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Hydrologic Inventory of the Great Salt Lake Desert Area

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HYDROLOGIC INVENTORY of the GREAT SALT LAKE DESERT AREA

DEVELOPING A STATE WATER PLAN - UTAH STATE UNIVERSITY - UTAH DIVISION OF WATER RESOURCES

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by

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PRWG40-7

ABSTRACT

The Great Salt Lake Desert, located in the southwest corner of the State of Utah, is a very dry region with sparse population and relatively small scattered areas of development.

Since only a meager amount of hydrologic data has been collected and compiled for this relatively undeveloped area, the inventory presented herein is but a general appraisal of hydrologic conditions.

Because of the small amount of development that has taken place and the general lack of hydrologic data, a water budget analysis is included for the Tooele Valley only.

ACKNOWLEDGMENTS

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INTRODUCTION

General

Utah, located in the arid southwest, is a state that experiences chronic water shortages. The pattern of valleys and high mountain ranges that exists in the state produces sharply contrasting differences in climatic conditions. Desert valleys in the western portion may receive as few as 4 inches of precipitation in a year while headwater areas in the Wasatch Mountains receive 60 inches or more. Wide cyclic as well as geographical variations of precipitation added to uneven seasonal distribution makes development and efficient utilization of water resources vital though difficult.

In order to make the most effective distribution and use of this precious water resource, the State of Utah is engaged in the preparation of a State Water Plan. The Utah Division of Water Resources, designated by the Utah Legislature to accept prime responsibility in this task, is cooperating with universities and other government agencies in this effort.

As a basis for planning and further development, an assessment of available water resources and the current stage of development is essential. To facilitate this assessment the area of the state has been divided geographically into several hydrologic study areas and sub-areas shown in Figure 1. The Division of Water Resources, the U.S. Geological Survey, the Utah Water Research Laboratory, and other organizations are cooperating in making hydrologic studies and reports for these areas. To provide for uniformity in this state-wide effort, the following general procedures have been established:

1. Review existing land use data for each hydrologic area and determine their adequacy for meeting the needs of the water planning program.
2. Conduct field land-use surveys for those areas where inadequate information is available in order to delineate the various land use categories for each hydrologic area and sub-area. Summarize the acreage data for use in the water budget studies.
3. For each sub-area, determine the quantity and quality of runoff. Also, assemble and prepare for computer processing relevant available data regarding the hydrology and climate of each area, together with appropriate maps and charts.
4. Investigate relationships between precipitation and runoff with respect to both time and space. In this regard, factors influencing runoff, such as physiography, geology, vegetative cover, slope, elevation, and aspect are evaluated.
5. Estimate all major depletions from the flow system of the area.
6. Prepare water budgets which account for the time and spatial distribution of the total water.

The hydrologic inventory presented herein pertains to the Great Salt Lake Desert Area lying in Tooele County and in portions of Box Elder and Juab Counties. The shaded portion of Figure 1 depicts the area and sub-areas included. Sparse population and widely scattered areas of development characterize this dry northwest region of the state. Because of the lack of hydrologic data for much of this relatively undeveloped region, only a rough appraisal of hydrologic conditions is possible.

Physiography

The Great Salt Lake Desert Area, shown in Figure 2, is in the northwestern quarter of Utah. It includes Tooele County, western Box Elder County, and a portion of western Juab County. It is part of the Great Basin and is characterized by mountain ranges separated by desert basins. As shown in Figure 3, the mountain ranges are of varied size, roughly aligned in a north-south direction, and are generally parallel (Wilson et al., 1968). The area is considered part of the Great Salt Lake Hydrologic Basin; however, some of the valleys do not drain into the Great Salt Lake.

During the Pleistocene geologic period the whole of the area below elevation 5,150 feet was submerged under Lake Bonneville. After Lake Bonneville had receded from its 5,150 foot surface elevation to an elevation of 4,750 feet, many bars, beaches, and deltas were formed as a result of erosion and runoff into the lake (Wilson et al., 1968). The water flowing into Lake Bonneville evaporated over tens of thousands of years, leaving all the salts in the basin (Feth, 1966). The Great Salt Lake is the remaining portion of Lake Bonneville.

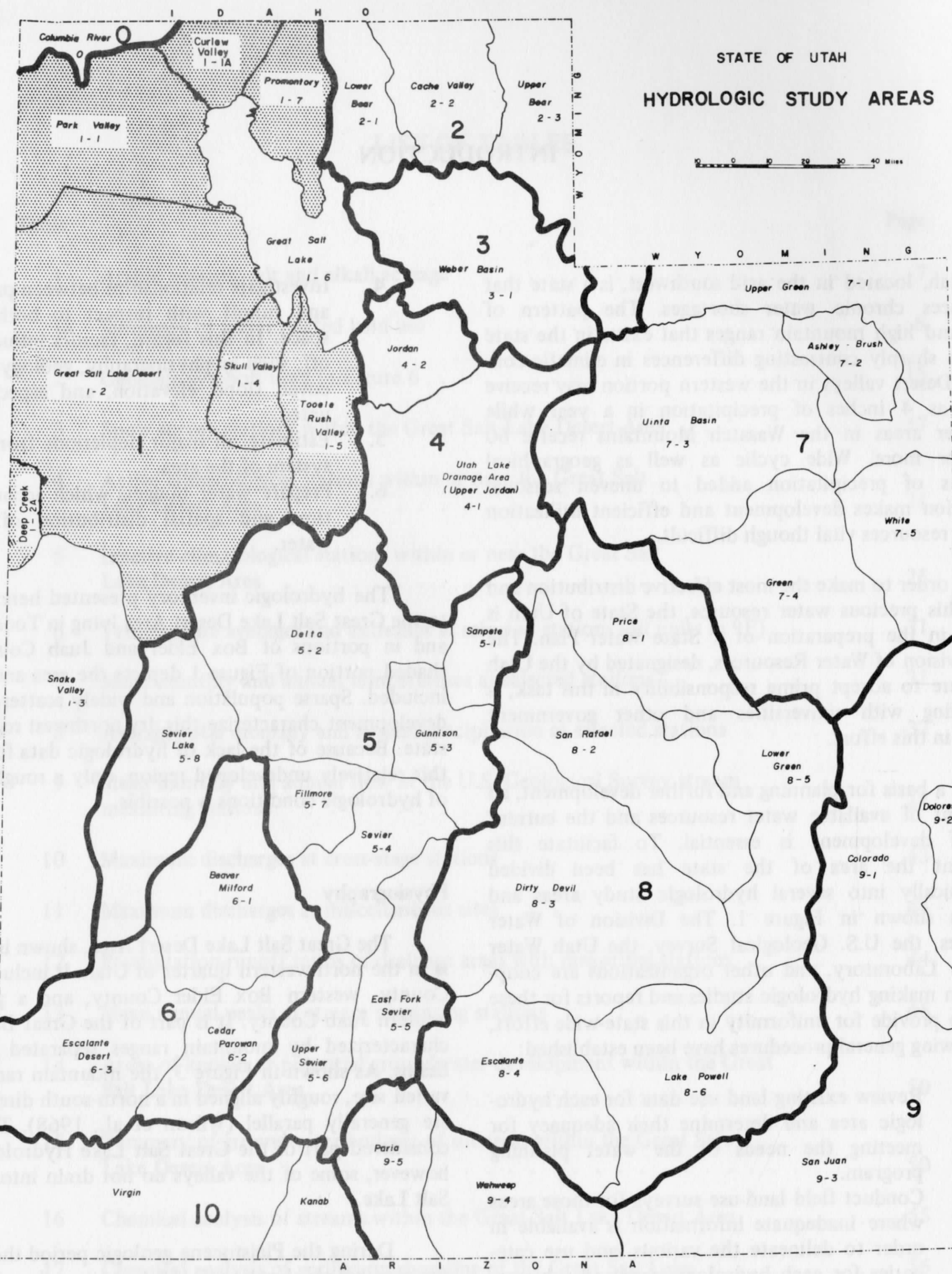
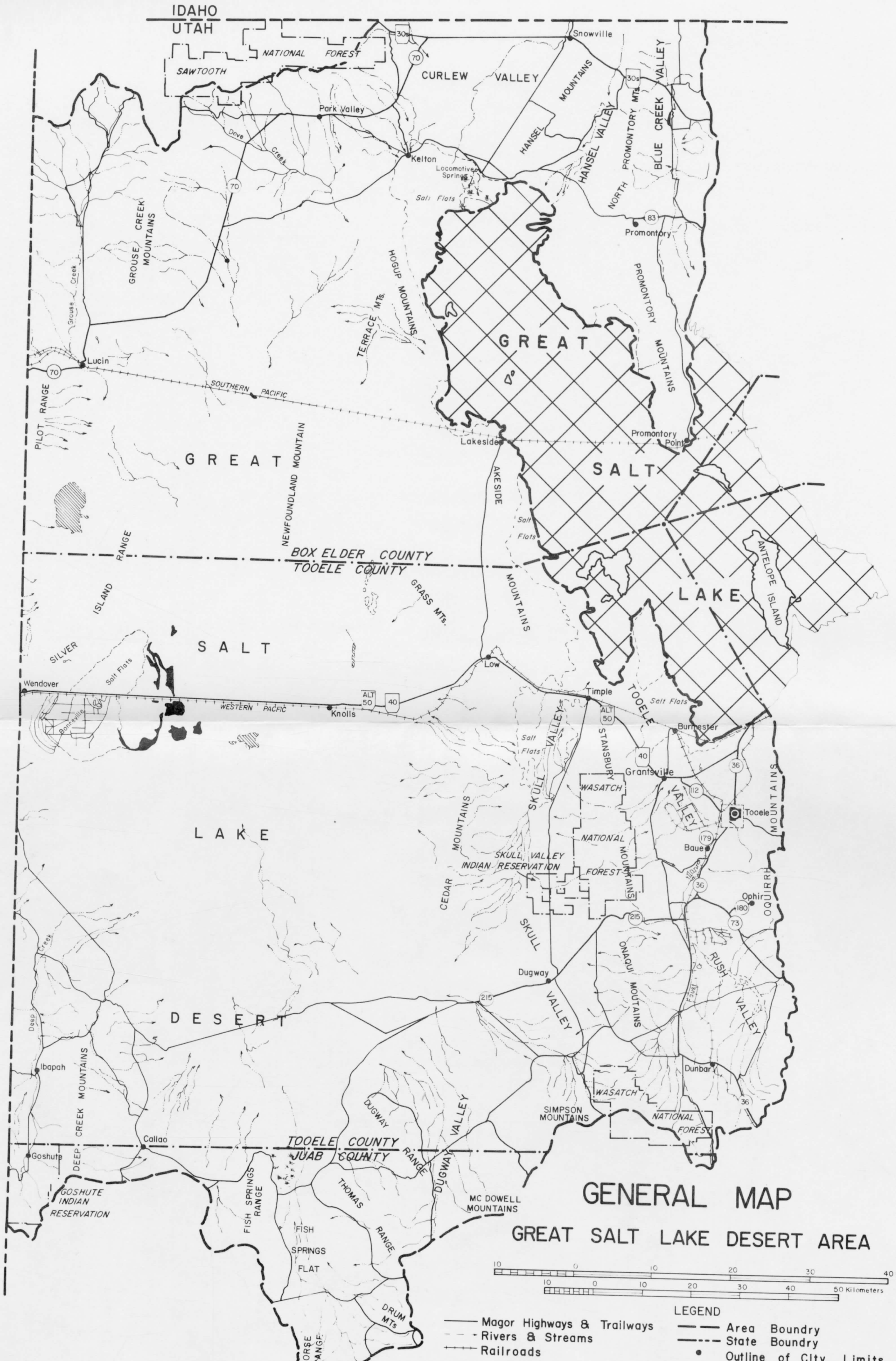


Figure 1. Hydrologic study areas in the State of Utah.

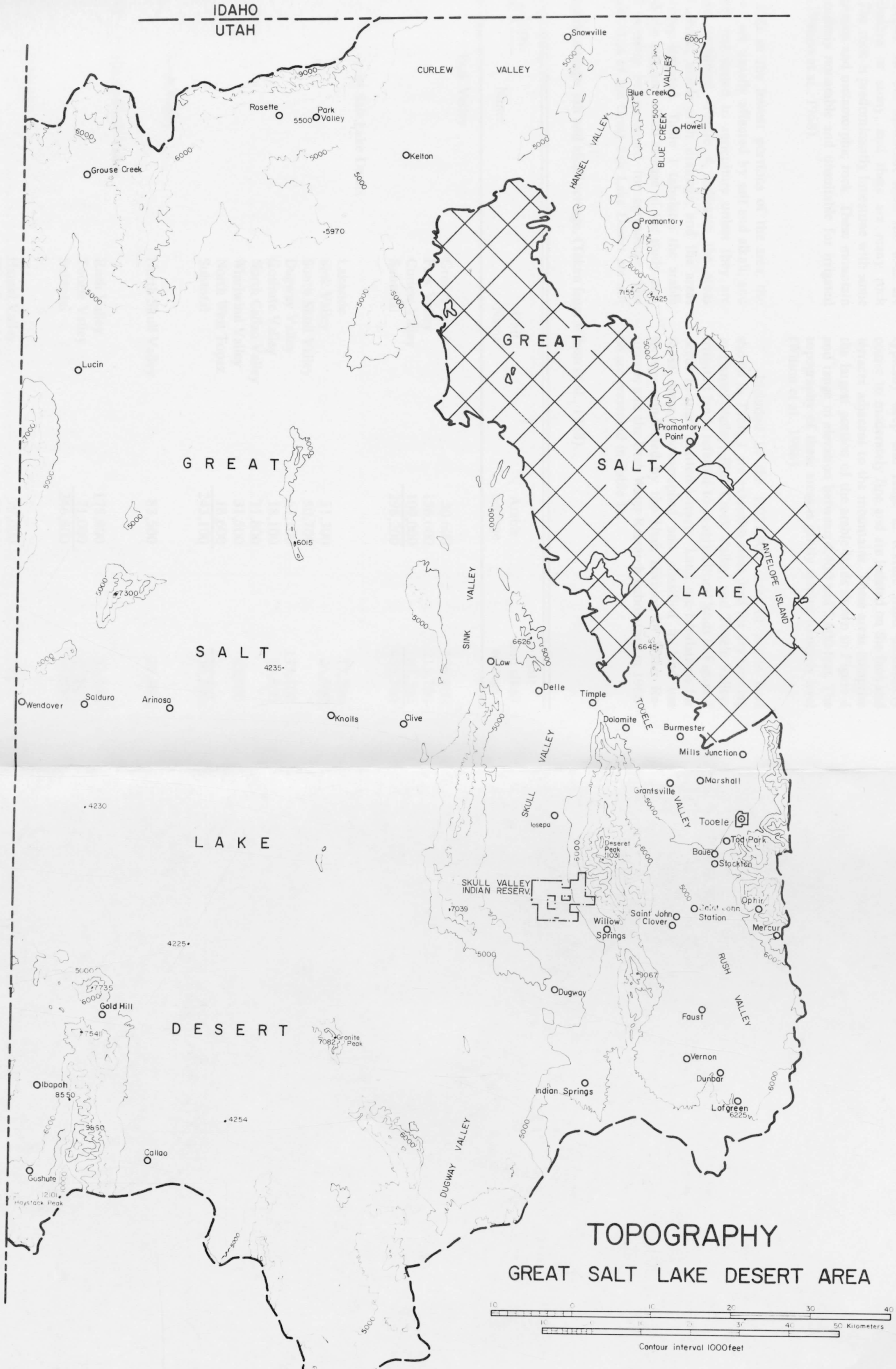
Figure 2. General map of the Great Salt Lake Desert Area.



GENERAL MAP

GREAT SALT LAKE DESERT AREA

Figure 3. Topography of the Great Salt Lake Desert Area.



TOPOGRAPHY
GREAT SALT LAKE DESERT AREA

The vegetation on the lower elevations of the desert mountains consists of grasses and shrubs with Piñon Pine, and Juniper on the north and east facing slopes. At higher elevations Douglas Fir and Ponderosa Pine occur on the northern slopes. In the mountain areas the soils are typically shallow or stony, and there are many rock outcrops. The rock is predominantly limestone with some areas of igneous and metamorphic rock. These mountain areas are entirely nonarable and unsuitable for irrigated agriculture (Wilson et al., 1968).

The soils in the lowest portions of the area, the valley floors, are usually affected by salt and alkali, and are generally not suited to agriculture unless they are drained and reclaimed. Figure 4 indicates the areas considered arable, arable with drainage, and the areas presently being irrigated. Table 1 tabulates the arable acreage and the salt and alkali acreage of the study area that could possibly be reclaimed for agriculture. The extensive salt flats of the Great Salt Lake Desert are not included in Table 1 due to the prohibitive costs involved in reclaiming the salt flats for agriculture.

The soils that are best suited for irrigation are typically deep and range in texture from moderately coarse to moderately fine and are located on the fans and terraces adjacent to the mountains. These areas comprise the largest portion of the arable lands shown in Figure 4 and range in elevation between 4,400 and 5,600 feet. The topography of these areas is gently sloping to nearly level (Wilson et al., 1968).

Included in the 1,027,900 acres of arable land shown in Table 1 are extensive areas used for dry farming in Hansel Valley, Blue Creek Valley, and Tooele Valley. Irrigated lands referred to as agricultural lands in Figure 4 occur in small scattered tracts. Land use tabulations for those areas, photographed and classified in land use surveys conducted by the Utah Division of Water Resources and the Utah Water Research Laboratory in 1966-68 are presented in Table 1a.

Table 1. Arable acreage, salt and alkali acreage. (Taken from Wilson et al., 1968).

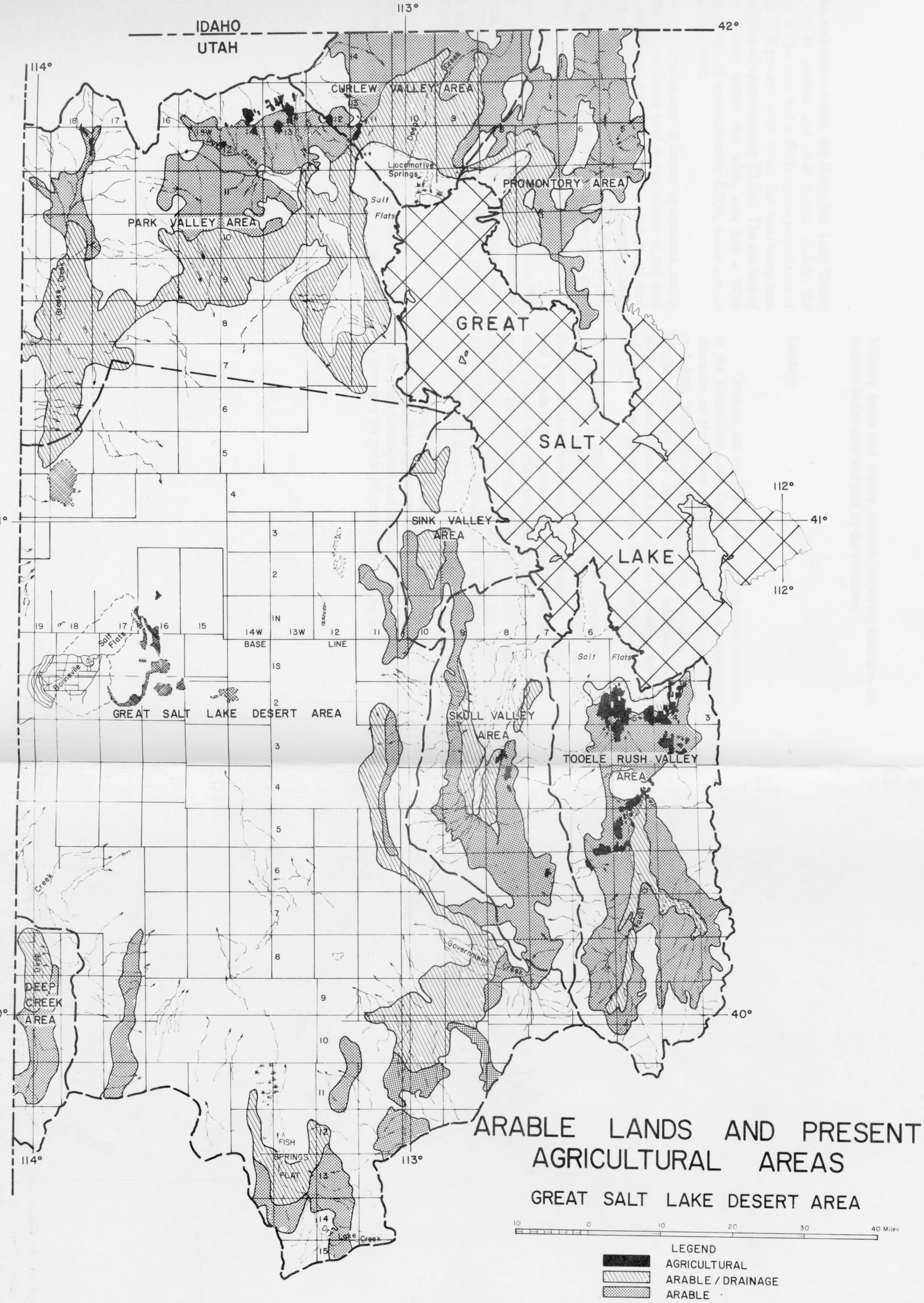
Hydrologic subarea No.	Name	Unit Name	Arable acreage	Salt and alkali acreage
1-1	Park Valley			
		Grouse Creek	30,600	156,400
		Park Valley	156,600	215,700
		Curlew Valley	109,000	87,200
		Subtotal	296,200	459,300
1-2	Great Salt Lake Desert			
		Lakeside		17,200
		Sink Valley	51,300	26,500
		South Skull Valley	50,700	
		Dugway Valley	61,100	133,100
		Goshute Valley	18,100	10,600
		North Callao Valley	11,800	
		Whirlwind Valley	31,500	42,900
		North West Topaz	18,600	
		Subtotal	243,100	230,300
1-4	Skull Valley			
		North Skull Valley	83,500	31,600
1-5	Tooele-Rush Valley			
		Rush Valley	175,800	37,500
		Tooele Valley	71,000	26,500
		Subtotal	246,800	64,000
1-7	Promontory			
		Hansel Valley	79,000	29,500
		Blue Creek Valley	79,300	
		Subtotal	158,300	29,500
		TOTAL	1,027,900	814,700

Table 1a. Summary of water related land use. Information from survey by Utah Division of Water Resources and Utah Water Research Laboratory in 1966-68. (All units in acres.)

Classification							
Symbol	Description	Tooele V.	Raft River D. Box Elder County	Skull V.	Curlew V.	Park V.	Rush V.
A	Irrigated Cropland						
A 1	Alfalfa	4,173	391	517	1,366	1,030	904
A 2	Pasture	6,991	0	5	0	40	475
A 3	All other hay	603	791	9	136	2,513	95
A 4	Grain	803	439	139	321	112	270
A 5	Corn	261	0	0	0	0	0
A 6	Sugar Beets	0	0	0	0	0	0
A 7	Potatoes	5	0	0	0	0	0
A 8	Orchard	14	0	0	0	0	0
A 9	Peas	0	0	0	0	0	0
A 10	Tomatoes	0	0	0	0	0	0
A 11	Small truck	7	0	0	24	0	0
A 12	Idle land	559	106	61	78	99	557
A 13	Beans	0	0	0	0	0	0
A 14	Other	1,755	0	0	0	2	1,511
A	Subtotal	15,171	1,727	731	1,925	3,796	3,812
B 1	Open Fresh Water Surfaces	3,662	837	1,287	1,167	1,820	1,531
C	Phreatophytes & Native Veg.						
C 1	Very Dense	0	0	20	0	0	0
C 2	Dense	2,591	0	5,791	43	0	48
C 3	Medium	3,675	0	12,017	0	69	453
C 4	Light	2,248	5	10,925	1,405	1,014	49
C 5	Native Veg. (receives precip. only)	90,677	31,699	49,757	70,799	86,579	66,861
C	Subtotal	99,191	31,704	78,510	72,247	87,662	67,411
D	Urban, Yards, Roads, etc.	7,934	667	1,176	805	1,581	1,844
E	Dry Farmland						
E 1	Grain	0	60	0	0	0	0
E 2	Alfalfa	0	0	0	0	0	0
E 3	Grasses (cult.)	11,984	1,404	297	4,848	3,395	4,964
E	Subtotal	11,984	1,464	297	4,848	3,395	4,964
	TOTAL	137,942	36,399	82,001	80,992	98,254	79,562

igure 4. Arable lands and present agricultural areas in the Great Salt Lake Desert Area. (The information for arable areas and arable areas with drainage was taken from Wilson et al., 1968. That for irrigated agricultural areas was obtained from land use surveys performed by the Utah Water Research Laboratory and the Utah Division of Water Resources during the summers of 1966 and 1968.)

TOTAL	137,942	36,399	82,001	80,992	98,254	[illegible]



Economy

Cities and towns within the Great Salt Lake Desert Area are few in number and small in size. Tooele, the largest city in the area had a 1970 census population of 12,539, up 20.6 percent since 1960. The total study area has a population of approximately 23,500. The portion of Box Elder County within this study area had a 1970 census population of approximately 1,700, down almost 20 percent since 1960.

Economic development is largely agricultural, and is sparsely distributed. Some land in the valleys of the area has been developed for the cultivation of crops and livestock production. Due to the prevalent aridity, farms and ranches are generally widely separated and agricultural development is considerably less than in other parts of the state.

Tooele County located almost entirely within the Great Salt Lake Desert study area, has an estimated 501,000 acres of arable land. Included are 80,000 acres of cropland, 29,000 of which are non-irrigated. In the portion of Box Elder County located in the study area, only 5,721 acres are irrigated out of an estimated 454,000 arable.

Mining and mineral processing have been smaller, but important, portions of the economy of the area. Military bases and testing grounds requiring isolation are located in the area and add to the economy.

Geology

Geology has an important effect on water resources in the Great Salt Lake Desert Area. The non-absorptive character of the desert mountains results in rapid runoff and high peak flows. The absorptive character of the alluvial fans and the desert results in retention of the water, via percolation and storage, thus providing recharge of groundwater basins to sustain late summer flows.

Figure 5 illustrates the areas representing four distinct geologic periods; Quaternary, Tertiary, Proterozoic, and Paleozoic. A comparison of Figures 3, 4, and 5 leads to the generalization that the higher mountain ranges are of the Paleozoic and Tertiary periods and are generally not considered arable. The present topographic features of the areas designated arable are largely the result of erosion and sedimentation in recent (Quaternary Period) geologic times.

Data for Figure 6 and Table 2 were obtained from the Geologic Map of Northwestern Utah, 1963, prepared by the Utah Geological and Mineralogical Survey. Figure 5 is a summary by geologic period of the same data.

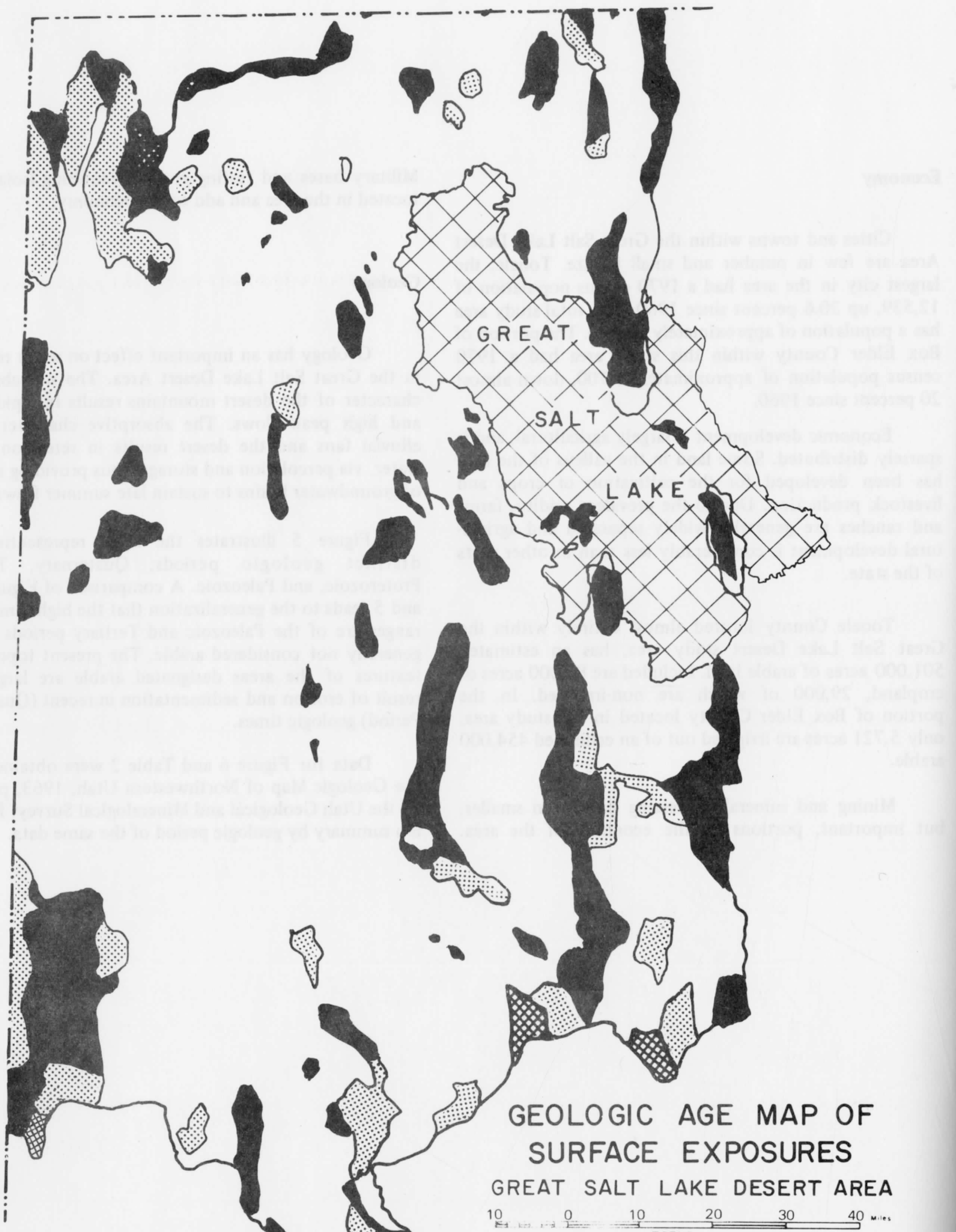


Figure 5. Geologic age map of surface exposures, Great Salt Lake Desert Area. (Generalized from the Geologic Map of Northwestern Utah, 1963, prepared by the Utah Geological and Mineralogical Survey.)

igure 6. Geologic map of the Great Salt Lake Desert Area. (Taken from the Geologic Map of Northwestern Utah, 1963, prepared by the Utah Geological and Mineralogical Survey.) See Table 2 for legend of geologic symbols.


IDAHO
UTAH
GREAT SALT LAKE
GEOLOGIC MAP
GREAT SALT LAKE DESERT AREA
10 0 10 20 30 40 Miles
LEGEND
Faults
Geologic area lines

Table 2. Geologic symbols used in Figure 6.

QUATERNARY PERIOD	
Sedimentary Rocks	
Qa,Qas	Alluvial surfaces; mostly sloping and well drained with soil profile suitable for crops. Mostly not stony
Qag	Colluvium and alluvium; mostly stony and unfit for agricultural crops
Qgs	Gravel surfaces; mainly terraces and pediments undergoing erosion
Qds,Qdg	Dunes; siliceous, gypsiferious respectively.
Qlcs	Lake bed sediments, mostly clay with very flat surfaces, permanently moist with high salt content
Qlc	Lake bed sediments, mostly dry clay or dust
Qlsa	Lake bed with permanent salt crust
Qltg	Constructional lake shore features (terraces, spits and bars); gravelly
Qm	Marshland, mostly freshwater but some salty or brackish
TERTIARY PERIOD	
Sedimentary Rocks	
TQu	Tertiary and Quaternary deposits and surfaces of uncertain age generally brownish and conglomeratic.
Tsl,Teu	Salt Lake Formation or Group; continental sandstone, shale, marlstone, silt, and pyroclastic rocks.
Igneous	
T_2bf	Late tertiary basalt and basaltic andesitic
T_2ap	Late tertiary andesite-trachyte-latite pyroclastics
T_2rp	Late tertiary rhyolite-dacite-quartz latite pyroclastics
T_1af	Early tertiary andesite-trachyte-latite flows
T_1ap	Early tertiary andesite-trachyte-latite pyroclastics
Intrusive Rocks	
Tig	Tertiary granitoid rocks
PALEOZOIC ERA	
Sedimentary Rocks	
Ppc	Park City Formation: chert, phosphorite, limestone and shale
Sl	Lake Town Dolomite: Light gray to black dolomite, chiefly massive and medium grained
Pdc	Diamond Creek Sandstone: Light-colored, cross-bedded, sandstone
Ppo	Oquirrh Formation or Group: Quartzite, limestone, dolomite, sandstone and shale
Mgb	Great Blue Limestone: Pure and cherty limestone, light to dark gray
Cun	Cambrian undivided: Chiefly limestone
Cuu	Upper Cambrian undivided: Limestone and dolomite
Cmu	Middle Cambrian undivided: Chiefly Maxfield and related limestones
Ct	Tintic Quartzite: white pink and yellow, relatively pure quartzite and sandstone, some conglomerate. Lower Cambrian
Mc	Chainman Shale: Very dark gray to black shale, with fetid carbonate beds and lenses of sandstone. Mississippian
Dg	Guilmette Formation: Chiefly cliff-forming limestone
Op	Pogonip Formation or Group: Limestone, silty limestone, olive shale and intraformational conglomerate
Cpm	Prospect Mountain Quartzite: Mostly white to brownish-red quartzite, some phyllite
Pun	Permian rocks undivided
Pcr	Rex Chert Member: Dark chert or cherty mudstone
Pp	Pequop Formation: Light colored limestone, fine grained standstone and reddish siltstone, locally with evaporites
Ppu	Permian and Pennsylvania Formations undivided
Mom	Ochre Mountain Limestone: Thick-bedded, massive, locally cherty limestone
PROTEROZOIC ERA	
Precambrian Rocks	
PCdc	Dove Creek Formation: Quartzite, schistand limestone
PCh	Harrison Formation: Quartzite, schist and dolomite
PCsr	Undifferentiated metasedimentary rocks, chiefly argillite and quartzite
PCs	Argillite, "tillite" and metaconglomerate
Intrusive Rocks	
PCi	Undifferentiated Precambrian intrusive rocks, chiefly granitic

CLIMATE

Data network

Perhaps the two most important meteorologic elements which characterize the climate of any region are temperature and precipitation. Neither are independent variables since both are dependent upon solar radiation, topography, elevation, position upon the earth, and perhaps other undefined phenomena. Because of the complex system of interdependence, most meteorologic elements are treated as random variables and an understanding of the phenomena is derived by studying the historical occurrence of the variable.

Temperature and precipitation data for the Great Salt Lake Desert Area have been recorded for more than 100 years. One station at Corinne located just outside the boundary of the area has continuous data for 100 years. Most of the stations, however, have short, intermittent records, and many stations have been discontinued. Most of the stations are located in the valleys. In recent years a few snow measurement stations have been established in the higher mountain regions. The snow measurement stations record data only during the winter season, but they are helpful in predicting runoff. The snow measurement stations are shown in Figure 7 and are listed in Table 3.

Table 3. Snow survey stations within the Great Salt Lake Desert Area.

No.	Station Name	Elevation	Beginning date of record
12J2	Bevan's Cabin	6,450	1954[a]
12J5	Deseret Peak	9,250	1965[b]
12J3	Middle Canyon	7,000	1954[a]
12J1	Rocky Basin Settlement Canyon	8,900	1954[a]
12K2	Vernon Creek	7,500	1961[b]

[a]Measurements taken monthly January through May. The January and February readings are not complete.

[b]Measurements taken monthly through the winter and accumulative through the summer.

More data, particularly in mountain areas, are needed to better determine the areal distribution of precipitation and temperature. More data are also needed for the study and definition of the frequency, size, and duration of the localized cloudburst-type storms which occur in the Great Salt Lake Desert.

Much of the data collection in the past was oriented toward resolving then current problems, such as those related to local irrigation or domestic supplies. Data are now needed to provide a firm basis for planning of coordinated development for a variety of needs.

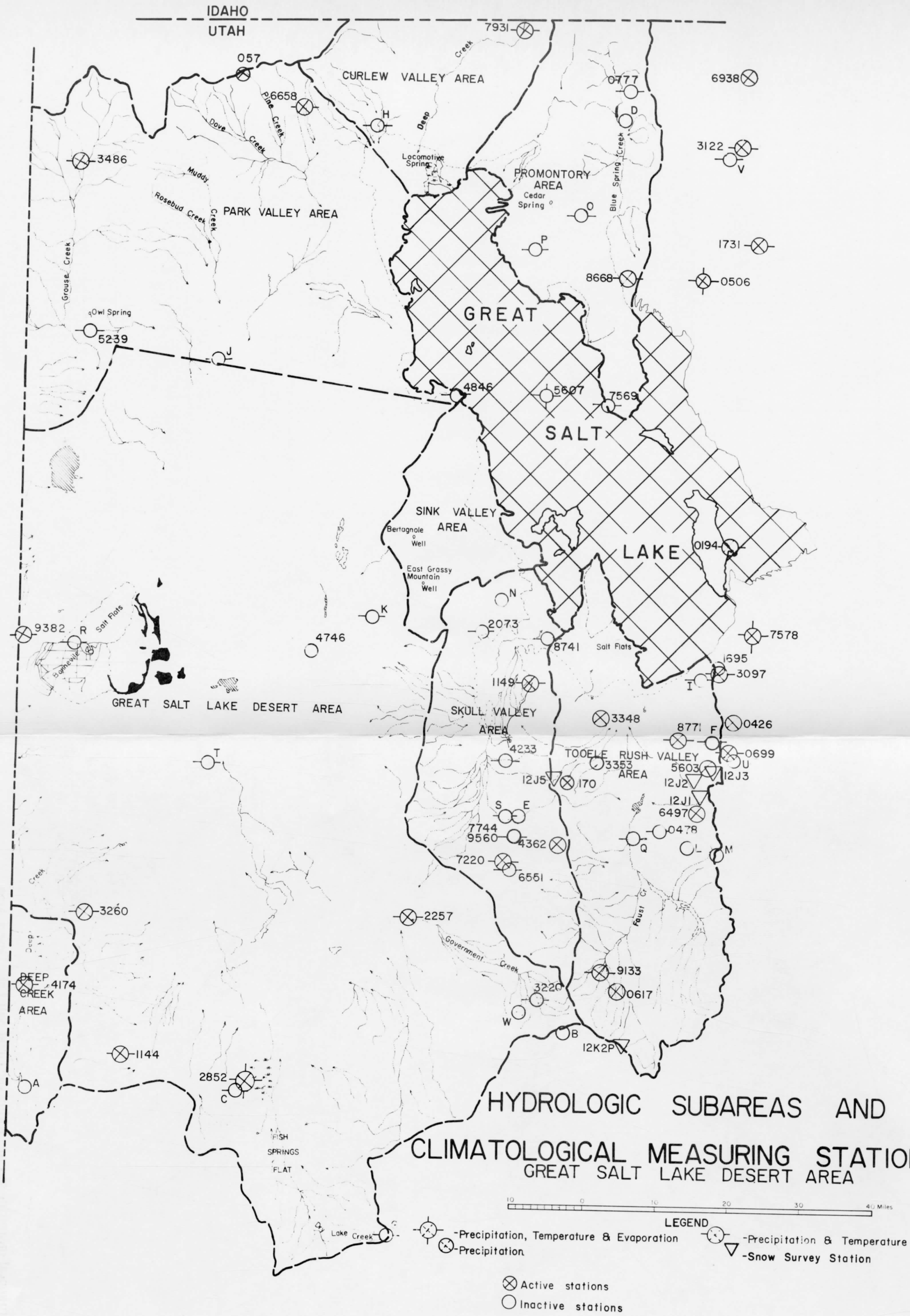
The location of temperature and precipitation stations within and adjoining the study unit is shown in Figure 7. A listing of these stations, including the periods of record, is given in Tables 4 and 5. The data used in this report consist of mean monthly temperature and precipitation measurements. Stations presently being monitored, are listed in Table 4. Table 5 gives the period of record of stations that are no longer being monitored but for which data are available from the U.S. Department of Commerce's climatic summaries.

Temperature

The arable areas within the study area, ranging in elevation from 4,400 to 5,600 feet, represent 18 percent of the state's arable lands. The average frost-free period for the arable areas varies from about 90 to 160 days (Wilson et al., 1968).

There is a wide range (120° to 130°F) between the high and low temperature extremes for the year. The average monthly maximum temperature, the average minimum monthly temperature, the mean monthly temperature, and the highest and lowest recorded temperature during the month are shown in Table 6 for three selected stations. The annual averages of each of these categories are also given.

Figure 7. Hydrologic sub-areas and climatological measuring stations within the Great Salt Lake Desert Area.



HYDROLOGIC SUBAREAS AND CLIMATOLOGICAL MEASURING STATIONS
GREAT SALT LAKE DESERT AREA

Table 4. Active climatological stations within or near the Great Salt Lake Desert Area.

Table 4. **Active climatological stations within or near the Great Salt Lake Desert Area.**

Station Number	Station Name	Type of Station	Periods of Record
0194	Antelope Island	Precip. & Temp.	
0426	Barney Canyon	Precip.	
0506	Bear River Refuge	Precip., Temp. & Evap.	
0617	Benmore	Precip.	
0699	Bingham Canyon	Precip. & Temp.	
1134	Callao	Precip. & Temp.	
1149	Callister Ranch	Precip. & Temp.	
1731	Corinne	Precip. & Temp.	
2257	Dugway	Precip. & Temp.	
2852	Fish Springs Refuge	Precip., Temp. & Evap.	
3097	Garfield	Precip. & Temp.	
3122	Garland	Precip. & Temp.	
3260	Gold Hill	Precip. & Temp.	
3348	Grantsville	Precip.	
3486	Grouse Creek	Precip. & Temp.	
4174	Ibapah	Precip. & Temp.	
4362	Johnson Pass	Precip.	

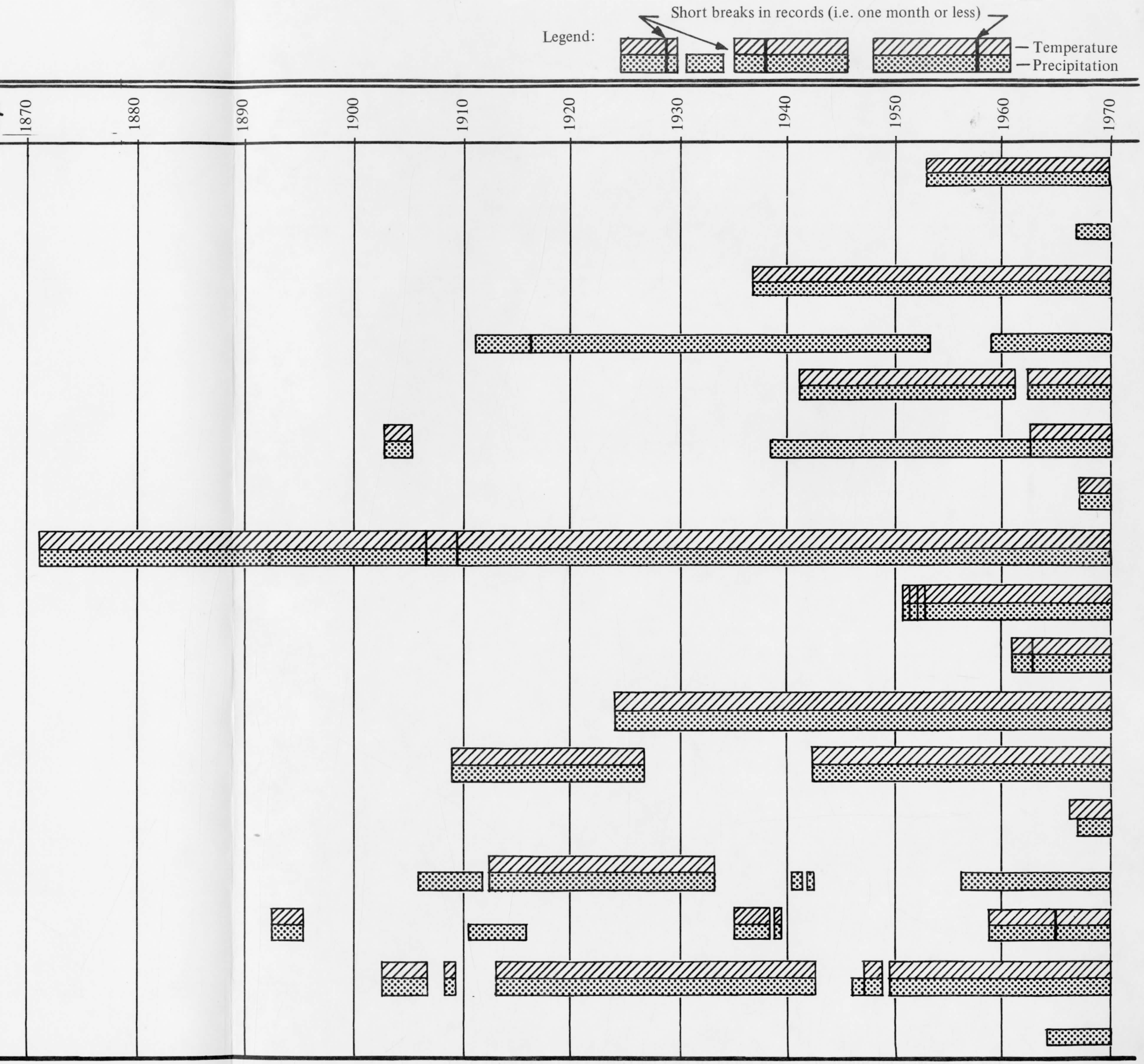


Table 4. Continued.

Table 4. Continued.

Station Number	Station Name	Type of Station
5603	Middle Canyon	Precip.
6497	Ophir Canyon	Precip.
6658	Park Valley	Precip. & Temp.
6938	Plymouth	Precip.
7220	Redden Ranch	Precip. & Temp.
7578	Saltair Salt Pl.	Precip. Temp. & Evap.
7931	Snowville	Precip. & Temp.
8668	Thiokol Plant No. 78	Precip. & Temp.
8771	Tooele	Precip. & Temp.
9133	Vernon	Precip. & Temp.
9382	Wendover WB AP	Precip. & Temp.
USU Network		
057	George Peak	Precip.
170	Deseret Peak	Precip.

Periods of Record

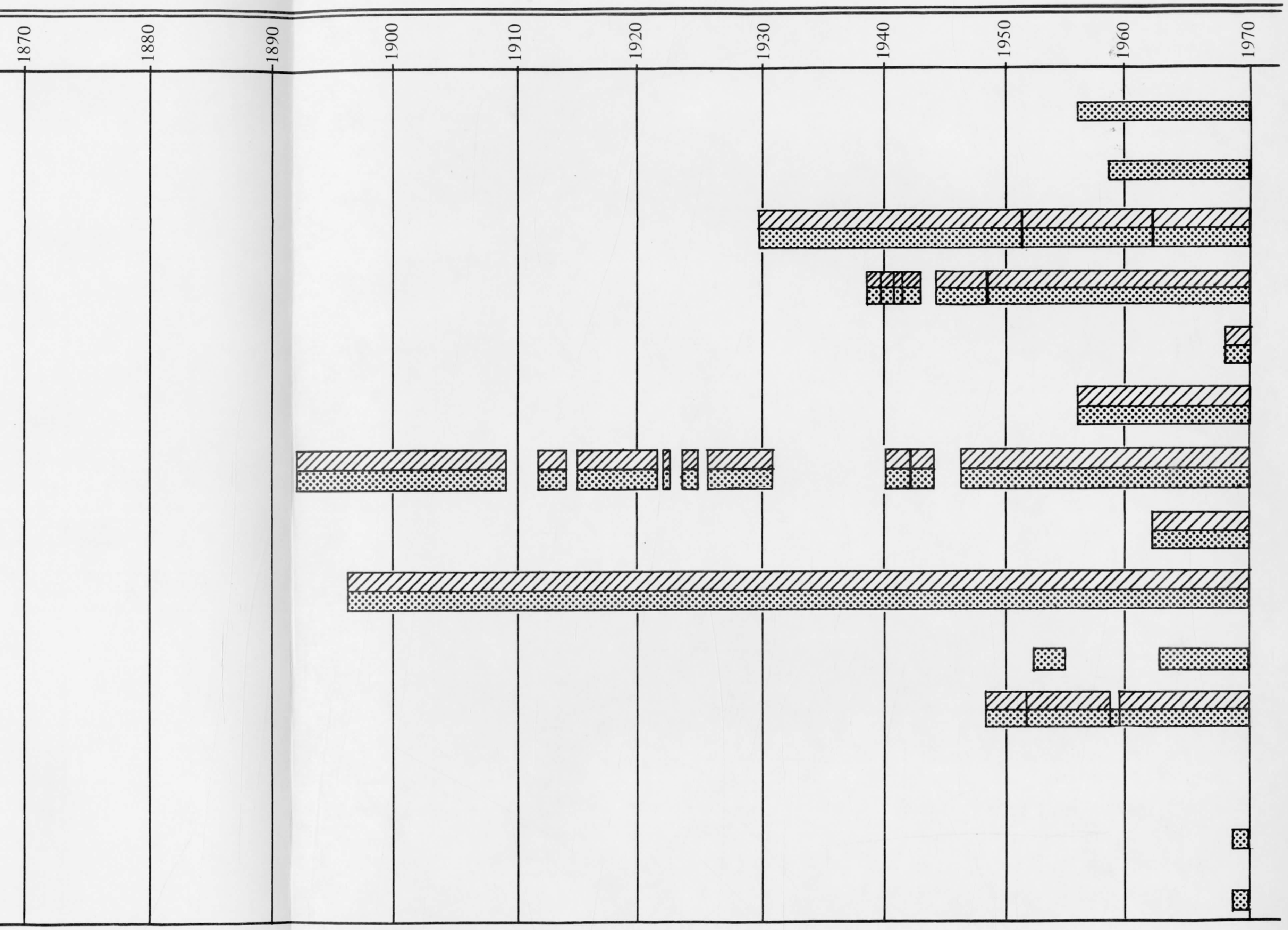


Table 5. Inactive climatological stations within or near the Great Salt Lake Desert Area.

Table 5. Inactive climatological stations within or near the Great Salt Lake Desert Area.

Station Number	Station Name	Type of Station
0478	Bauer	Precip. & Temp.
0777	Blue Creek	Precip. & Temp.
1695	Coon Peak KSLTV	Precip. & Temp.
—a	Deep Creek	Precip.
2073	Delle	Precip. & Temp.
—b	Erekson	Precip.
—c	Fish Springs	Precip. & Temp.
3320	Government Creek	Precip. & Temp.
3353	Grantsville PH	Precip.
—d	Howell	Precip.
—e	Indian Farm	Precip.
—f	International	Precip. & Temp.
4233	Iosepa South Ranch	Precip. & Temp.
—g	Joy	Precip. & Temp.
—h	Kelton	Precip. & Temp.
4746	Knolls	Precip.
—i	Lake Point	Precip. & Temp.

Periods of Record

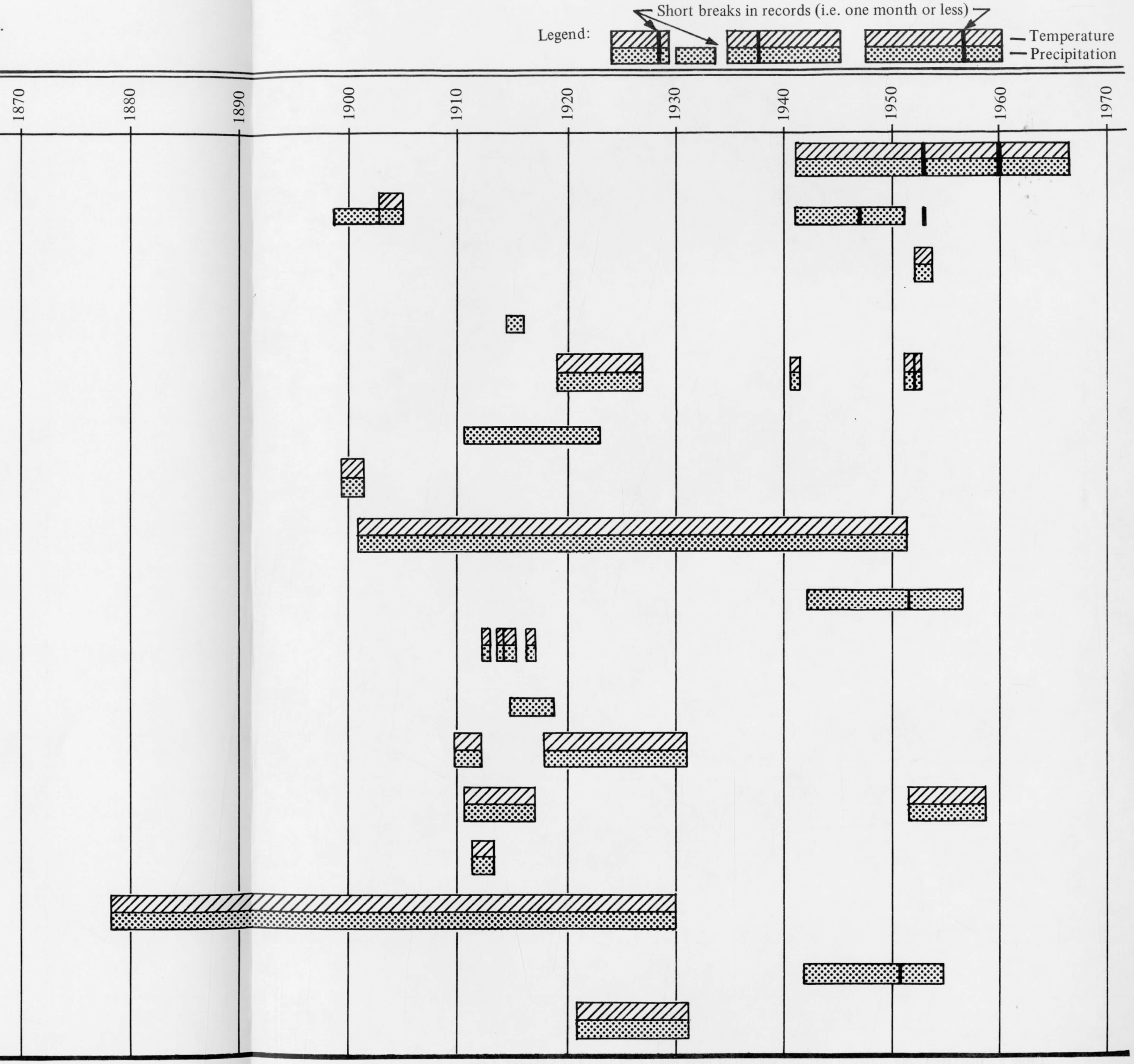


Table 5. Continued.

Table 5. Continued.

Station Number	Station Name	Type of Station
4846	Lakeside	Precip. & Temp.
——j	Lemay	Precip. & Temp.
——k	Low	Precip. & Temp.
5239	Lucin FAA AP	Precip. & Temp.
——l	Marvsvale Crystal Mine	Precip.
——m	Mercur	Precip.
5607	Midlake	Precip., Temp. & Evap.
6551	Orrs Ranch	Precip. & Temp.
——n	Plentiful	Precip.
——o	Promontory	Precip.
——p	Rozell	Precip.
——q	Saint John	Precip. & Temp.
——r	Salduro	Precip. & Temp.
7565	Saline	Precip. & Temp.
——s	Sells	Precip. & Temp.
7744	Severe Ranch	Precip. & Temp.
——t	Terrace	Precip. & Temp.

Periods of Record }

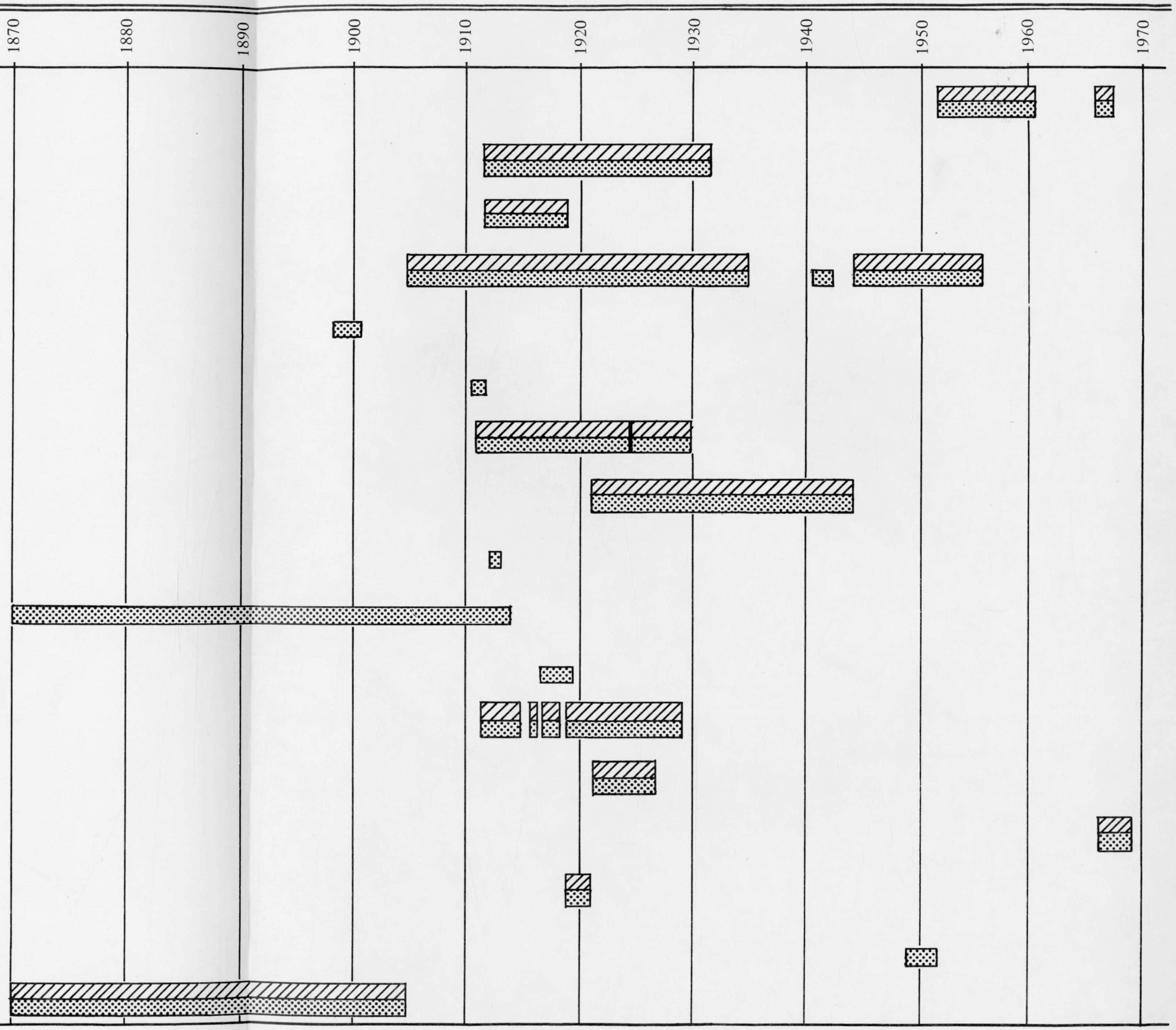


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Table 5. Continued.

Table 5. **Continued.**

Station Number	Station Name	Type of Station
8741	Timpie	Precip. & Temp.
––u	Tramway Mtn.	Precip.
––v	Tremonton	Precip. & Temp.
––w	West Canyon	Precip.
9560	Williams Ranch	Precip. & Temp.

Periods of Record

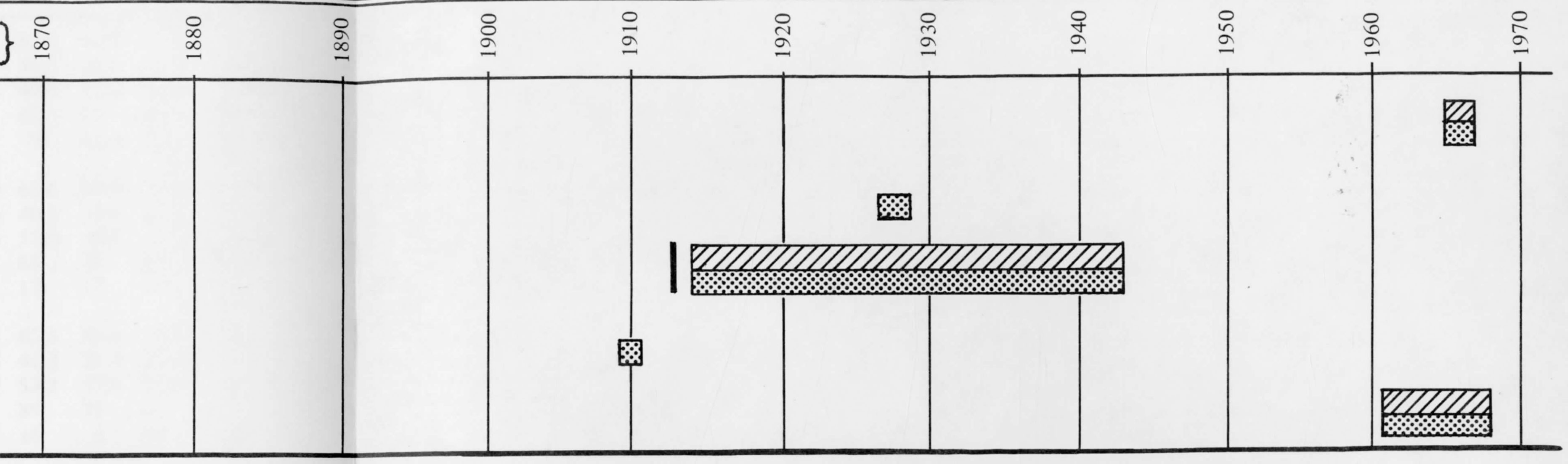

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Table 6. Temperature averages and extremes at selected stations (all units in ^{o}F).

Station	Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Park Valley, Utah	Av. Max.	34.3	37.7	45.5	57.1	66.8	76.1	87.4	85.6	76.4	62.8	46.1	37.8	59.5
	Av. Min.	14.1	17.8	24.9	32.5	40.4	47.9	57.3	55.3	46.1	36.3	24.2	18.1	34.6
	Mean	24.2	27.7	35.2	44.8	53.6	61.9	72.3	70.4	61.3	49.6	35.2	27.9	47.0
	Highest	54	60	70	80	88	98	100	100	95	85	70	60	100
	Lowest	-26	-21	3	5	20	27	35	32	22	9	-11	-17	-26
Tooele, Utah	Av. Max.	38.0	42.0	50.6	60.3	69.4	79.8	88.5	86.5	76.9	63.6	49.3	39.6	62.0
	Av. Min.	19.7	23.5	30.1	37.9	45.6	54.1	62.5	60.7	51.6	40.3	29.4	22.0	39.8
	Mean	28.5	32.6	40.2	50.0	58.7	67.5	76.6	74.7	65.4	53.0	38.8	32.0	51.5
	Highest	63	69	76	87	94	99	104	102	96	85	75	67	104
	Lowest	-15	-16	3	14	22	31	35	31	28	17	-7	-14	-16
Wendover, Utah	Av. Max.	36.6	43.2	53.6	64.0	74.1	84.0	93.5	90.8	80.3	65.5	48.9	38.9	64.5
	Av. Min.	18.0	23.9	31.4	40.0	49.7	58.0	66.5	64.0	52.8	41.2	28.4	20.5	41.2
	Mean	27.0	32.8	41.5	51.6	61.4	69.8	79.4	77.2	66.7	53.2	37.6	29.8	52.3
	Highest	62	65	79	92	103	105	112	104	100	89	75	65	112
	Lowest	-13	-19	8	18	31	31	43	36	28	18	6	-15	-19

The mean monthly and mean annual temperatures of selected stations within and near the area are listed in Table 7 for the 10 year period, 1961 through 1970. The average annual temperature is also given for each station.

Data collection stations are far apart and the records are not continuous within the area as shown in Figure 7 and Tables 4 and 5; therefore no isothermal maps were prepared.

Table 7. Mean monthly and annual temperatures at selected stations. (Taken from U.S. Department of Commerce, 1961 to 1970.) Units based on 10 year period of record, 1961-1970.

Station	Elev.	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Antelope Island 0194	4225	27.38	34.14	39.97	48.29	59.59	67.36	78.87	76.66	64.87	52.82	40.47	28.99	51.62
Bear River Refuge 0506	4208	23.48	31.96	38.98	48.32	60.01	67.05	76.40	73.85	64.01	51.62	39.85	27.71	50.27
Dugway 2257	4360	27.01	35.50	39.65	47.92	59.82	67.62	78.83	75.90	63.69	52.20	40.44	27.43	51.33
Fish Springs Refuge 2852	4335	28.84	36.61	41.31	45.92	61.09	68.81	79.49	77.82	65.80	53.67	41.20	29.04	52.47
Grouse Creek 3486	5270	22.04	28.80	32.94	40.63	52.30	59.09	69.00	67.43	57.16	46.18	36.13	23.47	44.60
Ibapah 4174	5280	25.67	34.70	30.16	43.50	53.40	59.79	69.09	67.88	57.99	46.49	36.97	25.83	45.95
Park Valley 6658	5570	26.16	32.68	36.54	42.66	53.69	60.21	71.40	69.61	59.06	47.75	36.71	25.62	46.84
Snowville 7931	4550	23.19	29.44	33.88	42.45	52.75	60.40	69.93	67.82	55.96	46.04	35.66	24.39	45.12
Tooele 8771	4820	29.44	34.57	39.08	47.18	58.42	65.66	76.04	73.34	62.96	51.40	40.29	29.61	50.67
Wendover WBAP 9382	4240	27.39	35.21	43.62	49.11	61.09	68.55	79.52	76.57	64.89	51.72	39.33	27.68	52.06

Precipitation

One common distinguishing feature of the climate of most of the Great Salt Lake Desert Area is the small amount of precipitation. The greatest portion (approximately 60 percent) of the area receives 8 inches or less annually. The amount in the high mountain portions, which occupy 2 percent of the total area, ranges from 20 to 40 inches annually.

The National Weather Service, formerly U.S. Weather Bureau, Salt Lake City, has prepared isohyetal maps showing the areal distribution of precipitation throughout the State of Utah. From these maps, isohyetal maps of the Great Salt Lake Desert Area have been prepared as shown in Figures 8 and 9. Figure 8 shows the normal annual precipitation and Figures 9 and 10 show the normal October-April precipitation and the normal May-September precipitation.

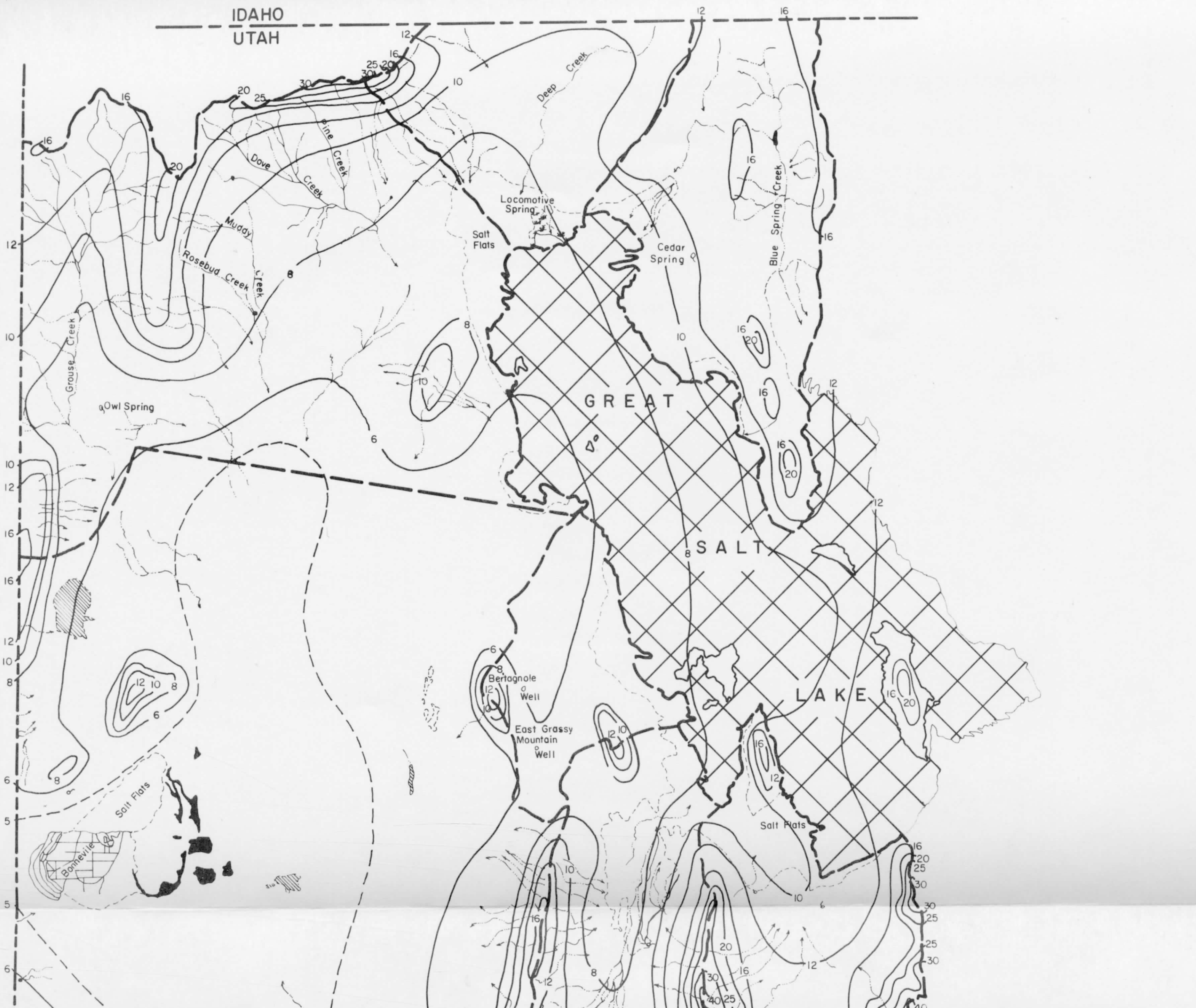
Figure 11 shows tables of selected stations indicating the estimated return periods for short duration precipitation as reported by Richardson (1971).

The average monthly and annual precipitation amounts for selected stations within and near the border of the study area are listed in Table 8. The 10 year period, 1961 through 1970, was used to compute these averages because the period was common to each of the stations and corresponds to the period of record of runoff measurements. These stations are the same stations that were used to illustrate the average temperatures of the area.

Table 8. Average total monthly and annual precipitation at selected stations. (Taken from U.S. Department of Commerce, 1961 to 1970.) Units based on 10 year period of record, 1961-1970.

Station	Elev.	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Antelope Island 0194	4225	0.97	1.55	1.42	2.53	1.62	1.68	0.23	0.90	1.19	1.39	1.46	1.61	16.55
Bear River Refuge 0506	4208	0.89	0.92	0.75	1.41	1.18	2.02	0.28	0.56	0.94	0.97	1.23	1.35	12.50
Dugway 2257	4360	0.33	0.59	0.47	0.93	0.68	1.11	0.50	0.55	0.63	0.63	0.52	0.74	7.68
Fish Springs Refuge 2852	4335	0.20	0.53	0.52	1.01	0.83	1.31	0.60	0.56	0.62	0.64	0.37	0.55	7.74
Grouse Creek 3486	5270	0.87	0.76	0.59	0.57	1.32	1.99	0.47	0.88	0.58	0.47	1.07	1.03	10.60
Ibapah 4174	5280	0.27	0.63	0.84	1.09	1.00	2.21	0.58	1.49	0.74	0.72	0.44	0.62	10.63
Park Valley 6658	5570	0.78	0.57	0.55	0.63	1.10	1.87	0.89	1.05	0.60	0.59	0.93	0.85	10.41
Snowville 7931	4550	1.12	0.75	0.60	1.11	1.54	1.90	0.71	0.67	0.79	0.58	1.45	0.99	12.21
Tooele 8771	4820	0.87	1.32	1.73	2.57	1.52	1.71	0.82	1.02	0.97	1.60	1.23	1.63	16.99
Wendover WBAP 9382	4240	0.19	0.38	0.34	0.50	0.71	1.25	0.28	0.28	0.27	0.42	0.44	0.40	5.46

Figure 8. Normal annual precipitation in the Great Salt Lake Desert Area. (Taken from isohyetal maps of the State of Utah prepared by the U.S. Weather Bureau.)



NORMAL ANNUAL PRECIPITATION

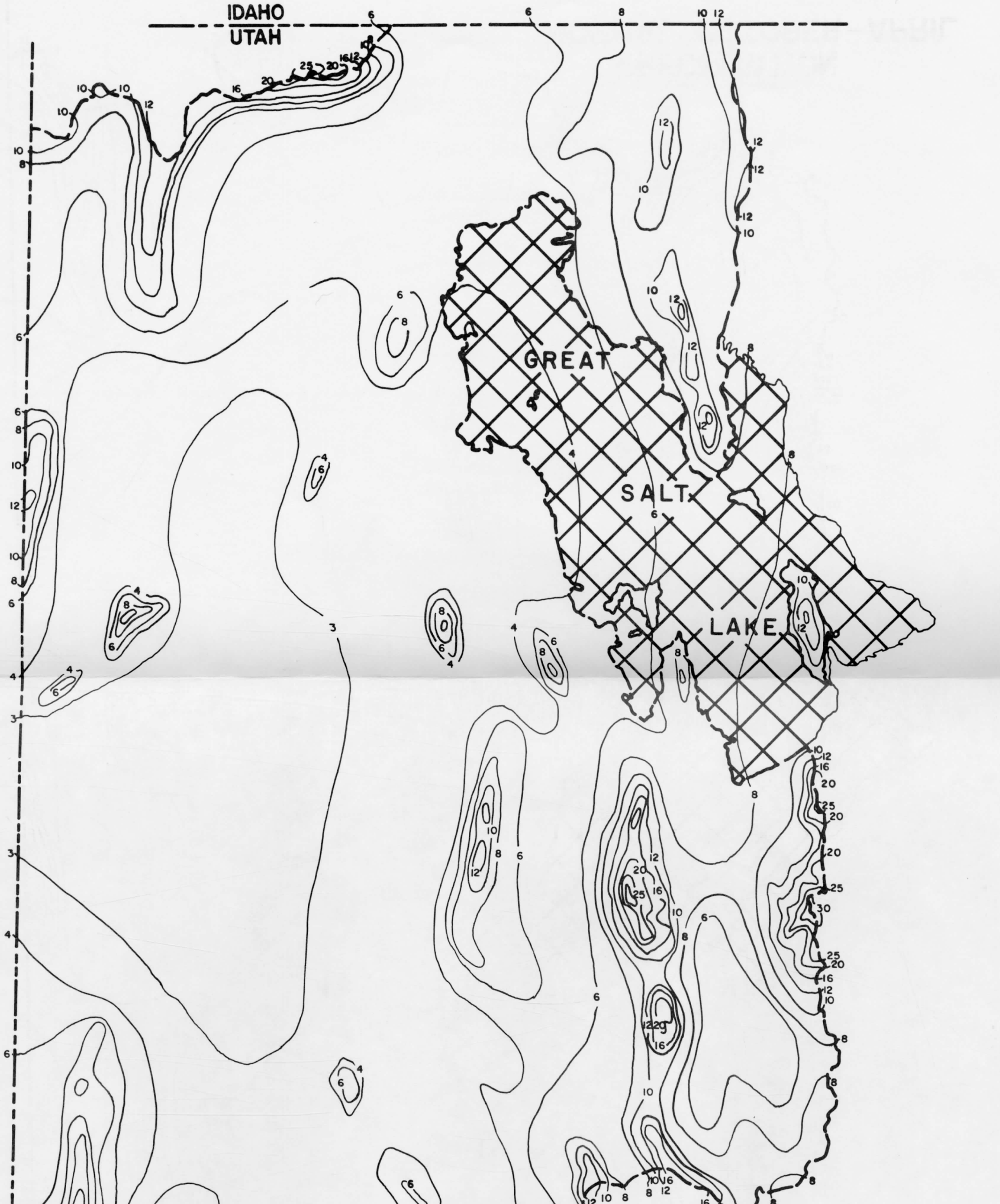
GREAT SALT LAKE DESERT AREA

LEGEND

Isohyetal lines

Rivers and streams

Figure 9. Precipitation, normal October-April, in the Great Salt Lake Desert Area. (Taken from isohyetal maps of the State of Utah prepared by the U.S. Weather Bureau.)



PRECIPITATION
NORMAL OCTOBER-APRIL
GREAT SALT LAKE DESERT AREA

Figure 10. Precipitation, normal May-September, in the Great Salt Lake Desert Area. (Taken from isohyetal maps of the State of Utah prepared by the U.S. Weather Bureau.)

PRECIPITATION
NORMAL MAY-SEPTEMBER
GREAT SALT LAKE DESERT AREA

igure 11. Estimated return periods for short duration precipitation of selected stations within the Great Salt Lake Desert Area. (Taken from Richardson, 1971.)

Station: Antelope Island
Latitude: 40° 56
Station Number: 0194
Elevation: 4225
Longitude: 112°10

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.12	.18	.23	.32	.41	.48	.55	.73	.89	1.05
2	.15	.23	.29	.40	.50	.59	.68	.91	1.11	1.32
5	.18	.28	.35	.49	.62	.75	.87	1.18	1.45	1.74
10	.21	.33	.42	.58	.74	.88	1.02	1.37	1.68	2.00
25	.24	.38	.48	.66	.84	1.02	1.20	1.63	2.02	2.42
50	.27	.42	.53	.73	.93	1.14	1.34	1.83	2.27	2.73
100	.30	.47	.60	.83	1.05	1.28	1.50	2.04	2.53	3.03

Station: Callao
Latitutde: 39°54
Station Number: 1134
Elevation: 4330
Longitude: 113°43

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.08	.12	.15	.21	.27	.34	.40	.56	.70	.85
2	.11	.18	.22	.31	.39	.47	.54	.73	.90	1.07
5	.15	.23	.29	.40	.51	.62	.72	.98	1.21	1.45
10	.20	.31	.39	.54	.68	.79	.89	1.15	1.38	1.62
25	.24	.38	.48	.66	.84	.97	1.09	1.40	1.67	1.96
50	.28	.43	.55	.76	.96	1.10	1.24	1.58	1.88	2.20
100	.31	.48	.61	.85	1.07	1.23	1.39	1.77	2.11	2.47

Station: Deseret Peak
Latitude: 40°27
Station Number: USU 170
Elevation: 11,000
Longitude: 112°37

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.14	.22	.28	.39	.49	.63	.76	1.09	1.38	1.69
2	.16	.25	.32	.44	.56	.73	.88	1.28	1.63	2.00
5	.18	.28	.35	.49	.62	.84	1.04	1.56	2.02	2.50
10	.19	.30	.38	.53	.67	.92	1.16	1.75	2.28	2.83
25	.23	.36	.45	.62	.79	1.08	1.35	2.03	2.64	3.27
50	.26	.41	.51	.71	.90	1.21	1.51	2.25	2.91	3.60
100	.29	.45	.58	.80	1.01	1.35	1.67	2.48	3.20	3.95

Station: Dugway
Latitude: 40°11
Station Number: 2257
Elevation: 4340
Longitude: 112°56

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.12	.18	.23	.32	.41	.44	.46	.53	.59	.65
2	.14	.22	.28	.39	.49	.54	.58	.69	.79	.89
5	.21	.32	.40	.56	.71	.77	.84	.99	1.13	1.27
10	.22	.34	.43	.59	.75	.84	.92	1.13	1.32	1.51
25	.25	.38	.48	.67	.85	.97	1.08	1.35	1.60	1.85
50	.27	.42	.53	.73	.93	1.07	1.20	1.53	1.82	2.13
100	.29	.45	.56	.78	.99	1.15	1.31	1.69	2.03	2.39

Station: Grouse Creek
Latitude: 40°41
Station Number: 3486
Elevation: 5270
Longitude: 113°53

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.20	.31	.39	.54	.68	.70	.71	.75	.78	.82
2	.21	.33	.42	.58	.74	.78	.82	.91	.99	1.08
5	.23	.35	.44	.62	.78	.86	.94	1.13	1.30	1.48
10	.24	.38	.48	.66	.84	.94	1.04	1.29	1.51	1.74
25	.28	.44	.55	.77	.97	1.10	1.23	1.54	1.82	2.11
50	.30	.47	.59	.82	1.04	1.20	1.35	1.72	2.05	2.40
100	.32	.50	.63	.88	1.11	1.29	1.47	1.90	2.29	2.69

Station: Ibapah
Latitude: 40°02
Station Number: 4174
Elevation: 5280
Longitude: 113° 59

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.14	.22	.27	.38	.48	.54	.59	.73	.85	.98
2	.16	.25	.32	.44	.56	.64	.71	.90	1.07	1.24
5	.20	.32	.40	.55	.70	.81	.91	1.17	1.40	1.64
10	.22	.34	.43	.60	.76	.89	1.02	1.33	1.61	1.90
25	.26	.41	.51	.71	.90	1.06	1.21	1.59	1.93	2.28
50	.30	.46	.58	.81	1.02	1.20	1.37	1.80	2.18	2.58
100	.32	.50	.63	.87	1.10	1.30	1.50	1.99	2.43	2.88

Station: Lakeside
Latitude: 41°14
Station Number: 4846
Elevation: 4812
Longitude: 112°52

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.13	.21	.26	.36	.46	.49	.53	.61	.68	.76
2	.16	.24	.31	.43	.54	.59	.64	.77	.88	1.00
5	.19	.30	.38	.52	.66	.74	.82	1.02	1.20	1.38
10	.21	.33	.42	.58	.74	.84	.94	1.18	1.40	1.62
25	.25	.38	.48	.67	.85	.98	1.10	1.41	1.68	1.97
50	.27	.42	.53	.73	.93	1.08	1.22	1.58	1.90	2.23
100	.30	.47	.59	.82	1.04	1.21	1.37	1.77	2.13	2.50

Station: Lucin
Latitude: 41°22
Station Number: 5239
Elevation: 4413
Longitude: 113°50

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.16	.25	.32	.44	.56	.58	.60	.64	.68	.72
2	.18	.28	.35	.49	.62	.66	.70	.80	.89	.98
5	.20	.31	.39	.55	.69	.77	.85	1.04	1.21	1.39
10	.21	.32	.40	.56	.71	.82	.92	1.18	1.41	1.65
25	.26	.40	.50	.70	.88	1.01	1.13	1.44	1.71	2.00
50	.27	.42	.54	.74	.94	1.10	1.25	1.62	1.95	2.30
00	.30	.46	.58	.81	1.02	1.20	1.37	1.80	2.18	2.58

Station: Park Valley
Latitude: 41°48
Station Number: 6658
Elevation: 5570
Longitude: 113°20

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.14	.22	.27	.38	.48	.53	.57	.68	.78	.88
2	.17	.26	.33	.46	.58	.64	.70	.85	.98	1.12
5	.21	.33	.42	.58	.73	.82	.90	1.11	1.30	1.49
10	.23	.36	.46	.64	.81	.92	1.02	1.27	1.50	1.73
25	.28	.44	.55	.77	.97	1.10	1.22	1.53	1.80	2.09
50	.32	.49	.62	.86	1.09	1.24	1.38	1.73	2.04	2.37
100	.34	.53	.67	.93	1.18	1.35	1.51	1.91	2.27	2.64

Station: Promontory Point (Saline)
Latitude: 41°13
Station Number:
Elevation: 4230
Longitude: 112°29

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.16	.24	.31	.43	.54	.57	.60	.68	.75	.82
2	.18	.27	.35	.48	.61	.67	.72	.85	.97	1.09
5	.21	.32	.40	.56	.71	.80	.89	1.11	1.31	1.51
10	.22	.34	.43	.60	.76	.88	.99	1.28	1.53	1.80
25	.26	.40	.50	.70	.88	1.03	1.17	1.53	1.85	2.18
50	.27	.42	.53	.73	.93	1.11	1.28	1.71	2.09	2.49
100	.29	.45	.57	.79	1.00	1.21	1.41	1.90	2.34	2.80

Station: Snowville
Latitude: 41°58
Station Number: 7931
Elevation: 4560
Longitude: 112°43

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.19	.29	.36	.51	.64	.67	.70	.78	.85	.92
2	.20	.31	.39	.55	.69	.75	.80	.94	1.06	1.19
5	.21	.33	.42	.58	.73	.83	.93	1.17	1.39	1.61
10	.22	.35	.44	.61	.77	.90	1.02	1.33	1.60	1.89
25	.26	.40	.50	.70	.88	1.04	1.20	1.58	1.92	2.28
50	.27	.42	.53	.73	.93	1.12	1.30	1.76	2.17	2.59
100	.29	.45	.56	.78	.99	1.21	1.42	1.94	2.41	2.89

Station: Standsbury Park
Latitude: 40°37
Station Number:
Elevation: 4300
Longitude: 112°17

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.17	.27	.34	.47	.59	.64	.69	.82	.93	1.05
2	.20	.32	.40	.55	.70	.77	.84	1.01	1.16	1.32
5	.24	.38	.48	.66	.84	.94	1.04	1.29	1.51	1.74
10	.27	.41	.52	.73	.92	1.04	1.16	1.46	1.72	2.00
25	.31	.49	.62	.85	1.08	1.23	1.38	1.74	2.06	2.40
50	.35	.54	.68	.95	1.20	1.37	1.54	1.95	2.32	2.70
100	.39	.60	.76	1.06	1.34	1.53	1.71	2.17	2.58	3.00

Station: Tooele
Latitude: 40°32
Station Number: 8771
Elevation: 4820
Longitude: 112°18

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.11	.18	.22	.31	.39	.49	.59	.83	1.05	1.27
2	.14	.22	.28	.39	.49	.61	.73	1.02	1.28	1.55
5	.19	.29	.37	.51	.65	.80	.94	1.30	1.62	1.95
10	.23	.36	.45	.62	.79	.96	1.11	1.51	1.86	2.23
25	.27	.42	.54	.74	.94	1.14	1.32	1.79	2.21	2.64
50	.31	.48	.61	.85	1.07	1.29	1.49	2.01	2.47	2.95
100	.34	.53	.67	.92	1.17	1.41	1.64	2.22	2.73	3.27

Station: Wendover WSO
Latitude: 40°44
Station Number: 9382
Elevation: 4237
Longitude: 114°02

RETURN PERIOD (years)	DURATION 5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.11	.17	.21	.29	.37	.40	.44	.52	.59	.67
2	.13	.20	.25	.35	.44	.50	.55	.68	.80	.92
5	.17	.26	.32	.45	.57	.65	.73	.93	1.11	1.29
10	.19	.29	.37	.51	.65	.75	.85	1.10	1.32	1.55
25	.22	.34	.43	.60	.76	.89	1.02	1.33	1.61	1.90
50	.25	.39	.49	.68	.86	1.01	1.16	1.52	1.84	2.18
100	.27	.42	.54	.74	.94	1.11	1.28	1.70	2.07	2.46

WATER RESOURCES

Runoff data network

The Great Salt Lake Desert Area contains only five permanent stream gaging stations at widely scattered points, as shown in Figure 12. The station at Trout Creek in Snake Valley, closely adjacent to the study area, has been included in this report. The South Willow Creek and Dove Creek stream gages each have an 11 year period of record through September 1970. These were the longest records available for the study area. The other stations have periods of record between 5 and 10 years.

The permanent stream gaging stations have been listed in Table 9 with the average monthly and annual discharges in acre-feet. The averages are based on the data available for the periods of record for each stream gage. The study area contains 22 crest-stage stations as listed in Table 10 and shown in Figure 12. Listed in Table 11 are three maximum discharge measurements at miscellaneous sites within the study area.

Geographic distribution of runoff

The mean annual water yield given in Figure 13 represents the runoff in inches of water for the area circumscribed by the isoyield lines shown. As can be seen, the maximum runoff within the study area occurs on the mountain ranges. Little or no runoff is available as a result of rainfall on the lower valley areas. The precipitation-runoff ratios given in Table 12 provide comparison of the five drainage areas that have had continuous measurement of runoff. These ratios are consistent with the pattern of runoff of the study area.

Ordinarily, as the runoff from the mountain ranges reaches the alluvial fans and bars, much of the water percolates into the ground. Peak flows, however, may pass over these fans without much reduction in volume. Some of the water percolating into the ground reaches aquifers where it is stored for possible future use.

Table 9. Mean monthly and annual flow at the U.S. Geological Survey stream measuring stations. (Taken from U.S. Geological Survey, 1963 and 1961-1969.)

	RUNOFF IN AC-FT				
Period of Record	1958-69	1958-69	1963-68	1958-68	1963-69
Station No.	1727	1728.7	1728.93	1729.4	1728
Title	Vernon Creek	Trout Creek	Deep Creek	Dove Creek	South Willow Creek
Location	Rush Valley	Callao, Utah	Goshute, Utah	Park Valley, U.	Grantsville, Utah
Drainage Area	25 sq. mi.	8.8 sq. mi.	43 sq. mi.	35 sq. mi.	4.2 sq. mi.
Elevation (approx.)	6,200	6,000	6,100	5,600	6,360
January	98.7	91.7	40.3	17.9	168.0
February	100.5	85.7	38.8	44.7	147.8
March	113.5	113.7	52.2	53.7	177.6
April	185.1	288.5	47.0	54.2	321.5
May	203.5	961.9	227.2	55.8	936.0
June	130.1	1,287.6	734.0	59.1	1,103.1
July	106.7	368.5	208.2	23.1	596.0
August	99.9	175.0	109.2	17.0	281.2
September	92.3	125.2	88.2	17.4	215.4
October	92.4	115.2	75.0	22.8	190.8
November	95.3	114.1	63.8	21.5	184.6
December	98.1	102.3	35.0	19.0	177.0
Annual	1,416	4,076	1,719	405	4,523

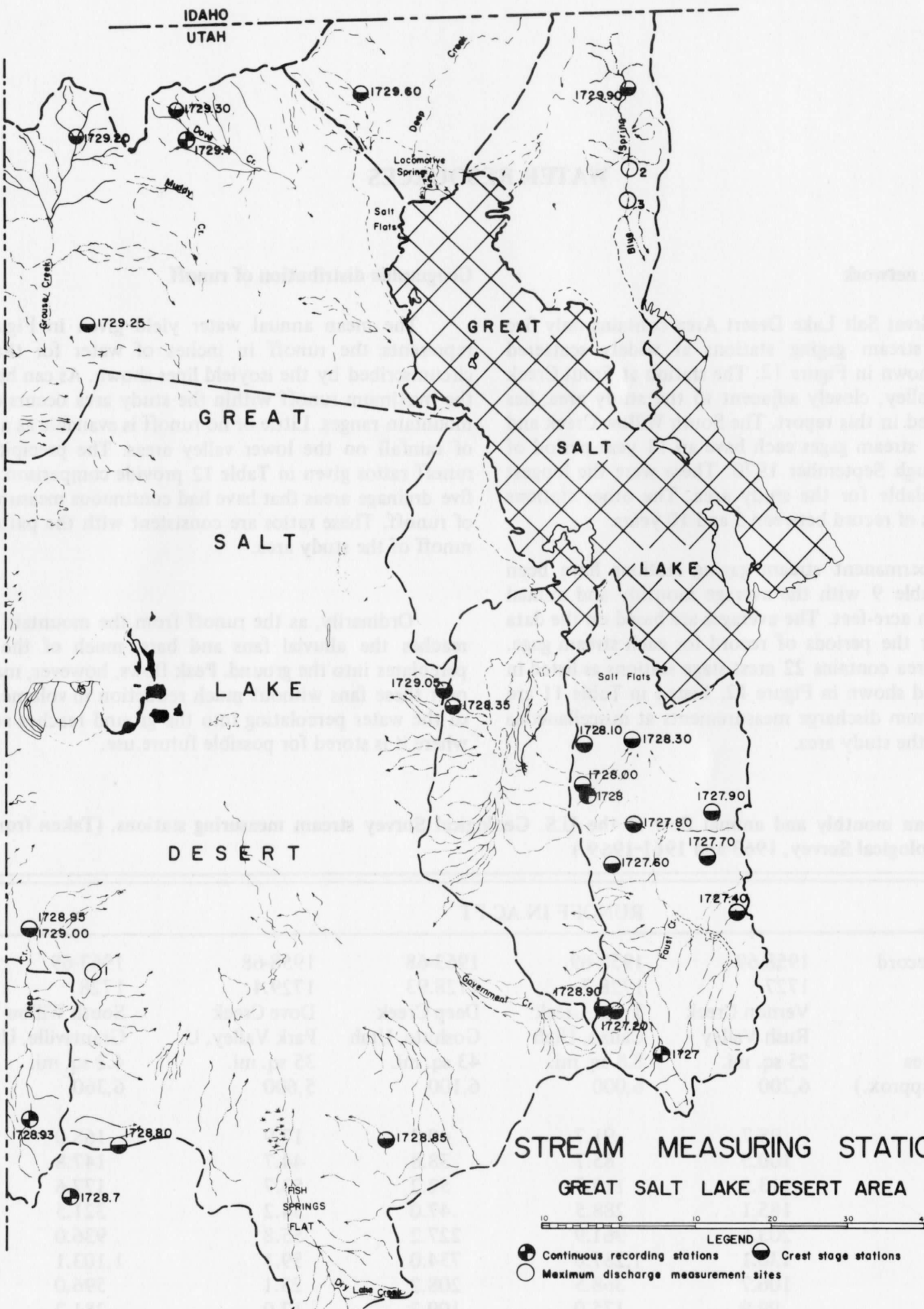


Figure 12. Stream measuring stations within the Great Salt Lake Desert Area.

Table 10. Maximum discharges at crest-stage stations. (Taken from Whitaker, 1969.)

Station number	Gaging Station	Latitude	Longitude	Mean altitude of drainage basin (feet)	Period of record	Drainage area	Maximum gage height and discharge			
							Date	Gage height (feet)	Discharge	
									Cfs	Cfs per sq mi
	Rush Valley									
10-1727.20	East Government Creek tributary near Vernon, Utah	40 05 45	112 32 30	5,950	1961-67	.98	Feb. 9, 1962	9.52	6	6.1
10-1727.40	Rush Valley tributary near Fairfield, Utah	40 15 25	112 12 20	5,750	1961-67	.26	Sept. 6, 1965	10.36	17	65.4
10-1727.60	Clover Creek near Clover, Utah	40 20 30	112 32 15	7,020	1961-67	4.45	Aug. 13, 1965	10.81	87	19.6
10-1727.70	Dry Canyon near Stockton, Utah	40 22 35	112 17 15	8,360	1961-67	1.42	Feb. 11, 1962	9.70	Not de-detmined	-
10-1727.80	Hickman Creek near St. John, Utah	40 26 55	112 28 30	7,540	1961-67	12.8	March 27, 1962	12.05	Not de-mined	-
							Sept. 13, 1963	11.90	18	1.4
	Tooele Valley									
10-1727.90	Settlement Canyon near Tooele, Utah	40 28 50	112 16 45	7,700	1961-67	5.77	July 18, 1965	10.92	52.4	9.1
10-1728.00	South Willow Creek near Grantsville, Utah	40 29 25	112 35 50	-	1960-63	3.26	June 10, 1963	10.30	11	3.4
10-1728.10	Mack Canyon near Grantsville, Utah	40 36 10	112 35 15	7,170	1961-67	2.84	Sept. 1962	9.95	1	.4
	Skull Valley									
10-1728.30	North Fork Muskrat Canyon near Timpie, Utah	40 37 55	112 38 15	6,970	1961-67	1.78	-	-	No flow	0
10-1728.35	Skull Valley tributary near Delle, Utah	40 41	112 55	5,650	1960-67	1.5	Sept. 13, 1963	9.90	20	13.3
	Great Salt Lake Desert									
10-1728.80	Thomas Creek near Callao, Utah	39 50	113 47	8,560	1959-67	6.8	June 7, 1964	11.09	40	5.9
10-1728.85	Great Salt Lake Desert tributary No. 2 near Dugway, Utah	39 51 30	113 06 40	5,530	1961-67	5.48	Sept. 6, 1965	11.66	215	39.2
10-1728.90	Government Creek near Dugway, Utah	40 05 00	112 41 35	6,140	1961-67	59	Aug. 12, 1961	12.58	328	5.6
10-1728.95	Deep Creek near Ibapah, Utah	40 15	113 59	6,150	1959-67	460	Aug. 25, 1961	17.14	1,250	2.7
10-1729.00	Bar Creek near Ibapah, Utah	40 15	113 59	5,470	1959-67	12	Aug. 25, 1961	15.55	2,690	224
10-1729.05	Great Salt Lake Desert tributary near Delle, Utah	40 43	112 57	5,980	1961-67	.97	Sept. 13, 1963	10.55	25	25.8
10-1729.20	Cotton Creek near Grouse Creek, Utah	41 48	113 50	6,540	1959-67	18.4	Apr. 1, 1961	10.80	2/	-
10-1729.25	Great Salt Lake Desert tributary No. 3 near Park Valley, Utah	41 26	113 46	5,010	1962-67	.4	May 24, 1963	11.43		
	Tributaries between Great Salt Lake Desert and Bear River									
10-1729.30	Right Hand Fork Dove Creek near Park Valley, Utah	41 49	113 35	6,920	1959-67	12.2	March 25, 1962	11.23	32.3	2.6
10-1729.60	West Fork Tenmile Creek near Park Valley, Utah	41 50	113 08	5,280	1959-67	5.93	Aug. 31, 1963	12.07	460	77.6
10-1729.90	Blue Spring Creek near Snowville, Utah	41 51	112 27	5,280	1959-67	78	Feb. 12, 1962	17.47	1,820	23.3

Table 11. Maximum discharges at miscellaneous sites. (Taken from Whitaker, 1969.)

Stream and Place of Determination	Drainage Area (sq mi)	Date	Peak Discharge Cfs	Peak Discharge Cfs per sq mi
1. Great Salt Lake Desert Little Valley Wash, tributary to Great Salt Lake Desert, lat. 40 10 50, long. 113 51 35, 2 mi northeast of Gold Hill, Utah	.9	8-19-59	2570	2860
2. Tributaries between Great Salt Lake Desert and Bear River Hereford Canyon, tributary to Blue Spring Creek, in Ne ¼ sec. 6, T. 11 N., R. 5 W., ½ mi upstream from bridge on County road, 5 mi south of Howell, and 22 mi northwest of Corinne, Utah	22.0	9-18-61	1020	46.4
3. Blue Spring Creek, tributary to Great Salt Lake in SW ¼ sec. 32, T. 11 N., R. 5 W., at bridge on State Highway 83, 3 mi southwest of Thiokol Chemical Corp. plant, and 18 mi northwest of Corinne, U.	230.0	9-18-61	3010	13.1

Table 12. Precipitation - runoff ratios of drainage areas with measuring stations.

Drainage Area Upstream of Measuring Stations	Average Annual Runoff (ac-ft)	Estimated Normal Annual Rainfall (ac-ft)	Precipitation-Runoff Ratio
Vernon Creek No. 1727	1,416	12,800	9.1
South Willow Creek No. 1728	4,523	6,540	1.5
Trout Creek No. 1728.7	4,076	6,600	1.6
Deep Creek No. 1728.93	1,719	31,400	29.2
Dove Creek No. 1729.4	405	18,100	44.7

Additional data are needed to better define and determine the streamflows within the study area. An obvious and serious lack of data exists throughout most of the study area.

Flood characteristics

Floods within the study area have the following characteristics: The high discharges per square mile occur in the small drainage areas in the mountain regions, and, conversely, the larger drainage areas produce smaller discharge per square mile. The low ratios of discharge per square mile are generally due to the flat slopes of the relatively permeable valley floors and desert areas and the high ratios to the steep impermeable slopes of the mountain ranges.

The recent trend toward utilization of crest-stage stations and maximum discharge readings at miscellaneous sites has aided the peak discharge prediction capabilities of responsible agencies. Miscellaneous discharge measurements are made for various reasons, and in ways that the data can be used for estimating peak discharges. However, more crest-stage stations are needed in the study area for flood control purposes.

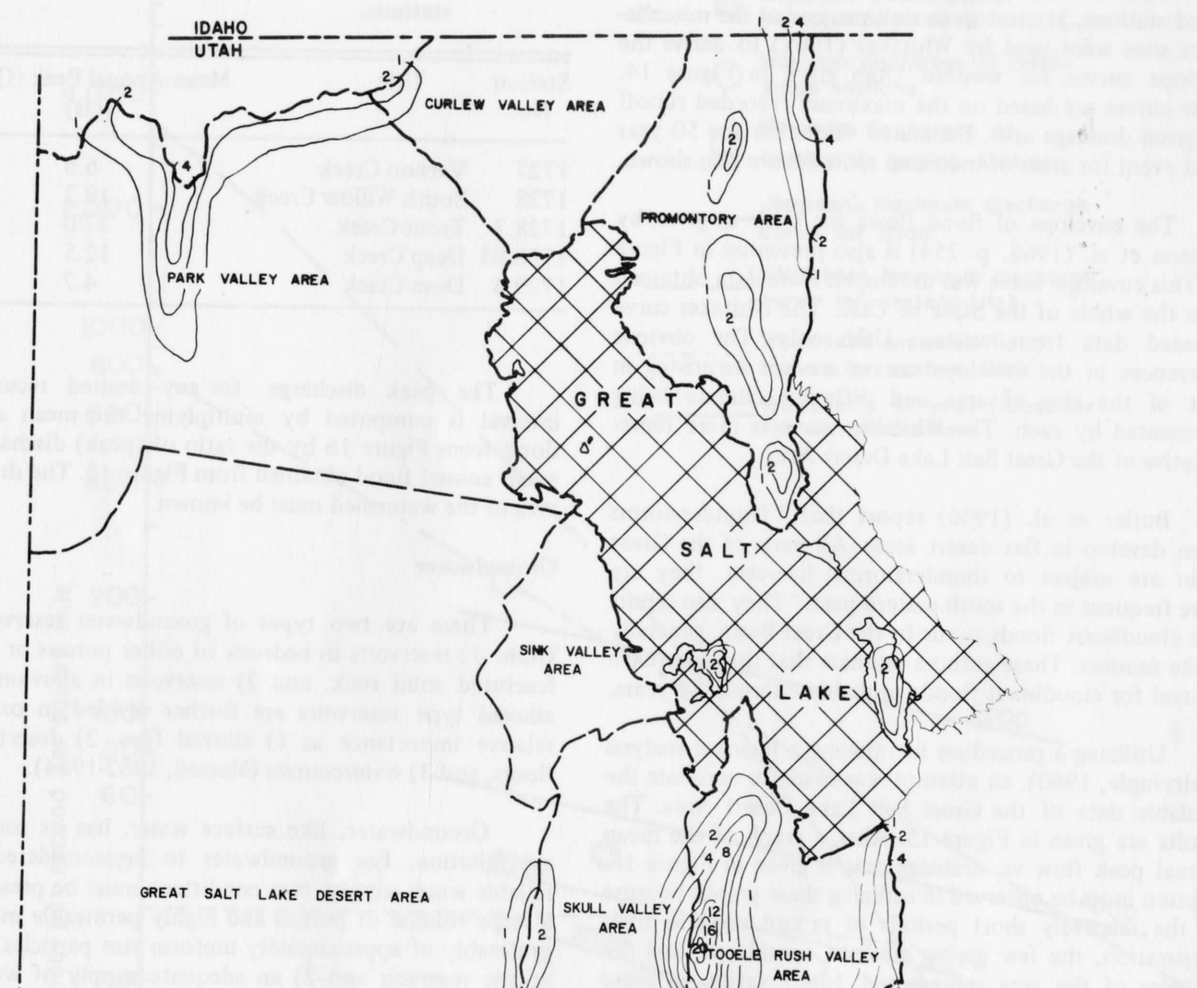


Figure 13. Mean annual water yield from within the Great Salt Lake Desert Area. (Taken from Bagley et al., 1964.)

Maximum discharges determined at the continuous-record stations, at crest-stage stations, and at the miscellaneous sites were used by Whitaker (1969) to derive the envelope curves for western Utah given in Figure 14. These curves are based on the maximum recorded runoff per given drainage area. Estimated values for the 50 year flood event for areas of indicated altitudes are also shown.

The envelope of flood flows for Utah as given by Jeppson et al. (1968, p. 254) is also presented in Figure 14. This envelope curve was developed from data obtained from the whole of the State of Utah. The Whitaker curve included data from western Utah only. The obvious differences in the envelope curves are not surprising in light of the size of area and different climate being represented by each. The Whitaker curve is more representative of the Great Salt Lake Desert Area.

Butler et al. (1966) report that "Thunderstorms often develop in flat desert areas. All parts of the Great Basin are subject to thunderstorms; however, they are more frequent in the south eastern part." They also report that cloudburst floods occur in the Great Basin, generally in the summer. These authors estimate that the recurrence interval for cloudburst floods probably exceeds 50 years.

Utilizing a procedure for making a regional analysis (Dalrymple, 1960), an attempt was made to correlate the available data of the Great Salt Lake Desert Area. The results are given in Figure 15. Also, a graph of the mean annual peak flow vs. drainage area is given in Figure 16. Caution must be observed in utilizing these graphs because of the relatively short periods of record used in their preparation, the few gaging stations considered, and the vastness of the area represented. Interpolation of these graphs for periods longer than 10 years is not recommended. Other sources for estimates of peak flows for the 50 year flood and the maximum recorded discharges are available and are discussed later in this report. The period of record for each of the stream gages was extended as required to an 11 year period for the purpose of assigning the proper recurrence interval to each year's recorded peak flow. Mean annual peak flows were determined from the station frequency curve by plotting the peak flows of record against the recurrence interval on extreme log data paper. From a straight line visual fit to the points plotted, the peak discharge was read for the recurrence interval of 2.33 years. This value represents the mean annual peak flow for the stream gaging station and is symbolized $Q_{2.33}$. The mean annual peak flows as computed for each stream gaging station are listed in Table 13. These values were plotted against the drainage areas of the respective measuring stations and a straight line fit was obtained by the least squares method as shown in Figure 16. The points are widely scattered due to the shortness of record.

A more lengthy procedure utilizing the existing data was required to obtain the regional frequency curve shown in Figure 14 (Dalrymple, 1960).

Table 13. Mean annual peaks at stream measuring stations.

Station No.	Title	Mean Annual Peak ($Q_{2.33}$) (cfs)
1727	Vernon Creek	6.6
1728	South Willow Creek	19.2
1728.7	Trout Creek	37.0
1728.93	Deep Creek	12.5
1729.4	Dove Creek	4.7

The peak discharge for any desired recurrence interval is computed by multiplying the mean annual flood from Figure 16 by the ratio of (peak) discharge to mean annual flood obtained from Figure 15. The drainage area of the watershed must be known.

Groundwater

There are two types of groundwater reservoirs in Utah: 1) reservoirs in bedrock of either porous or highly fractured solid rock, and 2) reservoirs in alluvium. The alluvial type reservoirs are further divided in order of relative importance as 1) alluvial fans, 2) desert basin floors, and 3) watercourses (Marsell, 1962-1964).

Groundwater, like surface water, has its source in precipitation. For groundwater to be considered as a reliable water supply, two conditions must be present: 1) a large volume of porous and highly permeable material, preferably of approximately uniform size particles, to act as the reservoir and 2) an adequate supply of water to replenish the reservoir of water withdrawn by pumping (Marsell, 1968). Most of the production of water from wells in Utah comes from the Great Basin and is obtained almost entirely from unconsolidated deposits of sand and gravel.

Within the study area, alluvial fan type reservoirs obtain their recharge mainly from the permeable bottoms of streams that cross the reservoir surface. Smaller amounts of water may enter the reservoir by direct infiltration from precipitation, canal losses, and irrigated fields. The quality of groundwater from the alluvial fan type reservoirs is generally good but the quantity of water available is less than in the desert basin floor type reservoirs.

The major current source of water for desert valley groundwater basins is the seepage loss of water courses. Of course, some of the water stored in these large groundwater basins no doubt infiltrated from prehistoric Lake Bonneville. Precipitation is generally discounted as a direct recharge potential because the small quantities received are absorbed by the surface soils only to be lost again by evapotranspiration. The quality of the ground-

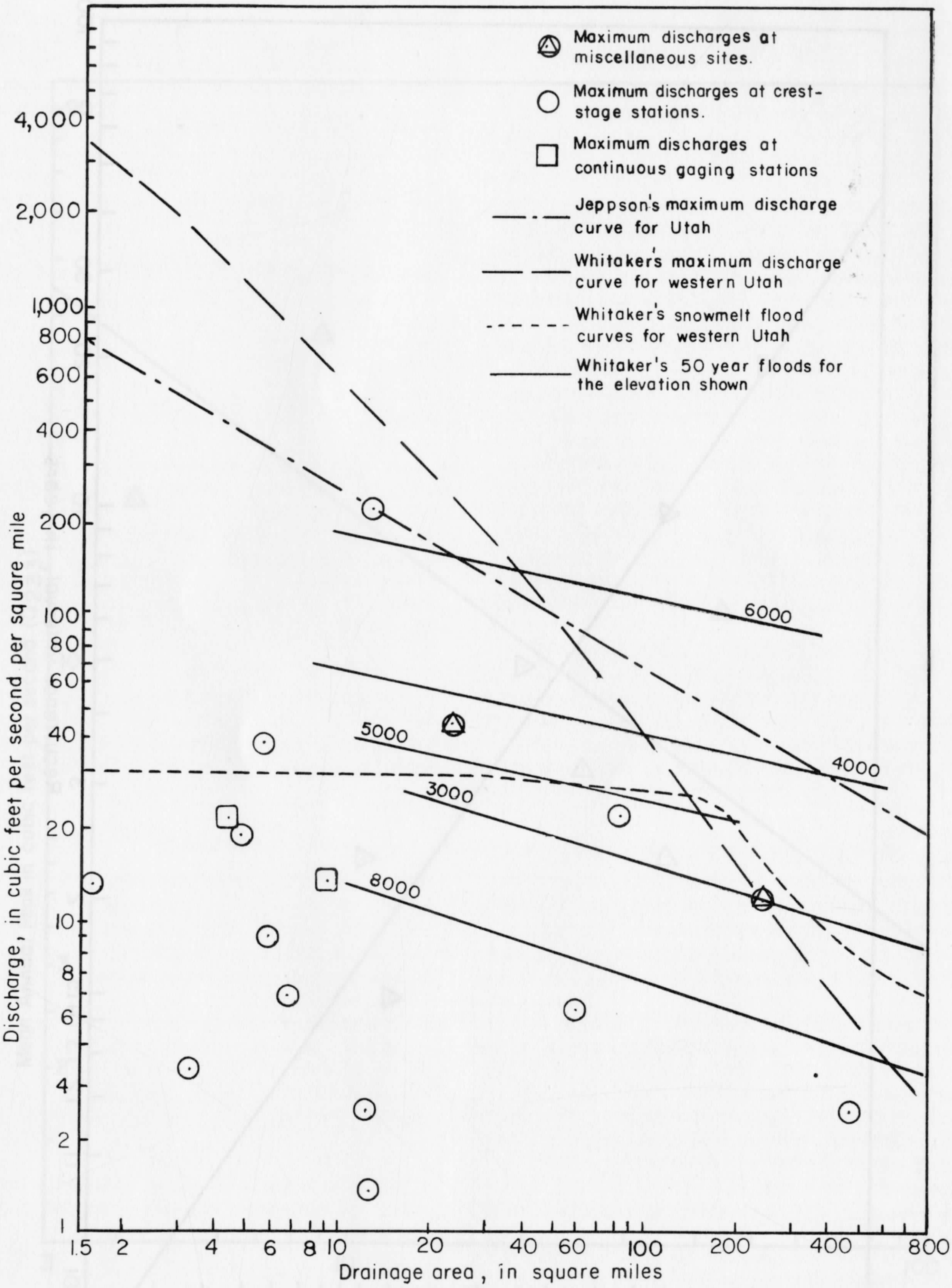


Figure 14. Regional maximum discharge curves. (Taken from Whitaker, 1969, and Jeppson et al., 1968.)

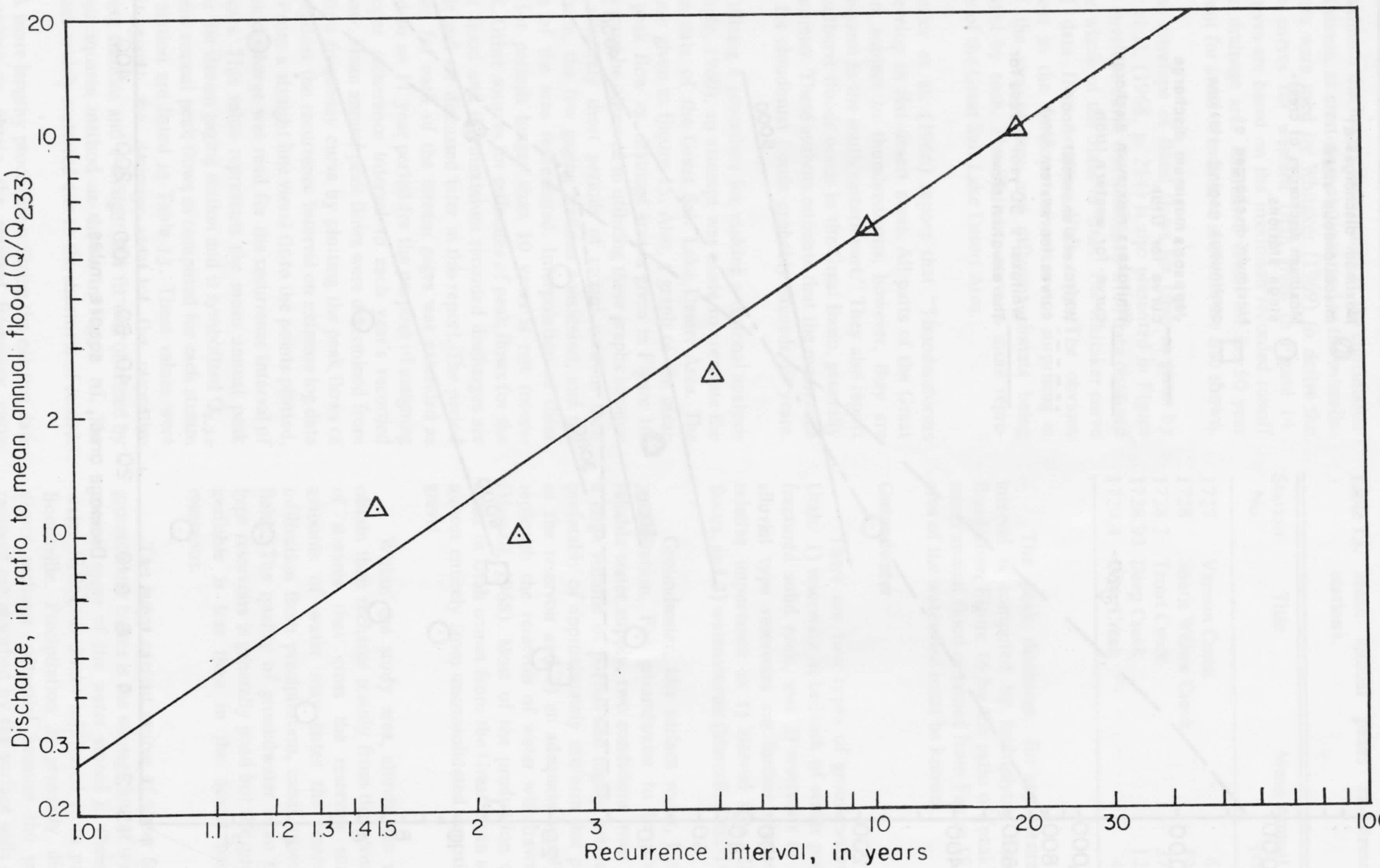


Figure 15. Regional frequency curve for the Great Salt Lake Desert Area. (Method of computation taken from Dalrymple, 1960.)

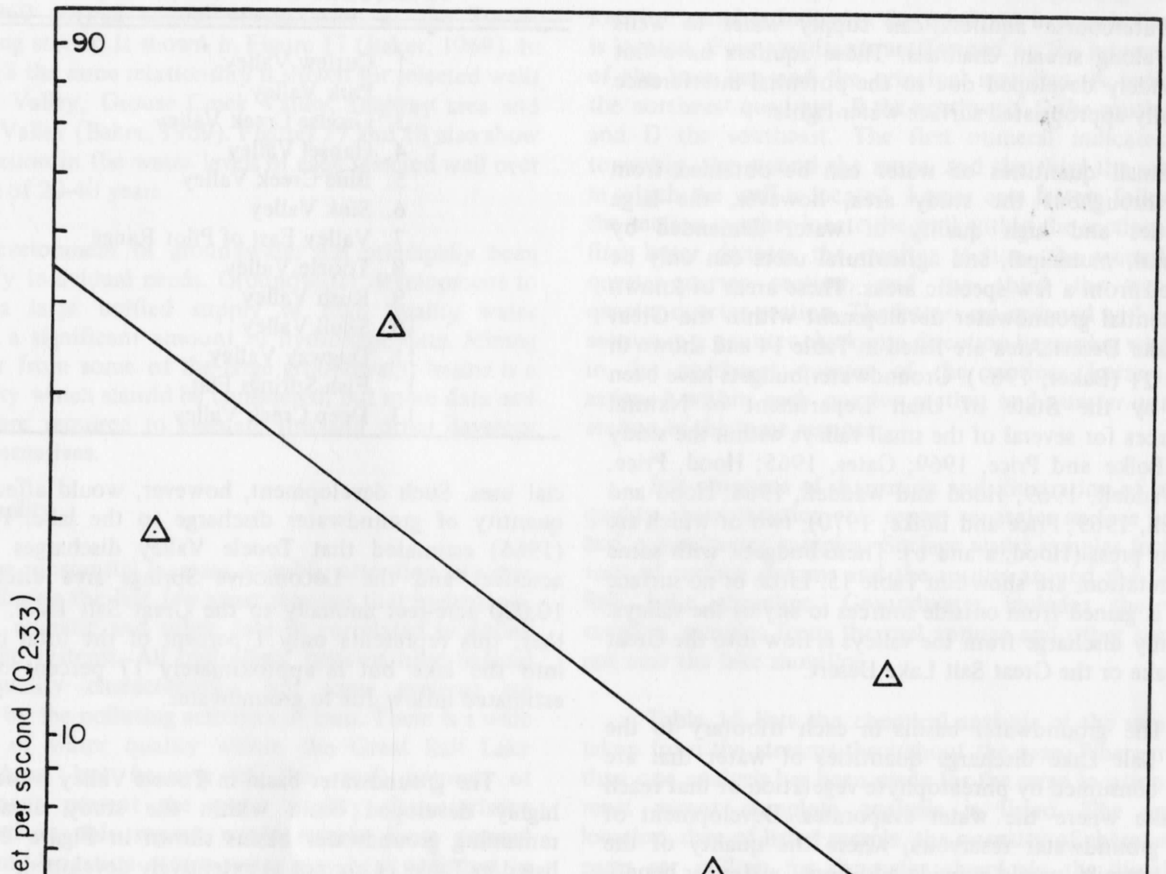


Figure 16. Regional mean annual flood versus drainage area curve.

water in the central portions of a desert valley is often poor due to high concentrations of salts.

Watercourse aquifers can supply water to wells drilled along stream channels. These aquifers have not been widely developed due to the potential interference with fully appropriated surface water rights.

Small quantities of water can be obtained from wells throughout the study area, however, the large quantities and high quality of water demanded by industrial, municipal, and agricultural users can only be supplied from a few specific areas. These areas of known or potential groundwater development within the Great Salt Lake Desert Area are listed in Table 14 and shown in Figure 21 (Baker, 1969). Groundwater budgets have been made by the State of Utah Department of Natural Resources for several of the small valleys within the study area (Bolke and Price, 1969; Gates, 1965; Hood, Price, and Waddell, 1969; Hood and Waddell, 1968; Hood and Waddell, 1969; Price and Bolke, 1970), two of which are now in press (Hood, a and b). These budgets, with some interpretation, are shown in Table 15. Little or no surface water is gained from outside sources to any of the valleys. The only discharge from the valleys is flow into the Great Salt Lake or the Great Salt Lake Desert.

The groundwater basins in each tributary to the Great Salt Lake discharge quantities of water that are either consumed by phreatophyte vegetation or that reach the lake where the water evaporates. Development of these groundwater reservoirs, where the quality of the water permits, would provide additional water for beneficial uses. Such development, however, would affect the quantity of groundwater discharge to the lake. Palmer (1966) estimated that Tooele Valley discharges 7,000 acre-feet and the Locomotive Springs area discharges 10,000 acre-feet annually to the Great Salt Lake. Together, this represents only 1 percent of the total inflow into the lake but is approximately 17 percent of the estimated inflow due to groundwater.

Table 14. Areas of known or potential groundwater development within the Great Salt Lake Desert Area. (Taken from Baker, 1969.)

1. Curlew Valley
2. Park Valley
3. Grouse Creek Valley
4. Hansel Valley
5. Blue Creek Valley
6. Sink Valley
7. Valley East of Pilot Range
8. Tooele Valley
9. Rush Valley
10. Skull Valley
11. Dugway Valley
12. Fish Springs Flat
13. Deep Creek Valley

The groundwater basin in Tooele Valley is the most highly developed basin within the study area. The remaining groundwater basins shown in Figure 21 and listed in Table 14 are not as extensively developed.

Table 15. Summary of groundwater budgets of subareas within the Great Salt Lake Desert Area.

Location	Recharge				Discharge				
	Surface flow from outside of valley	Under-flow	Precipi-tation	Total	Evapotran-spiration	Surface flow out of valley	Subsur-face	Pumpage	Total
Curlew Valley	neg	36,000 Idaho	3,600	39,600	34,000	6,000	neg	10,000	50,000[a]
Hansel Valley			8,000	8,000	7,600	2,400	1,000		11,000[a]
Sink Valley (inc. No. Valley & West Shore)	neg	100	1,700	1,800	2,560	neg	100	38	2,700[a]
Skull Valley	neg		47,000	47,000	30,000	4,400	2,200	5,000	41,600
Tooele Valley (tentative)	neg	neg	200,000	200,000	80,000	10,000	100,000	10,000	200,000
Rush Valley	neg		34,000	34,000	27,000	0	5,000	4,800	37,000[a]
Deep Creek Valley	neg		17,000 inc. Nev.	17,000	15,000	1,000	neg	600	17,000
Park Valley					16,000		8,000	500	24,000

[a]The respective water budget report shows water being mined or lack of accurate estimates of quantities.

The relation of water levels in selected wells in Tooele Valley to the cumulative departure from the 1931-1960 normal annual precipitation at the Tooele measuring station is shown in Figure 17 (Baker, 1969). In Figure 18 the same relationship is shown for selected wells in Park Valley, Grouse Creek Valley, Dugway area and Curlew Valley (Baker, 1969). Figures 17 and 18 also show the variation in the water levels of each selected well over a period of 20-40 years.

Development of groundwater has principally been to satisfy individual needs. Groundwater development to obtain a large unified supply of high quality water requires a significant amount of hydrologic data. Mining of water from some of the large groundwater basins is a possibility which should be considered, but more data and studies are required to evaluate this and other development alternatives.

Water quality

The substantial increase in public attention to water quality during the last few years requires that hydrologic, geologic, climatic and other data be correlated to define hydrologic systems. All hydrologic systems have natural water quality characteristics, but some systems are affected by the polluting activities of man. There is a wide variance of water quality within the Great Salt Lake Desert Area, but because of the small amount of development present the water quality characteristics considered in this report result largely from natural conditions. Irrigation return water may be a pollutant in isolated cases.

Terms used in this report are defined as follows:

Dissolved solids is the total content of dissolved material in the water. It is determined by weighing the residue remaining after a sample has been evaporated at 180°C, or it is calculated from the sum of the weights of the determined constituents.

pH (hydrogen-ion concentration) is a measure of the degree of acidity or alkalinity. A pH of 7.0 indicates that the water is neither acid nor alkaline. As pH values decrease from 7.0 the acidity increases; and as pH values increase from 7.0 the alkalinity increases.

Parts per million (ppm) is a unit expressing the concentration of chemical constituents by weight, usually as grams of constituents per million grams of a solution.

A system of locating known water sampling sites, is based on the U.S. Bureau of Land Management's system of land subdivision as used by the Utah State Engineer for numbering wells. The numbering system is illustrated in Figure 19. The number shows the location of the site by quadrant, township, range, section, and position within the section. The capital letter at the beginning of the location number indicates the quadrant in which the site is located. Four quadrants are formed by the intersection of the base line and the principal meridian—A indicates the northeast quadrant, B the northwest, C the southwest, and D the southeast. The first numeral indicates the township, the second the range, and the third the section in which the well is located. Lower case letters following the section number locate the well within the section. The first letter denotes the quarter section, the second the quarter-quarter section, and the third the quarter-quarter-quarter section. The letters are assigned within the section in a counter-clockwise direction beginning with (a) in the northeast quarter of the section. Letters are assigned within each quarter section and quarter-quarter section in the same manner.

For purposes of discussion and illustration of water quality characteristics, this report separates surface water and groundwater samples. Surface water samples include tests of surface streams and the springs around the Great Salt Lake shoreline. Groundwater includes the well samples, samples from thermal springs and other springs not near the lake shoreline.

Table 16 lists the chemical analysis of the samples taken from the streams throughout the area. Where more than one analysis has been made for the same location the most recent complete analysis is listed. The name, location, date of listed sample, the quantity of chemical in parts per million for six major chemicals, the dissolved solids content, and the pH are given.

The surface waters analyzed vary in dissolved solids from 38 to 17,200 ppm. Eliminating those samples near the Great Salt Lake and its salt flats, the range in dissolved solids is 38 to 1,170 ppm with the majority of samples ranging between 100 and 250 ppm. Some of the stream analyses were made several years ago and the chemical quantities in the streams may have changed subsequently.

The results of the analysis from the Deep Creek Valley may be considered typical for most of the study area (Hood and Waddell, 1969). The watersheds in the mountains, such as the Steves Creek and Sams Creek, are relatively non-polluted chemically. The water gradually gains in chemical constituents as it flows toward the valley floor. This occurs naturally as water is lost to evapotranspiration and as other uses return their unconsumed portions of water to the stream.

Water quality data are given in Table 17 for the various samples taken from springs around the Great Salt Lake shoreline. Comparison of the dissolved solids column of Table 17 with that of Table 16 indicates that these shoreline springs have a very high chemical content. In 1961 the weighted average of the dissolved solids contributed to the Great Salt Lake by these springs was

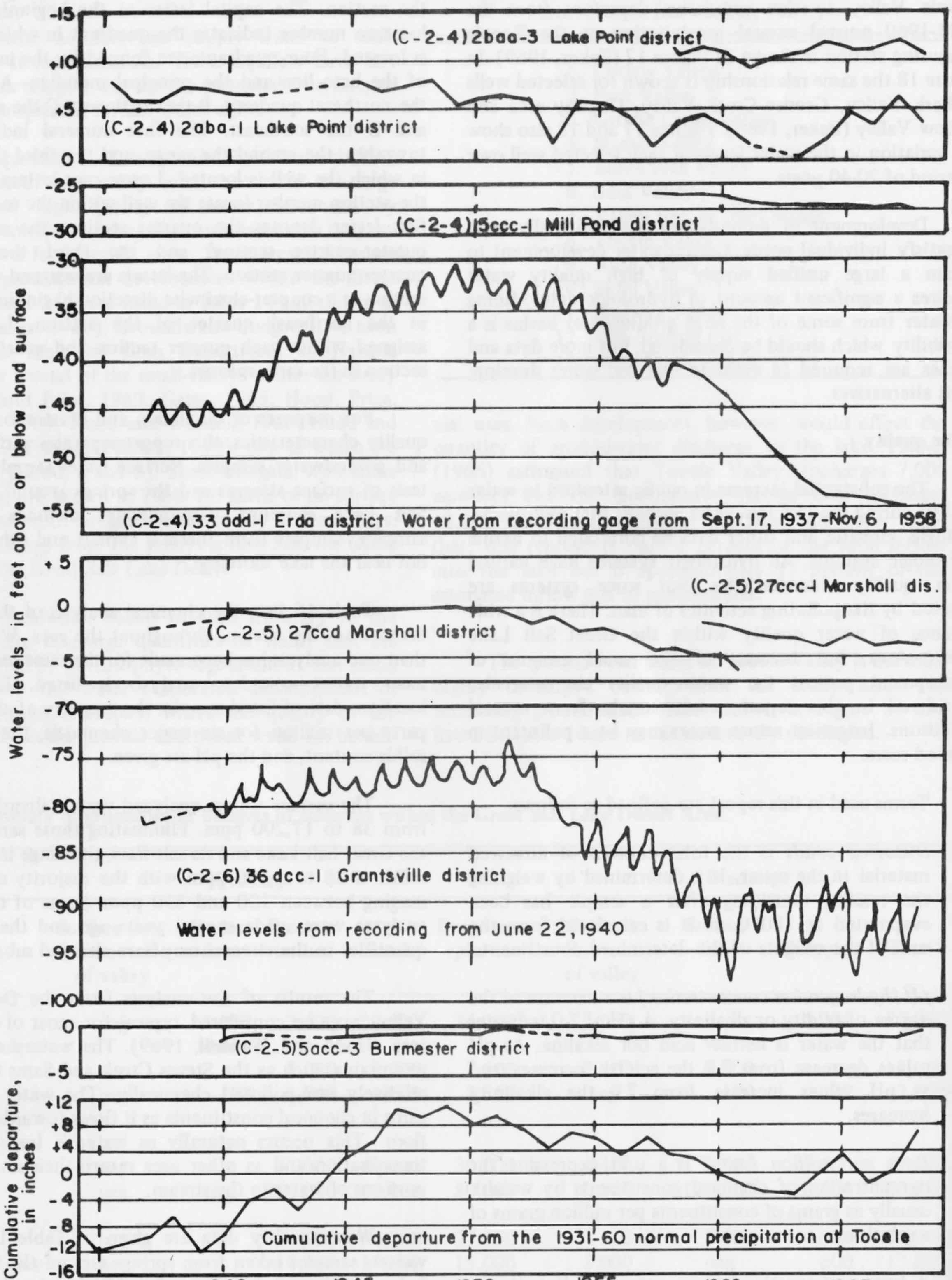


Figure 17. Water levels in selected wells in Tooele Valley. (Taken from Baker, 1969.)

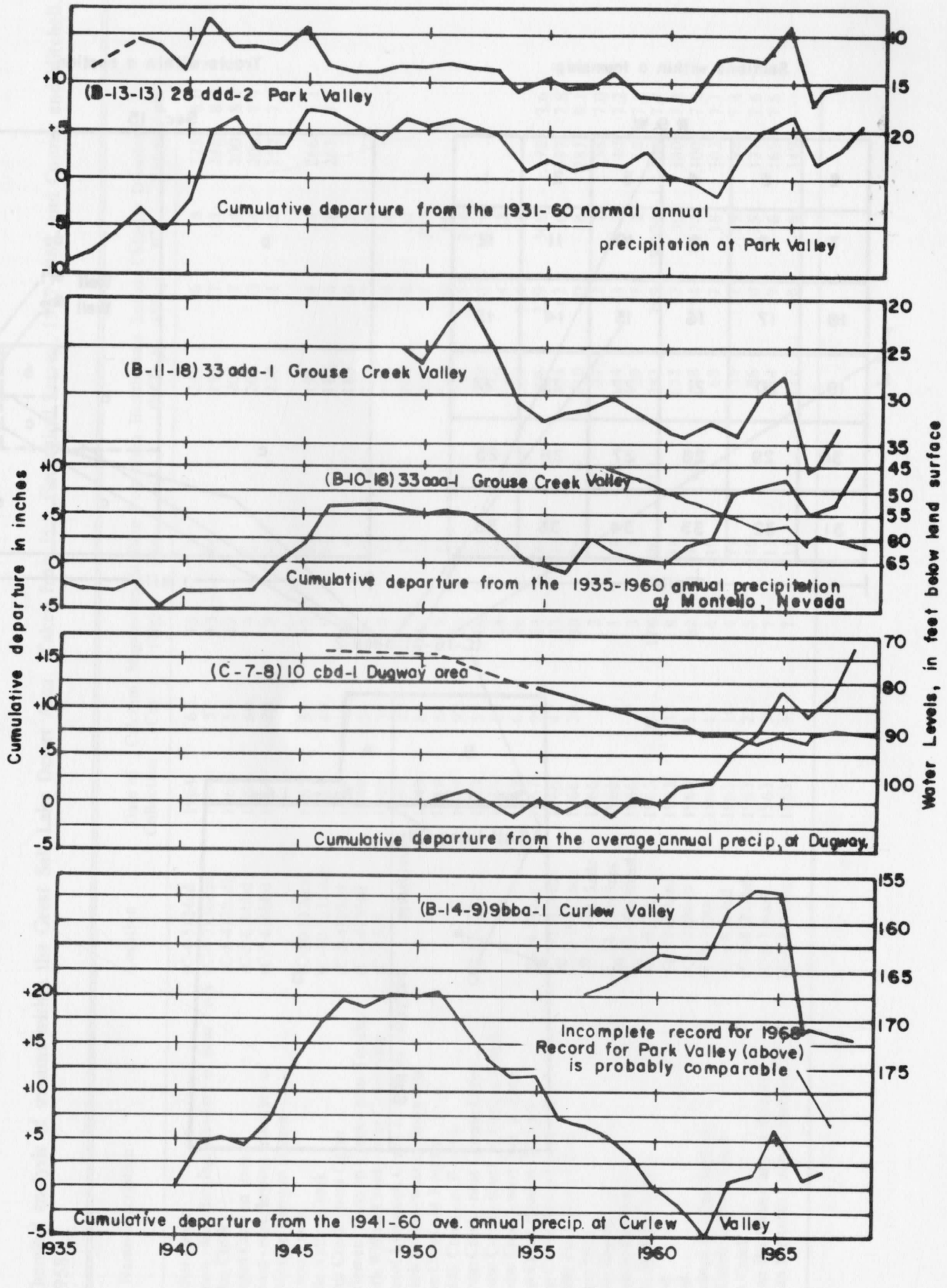


Figure 18. Water levels in wells within selected valleys. (Taken from Baker, 1969.)

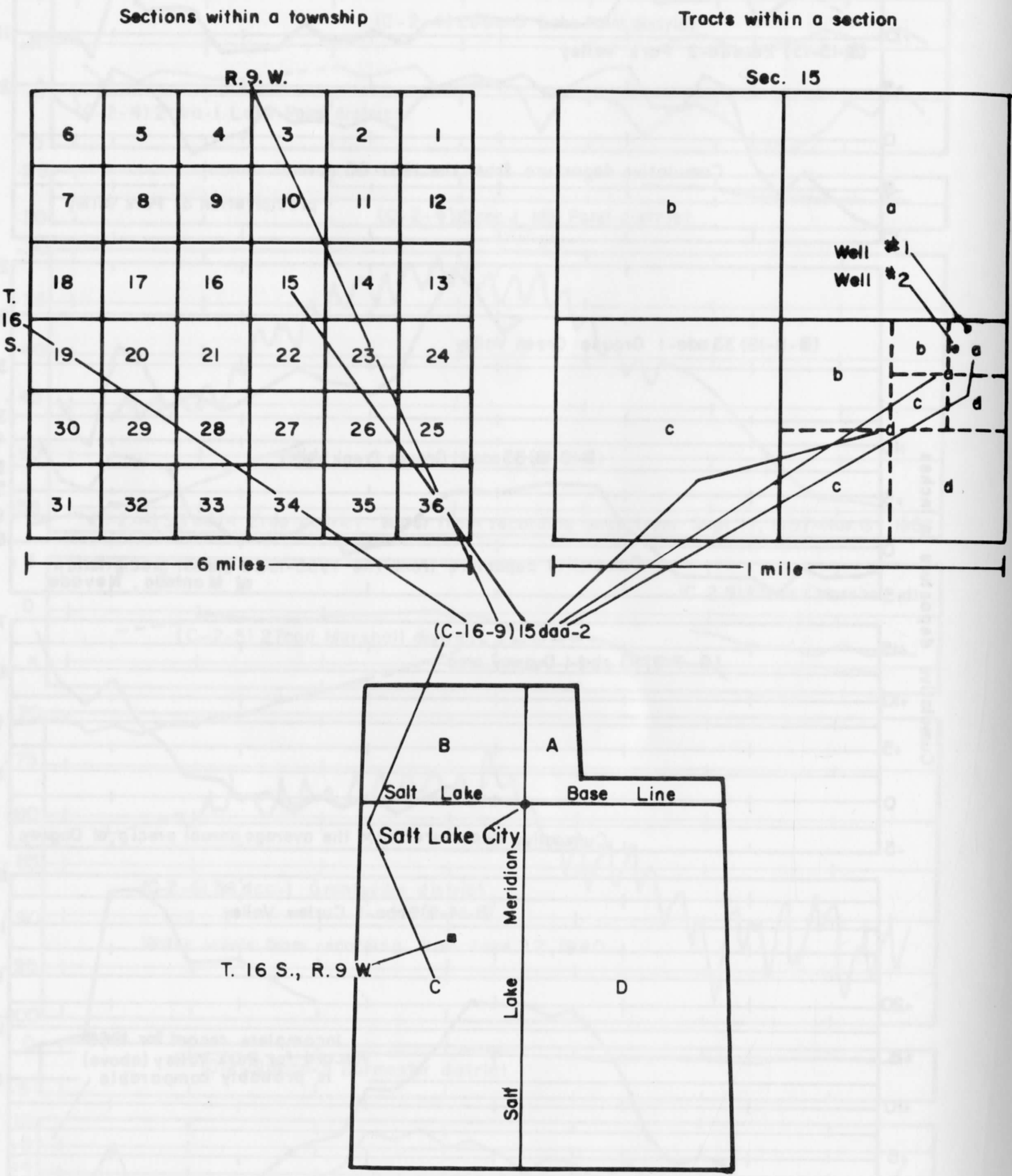


Figure 19. Water sampling site numbering system.

Table 16. **Chemical analysis of streams within the Great Salt Lake Desert Area. (Taken from U.S. Geological Survey, 1967-1969, and Conner and Mitchell, 1958.)**

Name-Description	Location	Date of Collection	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved Solids	pH
Soldier Creek	(C-4-5)24cd	1964	62	15	6	1	245	16	8	225	8.0
Stream–east flowing tributary of Bear Fork	(C-4-7)36daa	1964	57	13	16	1	199	27	27	248	8.0
Ophir Creek	(C-5-4)28cdb	1965	55	12	8	-	204	17	14	200	8.2
Morgan Canyon stream	(C-5-6)bbbd	1964	60	7	11	1	202	13	14	206	7.9
Stream–east flowing tributary of Morgan Canyon stream	(C-5-6)6bbd	1964	70	9	11	1	239	21	15	252	7.9
Vernon Creek	(C-10-5)2cca	1965	51	13	22	1	196	24	34	266	8.1
Little Valley Creek	(C-10-5)11dcc	1965	49	9	19	1	182	18	28	267	7.7
Ophir Creek–near Ophir	(C-5-4)23ad	1949	43	10	6	2	185	10	6		
Settlement Canyon Creek–near Tooele	(C-3-4)33ad	1949	54	14	13	2	234	17	16		
South Willow Creek–near Grantsville	(C-3-5)7	1949	38	9	11	2	154	10	14		
Deseret Livestock Creek near Skull Valley		1949	23	6	15	2	103	8	20		
Curlew Creek–west of Snowville		1949	81	46	226	19	321	237	302		
Dove Creek–at Rosette		1949	54	9	42	6	212	20	66		
Muddy Creek–at Rosette		1949	92	25	132	18	332	55	214		
Grouse Creek–near Grouse Creek	(B-11-18)2	1949	57	18	31	7	288	33	29		
Grouse Creek–south of Grouse Creek		1949	52	14	18	4	220	34	22		
Grouse Creek–west fork at Etna		1949	62	26	112	16	387	104	82		
Deep Creek (Curlew Valley)	(B-14-8)2cc	1967	99	54	229	13	306	229	368	1,170	7.6
Deep Creek (Deep Creek Valley)	(C-8-19)34caa	1966	42	33	40	7	254	62	36	397	7.8
Middle Fork Deep Creek	(C-9-19)21acc	1966	20	30	26	4	210	30	18	281	8.1
Sams Creek	(C-11-19)15adc	1966	5	2	3	1	27	2	1	38	7.0
Steves Creek	(C-11-19)15ccc	1966	8	1	4	1	34	3	2	40	7.2
Fifteenmile Creek	(C-11-19)28bad	1966	7	3	5	1	39	7	2	58	7.2
Delle Springs Creek	(C-1-8)2cd	1965	234	178	5,790	212	282	769	9,070	17,200	7.7
Canal	(C-3-7)30dac	1963	33	8	18	1	132	12	30	180	7.2
Canal	(C-3-8)9ddb	1963	152	62	1,990	68	208	294	3,220	6,100	7.2
Antelope Canyon Stream	(C-4-7)30c	1963	17	4	10	1	69	7	18	102	7.1
Big Creek Canyon Ditch	(C-4-8)12ad	1963	16	4	11	1	59	7	19	98	7.4
Lost Creek	(C-4-8)22abd	1963	22	5	16	1	86	10	25	131	7.6
Indian Hickman Canyon Stream	(C-5-7)6aa	1963	38	7	11	1	154	9	16	165	7.6
Indian Hickman Canyon Stream	(C-5-8)11acc	1965	35	7	11	1	122	8	16	149	-

Table 17. Chemical analysis of springs on shoreline of the Great Salt Lake. (Taken from Hahl and Mitchell, 1963.)

Name-Description	Location	Date of Collection	Calcium (Ca) PPM	Magnesium (Mg) PPM	Parts Per Million Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved Solids	pH
Blue Spring Creek–at bridge on St. Hwy. 83	(B-11-5)32	1961	184	126	2,540	65	551	715	3,740	7,690	8.0
Duck Spring–10 mi south of Kelton	(B-10-11)8	1960	168	134	2,780	102	134	313	4,740	8,340	6.9
Mos Spring–7 mi south of Kelton	(B-11-11)33	1960	200	182	3,560	158	249	386	6,120	10,800	7.4
Skull Spring–6 mi south of Kelton	(B-11-11)19	1960	322	169	6,700	241	299	738	11,000	19,400	7.5
Twenty-one Seeps–5 mi southwest of Kelton	(B-11-11)7	1960	586	168	8,430	346	202	327	14,600	24,600	7.4
Black Butte Springs–3 mi southwest of Kelton	(B-11-11)6	1960	516	123	6,650	273	204	222	11,500	19,400	7.2
West Locomotive Spring	(B-12-10)36	1960	122	52	861	60	208	93	1,570	2,920	7.6
Baker Spring–in Locomotive Springs area	(B-12-10)36	1960	125	54	483	28	216	87	960	1,890	7.5
West Lake–in Locomotive Springs area	(B-11-10)11	1960	127	52	748	51	206	99	1,390	2,610	7.6
Bar M Spring–in Locomotive Springs area	(B-11-10)1	1960	127	69	910	35	209	118	1,640	3,050	7.7
Teal Spring–in Locomotive Springs area	(B-11-10)12	1960	119	67	1,330	56	210	155	2,280	4,140	7.9
Sparks Spring–in Locomotive Springs area	(B-11-9)5	1960	109	66	1,130	51	225	152	1,970	3,620	7.6
East Lake–in Locomotive Springs area	(B-11-9)7	1960	186	179	3,440	140	59	389	5,970	10,400	7.6
Large Spring–near abandoned salt plant 3 mi east of Locomotive Springs area	(B-11-9)10	1960	611	1,040	27,100	1,070	105	2,670	43,700	76,400	6.5
Small Spring–near abandoned salt plant 3 mi east of Locomotive Springs area	(B-11-9)10	1960	533	916	23,100	934	69	2,300	37,800	65,800	6.9
Hansel Creek–at Hwy 83	(B-11-8)2	1960	125	73	2,270	75	312	172	3,770	6,660	7.6
Spring–east side Promontory Point	(B-7-5)16	1960	96	50	1,150	42	245	172	1,850	3,500	8.2
Yogurt Springs–at St. Hwy 83	(B-10-5)11	1959	853	327	10,900	526	447	153	19,400	32,400	6.6
Mill Pond Spring–at U.S. Hwy 40, at Mills Junction	(C-2-4)16	1961	99	47	315	8	272	253	460	1,340	8.1
Spring–13 mi east of Big Spring, near Timpie	(C-1-7)10	1960	211	117	4,420	155	225	504	7,060	12,600	7.4
Big Spring–at Timpie	(C-1-7)9	1961	144	88	2,890	103	218	352	4,720	8,430	7.8

estimated as 6,300 ppm or 326,000 tons per water year. This represented 19 percent of the total dissolved solids added to the lake that year. Most of the dissolved solids added by springs were sodium or chloride (Hahl and Langford, 1964).

Figure 20 shows the locations of the surface water samples previously described. It also shows the vast areas in which surface water quality has not been analyzed.

The range of dissolved solids concentration in groundwater is from zero to several thousand parts per million in the study area. Feth (1966, p. D237) in referring to the Great Basin reports, "In the lower ranges of concentration the waters are typically of calcium or sodium bicarbonate types. In the higher ranges, sodium or calcium sulfate or chloride types dominate." Most of the valleys in the area produce some potable groundwater.

Within the Great Salt Lake Desert Area are located 12 major thermal springs. Mundorff (1970) gives the chemical analysis, the temperature and estimated discharge of each of the thermal springs. The location and temperature of these springs are shown in Table 18. These springs have a definite relation to the geologic faults of the area. Mundorff discusses and illustrates this point in his report.

Chemical data are sparse for the area as some basins are represented by only 2 or 3 separate analyses. In general, the number of analyses available varies with the degree of development of man's use of the groundwater (Feth, 1966). Tooele Valley has by far the most complete analysis of groundwater quality.

Figure 21 shows the location and chemical quality of selected well and spring samples and the location of the thermal springs. These samples were selected by their location and the completeness of analysis to give only a representative overview of the groundwater quality of the recognized groundwater basins.

Several authors have listed analyses of groundwater within the study area. (See Connor and Mitchell, 1958; Bolke and Price, 1969; Gates, 1965; Hood, Price, and Waddell, 1969; Hood and Waddell, 1968, 1969; Price and Bolke, 1970; and Waddell, 1967.)

Table 18. Major thermal springs within the Great Salt Lake Desert Area. (Taken from Mundorff, 1970, and Milligan, Marsell, and Bagley, 1966.)

Name of Spring	Location	Temperature (°F)
1. Unnamed Hot Spring	(B-11-19)11 dda	107°
2. Warm Spring	(B-12-15)19 aab	80°
3. Blue Warm Spring	(B-13-5)29	80°
4. Big Warm Spring	(C-1-7)8 & 9	
5. Grantsville Warm Springs	(C-2-6)16 aad	76°
6. Morgans Warm Springs	(C-5-5)9 cba	80°
7. Russells Warm Springs	(C-5-5)17 aaa	72°
8. Wilson Hot Springs	(C-10-14)33	141°
9. Fish Springs	(C-11-14)23 c	82°
10. Fish Springs	(C-11-14)23 db	77°
11. Fish Springs	(C-11-14)23 dc	65°
12. Fish Springs	(C-11-14)23 dd	72°

Figure 20. Surface water quality sampling sites within the Great Salt Lake Desert Area.

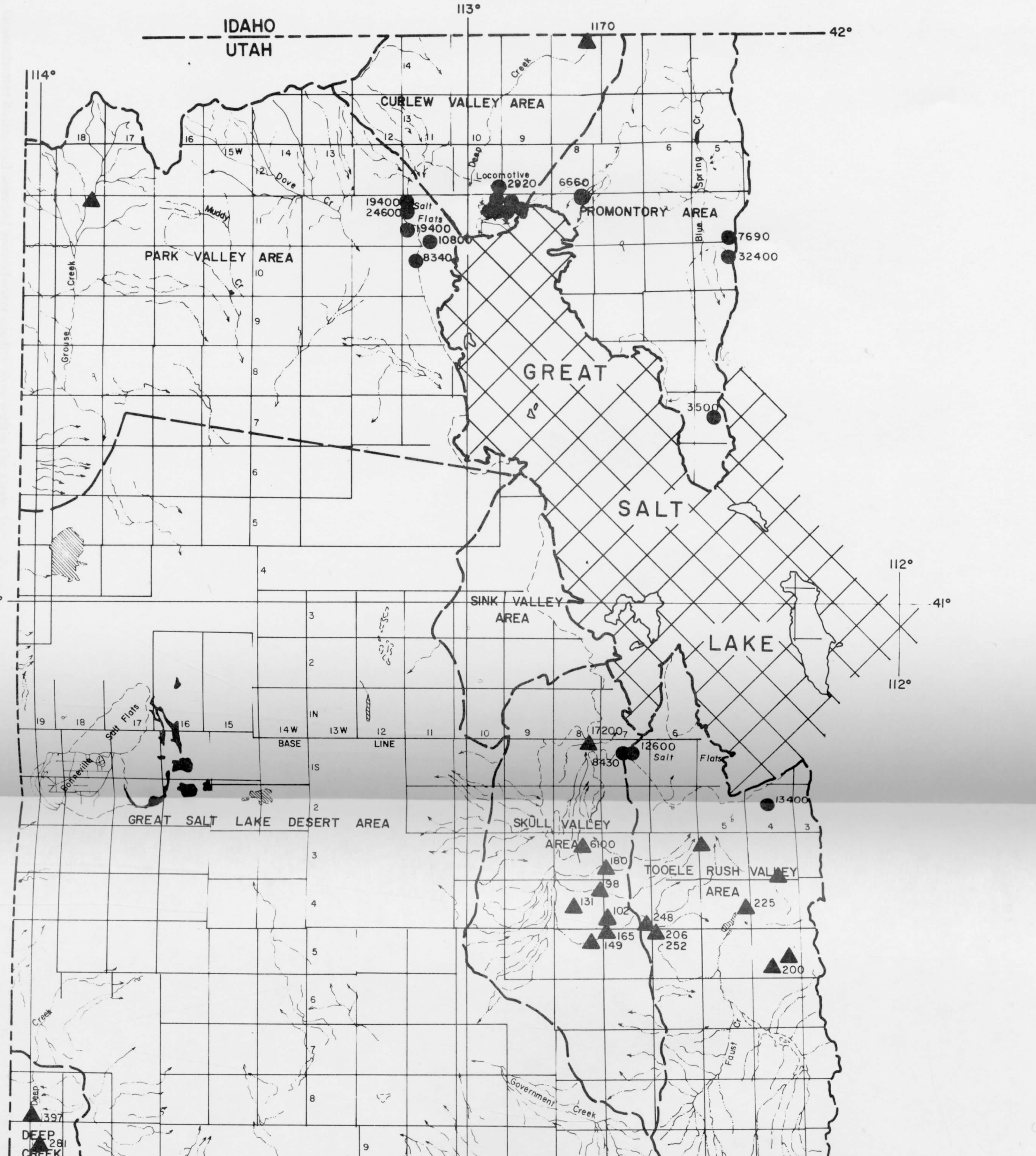
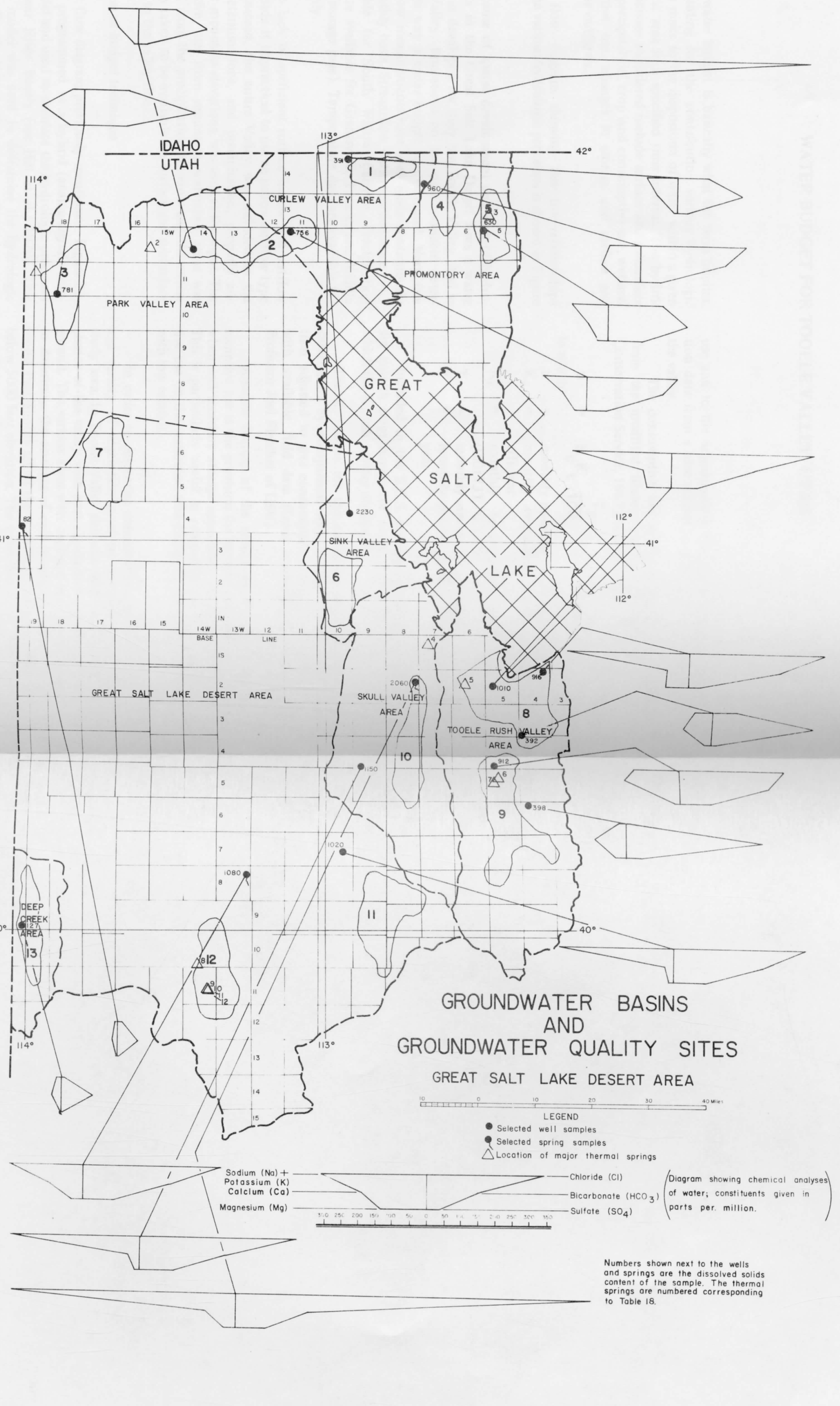

SURFACE WATER QUALITY SAMPLING SITES
GREAT SALT LAKE DESERT AREA
Numbers shown next to each sampling site are the dissolved solids content of the sample.
LEGEND
Rivers and streams
Sampling site of spring-water
Sampling site on stream
10 0 10 20 30 40 Miles
IDAHO
UTAH
113°
114°
112°
42°
41°
40°
CURLEW VALLEY AREA
PARK VALLEY AREA
PROMONTORY AREA
GREAT SALT LAKE
SINK VALLEY AREA
GREAT SALT LAKE DESERT AREA
SKULL VALLEY AREA
TOOELE RUSH VALLEY AREA
DEEP CREEK AREA
FISH SPRINGS FLAT
BASE LINE
Locomotive
Salt Flats
Bonneville Salt Flats
Grouse Creek
Dove Cr
Muddy Cr
Deep Creek
Blue Spring Cr
Government Creek
Faust Cr
Dry Lake Creek
1170
2920
6660
19400
24600
19400
10800
8340
7690
32400
3500
17200
8430
12600
13400
6100
180
98
131
102
165
149
248
206
252
225
200
266
267
397
281
38
40
58

Figure 21. Groundwater basins and selected groundwater quality sites within the Great Salt Lake Desert Area.


GROUNDWATER BASINS
AND
GROUNDWATER QUALITY SITES
GREAT SALT LAKE DESERT AREA
LEGEND
Selected well samples
Selected spring samples
Location of major thermal springs
Sodium (Na) + Potassium (K)
Calcium (Ca)
Magnesium (Mg)
Chloride (Cl)
Bicarbonate (HCO3)
Sulfate (SO4)
Diagram showing chemical analyses of water; constituents given in parts per million.
Numbers shown next to the wells and springs are the dissolved solids content of the sample. The thermal springs are numbered corresponding to Table 18.
IDAHO
UTAH
CURLEW VALLEY AREA
PROMONTORY AREA
PARK VALLEY AREA
GREAT
SALT
LAKE
SINK VALLEY AREA
GREAT SALT LAKE DESERT AREA
SKULL VALLEY AREA
TOOELE RUSH VALLEY AREA
DEEP CREEK AREA

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WATER BUDGET FOR TOOELE VALLEY, UTAH

A water budget is basically what the term implies, an accounting for the contribution various hydrologic processes make to the disposition of water within a given geographic area in a specified time interval. The hydrologic processes considered include surface and subsurface inflows, precipitation, crop land consumptive use, wetland consumptive use, changes in storage and surface and subsurface outflows.

A flow diagram showing the interrelationships among the various hydrologic processes is shown in Figure 22.

Because of sparse development and lack of hydrologic data in the Great Salt Lake Desert Area a water budget was developed for only the Tooele Valley. And in Tooele Valley, limitations on the data available determined the way a water budget was obtained. Very few stream flow measurements have been made continuously on a monthly basis. Streamflow data recorded since 1963 is available for South Willow Canyon. Precipitation records are available for Grantsville, Tooele, and Middle Canyon (storage gage). Temperature data are available for Tooele only.

The lack of sufficient surface inflow and outflow records made it impractical to use an inflow-outflow type budget. Instead, the entire Valley was included in the budget determinations, and precipitation, properly adjusted for mountain elevations, was used as the input. The consumptive use from mountain watershed areas was estimated from the precipitation amounts and the excess water was taken to be available for surface and subsurface discharge to the valley floor.

Description of budget technique

The flow diagram previously mentioned, Figure 22, has been programmed as a hybrid (analog-digital) computer model and used to simulate the hydrologic processes in the Bear River Basins (see Hill et al., 1970). This computer model was used to determine the hydrologic budget in Tooele Valley after proper adjustments were made to fit the new locations.

The principal features of the model applicable to this study pertain to the determination of consumptive use and to the adjustment of temperature and precipitation data from a base station to other elevation zones in the valley.

The consumptive use in the model is determined from the modified Blaney-Criddle equation (U.S. Soil Conservation Service, 1967). Briefly this is:

$$u = K_c K_t \frac{T_P}{100}$$

in which

u = monthly potential evapotranspiration

K_c = monthly vegetation growth stage coefficient

K_t = monthly temperature coefficient = (0.0173T - 0.314)

T = monthly average temperature

P = monthly percent daylight hours of the year

Included in the S.C.S. publication referenced also are growth stage curves for many different crops from which the K_c values were obtained.

The K_c values for the watershed vegetation were determined by comparison with similar crop types and then adjusted to give consumptive use values consistent with available field data (from unpublished work by Professor Joel Fletcher of USU).

Another feature of the model which affects consumptive use is the provision for limiting consumptive use when soil moisture storage approaches the wilting point. This is particularly useful in estimating actual consumptive use on the watershed area during the summer months with low rainfall.

In order to determine consumptive use the acreage and variety of vegetation must be determined for the study area. In Tooele Valley this was done by using aerial photos of the valley with spot checks being made on the ground. The various areas were outlined and planimetered to determine the acreages of each vegetative type. It was found that almost all of the agricultural crop areas were below 5000 feet elevation. The watershed above 5000 feet was divided into sub-areas consisting of 1000 feet elevation zones. For example the area between 5000 feet and 6000 feet elevation was taken to be one of sub-areas. These were further categorized as to whether the zone was on the west side or the east side of the valley. To

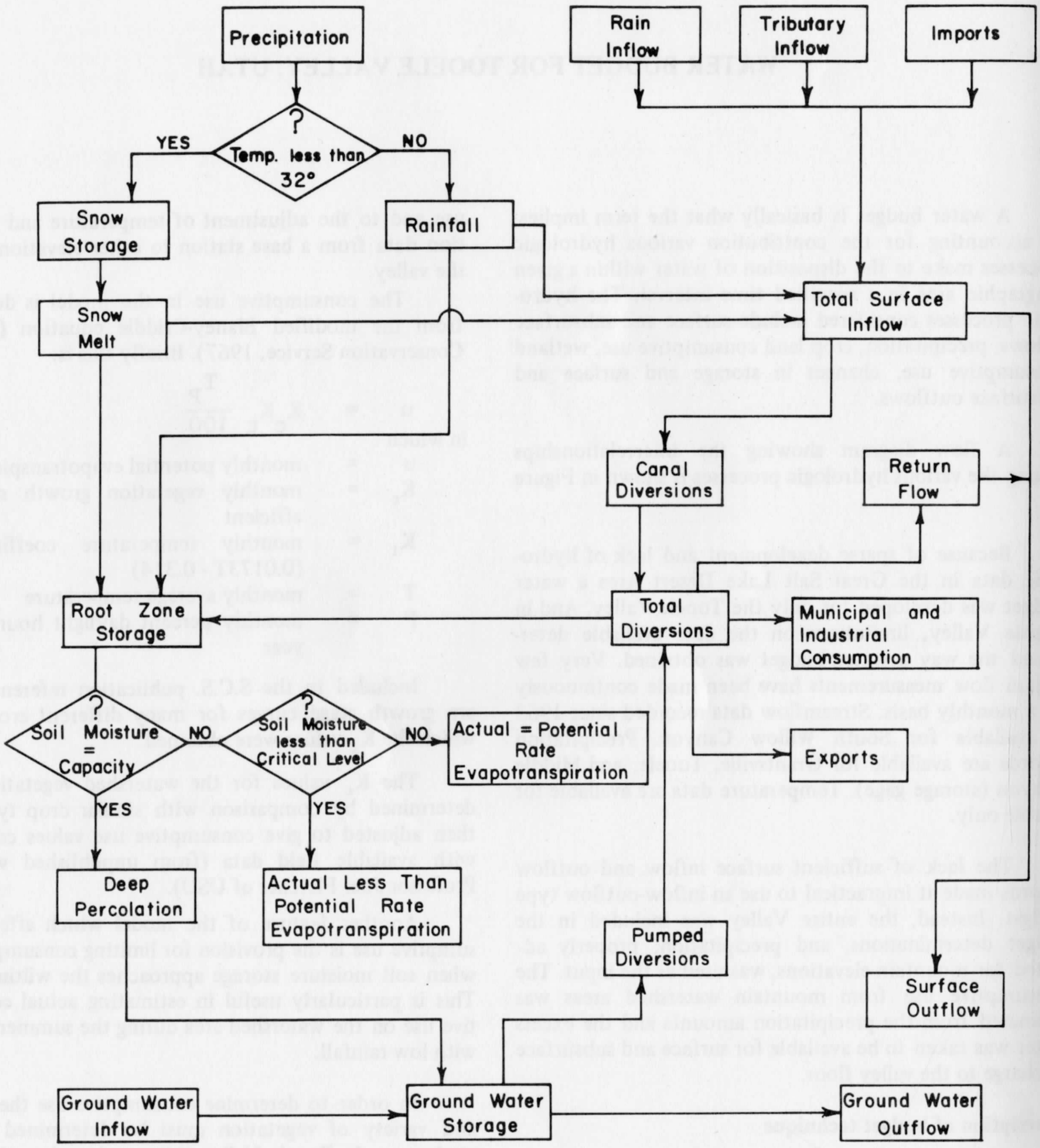

Figure 22. Flow diagram for hydrologic flow system.

determine the monthly temperatures on the watershed zones or sub-areas, the monthly data at Tooele was adjusted to the zone average elevation by use of a temperature lapse rate. For the east side a decrease of 3°F per 1000 feet of elevation increase was used. This is a combination of normal and wet adiabatic lapse rates and is considered to represent conditions on the mountains on the east side. For the mountain areas on the west side the dry adiabatic lapse rate is considered to be representative and a decrease of 5°F per 1000 feet elevation increase was used.

A precipitation depth versus elevation relationship was developed for the east side of the valley using annual data from the Grantsville, Tooele, and Middle Canyon measurements. This was compared with data from Gates (1965, Figure 2.) Very close agreement was found and the relationship was used in the study to estimate the precipitation on the various zones. A similar result was obtained for the west side of the valley.

The base stations used for precipitation were Tooele on the east side and Grantsville on the west side.

Precipitation and temperature data were assembled by months for the year 1963 - 1969, and the model was operated using these data for the seven years indicated. Averages of the annual values thus obtained were used for the budget determination, as presented in Table 19.

Discussion of water budget

The values presented in the water budget must be considered only as reasonable estimates of the actual condition because of the data limitations previously mentioned.

The outflow from the watershed and non-cropland areas was considered to be available as inflow to the cropland and wetland areas. No attempt was made to differentiate between subsurface and surface inflows or outflows. Since the monthly distribution of pumped diversions for irrigation use was not known, the consumptive use deficit of 9,000 acre-feet from the cropland may be much higher than the actual deficit. The outflow of 76,000 acre-feet from the cropland and wetland areas represents the net unconsumed water in the entire valley excluding wetlands at edge of lake (north of north boundary to T2S, R4W; T2S, R5W; and T2S, R6W row.) From consideration of subsurface and surface outflow conditions in the northern end of the valley and groundwater conditions throughout the valley, it appears that this outflow amount of 76,000 acre-feet may be almost entirely in the groundwater system. (See Gates, 1965.)

Table 19. Tooele Valley water budget.[a]

Division	Area Acres	Potential Consumptive Use (Ac-Ft)	Actual Consumptive Use (Ac-Ft)	Precipitation (Ac-Ft)	Inflow from Other Areas (Ac-Ft)	Outflow (Unconsumed Water) (Ac-Ft)
Westside Watershed	59,300	80,000	60,000	93,000	---	33,000
Eastside Watershed	51,400	82,000	68,000	138,000	---	70,000
Non-Cropland Below 5000 ft.	85,000	146,000	97,000	105,000	---	80,000
Total	195,700	308,000	225,000	336,000	---	111,000
Cropland	12,900	37,000	28,000	16,000		
Wetland	12,200	38,000	38,000[b]	15,000	111,000[c]	76,000[c]
Total	25,100	75,000	66,000	31,000	111,000	76,000

[a]As represented by the average annual values for the years 1963-1969.

[b]Wetlands are allowed to consume water at the potential rate.

[c]Cropland and wetland were combined for inflow and outflow values.

WATER MANAGEMENT ASPECTS

Much of the land in the Great Salt Lake Desert area is owned by the state or federal government. Although land uses in this relatively dry region include some that are non-agricultural, grazing and dry farm operations are the principal activities.

Since supplies of water from streams and springs in general are fully appropriated, future development, agricultural or otherwise, will depend upon water from wells or importation. Agricultural development based on existing groundwater supplies is possible in some of the valleys, but soil conditions and groundwater quality will be important factors in determining the extent. Furthermore, steep slopes and unevenness of land surface are constraints to development of large acreages of land that might otherwise be suitable for agriculture. Recent interest in mineral extraction from the Great Salt Lake makes some of the desert lands adjoining the lake potential industrial sites. Coupled with future water requirements for agricultural and industrial growth, of course, would be a minimal requirement to support attendent population growth.

To correctly assess development potentials in the Great Salt Lake Desert, a great deal more should be learned about the land and water resources. Detailed water resources and geologic investigations are needed to refine current estimates of available resources. This is particularly true for the numerous groundwater aquifers located in the desert. The feasibility of any water importation schemes for the area should be carefully evaluated within the framework of a statewide development plan.

Data gathering activities and studies may be expensive, and costs of such should be weighed against the potential benefits of developing the area.

LITERATURE CITED

Bagley, Jay M., Roland W. Jeppson, and Cleve H. Milligan. 1964. Water Yields in Utah. Developing a State Water Plan. Special Report 18, Agricultural Experiment Station, Utah State University, Logan, Utah. 65 p.

Baker, C.H., Jr. 1969. Developing a State Water Plan. Ground-water Conditions in Utah, Spring of 1969. Cooperative Investigations Report No. 7. Prepared by the U.S. Geological Survey in cooperation with the State of Utah Department of Natural Resources, Salt Lake City, Utah. 61 p.

Bolke, E.L. and Don Price. 1969. Hydrologic Reconnaissance of Curlew Valley, Utah and Idaho. State of Utah, Technical Publication No. 25. Prepared by the U.S. Geological Survey in cooperation with the State of Utah Department of Natural Resources, Salt Lake City, Utah. 40 p.

Butler, E., J.K. Reid, and V.K. Berwick. 1966. Magnitude and Frequency of Floods in the United States. Part 10. The Great Basin. U.S. Geological Survey Water-Supply Paper 1684. Washington, D.C. 256 p.

Connor, J.G. and C.G. Mitchell. 1958. A Compilation of Chemical Quality Data for Ground and Surface Waters in Utah. State of Utah, Technical Publication No. 10. Prepared in cooperation with U.S. Geological Survey, Salt Lake City, Utah. 276 p.

Dalrymple, Tate. 1960. Flood Frequency Analysis. U.S. Geological Survey Water-Supply Paper 1543-A. Manual of Hydrology: Part 3. Flood Flow Techniques. U.S. Government Printing Office, Washington, D.C. 80 p.

Feth, J.H. 1966. Reconnaissance Survey of Ground-water Quality in the Great Basin. U.S. Geological Survey Professional Paper 550-D. pp. D237-D241.

Gates, Joseph S. 1965. Reevaluation of the Ground-water Resources of Tooele Valley, Utah. State of Utah, Technical Publication No. 12. Prepared by U.S. Geological Survey in cooperation with State of Utah Department of Natural Resources, Salt Lake City, Utah. 68 p.

Hahl, D.C. and R.H. Langford. 1964. Dissolved-mineral Inflow to Great Salt Lake and Chemical Characteristics of the Salt Lake Brine. State of Utah, Water Resources Bulletin No. 3, Part II. Prepared by U.S. Geological Survey in cooperation with the College of Mines and Mineral Industries, University of Utah, Salt Lake City, Utah. 40 p.

Hahl, D.C. and C.G. Mitchell. 1963. Dissolved-mineral Inflow to Great Salt Lake and Chemical Characteristics of the Salt Lake Brine. State of Utah, Water Resources Bulletin No. 3, Part I. Prepared by U.S. Geological Survey in cooperation with the College of Mines and Mineral Industries. University of Utah, Salt Lake City, Utah. 40 p.

Hill, R.W., E.K. Israelsen, A.L. Huber, and J.P. Riley. 1970. A Hydrologic Model of the Bear River Basin. Utah Water Research Laboratory, Utah State University, Logan, Utah.

Hood, J.W., (in press) a. Hydrologic Reconnaissance of the Park Valley Area, Box Elder County, Utah. State of Utah, Technical Publication No. 30. Being prepared by U.S. Geological Survey in cooperation with the State of Utah Department of Natural Resources, Salt Lake City, Utah.

Hood, J.W., (in press) b. Hydrologic Reconnaissance of Hansel Valley and Northern Rozel Flat, Box Elder County, Utah. State of Utah, Technical Publication No. 33. Being prepared by U.S. Geological Survey in cooperation with the State of Utah Department of Natural Resources, Salt Lake City, Utah.

Hood, J.W., Don Price, and K.M. Waddell. 1969. Hydrologic Reconnaissance of Rush Valley, Tooele County, Utah. State of Utah, Technical Publication No. 23. Prepared by U.S. Geological Survey in cooperation with the State of Utah Department of Natural Resources, Salt Lake City, Utah. 63 p.

Hood, J.W. and K.M. Waddell. 1968. Hydrologic Reconnaissance of Skull Valley, Tooele County, Utah. State of Utah, Technical Publication No. 18. Prepared by U.S. Geological Survey in cooperation with State of Utah Department of Natural Resources, Salt Lake City, Utah. 57 p.

Hood, J.W. and K.M. Waddell. 1969. Hydrologic Reconnaissance of Deep Creek Valley, Tooele and Juab Counties, Utah, and Elko and White Pine Counties, Nevada. State of Utah, Technical Publication No. 24. Prepared by U.S. Geological Survey in cooperation with the State of Utah Department of Natural Resources, Salt Lake City, Utah. 54 p.

Jeppson, Roland W., Gaylen L. Ashcroft, A. Leon Huber, Gaylord V. Skogerboe, and Jay M. Bagley. 1968. Hydrologic Atlas of Utah. Utah Water Research Laboratory, Utah State University, Logan, Utah. 306 p.

Marsell, Ray E. 1968. Utah's Ground-water Resources. Department of Natural Resources, State of Utah. 28 p.

Marsell, Ray E. 1962-1964. State of Utah. Ground Water in Bedrock in Utah. Reprinted from 9th Biennial Report, Utah Water and Power Board.

Milligan, James H., Ray E. Marsell, and Jay M. Bagley. 1966. Mineralized Springs in Utah and Their Effect on Manageable Water Supplies. Utah Water Research Laboratory, Utah State University, in cooperation with the Utah Water and Power Board.

Mundorff, J.C. 1970. Major Thermal Springs of Utah. State of Utah, Water Resources Bulletin No. 13. Prepared by the U.S. Geological Survey in cooperation with the Utah Geological and Mineralogical Survey. 60 p.

Palmer, Roland. 1966. Developing a State Water Plan. A Hydrologic Study of the Great Salt Lake. Staff Report No. 2. Utah Water and Power Board. 16 p.

Price, Don and E.L. Bolke. 1970. Hydrologic Reconnaissance of the Sink Valley Area, Tooele and Box Elder Counties, Utah. State of Utah, Technical Publication No. 26. Prepared by the U.S. Geological Survey in cooperation with the State of Utah Department of Natural Resources, Salt Lake City, Utah. 34 p.

Richardson, E. Arlo. 1971. Estimated Return Periods for Short Duration Precipitation in Utah. Utah State University, Logan, Utah. 68 p.

U.S. Department of Commerce. 1961-1970. Climatological Data. National Oceanic and Atmospheric Administration, Environmental Data Service.

U.S. Geological Survey. 1961-1969. Surface Water Records of Utah. Prepared in cooperation with the State of Utah and Other Agencies, Salt Lake City, Utah.

U.S. Geological Survey. 1963. Compilation of Records of Surface Waters of the United States, October 1950 to September 1960. Part 10. The Great Basin. Geological Survey Water Supply Paper 1734. Washington, D.C. 318 p.

U.S. Geological Survey. 1967-1969. Water Quality Records of Utah. Prepared in cooperation with the State of Utah and Other Agencies. Salt Lake City, Utah.

U.S. Soil Conservation Service. 1967. Irrigation Water Requirement. Technical Release No. 21. Washington, D.C.

Waddell, K.M. 1967. Reconnaissance of the Chemical Quality of Water in Western Utah, Part I. State of Utah, Water Resources Bulletin No. 9. Prepared by the U.S. Geological Survey in cooperation with the Utah Geological and Mineralogical Surey. 15 p.

Whitaker, G.L. 1969. Summary of Maximum Discharges in Utah Streams. State of Utah, Technical Publication No. 21. Prepared by U.S. Geological Survey in cooperation with the State of Utah Department of Natural Resources, Salt Lake City, Utah. 42 p.

Wilson, LeMoyne, T.B. Hutchings, and Paul Shafer. February 1968. Arable Land Resources of Utah. Utah Resources Series 42. Utah State University. Utah Agricultural Experiment Station in cooperation with the Soil Conservation Service, Department of Agriculture and Bureau of Reclamation, Department of Interior. 33 p.

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