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HYDROLOGIC RECONNAISSANCE OF THE PROMONTORY MOUNTAINS AREA BOX ELDER COUNTY, UTAH

by

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Prepared by

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HYDROLOGIC RECONNAISSANCE OF THE PROMONTORY MOUNTAINS AREA, BOX ELDER COUNTY, UTAH

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ABSTRACT

The Promontory Mountains area is in eastern Box Elder County, and its drainage is directly tributary to Great Salt Lake. The drainage area consists of 228,000 acres extending from T. 6 N. to T. 11 N. and from R. 5 W. to R. 8 W. Ground water is most uniformly available from unconsolidated and semiconsolidated rocks of Cenozoic (Tertiary and Quaternary) age, but substantial quantities of water also are obtained, mainly through springs, from consolidated rocks of Precambrian and Palezoic age.

Part of the water in the Promontory Mountains area is derived from precipitation, which is estimated to average 240,000 acre-feet annually. Of this amount, about 93 percent is consumed at or near the point of fall. An estimated 4,000 acre-feet runs off in streams. The total runoff is estimated to average 6,000 acre-feet and includes unconsumed spring discharge.

For the study area as a whole, average annual ground-water recharge and discharge are in balance and amount to 27,000 acre-feet each. Recharge derived from precipitation within the Promontory Mountains area is estimated to average 12,000 acre-feet annually. Storage may have been depleted slightly only in the two small areas that contain a few irrigation wells. Estimates for ground-water discharge from the area include evapotranspiration (14,000 acre-ft), subsurface outflow (9,000 acre-ft), wells (2,000 acre-ft), and unconsumed spring discharge (2,000 acre-ft).

The estimated perennial yield of ground water in the area is 25,000 acre-feet per year, but the perennial yield of water of good chemical quality is about 5,000 acre-feet per year. Large-scale withdrawal by wells would cause a degradation of the chemical quality of the water. Without regard to chemical quality of the water, an estimated 760,000 acre-feet of water could be recovered by dewatering 100 feet of the rocks of Cenozoic age, but most of the water would be saline, and the lowering of water levels would induce the inflow of additional saline water.

The chemical quality of water in the Promontory Mountains area limits the potential development. The dissolved-solids concentration in water samples analyzed ranged from 272 to 24,900 milligrams per liter. Fresh water is obtained from wells and springs only in the Promontory Mountains and their northern extensions. In the rest of the area, the ground water ranges from slightly to very saline. Almost all the water is very hard. Only locally is the water suitable for public supply and all the water has a moderately high to very high salinity hazard for irrigation; but more than half the area yields ground water suitable for livestock.

Water in the Promontory Mountains area is used for stock and, as of 1966, ground water was used for the irrigation of 3,670 acres of land. Irrigation is from springs and, in two small areas, from wells. A reported 150 acre-feet per year is exported by pipeline for domestic and industrial use. Future development in most of the area is limited by the widespread occurrence of saline water, generally small well yields, and in some localities by large pumping lifts. Immediate detailed study is suggested only for the locality from the East Promontory community northward to the mouth of Blue Creek Valley.

INTRODUCTION

This report is the eleventh in a series by the U.S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights, which describes the water resources of the western basins of Utah (fig. 1). Its purpose is to present hydrologic data for the Promontory Mountains 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, water quality, and water use. These data were supplemented with data on landforms, vegetation, geology, and water sources collected during a field reconnaissance consisting of 2 man-days in November 1969 and 7 man-days in November and December 1970. Basic data for the area are presented in tables 4-8. Additional data for northern Rozel Flat are given by Hood (1971).

The Promontory Mountains area is in eastern Box Elder County, Utah. The area, as depicted on plate 1, extends from T. 6 N. to T. 11 N. and from R. 5 W. to R. 8 W. The area above the so-called meander line of Great Salt Lake, at a land-surface altitude of 4,200 feet, is 228,000 acres (about 357 sq mi).

The land in the Promontory Mountains area is used mainly for agriculture. Most is used for grazing, but some is used for the dryland cultivation of small grains around the flanks of the North Promontory Mountains and in the valley area near the old townsite of Promontory. Some dryland cultivation and irrigation of pastures and hayfields is done along the eastern base of the Promontory Mountains.

In addition to agriculture, some industrial use is made of the area. The Lake Crystal Salt Co. has an extraction plant on Great Salt Lake near Saline and the Great Salt Lake Minerals and Chemical Corp. has its intake for brine in the same general area. The Southern Pacific Railroad and Transportation Co. main line crosses the south edge of the area. At Rozel Point (pl. 1) small quantities of asphalt are produced from wells. Near the northeast corner of T. 9 N., R. 6 W., the Thiokol Chemical Corp. withdraws water from wells for industrial and domestic purposes, and exports this water by pipeline to their plant just north of the study area.

Several published reports listed in the selected references contain data on water in the study area. A substantial amount of data was supplied by Thiokol Chemical Corp. concerning their well field, and discussions with Mr. A. D. Allen of that company have aided in the interpretation of conditions near the well field. The principal sources of basic hydrologic data are the files of the U.S. Geological Survey and of the Utah State Engineer, who made a hydrographic survey of the area in 1966-67.

The locations of wells, springs, and other hydrologic-data sites given in this report are largely those reported to the Utah State Engineer by applicants or claimants. Only those sites actually visited or verified from recently published 7½-minute topographic maps are known to be accurately located. Only selected wells are shown on plate 1 and listed in table 5. All springs listed by the Utah State Engineer for the study area are shown on plate 1, but only selected springs are listed in table 7. The system of numbering wells, springs, and other hydrologic sites is described in the appendix.

The geologic map of Utah (Stokes, 1964) is the main source for the geology shown on plate 1. Other reports and related references on Lake Bonneville, Great Salt Lake, and the region are given in the selected references.

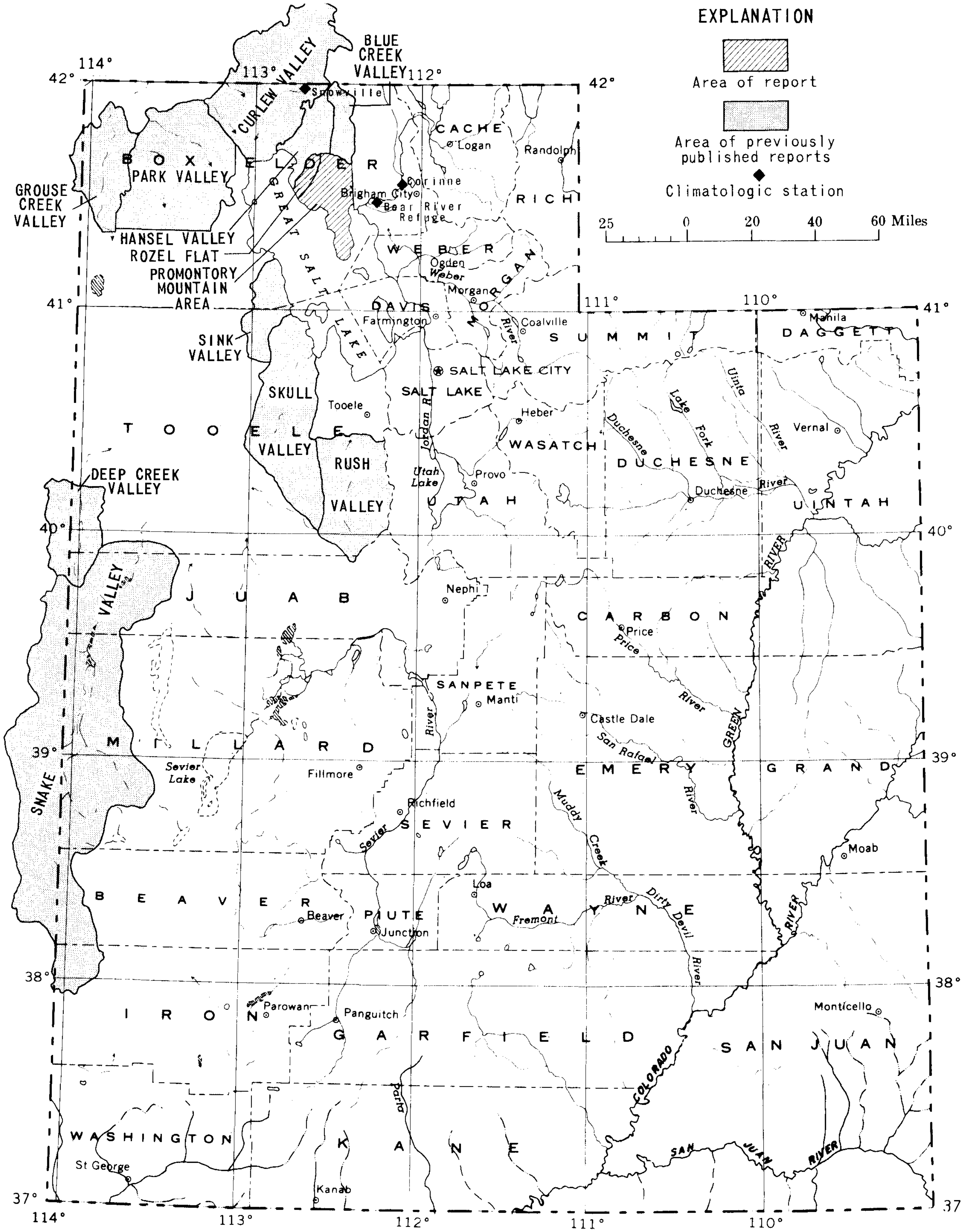

Figure 1.—Location of the Promontory Mountains area and of other areas described in previously published reports in this reconnaissance series.

GENERAL HYDROLOGIC ENVIRONMENT

In the following discussion of the water-resources system in the Promontory Mountains 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, vegetative, and climatic factors.

Physiography

The Promontory Mountains area is in the Great Salt Lake drainage basin, and all parts of the area drain directly to the lake (pl. 1). The area consists of three main elements—the flats adjacent to Bear River Bay on the east, the Promontory Mountains in the middle of the area, and Rozel Flat on the west.

The shapes of the landforms in the area and almost all the drainage pattern are due chiefly to basin- and range-type faulting that created the elongate Promontory Mountains upland and the subparallel lower hills west of Rozel Flat. The Promontory Mountains block was lifted and subsequent erosion produced the deep dissection and part of the present steep slopes. Today, the highest point in the area, Messix Peak (7,372 ft) stands nearly 3,200 feet above the lowest point in the area—Great Salt Lake (maximum elevation in 1970 about 4,195 ft).

Lake Bonneville inundated Rozel Flat and the eastern flats, and the effects of the lake include strongly eroded rock faces and numerous lake-bottom features below an altitude of about 5,280 feet (Crittenden, 1963, fig. 3). The principal effects of lake action were to plane off substantial areas of pre-Pleistocene rocks and to cover the cut surfaces with a few tens of feet of sediment. Examples can be seen in the extensive terrace deposits at the south end of the mountains in Tps. 6 and 7 N. and in the broad flats of lake-bottom deposits adjacent to Bear River Bay. The effects of these lake features on the water supply are discussed in the section on hydrology.

Geology

Rocks ranging in age from Precambrian to Holocene are exposed in the Promontory Mountains area. The pre-Tertiary rocks are consolidated sedimentary, metasedimentary, and metamorphic rocks of Paleozoic and Precambrian age. The consolidated and semiconsolidated rocks of Tertiary age are continental sedimentary and igneous rocks that include pyroclastic deposits. The rocks of Quaternary age are largely unconsolidated materials that were deposited by streams and lakes. Plate 1 shows the distribution of the rock units and table 1 gives a generalized description of their character and water-bearing properties.

Structural distortion of the rocks in the Promontory Mountains area has profoundly affected the water resources. Fracturing and solution have provided the openings for recharge, movement, and discharge of water in consolidated rocks. The relative raising and lowering of those rocks in the area has provided both the upland source of the debris which comprises the younger aquifers and the depressions in which the debris accumulated. Relative movement can be inferred from plate 1; the mountains represent the upthrown areas. At well (B-10-7)17acc-1 (table 5) the surface is a very small outcrop of rock of Paleozoic age (not shown on pl. 1), and that rock had not been completely penetrated at a depth of 7,922 feet (Peace, 1956, p. 23). At well (B-8-7)17aba-1 rocks of Paleozoic age were reported at a depth of 2,365 feet.

Table 1.—Age, character, and water-bearing characteristics of major lithologic units in the Promontory Mountains area

Age		Lithologic unit	Character of material	Water-bearing characteristics
CENOZOIC	Quaternary	Alluvium	Surficial deposits of clay, silt, sand, and gravel that include a soil zone; directly underlie most of the area of farming. Probably less than 10 feet thick in most parts of area. The deposits lie upon both older unconsolidated rocks and consolidated rocks.	Moderate to high permeability. Most of these deposits are above the water table, but in upland valleys and near the mountains they act as part of intake area for ground-water recharge. Locally, they contain ground water that is discharged by evapotranspiration.
CENOZOIC	Quaternary	Near-shore lake deposits	Chiefly deposits of boulders, gravel, and sand in terraces, probably less than 50 feet thick. Most of these deposits lie adjacent to outcrops of consolidated rocks, but they overlie both older unconsolidated rocks and consolidated rocks.	Moderate to high permeability. Act chiefly as part of intake area for recharge from precipitation and runoff; locally the rocks are source of fresh water to springs such as (B-7-5)27dca-S1 (table 7) which discharges from a boulder bed.
CENOZOIC	Quaternary	Lake-bottom deposits	Chiefly clay and silt, but include some fine sand, and near boundaries of mountains include reworked gravel; maximum thickness in Rozel Flat probably is about 50 feet; near Bear River Bay, maximum known thickness is 150 feet (inferred from log of well (B-9-5)20cbc-1, table 6).	Low permeability; not water bearing in most areas above altitude of about 4,250 feet; inhibits recharge and enhances discharge. Part of precipitation that falls on these deposits is retained as soil moisture and part is locally ponded and evaporates; the rest runs off to Bear River Bay and Great Salt Lake. The fine-grained deposits cause a capillary rise to near land surface, and water is discharged from them by evapotranspiration. (See also section on ground-water movement.) Produces gas from black deposits between 30 and 100 feet as in wells (B-9-5)20cbc-1 and (B-9-6)1aca-1. In areas where these deposits are water bearing, they contain slightly saline to briny water.
CENOZOIC	Quaternary	Alluvium and colluvium	Clay, silt, sand, and gravel. Bouldery deposits immediately adjacent to contacts with consolidated rocks. Probably less than 100 feet thick at most places and lie chiefly on consolidated rocks, as at well (B-8-6)1abb-1 (table 6).	Moderate to high permeability, depending on sorting. Most of these depostis are above the water table, but they act as part of intake area for ground-water recharge.
CENOZOIC	Tertiary and Quaternary	Older alluvial deposits	Conglomeratic deposits of sand and gravel and intercalated beds of clay (not shown on hydrogeologic map), which underlie surficial alluvium and lake deposits. These conglomeratic deposits are unconsolidated to well consolidated and cemented with calcium carbonate; may include some pyroclastic rocks. Very small outcrops of this unit(?) are found at east base of Promontory Mountains near contact of consolidated rocks with other alluvial deposits. In the small outcrops, the rocks are deformed and tilted. At well (B-6-6)11baa-1 (table 6), the inferred thickness is about 180 feet; at well (B-10-6)1ddd-1, it is at least 272 feet; may be much thicker beneath flats near Bear River Bay. Overlies Salt Lake Formation and older consolidated rocks, as inferred from logs of wells (B-10-6)26dbb-1 and (B-10-6)9bbb-2.	As a unit, has low to moderate permeability; uncemented gravel beds have high permeability; east of Promontory Mountains these deposits probably are the principal ground-water reservoir; in the valley near Promontory and in Rozel Flat, the deposits together with the Salt Lake Formation probably function as the principal reservoir. Well (B-9-6)12acd-5 has a specific capacity of 42 gallons per minute per foot of drawdown, and some other wells probably finished in this unit have yields of 400 to 1,700 gallons per minute (see table 5). In Rozel Flat irrigation test wells partly finished in this unit had yields of 450 to 900 gallons per minute; the specific capacities ranged from about 2.5 to 6 gallons per minute per foot. Ground water from wells that probably are finished in this unit ranges from fresh to moderately saline.

Table 1.—continued

Age		Lithologic unit	Character of material	Water-bearing characteristics
CENOZOIC	Tertiary	Basalt	Black, vesicular extrusive rock containing numerous fractures and joints; interbedded with sedimentary rocks of the Salt Lake Formation (Slentz and Eardley, 1956). Crops out mainly along west side of Rozel Flat and dips eastward beneath the flat. This unit has been penetrated in some wells in Rozel Flat, which indicates the unit has a greater areal extent in the subsurface.	Low primary permeability; high secondary permeability because of fractures. Well (B-10-7)19ccc-1 produced 125 gallons per minute of water with 14 feet of drawdown; the chemical quality of water from the basalt is unknown, but it is inferred to be saline.
CENOZOIC	Tertiary	Salt Lake Formation	Principal area of occurrence is in Rozel Flat where beds crop out in hills to west of flat. Section is as much as 3,700 feet thick and includes limestone, marl, tuff, claystone, ashy silt, sandstone, shale, and sand. Some sand and shale strata are unconsolidated and some limestone is massive and porous. Most of the formation is consolidated, and it contains the intercalated basalt described above (Slentz and Eardley, 1956, p. 33-36). Drillers' logs indicate that the formation underlies most of Rozel Flat. See (B-9-8)14acc-1, (B-9-7)14abd-1, and (B-10-7)17cbc-1 (table 6). Around edges of North Promontory Mountains the formation consists of white limestone, tuff, and claystone (Heylmun, 1965, p. 26) in small residual bodies that lie upon rocks of Paleozoic age.	Formation generally has low permeability; some beds of coarse-grained material and probably have moderate permeability and can yield small amounts of water to wells. For example, no appreciable water yield was reported for well (B-9-8)14acc-1, but well (B-11-7)35bcd-1 was bailed at 40 gallons per minute with 2 feet of drawdown (table 5). The formation probably functions together with older alluvial deposits as part of principal ground-water reservoir in western part of study area. Chemical quality of the water is inferred to range from fresh in North Promontory Mountains to moderately saline in western Rozel Flat.
PALEOZOIC	Middle Cambrian to Permian	Sedimentary and metasedimentary rocks	Limestone, dolomite, sandstone, conglomerate, shale, and quartzite. The Oquirrh Formation of Permian and Pennsylvanian age is extensively exposed in North Promontory Mountains, southern Blue Springs Hills, and much of Promontory Mountains. The rocks are extensively deformed, mainly by numerous boundary, cross, and some thrust faults. Underlie much of the study area at various depths from the surface to several thousand feet, as inferred from logs of (B-9-5)18cbb-4, (B-10-6)1adc-1, (B-10-7)25cac-1, and (B-11-5)35cbb-1 (table 6). In northern Rozel Flat numerous small outcrops (not mapped) are in an area where the principal surface rock is unconsolidated.	Low primary permeability; low to high secondary permeability due to joints, fractures, and cavernous zones caused by solution. Deformed rocks of this unit are the sources of some saline springs such as (B-7-6)14bcc-S1, (B-9-6)31bda-S1, and (B-10-5)11acc-S1 (table 7). The rocks probably are the source, at depth, of the thermal water from springs and wells alined with the east edge of the Promontory Mountains. In the Promontory Mountains, numerous springs issue from this unit (pl. 1); many are associated with faults. Several wells penetrate this unit (tables 5 and 6) and wells such as (B-8-6)1abb-1, (B-9-5)19bcd-2, and (B-10-7)25cac-1 draw part or all of their water from the unit. Water from the unit in the uplands is fresh (See (B-7-5)20ddd-S1, table 8). Near the edges of the mountain block the water may be fresh or may be saline as at (B-10-5)11acc-S1 (table 4).
PALEOZOIC AND PRECAMBRIAN	Precambrian to Lower Cambrian	Metamorphic, metasedimentary, and sedimentary(?) rocks	Phyllitic shale(?), quartzite, sandstone(?), and metamorphosed sediments, and bouldery clay (tillite[?]). Crop out in southern Promontory Mountains and underlie rest of area, probably at relatively great depths. Deformed by faulting.	Low primary permeability; low to high permeability in shattered zones in and adjacent to faults. Well (B-6-5)30bda-1 produced water from this unit. Water quality is unknown but probably ranges from fresh to briny.

Vegetation

The distribution of vegetation in the area of this reconnaissance was studied both because phreatophytic vegetation is direct evidence of ground-water discharge and because the distribution is useful in confirming the general availability of water.

In the Promontory Mountains area, data were obtained from a map (Foster, 1968) showing the generalized distribution of major plant communities, from a discussion of Utah range grasses by Vallentine (no date), and from field observation. In the lowlands and on lower mountain slopes, the study area contains salt-desert shrub, plains grassland, and sagebrush range types, and on the higher mountain slopes it contains juniper and mountain brush range types (Vallentine, no date, p. 2-4). Clearing of substantial areas of the native cover has partly changed the botanical regimen.

The principal native phreatophytes observed in the area are marsh grasses, including desert saltgrass (*Distichlis stricta*) and sedges (*Carex* sp.), greasewood (*Sarcobatus vermiculatus*), and pickleweed (*Allenrolfea occidentalis*). A nonnative invader, saltcedar (*Tamarix gallica*) has gained a foothold at a few places in the area. The areal and vertical density of these phreatophytes varies directly with the availability and chemical quality of water.

Saltgrass and other water-loving grasses fringe almost the entire shoreline of Great Salt Lake and the adjacent bare ground near Bear River Bay (pl. 1). In areas of wet soil, as near the larger springs, growth is very dense. These grassy areas along the shore generally range in width from a few feet to 0.25 mile.

Greasewood grows where the depth to water is about 5 to 60 feet and soil conditions are otherwise suitable. On higher slopes, pure stands of greasewood exist, and in some areas it grows in association with sagebrush (*Artemesia tridentata*) and range grasses. In the flats near Bear River Bay, greasewood grows in association with pickleweed and locally with saltgrass; the greasewood is densest on the tops of erosional remnants of a terrace that adjoins bare saline ground below the terrace level.

Pickleweed grows where most other plants cannot tolerate the salinity of the soil water. Sparse growth was seen on otherwise bare ground adjacent to Bear River Bay, but no dense growth was seen.

Saltcedar flourishes where the depth to water is small and there is opportunity for seed to germinate in standing water. The plant now (1970) grows at a few springs, such as (B-7-6)15aca-S1 where propagation conditions are optimum. Saltcedar, if not eradicated or well controlled, may supplant other plants such as saltgrass and increase the annual discharge of ground water, thereby leading to degradation of the quality of water.

Climate

The climate of the Promontory Mountains area is characterized by small to moderate amounts of precipitation, moderately cold winters, hot summers, and moderate evaporation rates. Climatologic records (see selected references) for Snowville (fig. 1) probably are representative of the western part of the study area. Records for Corinne and Bear River Refuge (fig. 1) probably are representative of the eastern part.

Normal annual precipitation (pl. 1) ranges from about 9 inches on the shore of Great Salt Lake west of Rozel Flat to more than 20 inches on the highest part of the Promontory Mountains. Approximately 60 percent of the area receives 12 to 16 inches annually, of which about two-thirds falls in winter and spring. The winter precipitation is important as a source of water to wells and springs in the area; most of the summer precipitation is consumed at the point of fall.

Average monthly air temperatures for the 63 years of record between 1899 and 1966 at Snowville ranged from 22°F (-5.5°C) in January to 69°F (20.5°C) in July. The average annual temperature was 45°F (7.0°C). At Corinne, the range was from 24°F (-4.5°C) in January to 74°F (23.5°C) in July; the annual average was 49°F (9.5°C). Air temperatures in the flats were slightly higher, as at Bear River Refuge where the annual average temperature was about 51°F (10.5°C). The growing season at Snowville for the period 1949-66 was 122 days (based on number of days between the last spring and first fall temperature of 28°F (-2.0°C). The growing season at Corinne for the same temperature was approximately 170 days.

Potential evapotranspiration and evaporation from a free-water surface are about the same. Potential evapotranspiration in the Promontory Mountains area was calculated by the Blaney-Criddle method (Cruff and Thompson, 1967, p. M15-M16) based on the stations cited, and is in the range of 40 to 45 inches annually. The figure for evaporation from a free-water surface at Bear River Refuge is calculated from the estimated average annual pan evaporation of 61 inches (based on April-October measurements for monthly periods of 17 to 34 years). Using a pan coefficient of 0.71, the evaporation from a free-water surface is approximately 43 inches.

HYDROLOGY

Volume of precipitation

Precipitation on the Promontory Mountains area is estimated to average 240,000 acre-feet annually. Of this amount, about 93 percent is consumed at or near the point of fall, because most of the precipitation falls on large areas of low altitude where the rate of precipitation is small, air temperatures are relatively high, and soil moisture requirements are high. Only in the higher parts of the mountains is the average annual precipitation sufficiently large to provide any appreciable amount of water in excess of the gross consumptive use at the point of fall. The average annual volume of precipitation was estimated from the precipitation data shown on plate 1, and the computation is shown in table 2.

Surface water

The estimated average annual runoff from the Promontory Mountains area is 6,000 acre-feet. This water includes direct runoff and an estimated 2,000 acre-feet of unconsumed spring discharge (see section on ground-water discharge).

The only perennial flow is in stream channels below large springs. Blue Creek, which discharges an estimated average of 3 cubic feet per second of water into the northeast edge of the area (pl. 1), flows most of the year, but most water in the creek originates in Blue Creek Valley. See Bolke and Price (1972, p. 7) for discussion of Blue Creek. The channels of ephemeral and intermittent streams show the results of infrequent flooding, but the average flow in any one is small.

Three channels were measured for mean annual flow by the channel geometry method described by Moore (1968, p. 36-38). The channel bottoms were on sand and gravel, and the channels head in mountain areas that receive an average of 15-20 inches of precipitation annually; none of the three appeared to have carried runoff in 1970. Pertinent points for measurement in the three available sections were poorly to very poorly defined, and the results listed in the following table are subject to substantial error.

Location (See pl. 1)	Estimated mean annual discharge (acre-ft)
(B-7-5)7cbd	Less than 2
21bac	Less than 2
(B-7-6)24bdc	24

These estimates confirm the observation by a local rancher, Mr. Claude Staples (oral commun., November 1970), that streams in the area have appreciable flow only after exceptionally heavy thunderstorms or during the melting of an extra thick snowpack. Generally the streambeds absorb most of the available water during the infrequent runoff events.

Overland runoff in the Promontory Mountains area cannot be calculated accurately because adequate streamflow data do not exist. A figure for runoff, therefore, was estimated by assuming that an average of 0.1 inch runs off all areas underlain by Quaternary and Tertiary sedimentary rocks and that 0.5 inch runs off areas underlain by igneous and pre-Tertiary consolidated sedimentary rocks. This amount is about 4,000 acre-feet.

The total runoff, in acre-feet, in the Promontory Mountains area, therefore, is:

Unconsumed springflow	2,000
Overland runoff	4,000
	6,000

Ground water

In the Promontory Mountains area, ground water is most uniformly available from the rocks of Cenozoic age. The ground-water reservoir consists of unconsolidated to consolidated sedimentary rocks, and in part of Rozel Flat may include intercalated basalt flows of Tertiary age.

A ground-water reservoir also exists in the consolidated rocks of Paleozoic and Precambrian age. At least seven wells and one infiltration gallery are finished in them; several large springs and many small ones derive their water from the older consolidated rocks. The relation between this reservoir and the one in the Cenozoic rocks has not been fully determined.

With respect to ground water, the Promontory Mountains area is not an isolated, discrete hydrologic unit. The ground-water reservoir in the consolidated rocks is connected hydraulically with areas to the north and probably receives inflow from those areas. The northeastern boundary of the area is arbitrarily drawn, and the ground-water reservoir in the unconsolidated deposits extends across that boundary. Thus, estimates given in the following sections are subject to substantial error and a water budget for the study area cannot be made with any accuracy without additional study that includes the adjacent areas.

Recharge

The estimated average annual recharge to the Promontory Mountains area is 27,000 acre-feet. This amount is based on the figure estimated for the ground-water discharge and on the estimate that little or no change in ground-water storage has occurred (see sections on ground-water storage and discharge).

That part of the recharge to the Promontory Mountains area derived from precipitation on the drainage area is estimated to average about 12,000 acre-feet annually, or about 5 percent of the total precipitation. The estimate was made using the method described by Hood and Waddell (1968, p. 22-23); the factors and computations are shown in table 2.

From these figures, it is inferred that ground-water inflow to the area amounts to about 15,000 acre-feet per year.

Table 2.—Estimated average annual volumes of precipitation and ground-water recharge

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

Precipitation zone (inches)	Acres	Estimated annual precipitation Feet	Estimated annual precipitation Acre-feet	Estimated annual recharge Precent of precipitation	Estimated annual recharge Acre-feet
Areas underlain by Quaternary and Tertiary sedimentary rocks					
8-12	57,600	0.88	50,700	0	0
12-16					
Lake-bottom deposits	55,000	1.08	59,400	0	0
All other	39,000	1.12	43,700	6	2,600
Subtotals (rounded)	151,600		153,800		2,600
Areas underlain by Tertiary igneous and pre-Tertiary rocks					
8-12	9,600	0.88	8,400	1	80
12-16	51,800	1.12	58,000	10	5,800
16-20	13,400	1.46	19,600	15	2,900
More than 20	1,900	1.83	3,500	20	700
Subtotals (rounded)	76,700		89,500		9,400
Totals (rounded)	228,000		240,000		12,000

Occurrence and movement

The records for most wells in the Promontory Mountains area indicate artesian (confined) conditions for the water-bearing zones in which the wells are completed. Locally, particularly in shallow beds, water-table (unconfined) conditions or perched conditions exist. Water from the Promontory Mountains moves generally westward to Rozel Flat and thence southward toward Great Salt Lake. Water also moves eastward from the mountains and southward from the Blue Creek Valley area toward Bear River Bay. The direction of ground-water movement is shown by arrows on plate 1.

The rocks of Cenozoic age on both sides of the Promontory Mountains contain water under artesian conditions as in the Thiokol well field (secs. 1 and 12, T. 9 N., R. 6 W.). Only along the edge of the range and in some of the valley around the townsite of Promontory have water-table or perched conditions been recognized in wells such as (B-9-7)16aaa-1. Water levels in the Cenozoic rocks range from 20 feet or more above land surface in part of the lowlands to about 400 feet below land surface near Promontory.

The consolidated rocks of Paleozoic and Precambrian age also contain water under both artesian conditions, as in well (B-8-6)1abb-1, and water-table conditions, as in well (B-11-5)35cbb-1. In the Central Pacific Railroad Co. infiltration gallery, (B-6-5)15bbc-1, water was first obtained in limestone (behind clay), about 800 feet from the mouth of the adit. At least seven wells yield water from these rocks; depths to water range from about 30 feet below land surface in well (B-9-5)19bcd-2 to 378 feet in well (B-10-6)9bbb-2.

The older consolidated rocks yield water to numerous springs in the area. Ground water from mountain springs probably is derived from recharge to the aquifer in the vicinity of the springs, and a good quality of water results. Some of the mountain springs are related to faults (pl. 1). Much of the recharge in the mountain area, however, probably percolates down through solution channels and fractures to a deep water table and thence to the edges of the mountain block and into the adjacent rocks of Cenozoic age. The rocks of Cenozoic age probably diminish in grain size and, therefore, in permeability toward Great Salt Lake and Bear River Bay, and lake-bottom deposits impede upward movement beneath the lakeshore and bottom. Most of the water moves upward, therefore, through fractures and solution openings in the consolidated rocks and through coarse-grained deposits near the mountain block. As a result, the edge of the Promontory Mountains block and the end of the Blue Springs Hills (pl. 1) are lined with a series of overflow seeps and springs, some of which have relatively large discharge—spring (B-9-6)31bda-S1 (estimated as 670 gallons per minute) and the line of stream-bottom springs (B-10-5)4dd-S (measured as 1,130 gallons per minute) are examples (table 7).

Some of the water from the artesian springs and from neighboring wells has circulated up from great depth; a temperature of 25°C (77°F) was measured at (B-7-5)15cba-S1 and was associated with a large discharge—estimated as 310 gallons per minute. Deep circulation along the boundary faults of the Promontory Mountains, together with the chemical quality, suggests that a part of the water originates at some distance from the spring and not in the immediately adjacent part of the mountain block.

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. Year-to-year changes in storage are indicated by corresponding changes in the water levels in wells. When recharge exceeds discharge, water levels rise; when discharge is greater, water levels decline.

Ground-water storage in most of the Promontory Mountains area in 1970 was still under natural conditions. The representative short-term water-level records for well (B-10-7)19ccc-1, in Rozel Flat, are tabulated below, and show that fluctuations in nonpumping water level amounted to less than half a foot.

Depth to water is in feet below land surface

Date	Depth to water	Date	Depth to water
May 8, 1967	140.2	Nov. 28, 1969	139.9
May 15, 1969	140.3	Apr. 1, 1970	140.0
Oct. 8, 1969	139.8		

The changes in storage were due to natural seasonal effects and are not appreciably affected by pumpage. Only in two areas have water levels declined due to withdrawals from wells. In the vicinity of sec. 4, T. 8 N., R. 6 W., and in and near secs. 1 and 12, T. 9 N., R. 6 W. (Thiokol Chemical Corp. well field) flowing wells were drilled in the early 1940's, and in both areas no early records of measured water levels are available. The release of artesian pressure has lowered water levels in those areas, but the quantity of storage change probably is small. Decline of water levels in the area of largest withdrawal, the present-day Thiokol well field, is indicated by the decrease in the discharge of flowing wells; most of the decrease probably occurred in the first few years of use during the 1940's when the artesian head was first released. Water-level fluctuations due to withdrawal in the area appear to extend at least as far south as well (B-9-5)19bcd-2. The owner of that well reports seasonal response of the water level to pumpage for irrigation north of his well and a decline of 5 feet or more since installation of the wells to the north (L. M. Richman, oral commun., December 1970).

As an approximation of the volume of storage, without regard to chemical quality, it is assumed that the area underlain by rocks of Cenozoic age shown in table 2 contains at least 100 feet of saturated water-bearing formation; the estimated average specific yield of the formations is 0.05. By dewatering the 100 feet of material, the volume recoverable is

$$100 \times 0.05 \times 151{,}700 = 760{,}000 \text{ acre-feet (rounded)}$$

Recovery of this amount of ground water would yield mainly saline water and the decline of 100 feet in water levels most certainly would induce the migration of additional saline water into the area.

Discharge

An estimated average amount of 27,000 acre-feet of ground water leaves the Promontory Mountains area annually by (1) evapotranspiration, (2) subsurface outflow, (3) withdrawal from wells, and (4) unconsumed spring discharge. During the growing season, the discharge of most small springs and part of the discharge from large springs is dissipated by evapotranspiration, and that discharge is included in the figure for evapotranspiration.

Evapotranspiration.—The areas in which significant quantities of ground water are discharged by evapotranspiration are shown on plate 1. The estimated average evapotranspiration is 14,000 acre-feet annually; the computation is shown in table 3.

Subsurface outflow.—The available data suggest that the aquifer characteristics and hydraulic gradient near the shoreline are similar to those in adjacent Hansel Valley where Hood (1971, p. 17) estimated the average ground-water outflow as about 125 acre-feet per year per mile. Using the same rate for the 70 miles of shoreline in the Promontory Mountains area, the ground-water discharge by subsurface outflow is estimated to average 9,000 acre-feet annually.

Withdrawal from wells.—The estimated annual discharge from wells is listed below.

USE	ACRE-FEET
Industrial (exported by Thokol Chemical Corp. to Blue Creek Valley)	150
Domestic and stock	100
Irrigation	1,600
Total (rounded)	2,000

Unconsumed spring discharge.—Springs discharge both in the mountain uplands and around the base of the mountains. Many of the springs have small rates of discharge, but some are large enough to create flow across the flats to Great Salt Lake and Bear River Bay. During the growing season, water from the larger springs is spread for irrigation of pasture and hay meadow grasses, and much, if not all, of the irrigation water is consumed. Water from most of the other springs is consumed near the point of discharge. The total of spring discharges measured and estimated in the Promontory Mountains area is about 9 cubic feet per second. Assuming this figure to be 75 percent of the total spring discharge, the total discharge is about 12 cubic feet per second, or about 8,700 acre-feet per year. Of this amount, an estimated 25 percent, or about 2,000 acre-feet, flows away from the project area.

Perennial yield

The perennial yield of a ground-water system is the maximum amount of water that can be withdrawn from the system for an indefinite period of time without causing a permanent and continuing depletion of ground water in storage. The perennial yield is limited ultimately to the amount of natural discharge of water that can be salvaged. The perennial yield of the Promontory Mountains area is 25,000 acre-feet per year or less.

The usual definition of perennial yield, as given above, must be restricted for economic reasons. Withdrawal of water in much of the area will lead to a deterioration of the already marginal to poor quality of water. Thus, the useful perennial yield given below is restricted to the amount of natural discharge of water of good quality that can be salvaged for beneficial use without causing a deterioration of the chemical quality of the water in storage. Based on the restricted definition and the present pattern of use, the useful perennial yield of the Promontory Mountains area is small. In the upland areas, where ground water is of good quality, about 1,000

Table 3.—Estimated average annual evapotranspiration of ground water

Evapotranspiration unit (See pl. 1)	Depth to water (ft)	Area (acres)	Evapotranspiration	
			Acre-feet per year	Acre-feet (rounded)
Mainly bare ground, with some pickleweed and some patches of greasewood on slightly higher ground	0-5(?)	31,700	0.15	4,800
About 70 percent bare ground and 30 percent greasewood, some moderate to dense; includes tracts of saltgrass and irrigated meadow	5(?)-20	18,500	.3	5,600
Mainly sparse greasewood	5(?)-60(?)	10,000	.2	2,000
Saltgrass fringe[1]	0-1	900	2.0	1,800
Totals (rounded)		61,000		14,000

[1]Not shown on plate 1 (see section on vegetation).

acre-feet can be diverted for use annually. Most of the natural discharge in the lowlands is of poor quality; about 2,000 acre-feet per year that is consumed by evapotranspiration sustains useful plants. The present withdrawal from wells (2,000 acre-ft per year) could probably not be increased without serious degradation of water quality. The maximum useful perennial yield, therefore, is estimated as 5,000 acre-feet.

Chemical quality of the water

The dissolved-solids concentration in water samples from the Promontory Mountains area ranges from 272 to 24,900 mg/l (milligrams per liter). The known and inferred areas in which fresh water (containing 1,000 mg/l or less of dissolved solids) may be obtained are in the mountain uplands, the small valley around the townsite of Promontory, and a narrow strip of land along the base of the mountains (pl. 1). In the rest of the area, the ground water ranges in chemical quality from slightly to very saline; most water in near-surface deposits at the strand of Great Salt Lake probably is a brine. With a few exceptions, the water is hard to very hard. The results of chemical analyses and measurements of specific conductance of water from 40 wells and 42 springs are given in tables 4 and 8.

Ground water in the area belongs mainly to two chemical types. The Stiff diagrams on plate 1 show that the water with the lowest dissolved-solids concentration is of the calcium magnesium bicarbonate type; water with high dissolved-solids concentrations is of the sodium chloride type. Water of low concentration as it moves through the system gains in dissolved-solids concentration and concurrently undergoes modification of type. At low concentration, some of the water appears to become a sodium bicarbonate type, but as the dissolved-solids concentration increases, the gain is mainly in sodium and chloride (fig. 2).

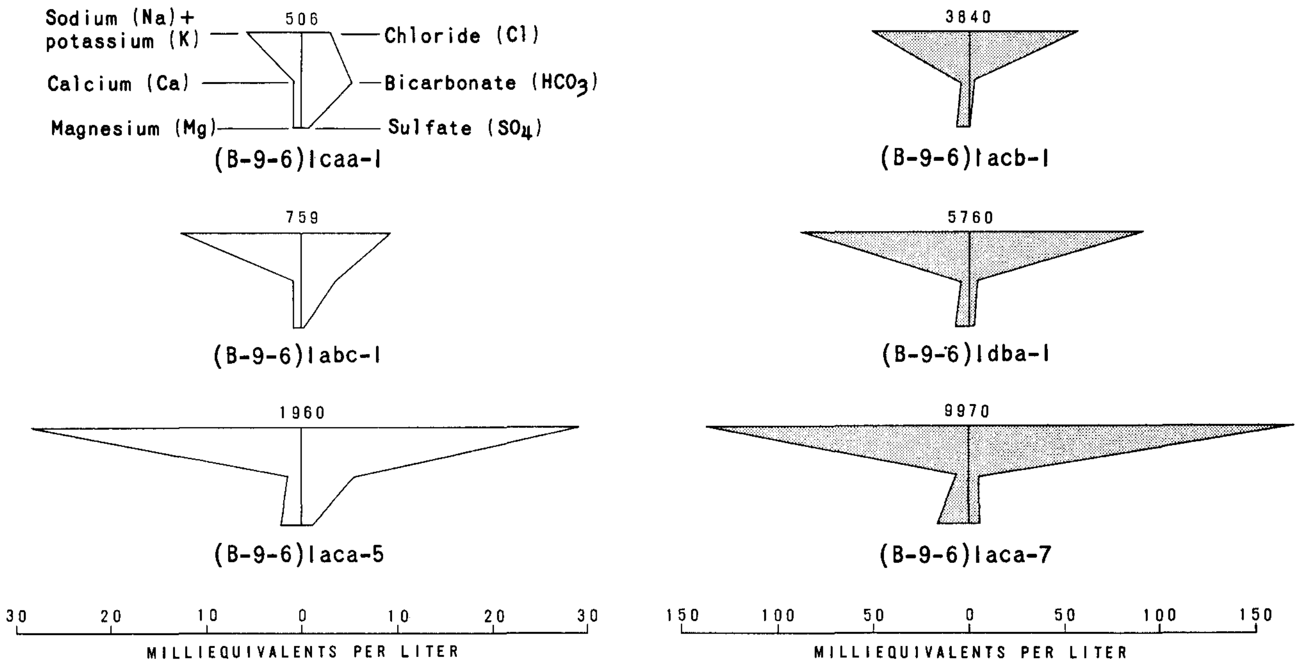

Figure 2.—Stiff diagrams showing the change in chemical character with increase in dissolved-solids concentration in water from wells in the Thiokol Chemical Corp. well field.

Water from Cedar Spring, (B-11-7)34dbb-S1, is an exception to the two basic types described above. Water from the spring is a calcium magnesium chloride type (pl. 1) and may derive its chemical character from the breakdown of clastic volcanic debris in the Salt Lake Formation from which the spring discharges.

The minerals that are dissolved in the water in the study area probably are derived from three main sources. Water dissolves minerals from the rocks over and through which it passes. Where recharge rates are low and the water-bearing beds have low permeability, the gain in dissolved solids is large. The poor chemical quality of much of the water in such areas as Rozel Flat probably results from the slow rate of movement.

A second source of the dissolved solids in water of the area is the spray from Great Salt Lake and dust from its adjacent flats. Much of the study area is directly exposed to this source.

The third source is subsurface inflow of saline ground water and the inflow of saline water in Blue Creek. Bolke and Price (1972, table 6) show that the creek water at location (B-10-5)5bab during June 1959-September 1970 had an average dissolved-solids concentration of 5,100 mg/l. A part of this water probably recharges the water-bearing formations along the edge of the flats adjacent to Bear River Bay.

Table 4.—Specific conductance and temperatures of water from selected wells and springs

Location: See appendix for description of well- and spring-numbering system used in Utah.

K: Specific conductance in micromhos per centimeter at 25°C; f, field determination.

Temperature: See appendix for equivalent temperature in °F.

Location	Date	K	Temperature (°C)
(B-7-5)9bbb-S1	11-28-70	1,250	17.0
15cdb-S1	do	10,500	19.5
16aaa-S1	do	2,700f	-
22bdb-S1	do	2,940	16.0
27dca-S1	11-27-70	830	14.5
(B-7-6)14bcc-S1	12- 2-70	10,600	16.0
15adb-S1	do	([1])f	13.0
(B-8-5)5caa-S1	11-28-70	6,560	20.0
20dad-S1	do	761	15.0
[2]29cdc-S1	do	598	-
(B-8-6)5dda-1	11-25-70	2,320f	16.0
(B-9-5)32bbc-S1	11-28-70	[3]5,700f	15.0
32cdd-1	do	4,850	-
(B-9-6)1cdd-S1	12- 3-70	797	14.5
[4]2bac-S1	do	800f	-
[5](B-10-5)4dab-S1	12- 2-70	9,530	-
[6]4dd-S1	do	10,100	15.0
11acc-S1	do	11,300	17.0
11daa-S1	do	8,230	16.5
[7](B-10-6)32ddb-S	11-29-70	744	-
(B-11-6)30dca-1	8- 7-70	1,020f	-
(B-11-7)27add-S1	11-28-69	1,170f	12.5

[1] More than 8,000.
[2] Sampled at end of pipeline at location (B-8-5)28ccc.
[3] Water contains hydrogen sulfide gas (H_2S).
[4] Sampled from line at stock trough by storage tank.
[5] Sampled from spring pool.
[6] Composite flow sample of series of streambed springs.
[7] Sampled from end of pipeline at location (B-10-6)30bcc.

Inflow of saline ground water is suggested by the existence of the saline thermal springs that bound the edges of the mountains, and by the record of an oil-test hole in Blue Creek Valley (Bolke and Price, 1972, table 3), which produced highly mineralized hot water.

Local recharge and upward movement of the warm saline water near the edges of the mountain blocks produce some sharply different qualities of water in short distances, both laterally and vertically. For example, in the Thiokol well field, the deeper wells produce water that contains more dissolved solids than the shallow ones, and the more concentrated water appears to be along the trace of the fault that bounds the mountain block. Shallow wells that are close to the consolidated rocks produce the freshest water in the well field. Some wells, such as (B-10-6)36bbb-3, penetrated salt-water zones at depth and were partially plugged to cut off the inflow of saline water (table 6).

Most water in the Promontory Mountains area does not meet standards for domestic and public supplies as set by the U.S. Public Health Service (1962, p. 7) because the dissolved solids exceed 500 mg/l.

Water in more than half of the area can be used by livestock because the more highly mineralized water is a chloride type that supplies a part of the salt needed by the animals. Concentrations of more than about 5,000 mg/l, however, probably would render the water unpalatable to most livestock.

Because of the prevalence of saline water in most of the study area, water suitable for irrigation of cultivated crops is relatively scarce; much of the water can be used only where large quantities can be applied to salt-tolerant vegetation, such as saltgrass. Figure 3 shows that even the best water in the study area has a moderate to very high salinity hazard. Some of this water, however, can be used for irrigation because it has a low sodium hazard. Lands irrigated with such water must have good permeability and drainage, and adequate water should be applied to assure flushing of the soil.

SUMMARY OF WATER USE

Past and present use

Known use of water in the Promontory Mountains area dates back to the building of the transcontinental railroad through the former towns of Promontory and Rozel in 1869. The railroad company constructed pipelines to mountain springs (table 7) to obtain water of quality suitable for domestic and locomotive use.

The earliest record of a well is for (B-10-6)14daa-1 (table 5), which was drilled in 1891. By 1920 dug and drilled wells for stock and domestic water were installed at ranches in many parts of the area. Many of those wells have since been abandoned or replaced. Carpenter (1913, p. 57) reported that several wells drilled in Rozel Flat had been abandoned because the water was unfit for use. The early development included the Central Pacific Railroad Co. infiltration gallery, (B-6-5)15bbc-1, which was installed in 1902 near the southern end of the Promontory Mountains when construction was beginning on the present route of the Southern Pacific Railroad across Great Salt Lake.

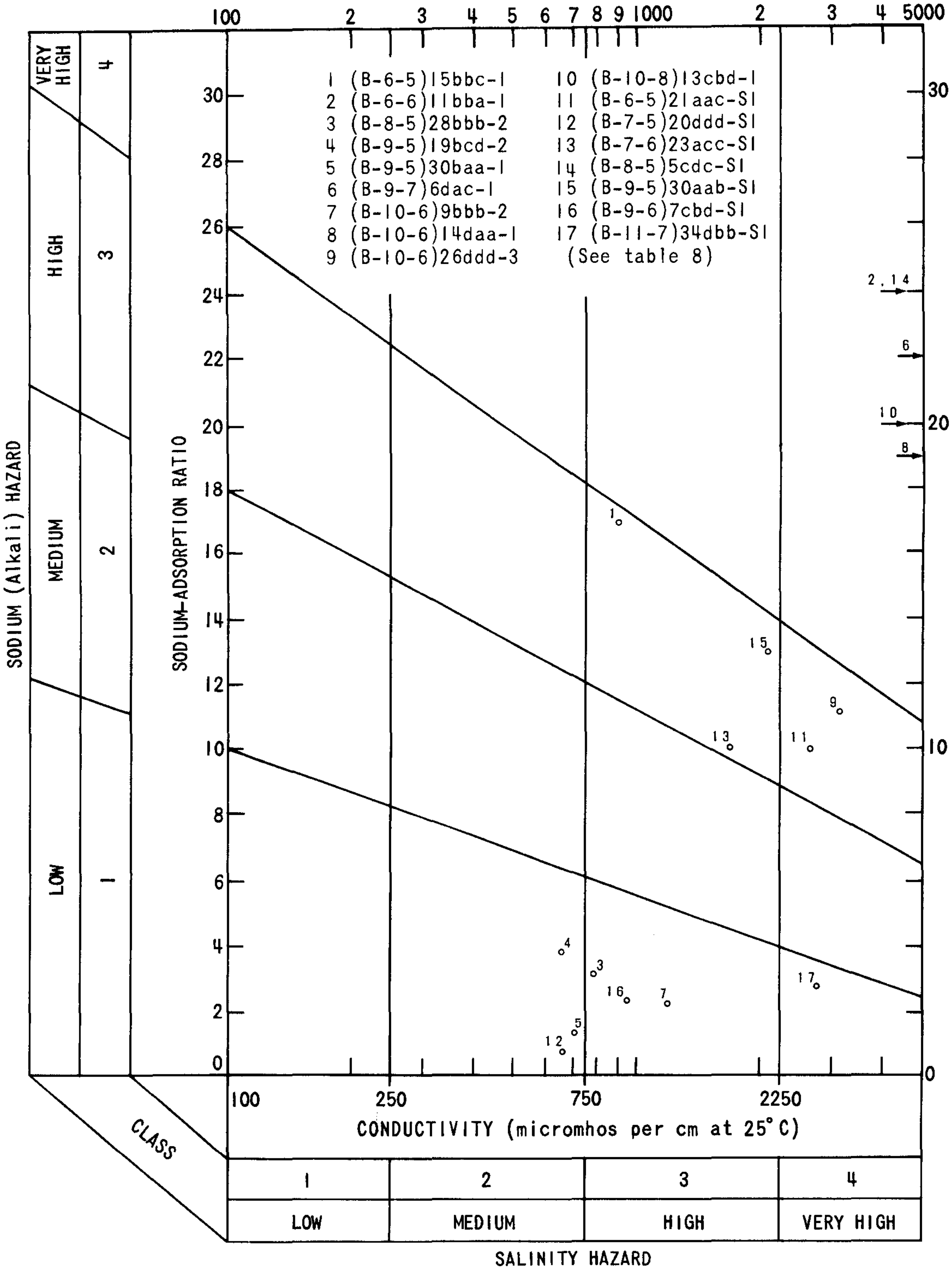

Figure 3.—Classification of representative well and spring water in the Promontory Mountains area for irrigation. (Diagram after U.S. Salinity Laboratory Staff, 1954, p. 79-81.)

In the early 1940's, the Bar-B Company, which then owned a substantial part of the study area, carried out a drilling program that resulted in about 25 flowing wells in the northeast corner of T. 9 N., R. 6 W. This is the location of the present Thiokol well and spring field; the corporation has since expanded its holdings of land and water rights into adjacent sections and produces both irrigation water for local use and water for export to its plant in Blue Creek Valley. The Bar-B Company also developed some flowing wells from test holes drilled in and near secs. 4 and 5, T. 8 N., R. 6 W. The most productive irrigation well in the Promontory Mountains area, which is pumped at 1,700 gpm and reportedly flows 450 gpm, is at location (B-8-6)4ccb-1.

To the north and south of the Thiokol well field, several other wells (table 5) have been installed for irrigation, but these have relatively low yields. The total irrigated land, as tabulated from the Utah State Engineer's hydrographic survey, was 3,670 acres; all but about 800 acres of the irrigated land was east of the Promontory Mountains and much of the land is irrigated from springs.

Future development

For the Promontory Mountains area, the future appears to hold little promise for large-scale development. Much of Rozel Flat does not appear to be subject to development because of the chemical quality of the water there. The southern part of the Promontory Mountains projects into Great Salt Lake and includes little arable land. Shallow wells in the mouths of some of the small canyons, such as that near Squaw Springs (table 7), might obtain small supplies of fresh or usable water for stock or small-scale irrigation, but large withdrawals very probably would induce saline-water migration from the lakeshore or from depth. Further detailed study should be made along the flats near Bear River Bay and the adjacent alluvial slopes. There a small increase in withdrawals might be made, if detailed investigations show that pumping would not alter the chemical quality of the ground water. In the Promontory Mountains and near the townsite of Promontory, small quantities of fresh to slightly saline water can be obtained. Large yields probably cannot be obtained and the pumping lift is large—on the order of 200 to 400 feet.

DATA NEEDED FOR FUTURE STUDIES

The results of this reconnaissance indicate that a detailed investigation is not immediately needed for the entire Promontory Mountains area. However, full development of the county and the State ultimately will require further consideration of the area. The main problem in development of usable water supplies is a careful delineation of the character and the horizontal and vertical extent of the aquifers that carry fresh and slightly saline water and their hydrologic relation to the underlying older rocks.

Of immediate importance is the east side of the area, from the East Promontory community northward to the mouth of Blue Creek Valley. For study of this specific area, the following is needed:

1. Detailed studies of both the unconsolidated deposits and the adjacent consolidated formations and an analysis of geologic structure as it affects the distribution and thickness of aquifers. This work should include field mapping, geophysical logging of existing wells, and test drilling at selected sites.

2. A detailed field inventory of all ground-water sources, including chemical analysis of water from each source. Aquifer characteristics must be determined.

3. Stream discharge should be determined for most stream channels by the methods best suited and available at the time of the study. For areal considerations, multiple regression analyses and other indirect methods should be considered.

4. Mapping of phreatophytes in connection with depth-to-water studies and water-level fluctuations is needed to refine estimates of evapotranspiration.

5. Supplemental data are needed including more detailed records of air temperature, rate of precipitation, chemical quality of precipitation, and soils characteristics. These data are needed in order to define more accurately the disposition of precipitation in the Promontory Mountains and adjacent areas, and therefore refine both recharge and discharge estimates.

Beyond the needs for immediate studies described above, studies needed for full evaluation of the Promontory Mountains area include a synthesis of all areal studies in drainage basins adjacent to the Promontory Mountains and, probably, some deep test drilling. The intent of such studies and drilling would be to define the nature of the unconsolidated and consolidated aquifers at depth throughout the area and thus evaluate the quantity of ground-water inflow to and outflow from the Promontory Mountains area.

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APPENDIX

The system of numbering wells and springs in Utah is based on the cadastral land-survey system of the U.S. Government. The number, in addition to designating the well or spring, describes its position in the land net. By the land-survey system, the State is divided into four quadrants by the Salt Lake base line and meridian, and these quadrants are designated by the upper case letters A, B, C, and D, indicating the northeast, northwest, southwest, and southeast quadrants, respectively. Numbers designating the township and range (in that order) follow the quadrant letter, and all three are enclosed in parentheses. The number after the parentheses indicated the section, and is followed by three letters indicating the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section (generally 10 acres); the letters a, b, c, and d indicate, respectively, the northeast, northwest, southwest, and southeast quarters of each subdivision. The number after the letters is the serial number of the well or spring within the 10-acre tract; the letter "S" preceding the serial number denotes a spring. If a well or spring cannot be located within a 10-acre tract, one or two location letters are used and the serial number is omitted. Thus (B-9-6)12acd-1 designates the first well constructed or visited in the SE¼SW¼NW¼ sec. 12, T. 9 N.,R. 6 W., and (B-9-6)12b-S designates a spring known only to be in the northwest quarter of the same section. Other sites where hydrologic data were collected are numbered in the same manner, but three letters are used after the section number and no serial number is used. The numbering system is illustrated in figure 4.

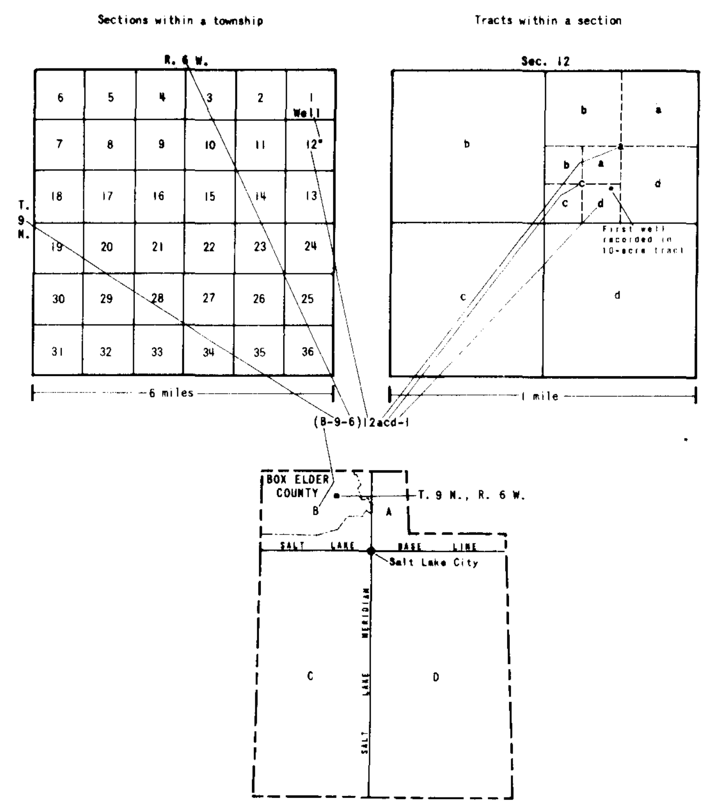

Figure 4.—Well- and spring-numbering system used in Utah.

[1]Although the basic land unit, the section, is theoretically a 1-mile square, many sections are irregular. Such sections are subdivided into 10-acre tracts, generally beginning at the southeast corner, and the surplus or shortage is taken up in the tracts along the north and west sides of the section.

Use of metric units

The results of chemical analyses and temperature measurements are given in this report in metric units, rather than the more familiar English units. Temperatures are given in degrees Celsius, and concentrations are reported in milligrams per liter or milliequivalents per liter.

Degrees Celsius (°C) are the units used for reporting temperature in the metric system. One degree Celsius is equal to 9/5 degrees Fahrenheit, and the freezing point of water is 0° on the Celsius scale. The following table may be used to convert the temperature data given in this report to the more familiar Fahrenheit scale:

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

Milligrams per liter (mg/l) is the base unit for expressing the concentration of chemical constituents in solution, and it represents the weight of solute per unit volume of water. For concentrations of less than about 7,000 mg/l, this unit is numerically very nearly equal to the unit parts per million (ppm), which was formerly used by the U.S. Geological Survey.

Milliequivalents per liter (meq/l) is the base unit for expressing the concentration of chemical constituents in terms of the interacting values of the electrically charged particles, or ions, in solution. One meq/l of a positively charged ion can react with 1 meq/l of a negatively charged ion. The unit meq/l is numerically equal to the unit equivalents per million, which was formerly used by the U.S. Geological Survey. For comparison of water types and for graphical presentation, meq/l is a more convenient unit than mg/l.

BASIC DATA

Table 5.—Records of selected wells

Location: See appendix for description of well- and spring-numbering system used in Utah.
Type of well: C, drilled with percussion (cable-tool) rig; D, dug; H, drilled with hydraulic rotary rig; T, trench (covered).
Casing diameter: Smallest casing that extends to the land surface.
Casing finish: F, gravel wall, perforated or slotted casing; H, horizontal collector (infiltration gallery); O, open end, unperforated casing; P, perforated casing (generally done with a Mills knife); S, screen; W, walled or shored; X, open hole (uncased) in aquifer.
Water-bearing formation: Material - B, unclassified sedimentary rock; HB, hard unclassified sedimentary rock; G, gravel; 2G, fine gravel; 4G, coarse gravel; 5G, very coarse gravel; 6G, clayey gravel; I, basalt ("lava"); JI, jointed or fractured basalt; L, limestone; R, sand and gravel; 6R, clayey sand and gravel; U, unconsolidated sediments; V, sandstone. Aquifer - Pzu, Paleozoic rocks; Tsl, Salt Lake Formation.
Altitude of land surface: In feet above mean sea level; interpolated from U.S. Geological Survey 7½-minute topographic maps.
Water level: In feet above(+) or below land surface; M, measured; R, reported; F, reported or observed flow, but head not determined; well reported dry may have been reported as such if yield was not adequate for intended purpose; measured dry wells had no water at indicated depth of well.
Type of lift: C, centrifugal; J, jet pump; N, none; P, piston pump (cylinder); S, submergible; T, turbine.
Production: Source of yield and drawdown data shown by D, from driller's report; M, measured; R, reported by source other than driller.
Use of water: F, fire protection; H, domestic; I, irrigation; N, industrial; P, public supply; S, stock; U, unused; use either observed or reported in Utah State Engineer's records of water-user's claim; in multipurpose wells, the use listed is the principal use according to claim.
Other data available: Chemical analysis in table 4 or 8 - C, complete; K, specific conductance measurement only; M, more than one analysis available; P, partial. D, driller's log; or G, geologic or sample log (table 6 for selected logs). W, periodic water-level measurements. Data from files of U.S. Geological Survey.

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	Type of lift	Production: Yield (gpm)	Production: Drawdown (ft)	Use of water	Other data available
(B-6-5)11bbc-1	Central Pacific Railroad Co.	1902	D	1/1,280	66	H	L	-	4,425	-	-	N	100	-	H	P,D
30bda-1	D. H. Adams	-	D	-	36	W	-	-	4,474	70M	11-70	N	-	-	U	-
(B-6-6)11baa-1	-	1957	C	216	8	P	-	-	4,340	134M	12-70	N	20D	9	U	D
11bba-1	-	1956	-	175	10	-	-	-	4,305	104M	12-70	N	80D	-	U	P,D
25dcb-1	Lake Crystal Salt Co.	1949	C	72	6	S	4G	-	4,220	-	-	-	12D	2	F	D
(B-7-5)4bba-1	A. D. Stokes	-	D	-	48	W	-	-	4,255	34M	11-70	P	-	-	U	-
4ccb-1	W. Jensen Estate	1903	-	-	-	-	-	-	4,235	10	1911	N	-	-	U	-
5ddd-1	Nick Chournos	1941	D	43	60	W	-	-	4,275	43M	11-70	P	-	-	U	-
(B-8-5)17dbb-1	F. A. Woodward	1914	D	-	-	-	-	-	4,235	-	-	-	-	-	H	-
17dbb-2	do.	1938	D	12	48	W	G	-	4,240	10R	11-41	-	-	-	S	D
28acb-1	W. Jensen Estate	-	D	30	10	W	-	-	4,242	-	-	P	-	-	S	-
28bbb-1	J. C. Flint	1912	C	36	48	P	-	-	4,237	16R	3-36	J	15R	2	I	W
28bbb-2	do.	1910	D	29	24	W	-	-	4,235	10R	-	C	75R	10	I	C
28bbb-3	do.	-	D	27	48	W	-	-	4,237	19M	11-70	N	-	-	U	-
33bcc-1	M. Nicholas	1910	-	153	6	-	-	-	4,360	142R	3-36	N	25R	3	U	-
(B-8-6)1abb-1	W. L. Flint	1970	C	470	8	P	L	Pzu	5,360	375R	9-70	S	5D	40	S	D
4ccb-1	Claude Staples	1958	-	158	-	P	G	-	4,217	+8R	12-58	T	1,700M	-	I	D
5dda-1	do.	1943	C	112	3	-	G	-	4,216	+8R	5-43	N	45M	-	S	K,D
(B-8-7)8ddc-1	King No. 3 State2/	1965		252	7	O	JI	Tsl	4,204	-	-	-	.1	-	U	-
17aba-1	Gulf No. 1 State3/	1964	-	3,505	8	-	-	-	4,194	-	-	-	-	-	U	-
(B-9-5)18cbb-2	J. G. Nicholas	1956	C	77	4	P	-	-	4,238	+6R	11-56	-	20D	-	S	D
18cbb-4	do.	1954	C	130	8	P	G	-	4,250	2R	5-54	T	330D	68	I	D
18cbd-1	do.	1956	C	84	4	P	R	-	4,239	+6R	11-56	-	12D	-	S	D
18ccb-1	do.	1956	C	138	12	P	R	-	4,255	14R	4-56	T	750D	40	I	D
19bcd-1	L. M. Richman	-	D	30	16	W	-	-	4,275	25R	3-56	N	10R	-	U	W
19bcd-2	do.	1956	C	65	8	X	HB	-	4,275	30R	8-56	J	60D	0	H	C,D
19cad-1	A. D. Stokes	1913	D	25	60	W	G	-	4,280	20R	3-36	-	10R	4	H	D
20ccc-1	D. J. Bitton	1969	C	226	6	P	G	-	4,220	+2R	5-69	-	30D	-	S	D
30aab-2	D. L. Wells	1916	D	14	72	W	-	-	4,250	11R	3-36	P	186R	2	I	-
30aba-2	L. M. Richman	-	D	25	14	W	-	-	4,260	20R	3-56	-	-	-	H	-
30baa-1	C. E. Tingey	1910	D	55	72	W	-	-	4,295	-	-	J	-	-	S	C
32cdd-1	W. L. Flint	1955	C	50	6	O	-	-	4,245	15R	9-55	J	36D	0	H	K,D
(B-9-6)1abc-1	Thiokol Chemical Corp.	1940	C	163	4	P	G	-	4,235	+21M	4-41	N	63D	-	I	M,D
1abc-2	do.	1940	C	198	4	P	G	-	4,235	+16R	12-40	N	95M	-	I	P,D,W
1aca-1	do.	1940	C	198	4	P	G	-	4,232	+24R	1940	N	-	-	U	D
1aca-2	do.	1944	C	196	4	S	G	-	4,232	F,R	-	S	220D	-	I	D
1aca-3	do.	1941	C	204	4	-	-	-	4,233	+23R	4-41	N	158M	-	I	M,D
1aca-4	do.	1940	C	184	4	P	G	-	4,233	+16R	11-40	N	77M	-	I	M,D
1aca-5	do.	1940	C	165	-	-	G	-	4,232	+25R	10-40	N	36M	-	I	M,D
1aca-6	do.	1941	C	202	4	-	G	-	4,233	+23R	5-41	N	112M	-	I	M,D
1aca-7	do.	1941	C	213	4	P	G	-	4,232	+13R	5-41	N	36M	-	I	M,D
1acb-1	do.	1941	C	204	4	S	G	-	4,235	+23R	5-41	N	104M	-	I	M,D
1acb-2	do.	1940	C	206	5	-	G	-	4,238	+21M	4-41	N	112M	-	I	M,D
1acd-1	do.	1940	C	193	4	-	G	-	4,232	+23R	8-40	N	105D	-	I	M,D
1acd-2	do.	1940	C	205	4	-	G	-	4,232	+17R	11-40	N	36M	-	I	M,D
1caa-1	do.	1940	C	161	4	P	G	-	4,238	+13R	8-40	N	53D	-	I	M,D
1cda-1	do.	1955	C	79	6	P	G	-	4,258	7R	-	-	30D	5	H	D
1dba-1	do.	1941	C	244	4	P	G	-	4,232	F,R	-	N	63M	-	I	M,D
1dbc-1	do.	1940	C	251	4	S	G	-	4,236	+20R	10-40	N	54M	-	I	M,D
1dcd-1	do.	1940	C	238	4	-	-	-	4,238	+14R	10-40	N	57M	-	I	M,D
12aac-1	do.	1940	C	234	4	-	G	-	4,238	+17R	7-40	N	87D	-	I	M,D
12aca-1	do.	1940	C	68	4	X	G	-	4,250	F,R	-	N	50D	-	U	D
12aca-2	do.	1941	C	126	4	-	G	-	4,245	+12R	3-41	N	22M	-	I	M,D
12acd-1	do.	1941	C	115	4	-	G	-	4,245	+13R	4-41	N	50M	-	I	M,D
12acd-2	do.	1941	C	106	4	-	G	-	4,245	+12R	3-41	N	75M	-	I	M,D
(B-9-6)12acd-3	Thiokol Chemical Corp.	1940	-	111	4	-	G	-	4,244	+12R	7-40	N	100D	-	I	M,D
12acd-4	do.	1940	C	116	4	-	G	-	4,245	+13R	-	N	30M	-	I	M,D
12acd-5	do.	1957	C	104	16	P	G	-	4,255	10M	12-70	T	1,050D	25	N	M,D,W
12dad-1	do.	1940	C	187	4	P	R	-	4,237	+16R	10-40	N	20M	-	I	M,D
12dbd-1	do.	1940	C	27	4	P	G	-	4,245	8R	10-40	-	8M	-	H	D
32cdd-1	Claude Staples	1943	C	27	3	-	G	-	4,220	6R	4-43	N	-	-	U	D
(B-9-7)5bcc-1	Swan Land and Livestock Co.	-	-	140	6	-	-	-	4,351	132R	9-45	-	10D	4	U	-
6dac-1	do.	1963	C	135	8	P	G	-	4,338	102M	10-69	P	22D	0	S	C,D,W
9acb-1	do.	1959	-	-	18	-	-	-	4,316	78M	10-69	T	470D	189	S	W
14abd-1	L. W. Keller Corp.	1963	C	212	6	-	5G	Tsl	4,401	166M	11-70	P	18D	-	S	D
16aaa-1	C. and J. Defton	1964	C	510	20	P	6R	-	4,289	75R	8-64	-	900D	165	I	D
16bcb-1	Swan Land and Livestock Co.	1945	-	85	6	S	G	-	4,288	53M	10-69	-	20D	2	S	D,W
28cd	-	-	D	50	72	-	-	-	-	-	-	-	-	-	U	G
32dbb-2	Swan Land and Livestock Co.	1951	C	56	4	P	I	Tsl	4,352	F,R	-	-	5M	-	S	D
(B-9-8)2bbd-1	do.	-	-	135	8	-	-	-	4,263	47M	11-69	P	-	-	S	W

Table 5.—Records of selected wells, cont.

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	Type of lift	Production: Yield (gpm)	Production: Drawdown (ft)	Use of water	Other data available
(B-9-8)14acc-1	Leonora Mining Co. and E. J. Raddatz	1929	C	2,280	8	-	-	Tsl	4,280	-	-	-	-	-	U	G
(B-10-5)6cdd-1	Claude Staples	1919	-	-	3	-	-	-	4,256	F,R	-	-	3R	-	S	-
7bac-2	M. H. Larsen	1968	C	81	8	O	2G	-	4,250	+3R	5-68	-	60D	-	I	D
7ddd-1	do.	-	-	-	-	-	-	-	4,233	F,R	-	-	-	-	S	-
18bcc-1	do.	-	-	-	-	-	-	-	4,230	F,R	-	-	-	-	I	-
(B-10-6)1adc-1	Claude Staples	1954	C	231	6	P	L	-	4,300	30R	4-54	N	300D	4	U	D
1adc-2	do.	-	-	82	18	-	-	-	4,300	35M	11-70	N	660R	57	U	-
1ddc-1	do.	1948	C	190	4	P	-	-	4,288	-	-	N	-	-	U	D
1ddd-1	do.	1948	C	337	4	P	-	-	4,274	-	-	N	-	-	U	D
4cdb-1	Lysle Wells	-	-	353	5	O	-	-	4,903	288R	2-36	N	5R	-	U	—
5ccd-1	J. F. Wells	1917	D	132	48	W	-	-	4,925	124R	-	N	20R	-	U	D
6ddc-1	L. E. Whitaker	1947	C	450	-	-	-	-	4,955	Dry R	-	N	-	-	U	D
9bbb-2	National Park Service	1967	C	423	6	F	6G	Tsl	4,907	378M	5-67	S	24M	19	P	C,G,W
12ada-1	Lloyd Poulsen	-	-	20	4	-	-	-	4,269	8M	12-70	-	-	-	I	-
13dbc-1	do.	1961	-	10	4	-	-	-	4,234	F,R	-	-	-	-	I	-
14daa-1	M. H. Larsen	1891	-	58	3	X	-	-	4,260	F,M	12-70	N	2R	-	S	C
19ddc-1	G. Hendricks	1969	C	43	6	O	-	-	4,975	Dry R	-	N	-	-	U	D
26dbb-1	F. E. Flint	1959	C	116	8	P	-	-	4,335	70R	9-59	J	18D	-	H	D
26ddd-2	do.	1945	C	70	6	S	G	-	4,285	28R	4-45	N	20D	4	U	D
26ddd-3	do.	-	-	164	8	-	-	-	4,290	-	-	-	-	-	U	P
26ddd-4	do.	1955	C	151	6	P	G	-	4,285	18R	9-55	-	25D	3	U	D
30cbb-1	-	-	-	192	6	-	-	-	4,855	Dry M	-	N	-	-	U	-
36bbb-2	T. K. Swan	1955	C	117	6	P	R	-	4,285	26R	10-55	-	30D	4	H	D
36bbb-3	do.	1954	C	205	8	P	U	-	4,290	27R	6-54	T	60D	5	I	D
36bcd-1	Thiokol Chemical Corp.	1960	-	107	12	P	R	-	4,287	-	-	T	175R	-	N	M,D
36ccb-1	do.	-	-	140	6	P	G	-	4,310	-	-	T	170R	5	N	M,D
36ccd-3	do.	1960	-	94	12	P	G	-	4,278	-	-	T	460R	6	N	M,D
36dcb-1	Perry Stanfill	-	-	-	3	-	-	-	4,238	F,M	12-70	-	5	-	I	M
(B-10-7)1daa-3	Wilford Johnson	1961	C	212	6	P	-	-	5,120	165R	12-61	-	10D	0	S	D
8ddd-1	O. C. Garn	1965	-	320	6	-	-	-	4,609	-	-	P	-	-	S	-
17acc-1	Utah Southern Oil Co.	1952	H	7,922	14	-	-	-	4,601	-	-	-	-	-	-	-
17cbc-1	O. C. Garn	1963	H	500	3	S	V	Tsl	4,555	-	-	-	3D	0	S	D
19ccc-1	Swan Land and Livestock Co.	1951	-	255	10	X	JI	-	4,369	140M	11-69	S	125D	14	S	D,W
25cac-1	L. W. Keller Corp.	1964	C	625	6	-	B	-	4,721	480R	-	S	9D	-	S	D
33bdc-1	do.	1969	C	540	16	P	6G	Tsl	4,395	-	-	-	450D	154	U	D
(B-10-8)13cbd-1	Swan Land and Livestock Co.	1963	C	286	12	P	2G	Tsl	4,456	235R	10-63	S	20D	0	H	P,D
26adb-1	do.	1937	-	154	4	O	-	-	4,338	25R	1945	P	65D	-	S	D
(B-11-5)31ddd-1	Ray Adams	1900	-	-	6	-	-	-	4,278	17M	9-70	-	-	-	S	-
35cbb-1	Thiokol Chemical Corp.	1962	C	420	10	P	L	Pzu	4,640	295R	10-62	-	195D	4	U	D
(B-11-6)21bcd-1	-	-	-	260	-	-	-	-	5,223	245R	1911	N	-	-	U	-
28abb-1	E. J. Cole Estate	1948	C	408	5	P	-	-	5,110	400R	9-48	-	-	-	U	D
29acd-1	W. I. Sandall	1900	-	-	-	-	-	-	5,120	-	-	-	-	-	S	-
30abc-1	D. W. Sandall	1917	-	323	4	O	V	Tsl	5,360	280R	3-36	-	10R	-	H	D
30dca-1	W. I. Sandall	1926	-	322	6	O	-	-	5,313	242R	2-36	P	11R	14	H	-
(B-11-7)24dda-1	do.	1968	C	190	8	P	C	Tsl	5,740	54R	9-68	-	6D	120	S	D
24ddb-1	do.	1956	-	100	5	O	G	-	5,768	57R	8-56	-	8D	0	S	D
26caa-1	M. V. W. Johnson	1912	D	26	4	-	G	-	5,300	20M	11-69	N	5R	-	U	-
34acc-1	R. J. Toombs	1942	T	10	3	H	V	Tsl	4,880	5R	6-42	N	2R	-	H	-
35bcd-1	W. B. Hendrix	1967	C	132	12	P	G	Tsl	5,079	49M	11-69	S	40D	2	H	D
35cbc-1	do.	-	-	-	12	-	-	-	4,968	76M	11-69	-	-	-	-	-
35cbd-1	do.	1968	C	290	12	P	-	-	5,030	-	-	-	-	-	-	D
36dad-1	W. I. Sandall	1933	-	322	6	-	-	-	5,286	49M	8-70	S	-	-	H	-

1/ Length of infiltration gallery.
2/ Oil (asphalt) well drilled by C. E. King under state lease.
3/ Oil test drilled by Gulf Oil Corp. under state lease.

Table 6.—Selected drillers' and sample logs of wells

Altitudes are in feet above mean sea level for land surface at well and are interpolated from U.S. Geological Survey 7½-minute topographic maps.
Thickness in feet.
Depth in feet below land surface.

Material	Thickness	Depth
(B-6-6)11baa-1. Log by M. L. Davis. Alt. 4,340 ft.		
Sand and gravel	10	10
Boulders	2	12
Clay	3	15
Boulders	2	17
Clay	2	19
Boulders, hard	4	23
Clay	7	30
Gravel, concreted	20	50
Gravel, concreted, and clay	30	80
Gravel and clay	16	96
Gravel, concreted	4	100
Clay and gravel, concreted, hard	4	104
Cobbles	5	109
Clay and gravel, concreted, hard	4	113
Boulders	4	117
Clay and gravel, concreted, hard	8	125
Boulders	7	132
Gravel and clay, concreted	8	140
Boulders	6	146
Gravel and clay, concreted	3	149
Boulders	3	152
Gravel and clay, concreted	6	158
Gravel and clay; water bearing	4	162
Clay	5	167
Boulders	4	171
Clay and gravel, concreted	10	181
Boulders	2	183
Clay and gravel, concreted	8	191
Boulders	2	193
Clay and gravel, concreted	10	203
Cobbles	3	206
Sand and gravel	5	211
Rock	2	213
Bedrock	3	216
(B-8-6)1abb-1. Log by R. J. Howell Drilling Co. and R. O. Denton and Son. Alt. 5,360 ft.		
Gravel	25	25
Clay and gravel	10	35
Gravel and boulders	22	57
Boulders and conglomerate	3	60
Clay and gravel	13	73
Rock ledge	8	81
Conglomerate	15	96
Solid rock, looks like granite with quartzite	27	123
Conglomerate	22	145
Limestone, brown	65	210
Limestone, brown and gray	90	300
Limestone, brown	40	340
Limestone, brown, and blue flint; water-bearing at 400-415 ft	75	415
Limestone, sandy, and blue flint; water-bearing	10	425
Conglomerate	2	427
Limestone, sandy-brown, and blue flint	23	450
Limestone, brown, and blue flint	20	470
(B-8-6)4ccb-1. Log by G. M. Kelley. Alt. 4,217 ft.		
Soil	8	8
Clay, blue	50	58
Gravel and fine blue clay	32	90
Gravel and brown clay	68	158
(B-9-5)18cbb-4. Log by T. J. Burkhart. Alt. 4,250 ft.		
Soil	2	2
Clay, sandy	15	17
Boulders, clay, and gravel. Small amount of water at 30-40 ft. Hole filled up with water at 70 ft	55	72
Gravel and some clay	49	121
Rock, hard, dark	9	130
(B-9-5)18ccb-1. Log by T. J. Burkhart. Alt. 4,255 ft.		
Gravel, clay, and boulders	12	12
Clay and gravel	12	24
Gravel, clay, and boulders	18	42
Sand and gravel; some clay	60	102
Gravel and boulders	6	108
Clay and boulders	16	124
Gravel, fine	2	126
Gravel and clay	22	148
Gravel; some clay	2	150
Clay or shale	2	152
Salty water at 148-150 ft; plugged well back to 138 ft.		
(B-9-5)19bcd-2. Log by T. J. Burkhart. Alt. 4,275(?) ft.		
Cellar	8	8
Gravel and some clay	44	52
Clay and gravel	6	58
Rock	7	65
Bailed only 5 gpm at 63 ft. Bailed 60 gpm without noticeable drawdown at 65 ft.		
(B-9-5)20cbc-1. Log by R. J. Howell Drilling Co. Alt. 4,220 ft.		
Clay, white lime	8	8
Clay, yellow	12	20
Mud, black, runny	60	80
Clay, gray	36	116
Mud, black	14	130
Clay, gray	10	140
Mud, black	10	150
Gravel and black mud	30	180
Clay, gray, sticky	23	203
Sand, quick	6	209
Gravel and black shale	26	235
Cased to 226 ft. Gas reported in interval 65-140 ft.		
(B-9-5)32cdd-1. Log by T. J. Burkhart. Alt. 4,245 ft.		
Pit	8	8
Boulders, gravel, and clay	17	25
Sand and gravel	3	28
Gravel and clay	2	30
Sand	9	39
Rock	5	44
Rock, with some gravel	6	50
(B-9-6)1acd-1. Log by J. V. and L. H. Stoddard. Alt. 4,232 ft.		
Soil	4	4
Hardpan	16	20
Clay	60	80
Sand; gas	20	100
Clay	20	120
Gravel	6	126
Clay	6	132
Gravel	32	164
Clay	4	168
Gravel	17	185
Hardpan	1	186
Gravel	7	193
(B-9-6)1dbc-1. Log by J. V. and L. H. Stoddard. Alt. 4,236 ft.		
Soil	3	3
Clay	3	6
Hardpan	24	30
Clay, soft	117	147
Gravel and clay, mixed	18	165
Clay	4	169
Gravel	17	186
Clay	14	200
Hardpan, streaks of	15	215
Gravel and clay	10	225
Gravel	26	251
(B-9-6)12aca-1. Log by D. G. Musselman. Alt. 4,250 ft.		
Soil	5	5
Clay, white	10	15
Clay, blue	17	32
Sand, black; water and gas	5	37
Clay, gray	3	40
Sand, black, and gravel; flowing water	13	53
Clay, yellow	4	57
Clay, red	3	60
Hardpan	1	61
Clay and gravel	4	65
Gravel, clean; flowing water	3	68
Bedrock reported at 68 ft.		
(B-9-6)12acd-5. Log by M. L. Davis. Alt. 4,255 ft.		
Clay and gravel	10	10
Sand and gravel	20	30
Clay, white	20	50
Gravel, cemented	10	60
Clay, sandy	10	70
Sand, hard	10	80
Clay	8	88
Rock, hard	4	92
Gravel; water	12	104
(B-9-7)14abd-1. Log by E. Q. Taylor and Siaperas Drilling Co. Alt. 4,401 ft.		
Clay and silt	12	12
Silt and pea gravel, dry	62	74
Clay, brown	22	96
Sandstone	36	132
Clay, sandy, and rock	23	155
Sandstone, hard	25	180
Gravel	5	185
Boulders	8	193
Bedrock	19	212
(B-9-7)32dbb-2. Log by R. Johnson. Alt. 4,352 ft.		
Clay	44	44
Sand	4	48
Lava	8	56
(B-9-8)14acc-1. Sample description by Slentz and Eardley (1956, p. 34-35). Alt. 4,280 ft.		
No sample	50	50
(B-9-8)14acc-1 - Continued		
Shale, white to buff, ashy, with pebbles of sandstone and quartzite	150	200
Silt, light-gray, ashy	30	230
Sandstone, permeable	20	250
Silt, as above	100	350
Shale, very light-gray, ashy	30	380
Sandstone	10	390
Shale, as above, locally laminated (Driller reported water)	220	610
Shale, with rounded pebbles of quartzite and limestone	100	710
Shale, dark-brown, very hard	10	720
Shale, gray, locally crystalline	110	830
Marl, very light-gray to green, interbedded with brown limy shale; marl grates into limestone	60	890
Shale, brown to pink, blocky	20	910
Shale, brown to gray, soft, silty	40	950
Marl or argillaceous limestone, white; gilsonite	30	980
Shale, white, bentonitic, with pebbles	100	1080
Shale, as above with oolites	10	1090
Marl, white, very argillaceous	30	1120
Shale, gray to tan, ashy, silty	60	1180
Graywacke, black to dull gray	70	1250
Shale, light tan, silty, interbedded with calcite	30	1280
Shale, gray, very soft, bentonitic	30	1310
Shale, gray, oolitic	110	1420
Shale, light to dark-brown, locally very silty	80	1500
Graywacke, as above	10	1510
Shale, white, hard, ashy, interbedded with graywackes and oolitic black shales	130	1640
Shale, black, flaky, carbonaceous material	20	1660
Graywacke, dark-green to black	10	1670
Shale, gray to brown, calcareous	110	1780
Mudstone, gray to white, very hard, interbedded with ash containing coal streaks	70	1850
Sandstone, black volcanic debris	50	1900
Sand, unconsolidated debris of andesite basalt, subrounded	240	2140
Shale, gray to gray-green, ashy, unconsolidated	140	2280
(B-10-6)1adc-1. Log by M. L. Davis. Alt. 4,300 ft.		
Clay	50	50
Sand	6	56
Clay and gravel	44	100
Sand	7	107
Clay	20	127
Sandstone	13	140
Sand and clay	8	148
Sand and gravel	8	156
Limestone, black	66	222
Sand and red clay	5	227
Sand, fine; water bearing	4	231
(B-10-6)1ddd-1. Log by Wasatch Drilling Co. Alt. 4,274 ft.		
Soil	2	2
Clay	24	26
Gravel; water bearing	6	32
Clay	33	65
Conglomerate	4	69
Clay	23	92
Hardpan	3	95
Clay	6	101
Conglomerate	3	104
Clay	1	105
Conglomerate	3	108
Clay	96	204
Hardpan	1	205
Clay	12	217
Hardpan	10	227
Clay	50	277
Sand; water bearing	1	278
Clay	10	288
Conglomerate	39	327
No record	10	337
(B-10-6)9bbb-2. Lithologic log (modified after driller's log) by Lester Binning. Alt. 4,907 ft.		
Top soil and clay, light brown	15	15
Clay, tan, and some small fragments of limestone	20	35
Clay, tan, silty	5	40
Clay, tan; some fragments of limestone and quartzite	20	60
Gravel, fine to medium, fairly well rounded; mostly limestone with some quartzite; some tan clay	5	65
Clay, tan; some fragments of limestone and quartzite	25	90
Clay, gravel, and boulders	5	95

Table 6.–Selected drillers' and sample logs of wells, cont.

Material	Thickness	Depth
(B-10-6)9bbb-2.--Continued.		
Gravel and boulders, mostly limestone; some calcium carbonate cement; some clay	5	100
Clay, tan, with fragments of limestone; some boulders	75	175
Clay and sand; very little gravel	10	185
Clay and sand; some gravel	15	200
Clay and sand; some gravel, soft, dry.	5	205
Clay, tan, and sand; some gravel fragments of mostly limestone	35	240
Gravel; some cobbles; very little clay; gravel and cobbles mostly limestone	5	245
Gravel and clay	5	250
Clay, grayish-brown, hard; some gravel fragments of mostly limestone	30	280
Clay, grayish-brown, soft, and sand	10	290
Clay and sand; some limestone fragments	25	315
Clay, tan, and sand, soft; very little gravel	15	330
Clay, tan; some gravel and cobbles	5	335
Gravel and boulders; mostly limestone.	10	345
Clay, gray, and gravel; mostly limestone, some quartzite	5	350
Clay, grayish-brown, with some gravel.	20	370
Gravel, fine to medium, mostly limestone with some quartzite; some gray clay	5	375
Gravel and clay; gravel mostly limestone	5	380
Gravel and some clay	5	385
Gravel, mostly limestone with calcium carbonate cement, some red and white quartzite; some volcanic tuff	8	393
Limestone, solid; yields warmer water than overlying gravel aquifer	30	423
(B-10-6)26dbb-1. Log by T. J. Burkhart. Alt. 4,335 ft.		
Gravel and clay	22	22
Rock ledges	13	35
Gravel, cemented; small amount of water	50	85
Rock ledges	38	123
Shale; caving into hole	183	306
Shale, dark, with quartzlike white specks	81	387
Shale, dark, extremely hard and creviced; salt water	3	390
Well produced 18 gpm at 106 ft; plugged back to 116 ft.		
(B-10-6)36bbb-3. Log by T. J. Burkhart. Alt. 4,290 ft.		
Clay and gravel	58	58
Boulders, sand, and gravel, with some clay	17	75
(B-10-6)36bbb-3--Continued.		
Boulders, gravel, and clay	29	104
Gravel and sand	24	128
Gravel and clay	58	186
Rock or boulders	13	199
Gravel	6	205
Gravel and clay	49	254
Gravel; salt water	6	260
Plugged hole back to 205 ft with clay and with cement plug at 205-218 ft.		
(B-10-6)36ccd-3. Log reported by Thiokol Inspector. Alt. 4,278 ft.		
Old dug well	17	17
Boulders and sand	38	55
Sand, hard, dark	5	60
Boulders	25	85
Gravel, water-worn	3	88
Gravel, cemented, and dark limestone	2	90
No record	4	94
(B-10-7)1daa-3. Log by Davis Drilling Co. Alt. 5,120 ft.		
Surface	10	10
Clay	30	40
Clay and gravel	40	80
Clay, white	20	100
Limestone	85	185
Clay, red	15	200
Rock, hard, blue	5	205
Gravel, coarse; water	7	212
(B-10-7)17cbc-1. Log by Intermountain Drilling Co. Alt, 4,555 ft.		
Soil	15	15
Gravel	30	45
Gravel, cemented	7	52
Clay	18	70
Sandstone	130	200
Shale, hard	80	280
Sandstone	35	315
Hardpan (marl?)	65	380
Sandstone and shale	120	500
Cased to 80 ft.		
(B-10-7)25cac-1. Log by Staperas Drilling Co. Alt. 4,721 ft.		
Clay and rock	30	30
Gravel	4	34
Granite, blue	46	80
Clay and limestone	95	175
Boulders	105	280
Rock, layers of	25	305
Rock and clay ledges	55	360
Mud	10	370
Rock	20	390
Gravel, boulders, and clay	10	400
(B-10-7)25cac-1--Continued.		
Lime(stone), hard gray	3	403
Clay, gray, lime boulders, and gravel	13	416
Clay, red, gravel, and boulders	5	421
Clay, gray, and gravel	9	430
Lime(stone), gray, and clay	45	475
Clay, red, gravel, and boulders	17	492
Clay, yellow, gravel, and boulders	7	499
Gravel	3	502
Lime(stone), gray, and flint; hard	8	510
Lime(stone), gray, flint, and clay streaks	35	545
Flint, gray and white, and gray clay	21	566
Lime(stone), gray, and flint; hard	11	577
Lime(stone), dark, gray, hard	21	598
Lime(stone), dark, gray, and brown clay streaks	6	604
Flint, gray and black, and gray limestone	14	618
Lime(stone), gray, and flint	7	625
Cased to 488 ft.		
(B-10-7)33bdc-1. Log by R. C. Denton. Alt. 4,395 ft.		
Clay, gray	25	25
Clay, yellow, and gravel	65	90
Clay, gray, and gravel	85	175
Clay, yellow, and gravel	25	200
Clay, gray, and gravel	10	210
Clay, yellow, and gravel; water	50	260
Gravel; water	10	270
Clay, yellow, and gravel	24	294
Gravel, yellow, and clay; water	11	305
Clay, yellow, and gravel	55	360
Clay, gray, and gravel; water	40	400
Clay, yellow, and gravel	65	465
Clay, white, and gravel	10	475
Clay, yellow, and gravel; water	45	520
Clay, white, and gravel; water(?)	20	540
(B-11-5)35cbb-1. Log by J. G. Lee. Alt. 4,640 ft.		
Clay	32	32
Clay and gravel	37	69
Conglomerate	7	76
Clay, boulders, and limestone	164	240
Limestone, gray, broken	55	295
Limestone, broken; water	125	420
(B-11-7)24dda-1. Log by M. Church Drilling Co. Alt. 5,740 ft.		
Conglomerate	58	58
Gravel; very small amount of water	2	60
Conglomerate	55	115
Gravel; water	1	116
Conglomerate	12	128
Gravel and conglomerate; water in thin strata	62	190

Table 7.—Records of selected springs

Altitude: In feet above mean sea level; interpolated from U.S. Geological Survey 7½-minute topographic maps.
Aquifer: Qa, Quaternary; Tsl, Salt Lake Formation; Pzu, Paleozoic rocks.
Discharge: E, estimated; M, measured; R, reported.
Use of water: H, domestic; I, irrigation; N, industrial; S, stock; U, unused; (a) spring improved for use indicated; for multipurpose springs, the use listed is the principal use according to claim.
Other data available: Chemical analysis in table 4 or 8 - C, complete; M, more than one analysis available; P, partial analysis. Data from files of U.S. Geological Survey.

Location	Name or owner	Altitude (ft)	Aquifer	Discharge (gpm)	Date measured	Temperature (°C)	Use of water	Other data available
(B-6-5)21aac-S1	Compton Spring	4,405	-	42M	Mar. 1967	21.0	H(a)	M
(B-7-5)9bbb-S1	Shaw Spring	4,230	-	10E	Nov. 1970	17.0	S(a)	K
15bcd-S1	H. S. Arthur	4,210	-	10E	Nov. 1970	16.5	S	K
15cba-S1	-	4,210	-	310E	Oct. 1963	25.0	U	P
15cdb-S1	-	4,210	-	3E	Nov. 1970	19.5	U	K
16aaa-S1	-	4,219	-	5E	Nov. 1970	-	U	K
16aad-S1	-	4,230	-	5E	Nov. 1970	15.5	U	P
20ddd-S1	South Maple Spring	5,520	Pzu	2M	Nov. 1970	9.5	S(a)	C
22bac-S1	H. S. Arthur	4,215	-	3E	Nov. 1970	18.5	S	P
22bdb-S1	-	4,217	-	3E	Nov. 1970	16.0	U	K
22bdb-S2	-	4,217	-	2E	Nov. 1970	18.0	U	K
22cac-S1	-	4,240	-	40E	Oct. 1963	16.5	U	K
22cdc-S1	-	4,240	-	-	-	19.5	U	P
27dca-S1	H. S. Arthur	4,215	Qa	5E	Nov. 1970	14.5	S	K
34bbb-S1	Miners Spring	5,240	-	4M	1926	-	S	-
(B-7-6)14bcc-S1	-	4,210	-	5E	Dec. 1970	16.0	S	K
15aca-S1	-	4,202	-	2E	Dec. 1970	-	S	-
15adb-S1	-	4,200	-	5E	Dec. 1970	13.0	S	-
23acc-S1	Squaw Spring 1	4,205	-	5E	Dec. 1970	16.5	S	C
(B-8-5)5caa-S1	V. S. Poulsen	4,235	Pzu	300E	Nov. 1970	20.0	I	K
5cdc-S1	do.	4,250	Pzu	220E	Mar. 1966	22.0	I	C
20dad-S1	Parsons Spring	4,238	-	20E	Nov. 1970	15.0	I	K
29cdc-S1	North Willow Spring	4,855	Pzu	1M	Oct. 1956	-	S(a)	K
(B-8-6)21cac-S1	Claude Staples	4,215	-	130E	Aug. 1963	-	S	P
21cdb-S1	do.	4,210	-	30E	Aug. 1963	-	S	K
(B-9-5)30aab-S1	D. L. Wells	4,235	-	220E	Dec. 1970	14.0	I(a)	C
32bbc-S1	Sweetwater Spring 2	4,230	-	5E	Nov. 1970	15.0	I	K
(B-9-6)1cdd-S1	Thiokol Chemical Corp.	4,255	-	2E	Dec. 1970	14.5	S(a)	K
2bac-S1	Maple Spring	4,720	Pzu	46M	Oct. 1963	-	N(a)	M
7cbd-S1	Mud Springs	4,738	-	3E	Nov. 1970	10.0	S(a)	C
1/9cbb	Spring area	5,400	-	-	-	-	S(a)	P
2/12dc-S	Sandall Springs	4,245	-	-	-	-	I(a)	M
31bda-S1	Claude Staples	4,233	-	670E	Aug. 1963	-	I(a)	P
(B-10-5)4dab-S1	Conner Land and Cattle Co.	4,255	-	-	-	-	S	K
4dd-S	do.	4,255	-	1,130M	Dec. 1970	15.0	S	K
11acc-S1	Fish Spring	4,250	Pzu	373M	Dec. 1970	17.0	S(a)	K
11daa-S1	Thiokol Chemical Corp.	4,260	Pzu	10M	Dec. 1970	16.5	S(a)	K
(B-10-6)23adc-S1	Card Spring	4,258	-	224M	May 1954	-	S(a)	-
3/32ddb-S	Spring area	5,900	Pzu	3M	Nov. 1970	-	S(a)	K
(B-10-7)23aab-S1	A. E. Whitaker	5,028	-	220R	-	-	S(a)	-
(B-11-7)27add-S1	-	5,075	-	1E	Nov. 1969	12.5	S(a)	K
34dbb-S1	Cedar Spring	4,885	Tsl	.5E	Nov. 1969	12.0	S(a)	P

1/ Location given is collection point for springs in NW¼ sec. 9. Water is piped as far north as location (B-10-7)16ddc (site of Rozel Station on former Central Pacific Railroad).
2/ Location of weir that measures combined flow of two springs.
3/ Water from two or more springs at this location is piped to stock troughs at location (B-10-6)30bcc.

Table 8.—Selected chemical analyses of water from wells and springs

Bicarbonate: c, contains some undetermined carbonate (CO_3).

Source of data: GS, analysis by U.S. Geological Survey; TC, reported by Thiokol Chemical Corp.

Local number	Date of sample	Sampling depth (ft)	Temperature (°C)	Silica (SiO_2)	Dissolved iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Sodium plus Potassium (Na + K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Residue at 180°C	Dissolved solids: Sum of constituents	Hardness as $CaCO_3$	Noncarbonate hardness	Specific conductance (micromhos/per cm at 25°C)	pH	Sodium-adsorption ratio	Source of data
				Milligrams per liter																					
Wells																									
1/(B-6-5)15bbc-1	6-21-58	800	-	16	-	60	35	-	-	68	290	0	53	100	-	6.9	-	-	480	290	56	896	8.0	17	GS
2/(B-6-6)11bba-1	6-21-58	175	-	15	-	150	140	-	-	1,700	230	0	540	2,700	-	6.2	-	5,400	5,400	950	760	8,580	7.8	24	GS
(B-8-6)28bbb-2	11-28-70	29	13.0	34	0.00	22	21	87	31	-	228	0	18	120	0.4	1.1	0.32	-	447	140	0	784	7.2	3.2	GS
(B-8-6)4ccb-1	8-28-63	158	-	-	-	-	-	-	-	-	-	-	-	620	-	-	-	1,290	-	230	-	2,390	-	-	GS
3/(B-9-5)19bcd-2	12- 3-70	65	-	50	.00	22	11	91	8.5	-	239	0	16	75	.2	3.8	.11	-	396	100	0	640	7.9	3.9	GS
3/30baa-1	12- 3-70	55	-	23	.00	75	16	47	3.2	-	241	0	24	80	.1	12	.04	-	399	250	52	700	7.7	1.3	GS
(B-9-6)1abc-1	11- -62	163	-	21	.16	12	6.0	300	-	-	221c	-	26	340	-	-	.18	759	-	55	0	-	8.4	18	TC
1aca-3	10- -62	204	-	11	.00	51	68	1,300	-	-	282	-	110	2,200	-	-	.05	4,270	-	410	180	-	8.1	28	TC
1aca-3	11- -62	204	-	19	.00	49	45	1,400	-	-	299c	-	110	2,200	-	-	.30	3,980	-	310	63	-	8.3	36	TC
1aca-4	11- -62	184	-	24	.07	41	30	470	-	-	263c	-	44	800	-	-	.14	1,600	-	220	9	-	8.4	14	TC
1aca-5	11- -62	165	-	21	.21	29	24	660	-	-	311c	-	49	1,000	-	-	.02	1,960	-	170	0	-	8.3	22	TC
1aca-6	10- -62	202	-	11	.09	40	48	920	-	-	277	-	81	1,600	-	-	.43	3,100	-	300	71	-	8.1	23	TC
1aca-6	11- -62	202	-	17	-	57	49	1,500	-	-	288c	-	96	2,100	-	-	.27	3,880	-	340	110	-	8.2	35	TC
1aca-7	11- -62	213	-	13	.00	110	200	3,200	-	-	271	-	250	5,600	-	-	.85	9,970	-	1,100	890	-	8.1	41	TC
1acb-1	11- -62	204	-	13	.00	62	65	1,200	-	-	213c	-	98	2,000	-	-	.21	3,840	-	420	250	-	8.3	26	TC
1acb-2	11- -62	206	-	11	.00	89	69	1,700	-	-	244c	-	130	2,800	-	-	.33	5,360	-	510	310	-	8.2	33	TC
1acd-1	11- -62	193	-	17	.00	15	12	540	-	-	335c	-	40	650	-	-	.18	1,360	-	87	0	-	8.4	25	TC
1acd-2	11- -62	205	-	19	.00	38	28	780	-	-	270c	-	54	1,200	-	-	.22	2,280	-	210	0	-	8.4	23	TC
1caa-1	10- -62	161	-	11	.03	17	10	110	-	-	276c	-	22	110	-	-	.09	490	-	84	0	-	8.3	5.2	TC
1caa-1	11- -62	161	-	13	.07	16	11	140	-	-	307c	-	24	100	-	-	.26	506	-	85	0	-	8.4	6.7	TC
1dba-1	11- -62	244	-	15	.00	58	83	2,000	-	-	296c	-	150	3,200	-	-	.50	5,760	-	490	240	-	8.3	38	TC
1dcb-1	11- -62	251	-	11	.11	41	41	1,600	-	-	312c	-	130	2,500	-	-	.35	4,480	-	270	15	-	8.4	44	TC
1dcd-1	11- -62	238	-	4.3	-	22	24	1,300	-	-	504c	-	130	1,900	-	-	.57	3,540	-	150	0	-	8.5	44	TC
12aac-1	10- -62	234	-	11	.12	10	6.0	550	-	-	396c	-	52	800	-	-	.35	1,840	-	49	0	-	8.7	34	TC
12aac-1	11- -62	234	-	15	-	4.0	2.0	310	-	-	390c	-	36	290	-	-	.32	856	-	18	0	-	9.0	32	TC
12aca-2	11- -62	126	-	13	.05	10	2.0	150	-	-	267c	-	21	120	-	-	.11	446	-	34	0	-	8.8	3.5	TC
12acd-1	10- -62	115	-	13	.05	20	6.0	89	-	-	206c	-	21	160	-	-	.30	378	-	76	0	-	8.2	4.5	TC
12acd-1	11- -62	115	-	15	.10	20	6.0	89	-	-	220c	-	19	100	-	-	.21	379	-	75	0	-	8.4	4.5	TC
12acd-2	11- -62	106	-	13	.02	23	7.0	86	-	-	218c	-	21	100	-	-	.13	369	-	86	0	-	8.4	4.0	TC
12acd-3	11- -62	111	-	-	.07	28	11	74	-	-	210	-	20	100	-	-	.10	394	-	120	0	-	8.1	2.9	TC
12acd-4	11- -62	116	-	13	.05	26	7.0	96	-	-	226c	-	21	120	-	-	.14	407	-	94	0	-	8.5	4.3	TC
12acd-5	10- -62	104	-	11	.03	28	8.0	73	-	-	218	-	21	110	-	-	.06	272	-	100	0	-	8.0	3.1	TC
12acd-5	11- -62	104	-	19	.02	34	11	84	-	-	229c	-	20	120	-	-	.18	411	-	130	0	-	8.2	3.2	TC
12acd-5	12- 3-70	104	-	15	.02	-	-	-	-	-	-	-	-	110	-	-	-	-	-	-	-	785	7.8	-	GS
12dad-1	10- -62	187	-	11	.07	22	6.0	110	-	-	218	-	16	120	-	-	.12	447	-	79	0	-	8.1	5.3	TC
12dad-1	11- -62	187	-	13	.03	21	6.0	120	-	-	238c	*	20	120	-	-	.21	424	-	78	0	-	8.3	6.0	TC
(B-9-7)6dac-1	11-25-70	135	13.0	-	.02	29	66	920	44	-	207	0	120	1,500	.6	1.8	.40	-	2,780	340	170	5,340	7.7	22	GS
4/(B-10-6)9bbb-2	5- 7-67	385	-	63	-	83	31	95	22	-	178	0	38	260	.8	4.2	.06	797	685	340	190	1,190	7.5	2.3	-
4/9bbb-2	5- 8-67	400	-	-	-	84	31	-	-	-	180	0	-	260	-	-	-	819	-	340	190	1,200	7.5	-	-
5/9bbb-2	5-31-67	423	22.5	-	-	-	-	-	-	-	177	0	-	260	-	-	-	837	-	340	190	1,190	7.4	-	-
5/9bbb-2	6- 2-67	423	21.5	66	.04	82	33	96	23	-	176	0	38	260	.8	3.8	.06	852	695	340	200	1,190	7.5	2.3	-
14daa-1	12- 3-70	-	14.5	50	.00	40	15	540	19	-	216	0	100	800	.8	3.3	.26	-	1,670	160	0	2,880	7.7	19	GS
26ddd-3	6-21-56	164	-	16	.17	96	38	500	13	-	246	0	74	850	.4	7.0	-	1,750	1,700	400	190	3,140	7.3	11	GS
36bcd-1	11- -62	107	-	26	.06	56	14	59	-	-	211	-	35	120	-	-	.06	558	-	200	24	-	8.0	1.8	TC
36ccb-1	11- -62	140	-	19	.03	52	9.0	56	-	-	241	-	30	120	-	-	.21	490	-	160	0	-	-	1.8	TC
36ccd-3	10- -62	94	-	15	.04	46	7.0	53	-	-	249	-	26	100	-	-	.08	520	-	140	0	-	8.0	1.9	TC
36ccd-3	11- -62	94	-	21	.03	47	11	56	-	-	385c	-	26	95	-	-	.17	446	-	160	0	-	8.3	1.9	TC
36dcb-1	10- -62	-	-	13	.03	9.0	3.0	143	-	-	329c	-	13	100	-	-	.12	496	-	35	0	-	8.5	11	TC
36dcb-1	11- -62	-	-	21	.00	10	4.0	160	-	-	354c	-	13	100	-	-	.19	508	-	42	0	-	8.7	4.1	TC
6/36dcb-1	12- 3-70	-	14.5	15	.00	-	-	-	-	-	-	-	-	200	-	-	-	-	-	-	-	1,050	7.8	-	GS
(B-10-8)13cbd-1	11-28-69	-	18.0	56	-	184	265	-	-	1,850	187	9	620	3,300	-	76	-	7,060	6,480	1,600	1,400	10,500	8.0	20	GS
Springs																									
(B-6-5)21aac-S1	3-16-67	-	21.0	13	-	81	36	440	9.8	-	242	0	76	750	0.4	3.0	0.12	1,520	1,530	350	152	2,660	7.7	10	GS
(B-7-5)15bcd-S1	10-16-63	-	16.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,110	-	-	-	3,700	-	-	GS
15cba-S1	10-16-63	-	25.0	-	-	-	-	-	-	-	-	-	-	13,100	-	-	-	24,900	-	3,100	-	34,400	-	-	GS
15cdb-S1	10-16-63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,130	-	-	-	10,100	-	-	GS
16aaa-S1	10-16-63	-	15.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,230	-	-	-	2,140	-	-	GS
16aad-S1	10-16-63	-	15.5	-	-	-	-	-	-	-	-	-	-	610	-	-	-	1,320	-	340	-	2,350	-	-	GS
20ddd-S1	11-28-70	-	9.5	12	0.00	59	36	29	2.7	-	325	0	29	42	.1	1.3	.05	-	371	300	34	648	7.7	.7	GS
22bac-S1	10-16-63	-	18.5	-	-	-	-	-	-	-	-	-	-	3,000	-	-	-	5,050	-	1,500	-	8,600	-	-	GS
22bdb-S2	10-16-63	-	17.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,900	-	-	-	6,650	-	-	GS
22cac-S1	10-16-63	-	16.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,390	-	-	-	4,170	-	-	GS
22cdc-S1	10-16-63	-	19.5	-	-	-	-	-	-	-	-	-	-	10,300	-	-	-	19,000	-	2,700	-	21,500	-	-	GS
(B-7-6)23acc-S1	12- 2-70	-	16.5	-	.00	32	20	290	14	-	184	0	67	420	.1	1.4	.17	-	933	160	9	1,680	7.6	10	GS
(B-8-5)5cdc-S1	3-23-66	-	22.0	15	-	92	54	1,180	43	-	246	0	176	1,950	1.0	5.0	.62	3,750	3,640	450	248	6,390	7.7	24	GS
(B-8-6)21cac-S1	8-28-63	-	-	-	-	-	-	-	-	-	-	-	-	730	-	-	-	1,490	-	250	-	2,760	-	-	GS
21cdb-S1	8-28-63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,590	-	-	-	2,860	-	-	GS
(B-9-5)30aab-S1	12- 3-70	-	14.0	30	.00	36	18	380	24	-	326	0	42	500	.4	4.0	.80	-	1,190	160	0	2,070	7.9	13	GS
(B-9-6)2bac-S1	11- -62	-	-	13	.03	42	7.0	40	-	-	241c	-	22	58	-	-	.09	347	-	130	0	-	8.4	1.5	TC
7cbd-S1	11-25-70	-	10.0	20	.03	74	22	93	2.1	-	304	0	71	120	.4	.4	.15	-	557	280	31	934	7.8	2.4	GS
7/9cbb	8-28-63	-	-	-	-	-	-	-	-	-	-	-	-	88	-	-	-	371	-	210	-	677	-	-	GS
8/12dc-S	11- -62	-	-	19	.03	32	10	74	-	-	229c	-	24	120	-	-	.09	434	-	120	0	-	8.2	2.9	TC
9/31bda-S1	8-28-63	-	-	-	-	-	-	-	-	-	-	-	-	1,400	-	-	-	2,620	-	620	-	4,700	-	-	GS
(B-11-7)34dbb-S1	11-28-69	-	12.0	56	-	230	92	-	-	202	214	0	131	760	-	16	-	1,910	1,600	960	780	2,740	7.8	2.8	GS

1/ Sampled at pipeline terminus at Promontory Point siding on Southern Pacific railroad.
2/ Sampled from water system at tap in medical aid building in construction camp.
3/ Sampled through pressure system near well.
4/ Sampled during drilling operations.
5/ Sampled during aquifer test.
6/ Water flowing from this well contained hydrogen sulfide (H_2S).
7/ Sampled from tap on pipeline at stock troughs at location (B-9-7)2bdb.
8/ Sampled at weir.
9/ Sampled at dam below spring pool.

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