | 5,090 | | | | | | S | P D |
| 21CDC-1 | M W KUNZLER | 1959 | C | 392 | 16 | P | | OA | 5,080 | 21 R | 10-59 | | 630 D | 110 | I | D |
| 21DDA-1 | M W KUNZLER | 1946 | C | 100 | 12 | P | G | OA | 5,050 | 8 R | 11-46 | N | | | U | D |
| 21DDA-2 | M W KUNZLER | 1950 | C | 161 | 12 | P | G | OA | 5,050 | 8 R | 10-50 | | 1350 D | | S | D |
| 23DDD-1 | O OLSEN 2/ | | D | 58 | | | | OA | 5,040 | 53 M | 9-11 | | | | | P |
| 28ABA-1 | M W KUNZLER | 1955 | C | 676 | 16 | P | | OA | 5,060 | | | | 720 D | | I | D |
| 28BAB-1 | M W KUNZLER | 1955 | C | 375 | 16 | P | G | OA | 5,080 | | | | 675 D | 130 | I | D |
| B-12-15 | | | | | | | | | | | | | | | | |
| 13ADD-1 | J J KUNZLER EST | 1959 | C | 168 | 12 | P | G | OA | 5,310 | 25 R | 11-59 | T | 1350 D | 125 | I | D |
| 13BBD-1 | J J KUNZLER EST | 1968 | C | 8,9/300 | 12 | P | | OA | 5,370 | 34 M | 11-68 | N | | | U | D |
| 13BDC-1 | J J KUNZLER EST | | | (8/) | | | | OA | 5,360 | | | N | | | U | |
| B-13-13 | | | | | | | | | | | | | | | | |
| 21CDC-1 | W P KENT | 1896 | D | 13 | 48 | W | 5Y | OA | 5,745 | 10 M | 11-68 | N | | | U | |
| 21DCC-1 | L G CARTER | | D | | | | | OA | 5,750 | | | | | | H | |
| 27CDD-1 | R H LARSEN | | D | | | | | OA | 5,550 | | | | | | S | |
| 27CDD-2 | R H LARSEN | | D | | | | | OA | 5,540 | | | | | | S | |
| 27CDD-3 | R H LARSEN | | | | | | | OA | 5,535 | 7 M | 9-11 | | | | H | |
| 27DCC-1 | C D LARSEN | | D | | | | | OA | 5,535 | | | | | | S | |
| 28ABB-1 | | | D | 12 | | | | OA | 5,700 | | | | | | | |
| 28ADD-1 | | | | 15 | | | | OA | 5,650 | | | | | | | |
| 28CCC-1 | JOSEPH PALMER | 1913 | D | 35 | 72 | W | | OA | 5,565 | | | | | | S | |
| 28CDC-1 | JOSEPH PALMER | | | | | | | OA | 5,555 | | | | | | H | |
| 28DAD-1 | PARK VAL SCHOOL | 1940 | C | 10/112 | 6 | P | S | OA | 5,590 | 21 R | 2-55 | | | | H | D |
| 28DDD-1 | C W GOODLIFFE | | D | 17 | 12 | W | 5Y | OA | 5,540 | 11 M | 9-11 | C | 27 M | 3 | I | P |
| 28DDD-2 | W P KENT | | D | 21 | 48 | W | BA | OA | 5,540 | 14 M | 11-68 | C | | | H | M W |
| 28DDD-3 | W P KENT | | D | | | W | BA | OA | 5,545 | 16 M | 10-54 | C | | | S | |
| 28DDD-4 | LDS CHURCH | | | | | | | OA | 5,545 | | | | | | H | |
| 29AAA-1 | JOSEPH PALMER | | D | | | | | OA | 5,750 | | | | | | H | |
| 29AAB-1 | JOSEPH PALMER | | D | | | | | OA | 5,765 | | | | | | H | |
| 3/29BBB-1 | CEN PACIFIC RR | | D | 12 | 48 | X | | OA | 5,765 | | | B | | | U | |
| 32AAA-1 | H A CARTER | | D | 47 | 60 | W | | OA | 5,550 | 32 M | 10-36 | P | | | S | W |
| 32AAA-2 | H A CARTER | | D | | | | | OA | 5,545 | | | | | | S | |
| 32CAB-1 | F C HIRSCHI | | D | | | | | OA | 5,490 | | | | | | H | |
| 32DDA-1 | L A HIRSCHI | | D | 35 | | W | | OA | 5,450 | 11 M | 9-11 | | | | H | W |
| 33AAA-1 | STATE ROAD COMM | 1964 | C | 11/105 | 6 | P | 6R | OA | 5,530 | 14 M | 11-68 | S | 30 D | 5 | H | P D |
| 33AAA-2 | L G CARTER | | | | | | | OA | 5,535 | | | | | | H | |
| 33CCA-1 | H A CARTER | | | | | | | OA | 5,430 | | | | | | S | |
| 33CCA-2 | H A CARTER | | | | | | | OA | 5,430 | | | | | | H | |
| 33CDC-1 | G R CARTER | | | | | | | OA | 5,410 | | | | | | H | |
| 34AAB-1 | G A ROSE | | | | | | | OA | 5,520 | | | | | | S | |
| 34AAB-2 | G A ROSE | | | | | | | OA | 5,520 | | | | | | H | |
| 34BAA-1 | W R CARTER | 1896 | D | 23 | 48 | W | | OA | 5,520 | | | | | | H | |
| 34BAB-1 | C D LARSEN | | | | | | | OA | 5,525 | | | | | | H | |
| 34BAC-1 | WALLACE LARSEN | | | | | | | OA | 5,500 | | | | | | H | |
| B-13-14 | | | | | | | | | | | | | | | | |
| 25CCB-1 | J H KUNZLER | 1947 | C | 100 | 6 | | B | OZ | 5,670 | + R | 5-47 | N | 1 D | | | D |
| 25CCB-2 | J H KUNZLER | 1955 | C | 303 | 16 | P | V | OZ | 5,665 | + R | 8-55 | N | 5 D | | S | D |
| 25CCB-3 | J H KUNZLER | 1910 | D | 28 | 48 | W | G | OA | 5,670 | 16 M | 10-36 | C | 7 R | | H | W |
| 26CBC-1 | ANTONIO OLAQUE | 1968 | C | 12/100 | 8 | P | 5G | OA | 5,715 | 0 R | 7-68 | | 250 D | 0 | H | |
| 26CDA-1 | M W KUNZLER | | D | 22 | 48 | W | | OA | 5,690 | 19 M | 10-36 | P | | | H | W |
| 26CDA-2 | M W KUNZLER | | D | | | | | OA | 5,682 | | | | | | H | |
| 26CDA-3 | M W KUNZLER | 1947 | C | 220 | 6 | P | 6R | OA | 5,685 | | | | | | H | D |
| 26DAC-1 | R P PUGSLEY | 1957 | C | 98 | 6 | P | R | OA | 5,695 | | | | | | H | D |
| 26DCA-1 | V L KUNZLER | 1947 | C | 100 | 6 | P | G | OA | 5,685 | 25 R | 6-47 | | | | I | D |
| 26DDB-1 | R P PUGSLEY | | | | | | | OA | 5,685 | | | | | | H | |
| 27BCC-1 | R E PALMER | | D | | | | | OA | 5,710 | | | | | | S | |
| 27BCD-1 | R E PALMER | 1911 | D | 22 | 60 | W | R | OA | 5,730 | 20 R | | P | | | H | |
| 27BCD-2 | R E PALMER | | | | | | | OA | 5,730 | | | | | | H | |
| 27DAD-1 | ANTONIO OLAQUE | | D | | 36 | W | | OA | 5,715 | | | | | | H | |
| 28ADD-1 | R E PALMER | | D | 14 | 48 | W | | OA | 5,700 | 8 M | 9-11 | | | | H | |
| 28BDC-1 | E R MORRIS | | D | | | | | OA | 5,690 | | | | | | H | |
| 28DCD-1 | E R MORRIS | | D | | | | | OA | 5,595 | 8 M | 9-11 | | | | S | |
| 33BCC-1 | E R MORRIS | | D | | | | | OA | 5,480 | | | | | | S | |
| 35DDB-1 | J C HIRSCHI | | D | 22 | 48 | W | | OA | 5,480 | 11 M | 10-36 | P | | | U | 13/P W |

1/ CASING CEMENTED TO 16 FEET; PERFORATED WITH CUTTING TORCH, 52-67 FEET.
2/ OWNER CITED BY CARPENTER (1913).
3/ WELL FOUND ABANDONED OR DESTROYED IN NOVEMBER 1968.
4/ WELL REPORTEDLY PENETRATED YELLOW LIMESTONE (CARPENTER, 1913).
5/ TWENTY PERFORATIONS, 94-104 FEET.
6/ TEST HOLE.
7/ PERFORATED (480 SLOTS), 19-80 FEET.
8/ WELL NOT COMPLETED BY NOVEMBER 1968; 1,200 PERFORATIONS, 20-300 FEET.
9/ PERFORATED (1,200 SLOTS), 20-300 FEET.
10/ DEEPENED OLD DUG WELL.
11/ PERFORATED 59-100 FEET.
12/ PERFORATED (250 6-INCH SLOTS), 20-90 FEET.
13/ WATER TEMPERATURE WAS 13°C.

# Table 12.—Drillers' logs of selected wells in the Park Valley Area

| Material | Thickness | Depth |
|---|---|---|
| (B-9-12)9bbb-1. Log by G. A. Holland. Alt. 4,450 ft. | | |
| Clay and gravel, stratified | 8 | 8 |
| Sand, clay, and gravel, stratified | 97 | 105 |
| Sand, clay, and gravel (mixed) | 65 | 170 |
| Clay, gravel, and sand (mixed) | 67 | 237 |
| Gravel and sand | 46 | 283 |
| Gravel; water bearing | 63 | 346 |
| (B-10-15)26bad-1. Log by H. H. Bell. Alt. 4,750 ft. | | |
| Sand | 10 | 10 |
| Clay | 30 | 40 |
| Quicksand | 60 | 100 |
| Clay, blue | 38 | 138 |
| Clay, sandy, brown | 72 | 210 |
| Gravel, black; water | 15 | 225 |
| Clay, blue | 55 | 280 |
| Gravel, big; hole filled up with water | 20 | 300 |
| Lime (stone), hard, blue | 33 | 333 |
| (B-11-13)4bac-1. Log by T. J. Burkhart Co. Alt. 4,850 ft. | | |
| Topsoil | 2 | 2 |
| Clay, sand, and gravel | 12 | 14 |
| Clay, gravel, and cobbles | 22 | 36 |
| Clay, blue | 12 | 48 |
| Gravel, "dirty" | 19 | 67 |
| (B-11-13)26ada-1. Log by H. H. Bell. Alt. 4,700 ft. | | |
| Clay | 40 | 40 |
| Clay and gravel | 40 | 80 |
| Gravel; yields "salt" water | 20 | 100 |
| Clay | 10 | 110 |
| Clay and gravel | 10 | 120 |
| Clay, yellow | 20 | 140 |
| Gravel; yields "fresh" water | 10 | 150 |
| Clay | 8 | 158 |
| Gravel; water bearing | 38 | 196 |
| (B-12-12)13ddd-1. Log by F. A. Cagle. Alt. 4,300 ft. | | |
| Sand and clay | 16 | 16 |
| Gravel | 15 | 31 |
| Clay | 42 | 73 |
| Gravel and cobble rock | 10 | 83 |
| (B-12-13)3bac-1. Log by W. Yarbrough. Alt. 5,355 ft. | | |
| Soil and gravel; water | 9 | 9 |
| Gravel, light brown | 6 | 15 |
| Boulders and fine-grained gravel | 20 | 35 |
| Clay and fine-grained gravel | 14 | 49 |
| Gravel | 4 | 53 |
| Clay | 47 | 100 |
| Clay and gravel | 15 | 115 |
| Clay | 20 | 135 |
| Gravel | 7 | 142 |
| Clay | 3 | 145 |
| (B-12-14)18cac-2. Log by Wayman Yarbrough. Alt. 5,260 ft. | | |
| Topsoil | 8 | 8 |
| Cobbles, brown | 15 | 23 |
| Clay, yellow | 11 | 34 |
| Cobbles, brown | 13 | 47 |
| Clay and sand, brown | 23 | 70 |
| Clay, sandy; some water | 10 | 80 |
| Clay, brown, sandy | 15 | 95 |
| Gravel, white; water | 20 | 115 |
| (B-12-14)20aaa-1. Log by L. N. Durfee. Alt. 5,140 ft. | | |
| Soil and some gravel | 19 | 19 |
| Sand and gravel, dirty | 11 | 30 |
| Clay and gravel | 60 | 90 |
| Clay | 110 | 200 |
| (B-12-14)21bba-1. Log by L. M. Page. Alt. 5,125 ft. | | |
| Clay, yellow, and boulders | 45 | 45 |
| Clay, soft, yellow | 35 | 80 |
| Sand and hard strata; water level at 31 ft | 105 | 185 |
| Gravel, hard cemented | 15 | 200 |
| Shale, green, and hard strata | 90 | 290 |
| Silt, very soft (like lake bed) | 10 | 300 |
| (B-12-14)21cab-1. Log by R. C. Neddo. Alt. 5,100 ft. | | |
| Clay and silt | 10 | 10 |
| Cobbles; water at 19 ft | 16 | 26 |
| Clay, tan, and sand | 2 | 28 |
| Cobbles | 8 | 36 |
| Clay and gravel; some water at 45 ft | 23 | 59 |
| Sandstone, hard | 5 | 64 |
| Clay and gravel; some water at 90 ft | 44 | 108 |
| Sandstone | 1 | 109 |
| Clay, sand, and gravel | 11 | 120 |
| Sandstone | 5 | 125 |
| Clay and gravel | 15 | 140 |
| Clay and sand | 8 | 148 |
| Clay and gravel | 16 | 164 |
| Clay, white, hard, and gravel | 6 | 170 |
| Clay, brown, and sand | 5 | 175 |
| Clay, brown, and gravel | 20 | 195 |
| Conglomerate | 5 | 200 |
| Clay, brown, and gravel | 5 | 205 |
| Clay, white, and gravel | 10 | 215 |
| Clay, brown, hard | 2 | 217 |
| Gravel, fine; some water | .5 | 217.5 |
| Clay, brown | 32.5 | 250 |
| (B-12-14)21cad-1. Log by W. T. Chealey. Alt. 5,090 ft. | | |
| Soil | 4 | 4 |
| Hardpan | 2 | 6 |
| Gravel | 18 | 24 |
| Clay, sandy; water | 10 | 34 |
| Gravel and sandy clay | 6 | 40 |
| Clay, sandy | 15 | 55 |
| Gravel and sandy clay; water | 15 | 70 |
| Gravel; water | 16 | 86 |
| Clay, sandy | 14 | 100 |
| Gravel | 5 | 105 |
| Clay, sandy | 40 | 145 |
| Hardpan, light | 5 | 150 |
| Sandstone | 50 | 200 |
| Limestone, soft | 25 | 225 |
| (B-12-14)21cdc-1. Log by L. N. Durfee. Alt. 5,080 ft. | | |
| Soil | 19 | 19 |
| Gravel, coarse grained | 7 | 26 |
| Clay and gravel | 12 | 38 |
| Gravel, small | 14 | 52 |
| Clay, hard, and gravel | 16 | 68 |
| Gravel, loose, sandy | 7 | 75 |
| Gravel, tight | 6 | 81 |
| Gravel, hard clay, and sand | 69 | 150 |
| Sandstone | 4 | 154 |
| Gravel, loose | 2 | 156 |
| Clay, hard, white, with rocks | 4 | 160 |
| Sandstone | 1 | 161 |
| Sandstone and clay | 31 | 192 |
| Gravel and rocks to 8 inches in diameter | 3 | 195 |
| Clay and sandstone | 28 | 223 |
| Sandstone | 2 | 225 |
| Clay and sandstone | 35 | 260 |
| Gravel and clay | 4 | 264 |
| Clay, sandy, with some sandstone | 128 | 392 |
| (B-12-14)21dda-1. Log by W. T. Chealey. Alt. 5,050 ft. | | |
| Soil | 10 | 10 |
| Gravel; water | 50 | 60 |
| Hardpan | 20 | 80 |
| Sandstone | 10 | 90 |
| Gravel; water | 10 | 100 |
| (B-12-14)21dda-2. Log by Davis and Davis. Alt. 5,050 ft. | | |
| Clay | 26 | 26 |
| Gravel | 15 | 41 |
| Clay and sand | 18 | 59 |
| Sand and sandstone | 32 | 91 |
| Hardpan | 9 | 100 |
| Sand | 14 | 114 |
| Gravel; water | 18 | 132 |
| Sand and clay | 22 | 154 |
| Clay | 7 | 161 |
| (B-12-14)28aba-1. Log by D. E. Rogers. Alt. 5,060 ft. | | |
| Soil | 6 | 6 |
| (B-12-14)28aba-1 - Continued | | |
| Gravel | 20 | 26 |
| Clay | 13 | 39 |
| Gravel | 4 | 43 |
| Clay and sand | 5 | 48 |
| Gravel | 12 | 60 |
| Clay, hard, and sand | 5 | 65 |
| Sandstone | 8 | 73 |
| Gravel, dry, loose | 2 | 75 |
| Clay, hard, and sand | 3 | 78 |
| Gravel; water | 2 | 80 |
| Sandstone | 10 | 90 |
| Gravel; water | 5 | 95 |
| Sandstone | 23 | 118 |
| Gravel, loose, and clay | 6 | 124 |
| Clay | 4 | 128 |
| Gravel, loose | 5 | 133 |
| Gravel, coarse-grained lava | 9 | 142 |
| Gravel, green (smaller than at 142 ft) | 9 | 151 |
| Sandstone, green | 2 | 153 |
| Gravel, green, interbedded with sandstone | 10 | 163 |
| Sandstone, solid (like concrete) | 13 | 176 |
| Gravel, lava fragments and layers of sandstone | 40 | 216 |
| Clay and sandstone, blue | 15 | 231 |
| Sand, very fine grained, tight | 37 | 268 |
| Clay, light brown, filled with sand | 37 | 305 |
| Gravel, extremely hard | 14 | 319 |
| Clay, dark blue-gray | 21 | 340 |
| Sandstone, solid | 20 | 360 |
| Clay, light blue | 25 | 385 |
| Sandstone, solid | 12 | 397 |
| Clay, blue | 8 | 405 |
| Sandstone and layers of clay | 25 | 430 |
| Sandstone, dark gray, and clay | 17 | 447 |
| Clay, hard, and strata of sandstone | 70 | 517 |
| Sandstone and clay strata, blue | 111 | 628 |
| Silt, wet spongy, gray | 1 | 629 |
| Clay, hard, dry | 47 | 676 |
| (B-12-14)28bab-1. Log by D. E. Rogers. Alt. 5,080 ft. | | |
| Clay, sandy | 19 | 19 |
| Mud, black | 1 | 20 |
| Gravel, coarse grained | 4 | 24 |
| Clay and gravel | 8 | 32 |
| Gravel, small | 6 | 38 |
| Gravel and hard clay | 32 | 70 |
| Gravel, loose, sandy | 5 | 75 |
| Gravel, tight | 5 | 80 |
| Clay, hard, with embedded gravel | 25 | 105 |
| Clay, hard, with embedded sand | 39 | 144 |
| Sandstone | 3 | 147 |
| Gravel, loose | 1 | 148 |
| Sandstone | 2 | 150 |
| Clay, filled with hard white rock | 10 | 160 |
| Sandstone | 1 | 161 |
| Clay, white | 4 | 165 |
| Sandstone | 5 | 170 |
| Clay | 5 | 175 |
| Sandstone | 6 | 181 |
| Gravel and rocks to 8 inches in diameter | 14 | 195 |
| Clay, hard, and gravel | 5 | 200 |
| Sandstone | 14 | 214 |
| Clay, hard | 10 | 224 |
| Gravel, sand, and rocks to 6 inches in diameter | 7 | 231 |
| Clay with sand | 3 | 234 |
| Sandstone, hard, brown | 6 | 240 |
| Clay, hard, white | 25 | 265 |
| Sandstone interbedded with gravel | 19 | 284 |
| Clay, white | 10 | 294 |
| Sandstone | 56 | 350 |
| Clay, white | 25 | 375 |
| (B-12-15)13add-1. Log by L. N. Durfee. Alt. 5,310 ft. | | |
| Topsoil | 14 | 14 |
| Rocks and gravel | 11 | 25 |
| Gravel, tight | 3 | 28 |
| Gravel, tight, and clay | 113 | 141 |
| Sandstone | 3 | 144 |
| Gravel, loose | 14 | 158 |
| Sandstone and conglomerate | 4 | 162 |
| Clay. Cased to 168 ft | 12 | 174 |
| Gravel, tight, and clay | 26 | 200 |

## Table 12.—Drillers' logs of selected wells in the Park Valley Area - cont.

| Material | Thickness | Depth |
|---|---|---|
| (B-13-13)33aaa-1. Log by F. H. Peterson and Sons. Alt. 5,530 ft. | | |
| Topsoil | 5 | 5 |
| Boulders, hard | 32 | 37 |
| Clay, gravel, and boulders | 21 | 58 |
| Clay and gravel; water | 25 | 83 |
| Gravel, sand, and clay; water | 8 | 91 |
| Gravel, hard, coarse grained; water | 14 | 105 |
| (B-13-14)25ccb-1. Log by W. T. Chealey. Alt. 5,670 ft. | | |
| Hardpan | 8 | 8 |
| Gravel; water | 8 | 16 |
| Hardpan | 6 | 22 |
| Clay, "brick colored" | 18 | 40 |
| Sandstone | 40 | 80 |
| Boulders; flowing water | 5 | 85 |
| No record | 15 | 100 |
| (B-13-14)25ccb-2. Log by D. E. Rogers. Alt. 5,665 ft. | | |
| Soil | 1 | 1 |
| Cobblestones and rocks | 44 | 45 |
| Clay, sandy, yellow | 5 | 50 |
| Sand and gravel | 5 | 55 |
| Clay, yellow | 10 | 65 |
| Gravel | 5 | 70 |
| (B-13-14)25ccb-2-Continued | | |
| Clay, yellow | 5 | 75 |
| Clay, yellow, and gravel | 10 | 85 |
| Clay, yellow | 5 | 90 |
| Gravel | 5 | 95 |
| Clay, brown | 13 | 108 |
| Clay, yellow | 17 | 125 |
| Clay, yellow, and gravel | 7 | 132 |
| Sandstone | 3 | 135 |
| Clay, sandy, red | 3 | 138 |
| Sand and gravel | 10 | 148 |
| Clay, sandy, and gravel | 20 | 168 |
| Sand and gravel | 4 | 172 |
| Clay, yellow | 8 | 180 |
| Sandstone | 5 | 185 |
| Clay, yellow | 105 | 290 |
| "Soapstone", yellow | 13 | 303 |
| (B-13-14)26cda-3. Log by W. T. Chealey. Alt. 5,685 ft. | | |
| Soil | 4 | 4 |
| Hardpan | 2 | 6 |
| Boulders | 13 | 19 |
| Clay, sandy; water | 5 | 24 |
| Gravel and sandy clay | 10 | 34 |
| Sand and clay | 6 | 40 |
| Gravel; water | 4 | 44 |
| No record | 7 | 51 |
| Clay, sandy | 4 | 55 |
| (B-13-14)26cda-3-Continued | | |
| Gravel; water | 5 | 60 |
| Clay, Sandy | 26 | 86 |
| Gravel | 14 | 100 |
| Hardpan, light | 45 | 145 |
| Sandstone, soft | 5 | 150 |
| Limestone, soft | 70 | 220 |
| (B-13-14)26dac-1. Log by W. T. Chealey. Alt. 5,695 ft. | | |
| Hardpan and rock | 62 | 62 |
| Gravel and boulders; water | 5 | 67 |
| Clay, brown | 5 | 72 |
| Sand and gravel; water | 14 | 86 |
| Shale, brown | 12 | 98 |
| (B-13-14)26dca-1. Log by W. T. Chealey. Alt. 5,685 ft. | | |
| Soil and hardpan | 8 | 8 |
| Boulders | 14 | 22 |
| Clay, sandy, and gravel; water | 12 | 34 |
| Gravel; water | 6 | 40 |
| Sandstone | 5 | 45 |
| Gravel; water | 15 | 60 |
| Hardpan | 20 | 80 |
| Gravel and boulders | 16 | 96 |
| No record | 4 | 100 |

# Table 13.—Records of selected springs.

LOCATION. SEE APPENDIX FOR DESCRIPTION OF WELL- AND SPRING-NUMBERING SYSTEM USED IN UTAH.

NAME OR OWNER. BUR LAND MANAGE, U.S. BUREAU OF LAND MANAGEMENT; EST., ESTATE.

ALTITUDE. IN FEET ABOVE MEAN SEA LEVEL, INTERPOLATED FROM MOST ACCURATE AVAILABLE TOPOGRAPHIC MAPS.

AQUIFER. OA, UNCONSOLIDATED ALLUVIUM; OT, UNCONSOLIDATED TERRACE DEPOSITS; 7C, OQUIRRH FORMATION (PERMIAN AND PENNSYLVANIAN AGE); 5X, UNDIFFERENTIATED PALEOZOIC ROCKS; F6 OR F7, ALBION RANGE GROUP (PRECAMBRIAN AGE).

DISCHARGE. SOURCE OF DISCHARGE DATA SHOWN BY M, MEASURED; E, ESTIMATED; R, REPORTED.

USE OF WATER. H, DOMESTIC; I, IRRIGATION; N, INDUSTRIAL; S, STOCK; U, UNUSED. USE EITHER OBSERVED OR REPORTED IN UTAH STATE ENGINEER'S RECORDS OF CLAIMS. WHERE USED FOR SEVERAL PURPOSES, THE USE LISTED IS THE PRINCIPAL USE ACCORDING TO CLAIM.

OTHER DATA AVAILABLE. C, M, OR P, COMPLETE, MULTIPLE, OR PARTIAL CHEMICAL ANALYSIS (SEE TABLE 14); K, SPECIFIC CONDUCTANCE (SEE TABLE 9).

| LOCATION | NAME OR OWNER | ALTITUDE (FEET) | AGE OF AQUIFER | DISCHARGE (GPM) | DATE MEASURED | TEMP (°C) | USE OF WATER | OTHER DATA AVAILABLE |
|---|---|---|---|---|---|---|---|---|
| B- 8-13 | | | | | | | | |
| 36DDDS-1 | CRESCENT SPRING | 4,350 | OA | | | | U | C |
| B-10-15 | | | | | | | | |
| 6ACCS-1 | WATERCRESS SPGS | 5,170 | 5X | 29 M | NOV. 1968 | 16.0 | 1/N | K |
| 6CDBS-1 | WARM SPRING NO. 2 | 5,170 | 7C | 386 M | NOV. 1968 | 20.0 | 1/N | P |
| B-11-11 | | | | | | | | |
| 6DBBS-1 | BLACK BUTTE SPG | 4,350 | | 18 R | SEPT. 1960 | 19.0 | U | P |
| 7CCCS-1 | TWENTY ONE SEEP | 4,220 | OA | 4 R | SEPT. 1960 | 15.0 | U | P |
| 19DAAS-1 | SKULL SPRING | 4,220 | OA | 59 R | SEPT. 1960 | 14.0 | U | P |
| B-11-15 | | | | | | | | |
| 14BBAS-1 | BUR LAND MANAGE | 5,200 | OT | 2 E | NOV. 1968 | 10.0 | S | K |
| B-11-16 | | | | | | | | |
| 1DBDS-1 | E C MOTT | 5,450 | 5X | 50 M | NOV. 1968 | 15.0 | 2/H | M |
| 33CCDS-1 | ROSEBUD SPG NO. 1 | 5,700 | 5X | (3/) | | | 1/N | |
| B-12-12 | | | | | | | | |
| 10AADS-1 | SHAW SPRING NO. 3 | 4,590 | OA | | | | S | |
| B-12-13 | | | | | | | | |
| 8DACS-1 | JOSEPH PALMER | 5,205 | OA | | | | S | P |
| B-12-15 | | | | | | | | |
| 19AABS-1 | WARM SPRING 1 | 5,720 | 4/F6 | 340 E | AUG. 1966 | 26.5 | I | C |
| B-12-16 | | | | | | | | |
| 11DBAS-1 | J H KUNZLER | 6,640 | OA | (5/) | | | S | |
| B-13-12 | | | | | | | | |
| 30CAAS-1 | L G CARTER | 5,440 | OA | 5 E | | 25.0 | S | C |
| B-13-13 | | | | | | | | |
| 21DBDS-1 | I H BURTON | 5,815 | OA | | | | I | P |
| 27DDDS-1 | C D LARSON | 5,540 | OA | (6/) | | 21.0 | S | C |
| 34CBBS-1 | W R CARTER EST. | 5,445 | OA | (6/) | | 21.0 | S | C |
| 35BBBS-1 | E M RICHARDSON | 5,520 | OA | (6/) | | 23.0 | S | C |
| 36ABAS-1 | L G CARTER | 5,460 | OA | 1 M | JUNE 1966 | 11.0 | S | C |
| B-13-14 | | | | | | | | |
| 14BDAS-1 | BUR LAND MANAGE | 6,470 | F7 | 10 M | NOV. 1968 | 13.0 | S | K |
| 14BDBS-1 | BUR LAND MANAGE | 6,390 | F7 | 16 M | NOV. 1968 | 14.0 | S | K |
| 21DDDS-1 | R E PALMER | 5,830 | OA | 2 E | AUG. 1966 | 19.5 | I | P |
| 24CACS-1 | M W KUNZLER | 5,885 | 7/OA | 2 E | JUNE 1966 | 17.0 | I | C |
| 24DDCS-1 | R R PUGSLEY | 5,790 | 7/OA | | | 23.0 | S | C |
| 26CDCS-1 | RALEIGH SPRING | 5,650 | OA | (8/) | | | I | |
| 26DCCS-1 | CAMBELL SPRING | 5,665 | OA | (8/) | | | I | |
| 26DDAS-1 | J H KUNZLER | 5,660 | OA | (9/) | | 17.0 | I | C |
| 26DDCS-1 | PUGSLEY SPRING | 5,665 | OA | (10/) | | | I | |
| 28ABCS-1 | E.R.MORRIS | 5,775 | 7/OA | 20 E | AUG. 1966 | 15.5 | I | P |
| B-13-15 | | | | | | | | |
| 16CAAS-1 | UTAH LAND BOARD | 6,910 | F6 | (11/) | | | S | |
| B-13-16 | | | | | | | | |
| 23CCDS-1 | HEAD SPRING 12/ | 6,620 | F6 | 20 E | AUG. 1966 | 21.0 | S | C |

1/ FLOWS TO ROSEBUD RESERVOIR WHICH SUPPLIES SOUTHERN PACIFIC CO. PIPELINE TO LEMAY SIDING, ALSO USED FOR DOMESTIC, STOCK, AND IRRIGATION SUPPLIES.
2/ MAIN SPRING OF THREE IN SMALL GROUP THAT ALSO SUPPLY WATER FOR IRRIGATION AND STOCK.
3/ WATER USER CLAIMS FLOW OF 1.02 CFS (458 GPM) FROM SPRING.
4/ WATER ISSUES BOTH FROM SEVERAL OPENINGS AND FROM SEEPAGE AREA NEAR ROCK OUTCROP.
5/ WATER USER CLAIMS FLOW OF 0.5 CFS (225 GPM) FROM SPRING.
6/ SAMPLE FROM POND THAT COVERS SPRING AND THAT WAS NOT DISCHARGING WHEN SAMPLED.
7/ WATER RISES IN BOGGY AREA.
8/ WATER USERS CLAIM FLOW OF 1 CFS (448.8 GPM) FROM SPRING.
9/ SAMPLE FROM POND THAT COVERS SPRING. WATER USERS CLAIM FLOW OF 0.24 CFS (107 GPM) FROM SPRING.
10/ WATER USERS CLAIM FLOW OF 0.8 CFS (359 GPM) FROM SPRING.
11/ WATER USER CLAIMS FLOW OF 0.11 CFS (49 GPM) FROM SPRING.
12/ HEAD OF FLOW IN LEFT HAND FORK OF DOVE CREEK.

## Table 14.—Chemical analyses of water from wells, springs, and streams in the Park Valley area

Location number: *, location of sampling site uncertain and that given is the most probable site; **, sample from pond at or over spring area.
Owner or name: BLM, U.S. Bureau of Land Management; *, name of owner given by Carpenter (1913, p. 69).
Sodium and potassium: Where no potassium value is shown, sodium plus potassium is calculated and reported as sodium.
Sulfate: a, value for sulfate was less than 30 mg/l.
Dissolved solids: Residue on evaporation at 180°C, except c, sum of determined constituents.
Source of analysis: A, Utah Agricultural College; E, Utah Emergency Relief Administration; GS, U.S. Geological Survey; W, listed by Carpenter (1913).

| Location No. | Owner or name | Date of collection | Temperature (°C) | Milligrams per liter | | | | | | | | | | | | | | | Percent sodium | Sodium-adsorption ratio | Specific conductance (micromhos/cm at 25°C) | pH | Source of analysis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 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 $CaCO_3$ | | | | | |
| (B-8-13) | | | | | | | | | | | | | | | | | | | | | | | |
| 36ddS-1 | Crescent Spring | 7-30-68 | - | 34 | 100 | 99 | 2,110 | 103 | 324 | 0 | 193 | 3,610 | 0.6 | 4.2 | 0.21 | 1/ 6,780 | 656 | 390 | 85 | 36 | 11,100 | 7.2 | GS |
| (B-10-15) | | | | | | | | | | | | | | | | | | | | | | | |
| 6cdbS-1 | Warm Spring No. 2 | 11- 7-68 | 20 | 19 | 63 | 21 | 77 | | 184 | 0 | 29 | 162 | - | 1.1 | - | 501 | 244 | 93 | 41 | 2.1 | 860 | 7.6 | GS |
| 26bad-1 | BLM (UERA well 70) | 1935 | - | - | - | - | - | - | - | - | 73 | 410 | - | - | - | 1,360 | - | - | - | - | - | - | E |
| (B-11-11) | | | | | | | | | | | | | | | | | | | | | | | |
| 6ddbS-1 | Black Butte Spring | 9-23-60 | 19 | 14 | 520 | 124 | 6,670 | 276 | 206 | 0 | 224 | 11,600 | - | 15 | - | 20,300 | 1,810 | 1,640 | 87 | 68 | 30,400 | 7.2 | GS |
| 7cccS-1 | Twenty-one Seeps | 9-23-60 | 15 | 23 | 594 | 170 | 8,540 | 350 | 205 | 0 | 331 | 14,800 | - | 12 | - | 26,100 | 2,180 | 2,020 | 88 | 79 | 37,400 | 7.4 | GS |
| 19daaS-1 | Skull Spring | 9-23-60 | 14 | 42 | 325 | 171 | 6,760 | 243 | 302 | 0 | 745 | 11,100 | - | 12 | - | 20,300 | 1,510 | 1,260 | 89 | 75 | 29,900 | 7.5 | GS |
| (B-11-13) | | | | | | | | | | | | | | | | | | | | | | | |
| 26ada-1 | BLM (UERA well 62) | 1935 | - | - | - | - | - | - | - | - | 56 | 356 | - | - | - | 1,160 | - | - | - | - | - | - | E |
| (B-11-15) | | | | | | | | | | | | | | | | | | | | | | | |
| 16ccc-1 | Frank Highland* | 9- -11 | - | - | - | - | - | - | 340 | 0 | 110 | 335 | - | - | - | 990 | 175 | 0 | - | - | - | - | W |
| 27cab* | Muddy Creek | 6-17-49 | - | - | 92 | 25 | 132 | 18 | 332 | - | 55 | 214 | - | .4 | .22 | 700c | 332 | 60 | 45 | 3.1 | 1,320 | - | GS |
| (B-11-16) | | | | | | | | | | | | | | | | | | | | | | | |
| 1dbdS-1 | E. C. Mott | 9- -11 | - | - | - | - | - | - | 240 | 0 | a | 125 | - | - | - | 400c | 175 | 0 | - | - | - | - | W |
| | | 11- 7-68 | 15 | 19 | 53 | 12 | 34 | | 158 | 0 | 24 | 70 | - | .6 | - | 304 | 180 | 50 | 29 | 1.1 | 519 | 7.5 | GS |
| (B-12-13) | | | | | | | | | | | | | | | | | | | | | | | |
| 8dacS-1 | Joseph Palmer* | 9- -11 | - | - | - | - | 220 | | 265 | 0 | a | 135 | - | - | - | 500c | 205 | 0 | 70 | 6.7 | - | - | W |
| 22bcc-1 | Thomas Stirland* | 9- -11 | - | - | - | - | 385 | | 255 | 0 | 60 | 355 | - | - | - | 780c | 205 | 0 | 80 | 12 | - | - | W |
| (B-12-14) | | | | | | | | | | | | | | | | | | | | | | | |
| 2abb-1 | H. J. Sandall | 9- -11 | - | - | - | - | 155 | | 45 | 75 | a | 85 | - | - | - | 350c | 90 | 0 | 79 | 7.1 | - | - | W |
| 8bba-1 | Henry Peterson* | 9- -11 | - | - | - | - | 225 | | 170 | 0 | a | 195 | - | - | - | 500c | 95 | 0 | 84 | 10 | - | - | W |
| 21cad-1 | M. W. Kunzler | 8-29-55 | - | - | 66 | 17 | 51 | 3.5 | 195 | 0 | 26 | 110 | - | - | .10 | 370c | 235 | 75 | 32 | 1.3 | 720 | - | A |
| 23ddd-1 | O. Olsen* | 9- -11 | - | - | - | - | 265 | | 350 | 0 | a | 150 | - | - | - | 535c | 215 | 0 | 73 | 7.9 | - | - | W |
| (B-12-15) | | | | | | | | | | | | | | | | | | | | | | | |
| 13adb* | Dove Creek | 6-17-49 | - | - | 54 | 9.0 | 42 | 5.9 | 212 | - | 20 | 66 | - | .4 | .08 | 301c | 172 | 0 | 34 | 1.4 | 580 | - | GS |
| 19aabS-1 | Warm Spring No. 1 | 8-12-66 | 27 | 14 | 36 | 8.0 | 27 | 1.7 | 108 | 2 | 15 | 57 | .2 | .1 | .02 | 223 | 123 | 31 | 32 | 1.1 | 406 | 8.5 | GS |
| (B-13-12) | | | | | | | | | | | | | | | | | | | | | | | |
| 30caaS-1 | L. G. Carter | 6-17-66 | 25 | 10 | 39 | 11 | 44 | .6 | 156 | 0 | 19 | 65 | .2 | 1.4 | .07 | 274 | 144 | 16 | 40 | 1.6 | 482 | 8.0 | GS |
| (B-13-13) | | | | | | | | | | | | | | | | | | | | | | | |
| 21dbdS-1 | I. H. Burton | 9- -11 | - | - | - | - | - | - | 385 | 0 | a | 60 | - | - | - | 470c | 175 | 0 | - | - | - | - | W |
| 27dddS-1** | C. D. Larsen | 6-17-66 | 21 | 15 | 44 | 10 | 250 | 3.2 | 588 | 0 | 39 | 125 | 1.0 | 3.0 | .51 | 795 | 152 | 0 | 78 | 8.8 | 1,290 | 8.0 | GS |
| 28ddd-1 | C. W. Goodliff* | 9-30-11 | - | - | 56 | 21 | 112 | | 315 | 15 | 33 | 107 | - | - | - | 2/ 534 | 227 | 0 | 52 | 3.2 | - | - | GS |
| 28ddd-2 | W. P. Kent | 3/ 10-17-57 | - | 25 | 63 | 21 | 123 | | 386 | 0 | 39 | 108 | - | 1.2 | - | 570c | 244 | 0 | 52 | 3.4 | 982 | 7.2 | GS |
| | | 4/ 11- 8-68 | - | 23 | 67 | 28 | 103 | .3 | 436 | 0 | 32 | 72 | .7 | 2.2 | .17 | 538 | 280 | 0 | 44 | 2.7 | 903 | 8.0 | GS |
| 33aaa-1 | Utah State Road Commission | 11- 8-68 | - | 15 | 64 | 25 | 101 | | 412 | 0 | 29 | 80 | - | 1.0 | - | 515 | 262 | 0 | 46 | 2.7 | 899 | 7.8 | GS |
| 34cbbS-1** | W. R. Carter estate | 6-17-66 | 21 | 12 | 24 | 21 | 52 | 1.5 | 208 | 0 | 20 | 49 | .5 | 1.1 | .15 | 292 | 148 | 0 | 43 | .2 | 491 | 8.1 | GS |
| 35bbbS-1** | E. M. Richardson | 6-17-66 | 23 | .8 | 28 | 17 | 290 | 3.2 | 578 | 47 | 31 | 148 | 1.1 | 1.0 | .56 | 918 | 140 | 0 | 81 | 11 | 1,490 | 8.9 | GS |
| 36abaS-1 | L. G. Carter | 6-17-66 | 11 | 13 | 50 | 10 | 48 | 1.1 | 168 | 0 | 20 | 83 | .3 | 2.3 | .07 | 323 | 168 | 30 | 38 | .2 | 566 | 7.8 | GS |
| (B-13-14) | | | | | | | | | | | | | | | | | | | | | | | |
| 21dddS-1 | R. E. Palmer | 8-12-66 | 19 | 11 | 25 | 5.4 | 31 | | 114 | 0 | 12 | 32 | - | .1 | - | 162 | 84 | 0 | 44 | 1.5 | 304 | 8.1 | GS |
| 24cacS-1 | M. W. Kunzler | 6-17-66 | 17 | 11 | 26 | 8.3 | 49 | .4 | 117 | 0 | 19 | 61 | .2 | .3 | .07 | 233 | 98 | 2 | 52 | 2.2 | 414 | 7.5 | GS |
| 24ddcS-1** | R. R. Pugsley | 6-17-66 | 23 | 11 | 45 | 12 | 43 | 2.9 | 150 | 0 | 20 | 76 | .5 | 1.2 | .09 | 314 | 162 | 39 | 36 | .1 | 500 | 7.2 | GS |
| 26ddaS-1** | J. H. Kunzler | 8-12-66 | 17 | 13 | 35 | 11 | 24 | 2.8 | 189 | 0 | 6.2 | 20 | .3 | 1.1 | .04 | 204 | 132 | 0 | 28 | .9 | 362 | 8.0 | GS |
| 28abcS-1** | E. R. Morris | 8-12-66 | 16 | 11 | 14 | 3.4 | 23 | | 82 | 0 | 6.6 | 18 | - | .1 | - | 111 | 50 | 0 | 50 | 1.4 | 199 | 7.3 | GS |
| 35ddb-1 | J. C. Hirschi | 10-17-57 | - | 38 | 54 | 19 | 39 | | 296 | 0 | 20 | 24 | - | .2 | - | 340c | 213 | 0 | 29 | 1.2 | 538 | 7.2 | GS |
| (B-13-15) | | | | | | | | | | | | | | | | | | | | | | | |
| 32abd | Right Hand Fork Dove Creek | 11- 5-68 | 4 | 18 | 61 | 12 | 38 | | 224 | 0 | 20 | 56 | - | .2 | - | 297 | 200 | 16 | 29 | 1.2 | 535 | 8.2 | GS |
| (B-13-16) | | | | | | | | | | | | | | | | | | | | | | | |
| 23ccdS-1 | Head Spring | 8-12-66 | 21 | 10 | 54 | 8.3 | 20 | 1.0 | 187 | 0 | 8.8 | 36 | .1 | .1 | .02 | 240 | 168 | 15 | 20 | .7 | 421 | 8.0 | GS |

1/ Density 1.002 g/ml at 20°C.
2/ Analysis includes 0.45 mg/l iron.
3/ Depth 17 feet.
4/ Depth 21 feet.

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

(*)—Out of Print

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*No. 4. Ground water in Tooele Valley, Tooele County, Utah, by H. E. Thomas, U. S. Geological Survey, in Utah State Eng. 25th Bienn. Rept., p. 91-238, pls. 1-6, 1946.

*No. 5. Ground water in the East Shore area, Utah: Part I, Bountiful District, Davis County, Utah, by H. E. Thomas and W. B. Nelson, U. S. Geological Survey, in Utah State Eng. 26th Bienn. Rept., p. 53-206, pls. 1-2, 1948.

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*No. 8. Consumptive use of water and irrigation requirements of crops in Utah, by C. O. Roskelly and Wayne D. Criddle, 1952.

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No. 11. Ground water in northern Utah Valley, Utah: A progress report for the period 1948-63, by R. M. Cordova and Seymour Subitzky, U. S. Geological Survey, 1965.

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

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

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

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

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

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

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No. 2. Ground water in Tooele Valley, Utah, by J. S. Gates and O. A. Keller, U. S. Geological Survey, 1970.

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

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

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

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

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No. 13. Water requirements of lower Jordan River, Utah, by Karl Harris, Irrigation Engineer, Agricultural Research Service, Phoenix, Arizona, prepared under informal cooperation approved by Mr. William W. Donnan, Chief, Southwest Branch (Riverside, California) Soil and Water Conservation Research Division, Agricultural Research Service, U.S.D.A. and by Wayne D. Criddle, State Engineer, State of Utah, Salt Lake City, Utah, 1964.

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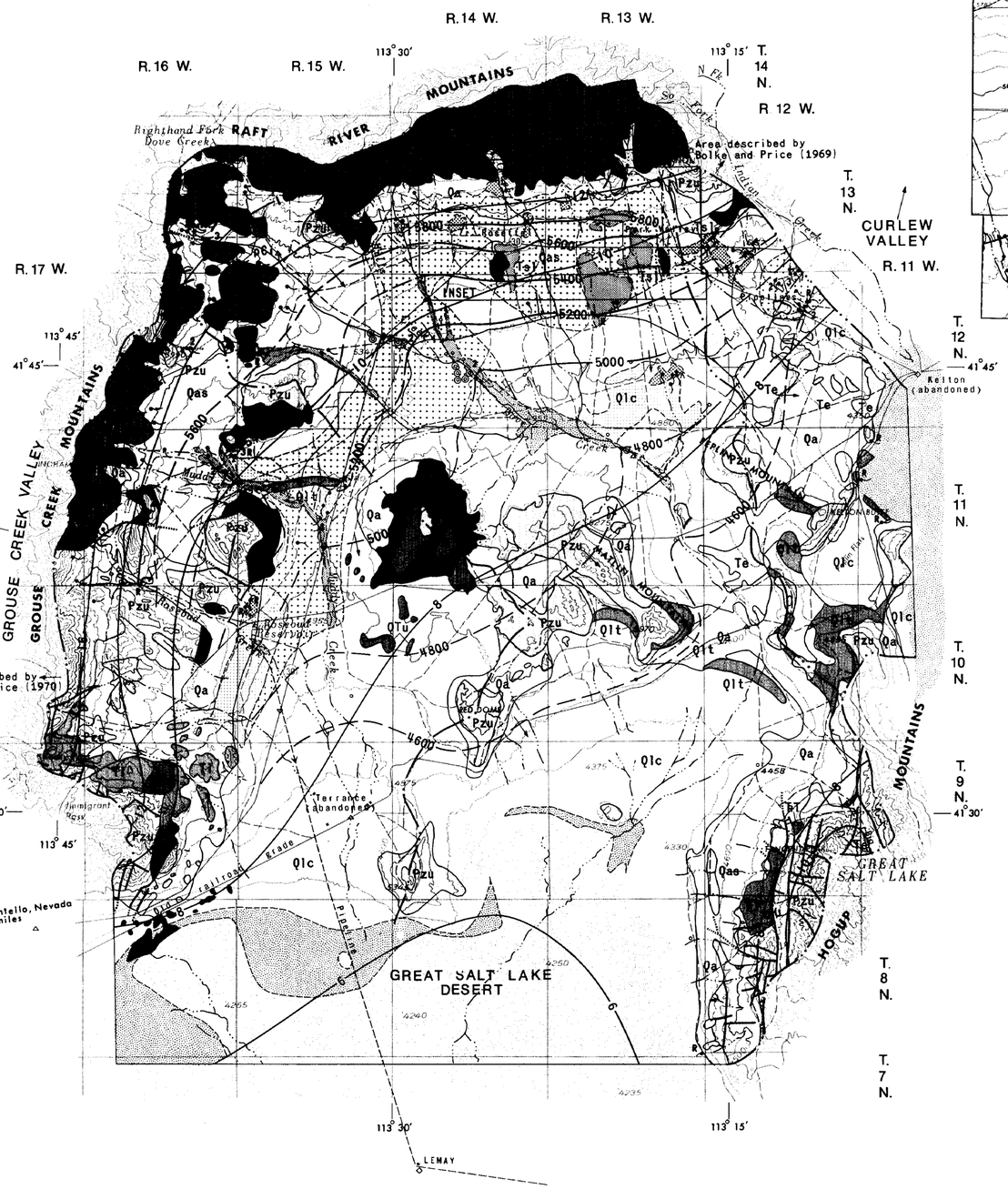
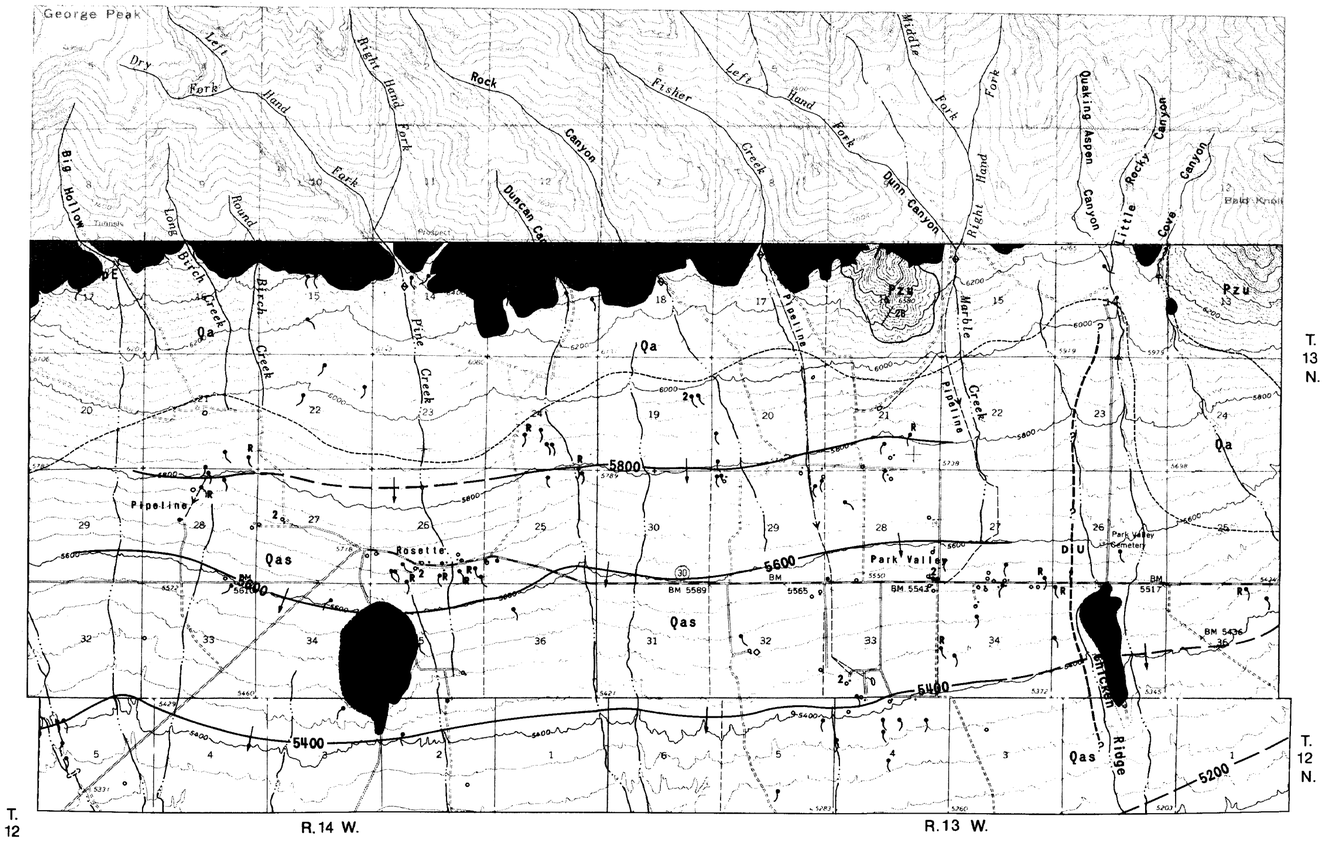
No. 20. Fluvial sediment in Utah, 1905-65, A data compilation by J. C. Mundorff, U. S. Geological Survey, 1968.




Base from U.S. Geological Survey 1:250,000 series: Brigham City (1962)

Hydrogeology by J. W. Hood, 1968. Geology adapted from Stokes (1964). Isohyets from U.S. Weather Bureau (1963a)




Base from U.S. Geological Survey 15 minute series: Park Valley, Utah-Idaho (1958)

Geology adapted from Felix (1956)

Inset shows locations of hydrologic-data sites

## GEOLOGY

*(See table 1)*

**QUATERNARY**

**Qa** — Alluvium and colluvium
*Clay, silt, sand, and gravel; moderate to high permeability*

**Qlt** — Lakeshore deposits
*Sand and gravel; moderate to high permeability*

**Qlc** — Lake-bottom deposits
*Clay, silt, and fine sand; low permeability*

**Qas** — Alluvium
*Clay, silt, sand, and gravel; well-developed soil profile in most places; moderate to high permeability*

**Qao** — Older alluvial deposits
*Conglomeratic clay, sand, and gravel; unconsolidated to well cemented; low to moderate permeability*

**TERTIARY**

**Te** — Extrusive igneous rocks
*Mainly dark, vesicular basalt; some rhyolite and pyroclastic rocks; low to high permeability*

**Tsl** — Salt Lake Formation
*Vitric and pumice lapilli tuff, claystone, sandstone, and some loosely consolidated sand and gravel; low to moderate permeability*

**Ti** — Intrusive igneous rocks
*Quartz monzonite and quartz diorite; low permeability*

**TRIASSIC**

**Ttr** — Thaynes Formation
*Sandy to shaly limestone, dolomite, siltstone, and shale; chert common; low permeability*

**DEVONIAN to PERMIAN**

**Pzu** — Sedimentary and metasedimentary rocks undivided
*Limestone, dolomite, sandstone, shale, and quartzite; some mudstone, chert, and phosphate rock; low to high permeability*

## EXPLANATION

**UPPER(?) PRECAMBRIAN(?)**

**Pzg** — Intrusive igneous rocks
*Mainly granite, locally pegmatitic; some amphibolite; low permeability*

**Pzu** — Metamorphic and sedimentary rocks
*Quartzite, schist, limestone, and dolomite; rocks strongly deformed by faulting, folding, and intrusion; low to locally high permeability*

Approximate contact

U / D — Fault
*Dashed where inferred; dotted where concealed. U, upthrown side; D, downthrown side*

Thrust fault
*Barbs on side of thrust sheet*

Anticline
*Showing trace of axial plane*

Syncline
*Showing trace of axial plane*

28 — Dip and strike of beds

## HYDROLOGY

4800 — Water-level contour
*Shows altitude of water level; dashed where approximate or inferred; contour interval is 200 feet; datum is mean sea level. Arrow indicates direction of ground-water movement*

2 — Nonflowing; Flowing
Dug or small-diameter (6 in. or less) drilled well
*(See table 11)*

2 — Large-diameter (8 in. or more) drilled well
*(See table 11)*

R 2 — Spring
R, *record in table 13; locations for other springs from records of the Utah State Engineer*

Gaging station
*(See tables 4 and 5)*

Partial-record or miscellaneous discharge data site
*(See tables 4 and 6)*

2 — Site sampled for chemical analysis of surface water
*(See tables 9 and 14). Estimate or measurement of discharge in table 4*

*Number by symbol indicates more than one hydrologic site at location shown*

Pipeline
*Arrow shows direction of flow*

6 — Line of equal normal annual precipitation, 1931-60
*Intervals 2, 4, and 5 inches*

Climatologic station
*(See tables 2 and 10)*

Boundary of drainage basin
*Boundary arbitrary west of Kelton and in Great Salt Lake Desert; drainage divides between Muddy Creek, Dove Creek, and Indian Creek drainage basins shown by same symbol*

## AREAS OF EVAPOTRANSPIRATION

*(See table 7)*

Approximate or inferred boundary of evapotranspiration unit

Depth to water, 0-10 feet; grass, rabbitbrush, and patches of willow

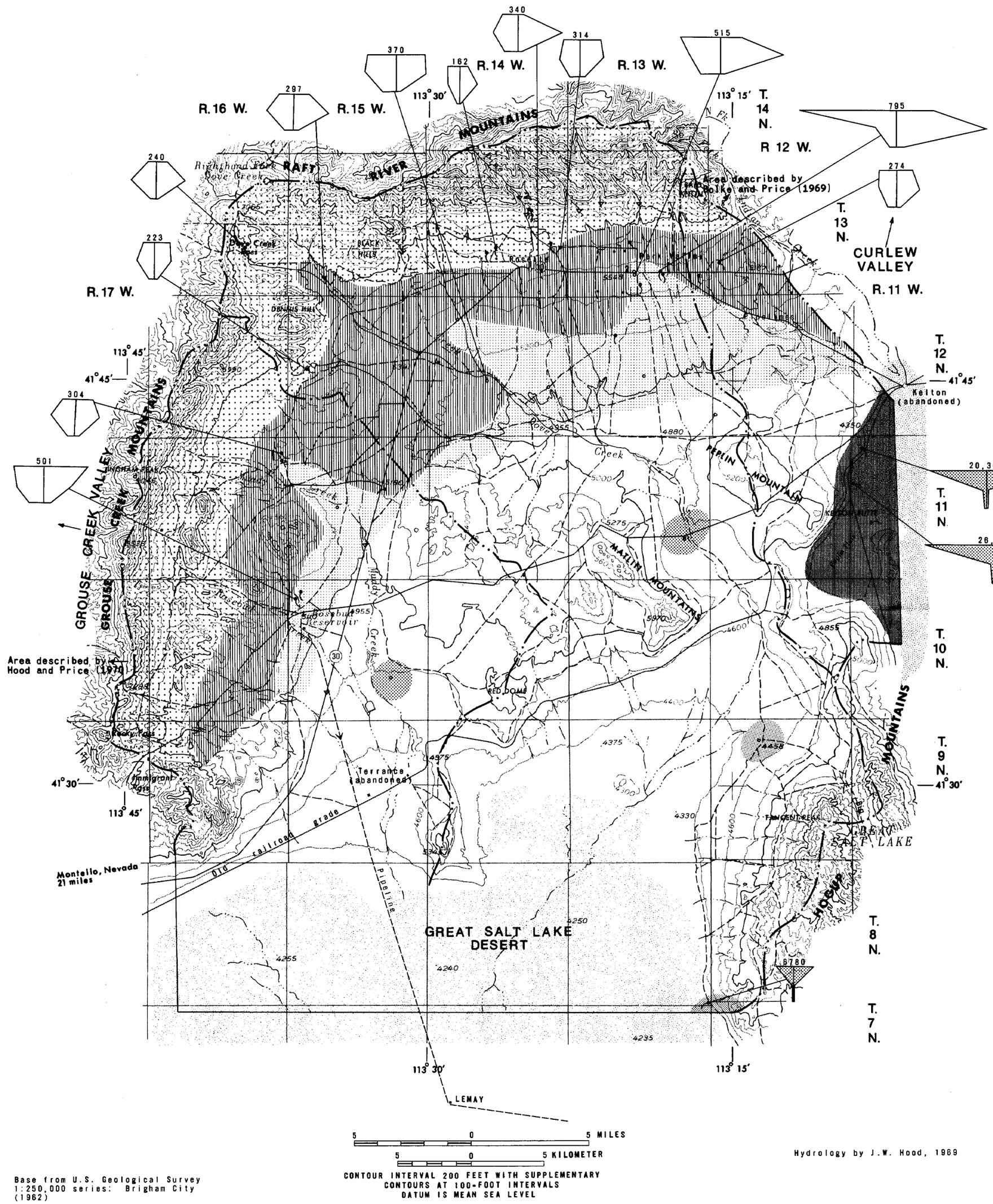
Depth to water, 0-30 feet; mainly greasewood with areas of rabbitbrush

Depth to water, 5-30 feet; grass, rabbitbrush, and patches of willow partly watered with applied irrigation water

Depth to water, 10-30 feet; very sparse greasewood and rabbitbrush associated with sage

Depth to water, 10-60(?) feet; mainly sparse greasewood and patches of bare ground

# GENERALIZED HYDROGEOLOGIC MAP OF THE PARK VALLEY AREA, BOX ELDER COUNTY, UTAH




Hydrology by J.W. Hood, 1969

Base from U.S. Geological Survey 1:250,000 series: Brigham City (1962)

## EXPLANATION

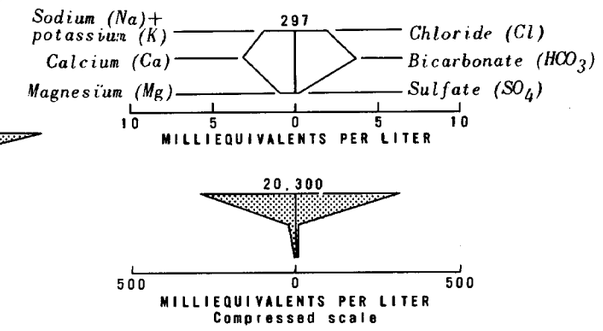
CHEMICAL QUALITY OF WATER

Dissolved-solids concentration, in milligrams per liter

- Less than 250
- 250-500
- 500-1,000
- 1,000-3,000
- 3,000-10,000
- More than 10,000
- No data available

STIFF DIAGRAMS (Stiff, 1951)

*Show concentrations of cations and anions, in milliequivalents per liter, for representative analyses of water. Figure above diagram indicates concentration of dissolved solids in milligrams per liter*




HYDROLOGY

- Well
- Spring
- Stream-sampling point

*Chemical data for individual sources given in tables 9 and 14*

Boundary of drainage basin

# MAP SHOWING GENERALIZED DISTRIBUTION OF DISSOLVED SOLIDS IN GROUND AND SURFACE WATERS AND THE CHEMICAL CHARACTER IN REPRESENTATIVE WATER SOURCES IN THE PARK VALLEY AREA, BOX ELDER COUNTY, UTAH