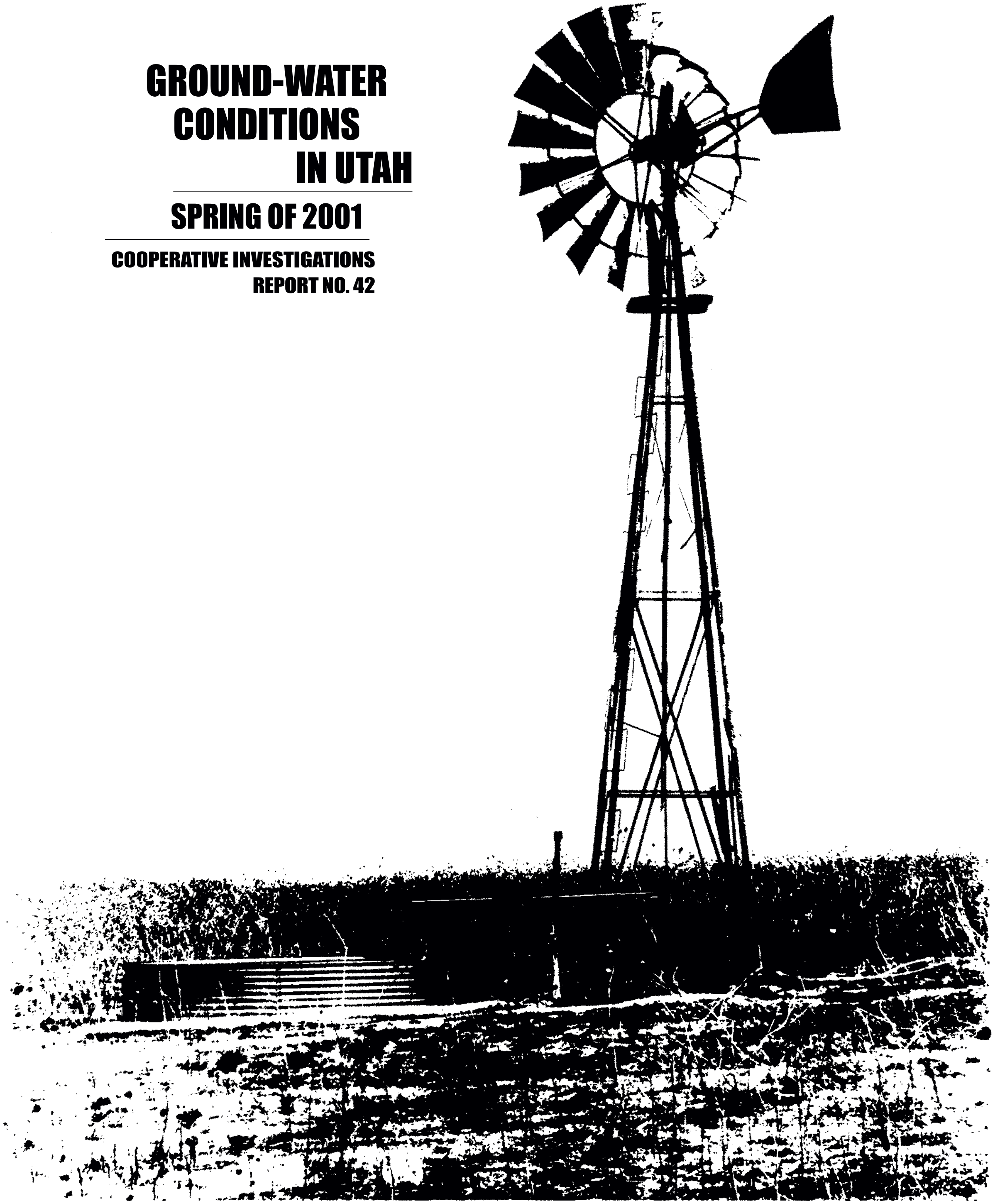
GROUND-WATER CONDITIONS IN UTAH

SPRING OF 2001

COOPERATIVE INVESTIGATIONS
REPORT NO. 42



UTAH DIVISION OF WATER RESOURCES • UTAH DIVISION OF WATER RIGHTS • U.S. GEOLOGICAL SURVEY

GROUND-WATER CONDITIONS IN UTAH, SPRING OF 2001

By

C.B. Burden and others

U.S. Geological Survey

Prepared by the U.S. Geological Survey

in cooperation with the Utah Department of Natural Resources,

Division of Water Resources and

Division of Water Rights

Published by the

Utah Department of Natural Resources

Division of Water Resources

Cooperative Investigations Report Number 42

2001

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS—Continued

ILLUSTRATIONS—Continued

TABLES

CONVERSION FACTORS

Multiply	By	To obtain
acre-foot	1,233	cubic meter
foot	0.3048	meter
gallon per minute	0.06308	liter per second
inch	25.4	millimeter
mile	1.609	kilometer
square mile	2.590	square kilometer

Chemical concentration is reported only in metric units—milligrams per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in parts per million.

DEFINITION OF TERMS

Acre-foot—The quantity of water required to cover 1 acre to a depth of 1 foot; equal to 43,560 cubic feet or about 326,000 gallons or 1,233 cubic meters.

Aquifer—A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield substantial amounts of water to wells and springs.

Artesian—Describes a well in which the water level stands above the top of the aquifer tapped by the well (confined). A flowing artesian well is one in which the water level is above the land surface.

Dissolved—Material in a representative water sample that passes through a 0.45–micrometer membrane filter. This is a convenient operational definition used by Federal agencies that collect water data. Determinations of "dissolved" constituents are made on subsamples of the filtrate.

Land-surface datum (lsd)—A datum plane that is approximately at land surface at each ground-water observation well.

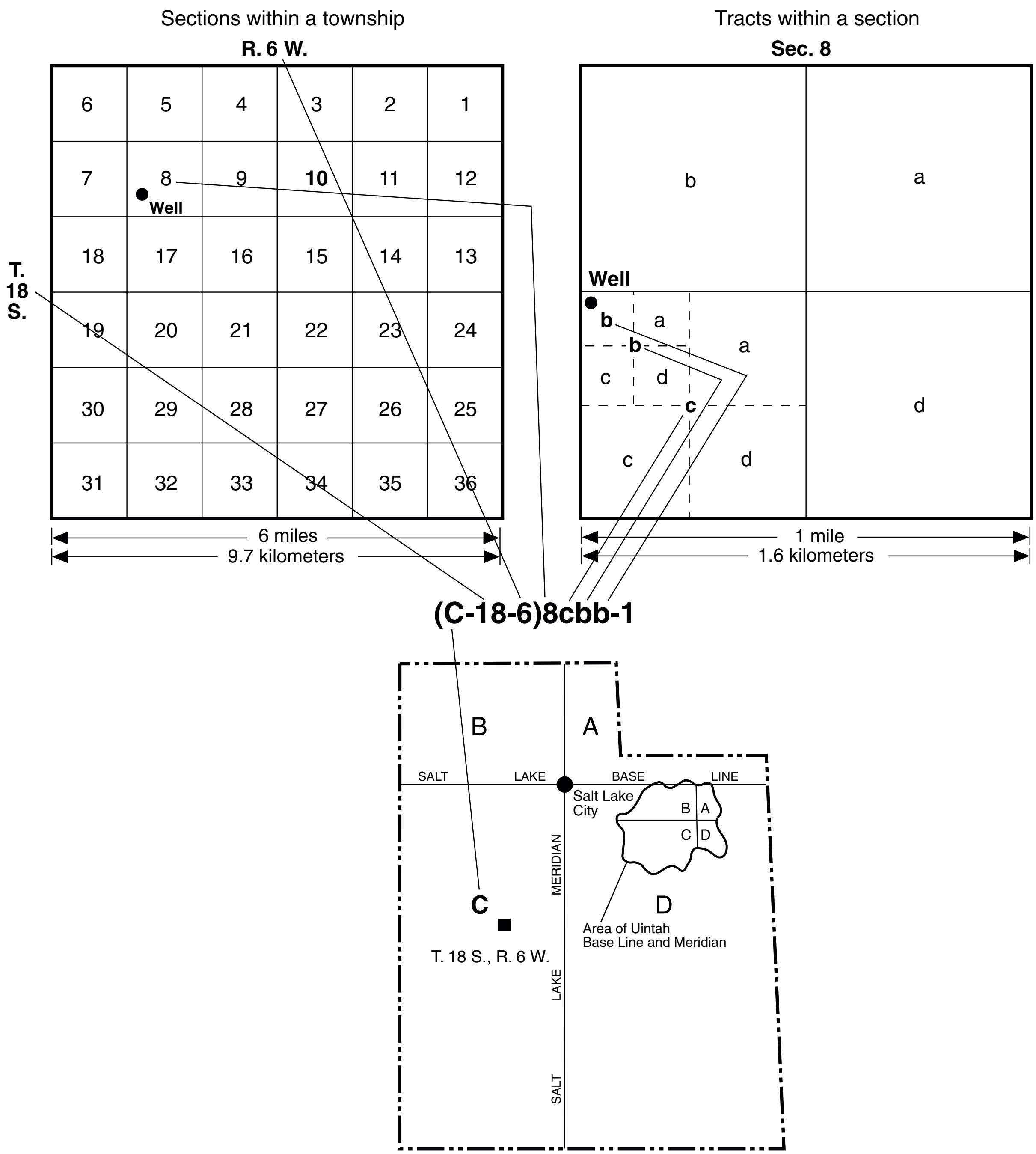
Milligrams per liter—A unit for expressing the concentration of chemical constituents in solution. Milligrams per liter represents the mass of solute per unit volume (liter) of water.

Specific conductance—A measure of the ability of water to conduct an electrical current. It is expressed in microsiemens per centimeter at 25 degrees Celsius. Specific conductance is related to the type and concentration of ions in solution and can be used for approximating the dissolved-solids concentration of the water. Commonly, the concentration of dissolved solids (in milligrams per liter) is about 65 percent of the specific conductance (in microsiemens). This relation is not constant in water from one well or stream to another, and it may vary for the same source with changes in the composition of the water.

Cumulative departure from average annual precipitation—A graph of the departure or difference between the average annual precipitation and the value of precipitation for each year, plotted cumulatively. A cumulative plot is generated by adding the departure from average precipitation for the current year to the sum of departure values for all previous years in the period of record. A positive departure, or greater-than-average precipitation, for a year results in a graph segment trending upward; a negative departure results in a graph segment trending downward. A generally downward-trending graph for a period of years represents a period of generally less-than-average precipitation, which commonly causes and corresponds with declining water levels in wells. Likewise, a generally upward-trending graph for a period of years represents a period of greater-than-average precipitation, which commonly causes and corresponds with rising water levels in wells. However, increases or decreases in withdrawals of ground water from wells also affect water levels and can change or eliminate the correlation between water levels in wells and the graph of cumulative departure from average precipitation.

WELL-NUMBERING SYSTEM

The well-numbering system used in Utah is based on the Bureau of Land Management's system of land subdivision. The well-numbering system is familiar to most water users in Utah, and the well number shows the location of the well by quadrant, township, range, section, and position within the section. Well numbers for most of the State are derived from the Salt Lake Base Line and the Salt Lake Meridian. Well numbers for wells located inside the area of the Uintah Base Line and Meridian are designated in the same manner as those based on the Salt Lake Base Line and Meridian, with the addition of the "U" preceding the parentheses. The numbering system is illustrated below.



GROUND-WATER CONDITIONS IN UTAH, SPRING OF 2001

By

C.B. Burden and others

U.S. Geological Survey

INTRODUCTION

This is the thirty-eighth in a series of annual reports that describe ground-water conditions in Utah. Reports in this series, published cooperatively by the U.S. Geological Survey and the Utah Department of Natural Resources, Division of Water Resources and Division of Water Rights, provide data to enable interested parties to maintain awareness of changing ground-water conditions.

This report, like the others in the series, contains information on well construction, ground-water withdrawal from wells, water-level changes, precipitation, streamflow, and chemical quality of water. Information on well construction included in this report refers only to wells constructed for new appropriations of ground water. Supplementary data are included in reports of this series only for those years or areas which are important to a discussion of changing ground-water conditions and for which applicable data are available.

This report includes individual discussions of selected significant areas of ground-water development in the State for calendar year 2000. Most of the reported data were collected by the U.S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights and Division of Water Resources.

The following reports deal with ground water in the State and were printed by the U.S. Geological Survey or by cooperating agencies from May 2000 through April 2001:

Ground-water conditions in Utah, spring of 2000, by C.B. Burden, and others, Utah Division of Water Resources Cooperative Investigations Report No. 41.

Analysis of nitrate and volatile organic compound data for ground water in the Great Salt Lake Basins, Utah, Idaho, and Wyoming, 1980-98, by S.A. Thiros, U.S. Geological Survey Water-Resources Investigations Report 00-4043.

Geohydrology and numerical simulation of ground-water flow in the central Virgin River basin of Iron and Washngton Counties, Utah, by V.M. Heilweil, G.W. Freethey, B.J. Stolp, C.D. Wilkowske, and D.E. Wilberg, Utah Department of Natural Resources Technical Publication No. 116.

Quality of shallow ground water in areas of recent residential and commercial development in Salt Lake Valley, Utah, 1999, by S.A. Thiros, U.S. Geological Survey Fact Sheet FS-106-00.

Ground-water hydrology of Dugway Proving Ground and surrounding area, Tooele and Juab Counties, Utah, by J.I. Steiger and G.W. Freethey, U.S. Geological Survey Water-Resources Investigations Report 00-4240.

UTAH'S GROUND-WATER RESERVOIRS

Small amounts of ground water can be obtained from wells throughout most of Utah, but large amounts that are of suitable chemical quality for irrigation, public supply, or industrial use generally can be obtained only in specific areas. The areas of ground-water development discussed in this report are shown in figure 1 and listed in table 1. Relatively few wells outside of these areas yield large amounts of ground water of suitable chemical quality for the uses listed above, although some of the basins in western Utah and many areas in eastern Utah have not been explored sufficiently to determine their potential for ground-water development.

About 2 percent of the wells in Utah yield water from consolidated rock. Consolidated rocks that yield the most water are lava flows, such as basalt, which contain interconnected vesicular openings, fractures, or permeable weathered zones at the tops of flows; limestone, which contains fractures or other openings enlarged by solution; and sandstone, which contains

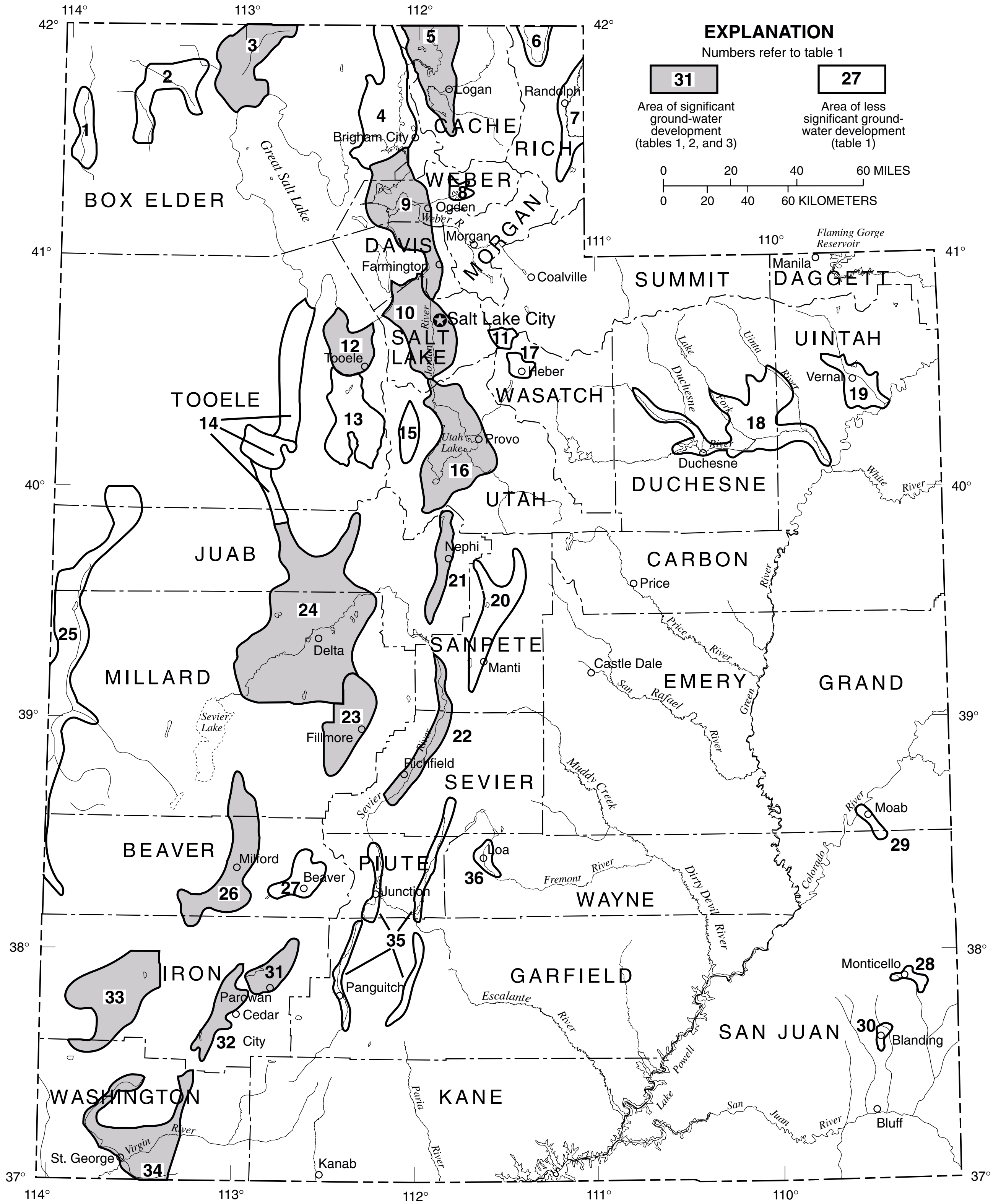


Figure 1. Areas of ground-water development in Utah specifically referred to in this report.

Table 1. Areas of ground-water development in Utah specifically referred to in this report

Number in figure 1	Area	Principal types of water-bearing rocks
1	Grouse Creek Valley	Unconsolidated.
2	Park Valley	Do.
3	Curlew Valley	Unconsolidated and consolidated.
4	Malad-lower Bear River Valley	Unconsolidated.
5	Cache Valley	Do.
6	Bear Lake Valley	Do.
7	Upper Bear River Valley	Do.
8	Ogden Valley	Do.
9	East Shore area	Do.
10	Salt Lake Valley	Do.
11	Park City area	Unconsolidated and consolidated.
12	Tooele Valley	Unconsolidated.
13	Rush Valley	Do.
14	Dugway area	Do.
	Skull Valley	Do.
	Old River Bed	Do.
15	Cedar Valley, Utah County	Do.
16	Utah and Goshen Valleys	Do.
17	Heber Valley	Do.
18	Duchesne River area	Unconsolidated and consolidated.
19	Vernal area	Do.
20	Sanpete Valley	Do.
21	Juab Valley	Unconsolidated.
22	Central Sevier Valley	Do.
23	Pahvant Valley	Unconsolidated and consolidated.
24	Sevier Desert	Unconsolidated.
25	Snake Valley	Do.
26	Milford area	Do.
27	Beaver Valley	Do.
28	Monticello area	Consolidated.
29	Spanish Valley	Unconsolidated and consolidated.
30	Blanding area	Consolidated.
31	Parowan Valley	Unconsolidated and consolidated.
32	Cedar Valley, Iron County	Unconsolidated.
33	Beryl-Enterprise area	Do.
34	Central Virgin River area	Unconsolidated and consolidated.
35	Upper Sevier Valleys	Unconsolidated.
36	Upper Fremont River Valley	Unconsolidated and consolidated.

open fractures. Most of the wells that penetrate consolidated rock are in the eastern and southern parts of the State in areas where water cannot be obtained readily from unconsolidated deposits.

About 98 percent of the wells in Utah yield water from unconsolidated deposits. These deposits may consist of boulders, gravel, sand, silt, or clay, or a mixture of some or all of these materials. The largest yields are obtained from coarse materials that are sorted into deposits of uniform grain size. Most wells that yield water from unconsolidated deposits are in large intermountain basins that have been partly filled with rock material eroded from the adjacent mountains.

SUMMARY OF CONDITIONS

The total estimated withdrawal of water from wells in Utah during 2000 was about 941,000 acre-feet (table 2), which is about 136,000 acre-feet more than the revised total for 1999 and 98,000 acre-feet more than the 1990-99 average annual withdrawal (table 3). The increase in withdrawals mostly resulted from increased irrigation and public supply usage. The total estimated withdrawal for irrigation was about 511,000 acre-feet (table 2), which is 67,000 acre-feet more than in 1999. Withdrawal for industrial use increased about 5,000 acre-feet to about 78,000 acre-feet. Withdrawal for public supply was about 287,000 acre-feet (table 2), which is about 67,000 acre-feet more than in 1999. Withdrawal for domestic and stock use was about 65,000 acre-feet, which is about 3,000 acre-feet less than in 1999.

Ground-water withdrawal increased from 1999 to 2000 in 14 of the 16 areas of ground-water development discussed in this report (table 2). Withdrawal in “other areas” increased about 34,000 acre-feet, the largest increase among the areas (fig. 1). The 2000 withdrawal was more than the average annual withdrawals for 1990-99 in 11 of the 16 areas (tables 2 and 3).

The amount of water withdrawn from wells is related to demand and availability of water from other sources, which, in turn, are partly related to local climatic conditions. Precipitation during calendar year 2000 at 18 of 29 weather stations included in this report (National Oceanic and Atmospheric Administration, 2000), was greater than the long-term average. The greatest increase in precipitation from average in 2000 was the 3.53 inches recorded at Oak City, and the greatest decrease in precipitation from average was the 5.07 inches recorded at Logan Utah State University, in northeastern Utah.

A total of 762 wells were constructed for new appropriations of ground water in 2000, as determined by the Utah Division of Water Rights (table 2). This is 38 more wells than was reported for 1999. In 2000, 151 large-diameter wells (12 inches or more) were constructed for new appropriations of ground water (table 2). These are principally for withdrawal of water for public supply, irrigation, and industrial use.

Table 2. Number of wells constructed and estimated withdrawal of water from wells in Utah
Estimated withdrawal from wells—
1999 total: From Burden, and others (2000, table 2).

Area	Number in figure 1	Number of wells[1] constructed in 2000		Estimated withdrawal from wells (acre-feet)					
				2000					
		Total	Diameter of 12 inches or more	Irrigation	Industry[1]	Public supply[1]	Domestic and stock	Total (rounded)	1999 Total (rounded)
Curlew Valley	3	3	0	40,600	0	180	100	41,000	29,000
Cache Valley	5	55	12	10,300	7,200	10,200	2,000	30,000	24,000
East Shore area	9	8	1	18,600	3,500	33,100	5,000	60,000	61,000
Salt Lake Valley	10	14	7	2,200	[2]23,400	93,800	25,000	145,000	126,000
Tooele Valley	12	35	6	[3]17,600	440	4,500	1,100	24,000	21,000
Utah and Goshen Valleys	16	82	5	48,700	4,800	59,100	19,600	132,000	[4]110,000
Juab Valley	21	5	1	25,300	190	[5,6]730	400	27,000	14,000
Sevier Desert	24	10	2	8,300	4,000	1,600	1,200	15,000	12,000
Central Sevier Valley	22	[7]39	[7]5	8,300	80	4,100	980	13,000	20,000
Pahvant Valley	23	7	1	78,800	[8]540	920	100	80,000	76,000
Cedar Valley, Iron County	32	18	12	28,500	30	7,100	800	36,000	32,000
Parowan Valley	31	5	3	[9]30,000	0	90	300	30,000	[4]26,000
Escalante Valley									
Milford area	26	2	1	39,600	[10]7,900	1,200	270	49,000	41,000
Beryl-Enterprise area	33	19	11	81,100	[11]1,800	630	830	84,000	79,000
Central Virgin River area	34	4	3	4,900	150	29,900	250	35,000	28,000
Other areas[12,13]		456	81	68,500	24,200	40,000	7,300	140,000	106,000
Total (rounded)		**762**	**151**	**511,000**	**78,000**	**287,000**	**65,000**	**941,000**	**[4]805,000**

[1] Data provided by Utah Department of Natural Resources, Division of Water Rights.
[2] Includes some use for air conditioning, about 2,800 acre-feet. About 70 percent was injected back into the aquifer.
[3] Includes some domestic and stock use.
[4] Revised.
[5] Includes some industrial use.
[6] Previously included some springs.
[7] Includes wells constructed in upper Sevier Valley and upper Fremont River Valley.
[8] Withdrawal for geothermal power generation. About 85 percent was injected back into the aquifer.
[9] Includes some stock use.
[10] Withdrawal for geothermal power generation. About 99 percent was injected back into the aquifer.
[11] Includes 1,440 acre-feet used for heating greenhouses. About 95 percent was injected back into the aquifer.
[12] Withdrawal totals are estimated minimum. See “Other areas” section of this report for withdrawal estimates for other areas.
[13] Includes withdrawals for upper Sevier Valley and upper Fremont River Valley that were included with central Sevier Valley in reports prior to number 31 of this series.

Table 3. Total annual withdrawal of water from wells in significant areas of ground-water development in Utah, 1990-99
[From previous reports of this series]

Area	Number in figure 1	Thousands of acre-feet										1990-99 average (rounded)
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
Curlew Valley	3	43	37	44	35	41	31	39	36	29	29	36
Cache Valley	5	32	29	36	23	31	23	24	25	26	24	27
East Shore area	9	65	68	59	56	60	53	57	62	56	61	60
Salt Lake Valley	10	143	135	138	116	142	120	138	123	122	126	130
Tooele Valley	12	33	30	30	22	31	26	23	25	[1]19	21	26
Utah and Goshen Valleys	16	129	124	141	89	114	77	99	96	86	[1]110	106
Juab Valley	21	27	25	29	20	26	13	19	15	12	14	20
Sevier Desert	24	34	34	33	31	37	18	17	17	12	12	24
Central Sevier Valley[2]	22	18	18	19	19	20	20	21	20	20	20	20
Pahvant Valley	23	88	74	86	87	93	69	83	67	66	76	79
Cedar Valley, Iron County	32	30	34	34	33	34	31	35	34	36	32	33
Parowan Valley	31	31	32	31	28	30	24	29	25	28	[1]26	28
Escalante Valley												
Milford area	26	48	54	42	50	61	48	52	52	41	41	49
Beryl-Enterprise area	33	86	79	72	78	86	70	92	81	74	79	80
Central Virgin River area	34	22	15	14	13	14	15	17	18	20	28	18
Other areas		111	111	120	94	113	97	113	107	99	106	107
Total		**940**	**899**	**928**	**794**	**933**	**735**	**858**	**803**	[1]**746**	[1]**805**	**843**

[1] Revised.
[2] Prior to 1991, included upper Sevier and upper Fremont River Valleys.

MAJOR AREAS OF GROUND-WATER DEVELOPMENT

CURLEW VALLEY

By J.D. Sory

The Curlew Valley drainage basin extends across the Utah-Idaho State line between latitude 40°41' and 42°30' north and longitude 112°30' and 113°20' west, and covers about 1,200 square miles. The valley is bounded on the west, north, and east by mountain ranges that range in altitude from about 6,500 to nearly 10,000 feet and is open to the south, where it drains into Great Salt Lake.

The Utah part of Curlew Valley (Utah subbasin) covers about 550 square miles. It is an arid to semiarid, largely uninhabited area, with a community center at Snowville. Average annual precipitation in the Utah subbasin is less than 8 inches on part of the valley floor and reaches a maximum that exceeds 35 inches on one of the highest mountain peaks.

The principal source of water in the Utah subbasin is the ground-water reservoir. Confined aquifers in alluvial and lacustrine deposits and intercalated volcanic rocks in the valley fill yield several hundred to several thousand gallons of water per minute to individual large-diameter irrigation wells west of Snowville and near Kelton.

Total estimated withdrawal of water from wells in Curlew Valley in 2000 was about 41,000 acre-feet, which is 12,000 more than reported for 1999 and 5,000 acre-feet more than the average annual withdrawal for 1990-99 (tables 2 and 3). The increase resulted from the need for more water for irrigation.

The location of wells in Curlew Valley in which the water level was measured during March 2001 is shown in figure 2. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells is shown in figure 3.

Water levels generally declined from March 1999 to March 2001 in Curlew Valley. Water levels generally rose from 1982 to 1987, a period of much-greater-than-average precipitation, generally declined from 1987 to 1997, and generally rose slightly from 1997 to 1999. The decline in water level in the northern part of the valley probably resulted from an increase in withdrawal for irrigation.

Precipitation at Grouse Creek in 2000 was 11.46 inches, which is 2.74 inches more than in 1999 and 0.24 inch more than the average annual precipitation for 1959-2000.

The concentrations of dissolved solids in water from well (B-14-9)5bbb-1, west of Snowville, and well (B-12-11)4bcc-1, north of Kelton, generally have increased since 1972. These increases may be a result of recharge from unconsumed irrigation water in which dissolved solids are concentrated by evaporation.

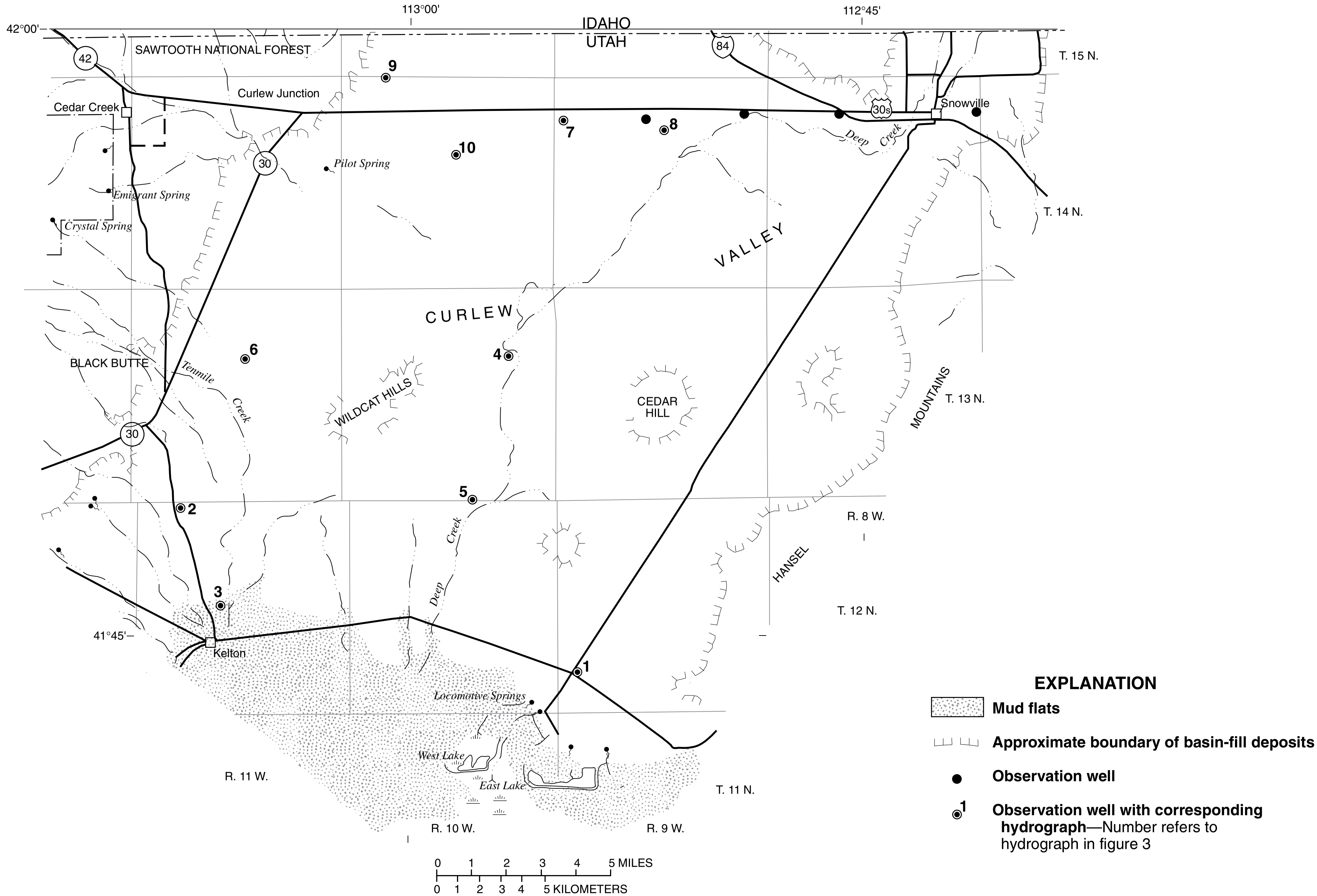


Figure 2. Location of wells in Curlew Valley in which the water level was measured during March 2001.

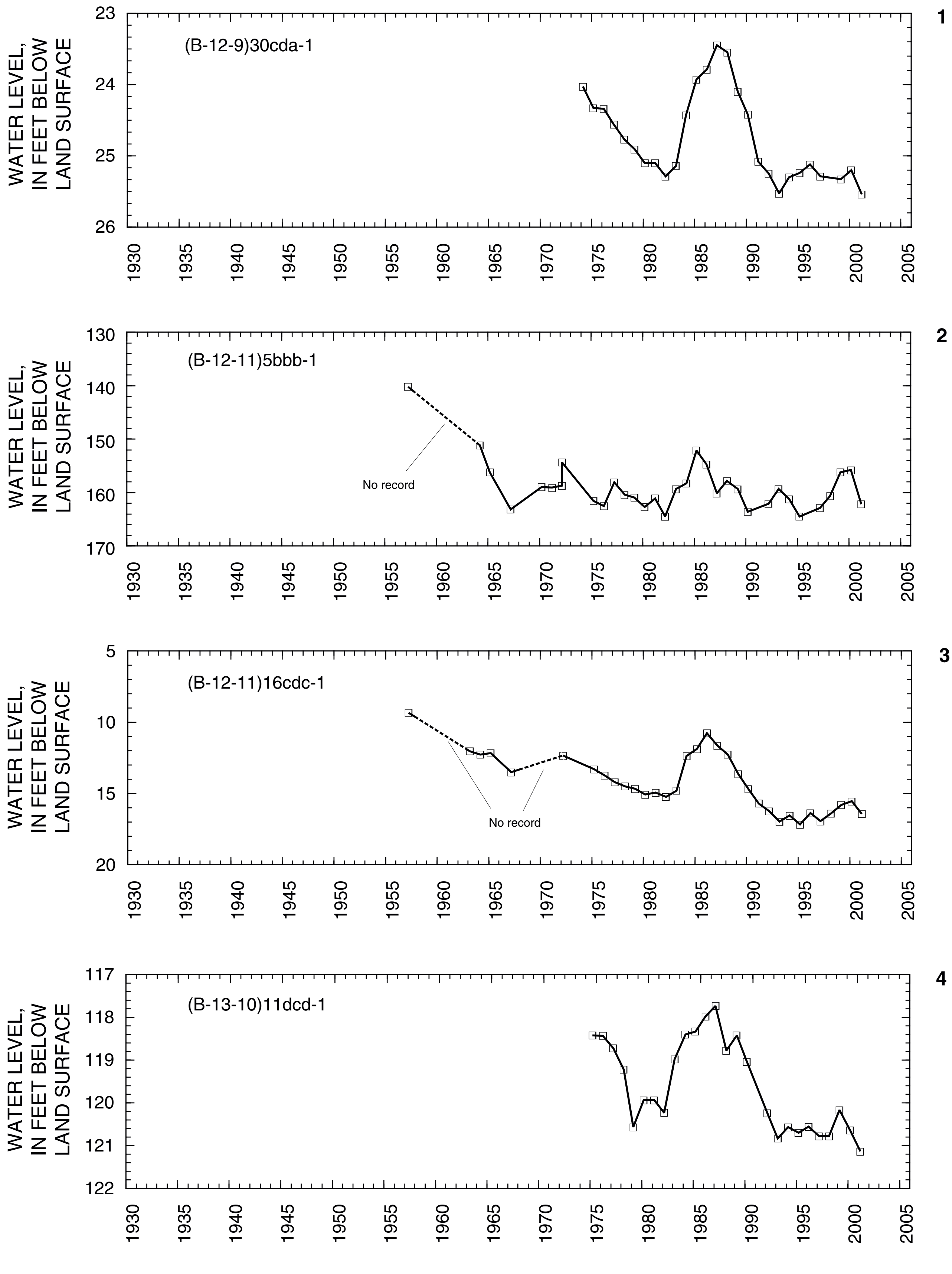


Figure 3. Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.

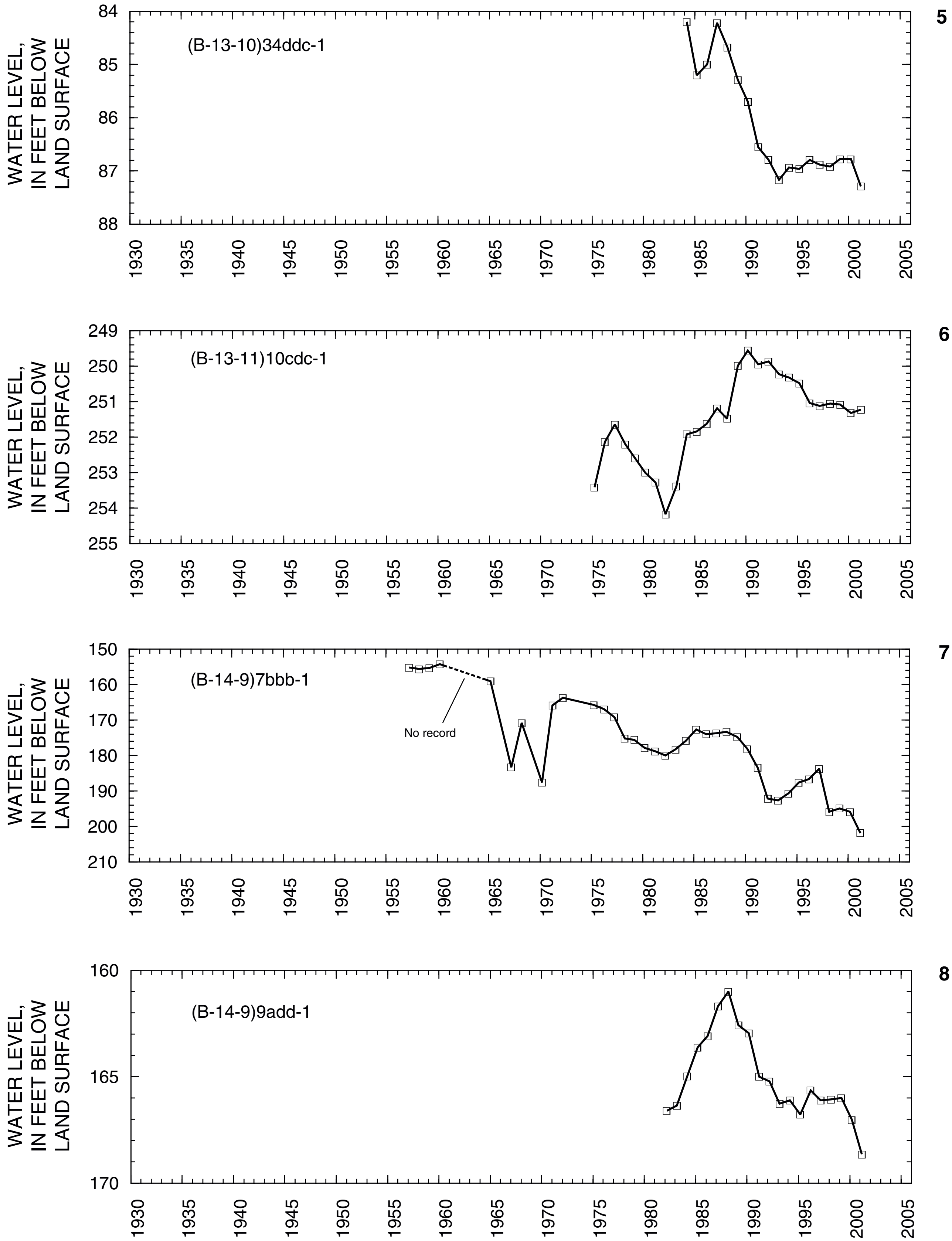
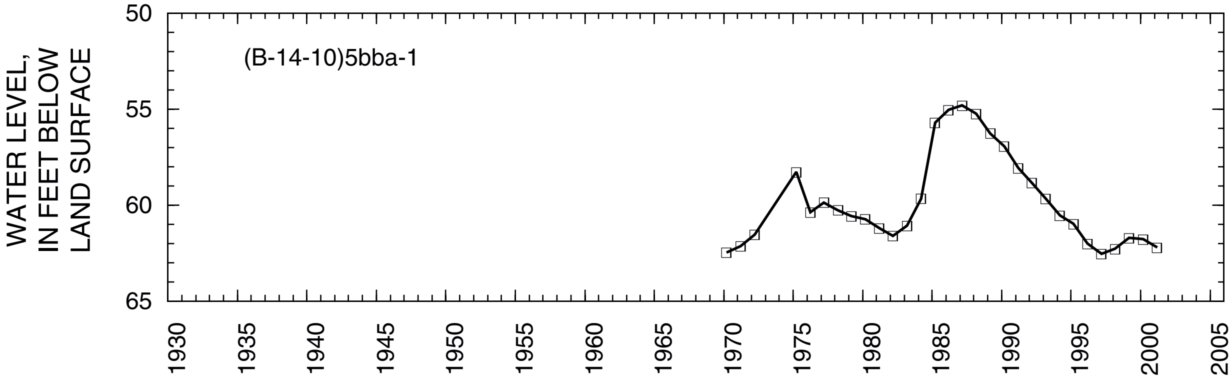
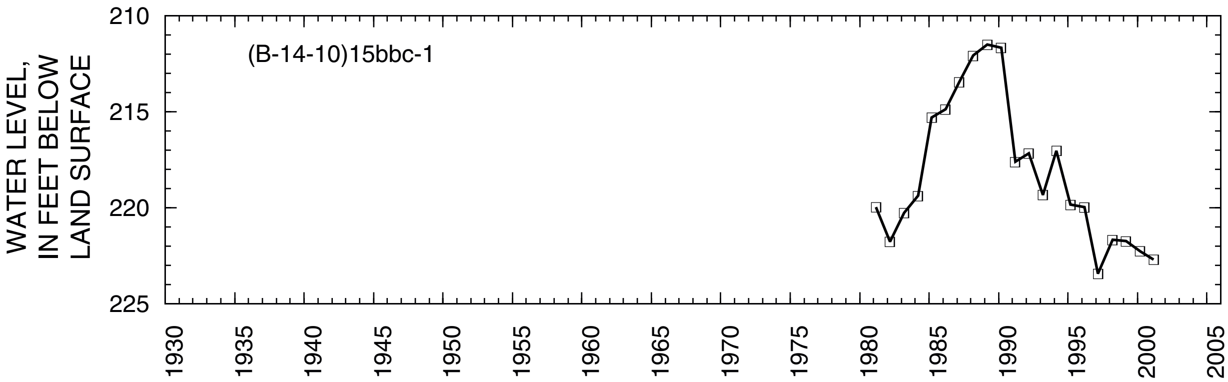


Figure 3. Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells —Continued.



9



10

Figure 3. Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells —Continued.

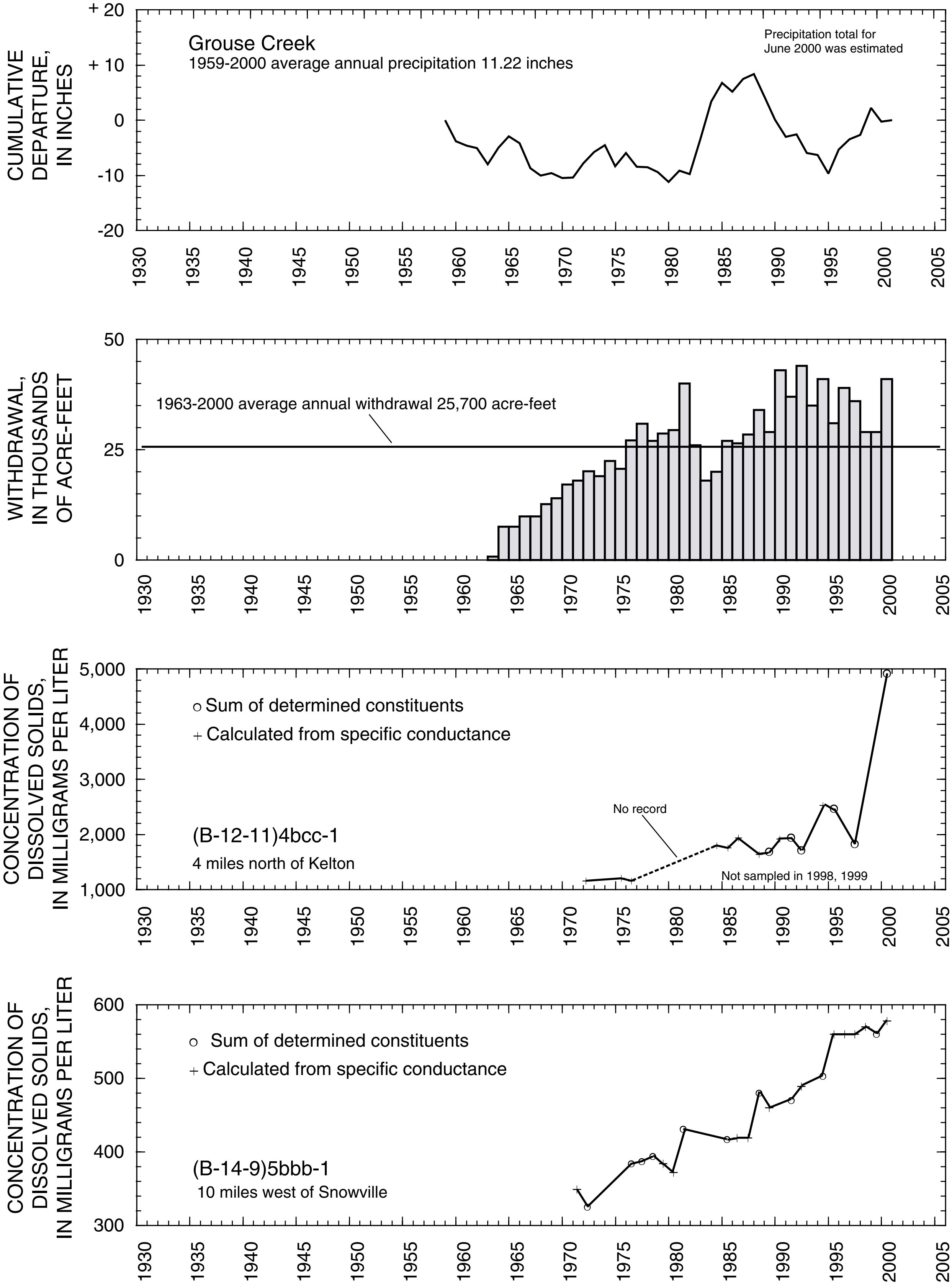


Figure 3. Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Grouse Creek, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.

CACHE VALLEY

By M.R. Danner

Cache Valley, as referred to in this report, covers about 450 square miles in Utah. Ground water occurs in unconsolidated deposits in the valley, under both water-table and artesian conditions. Recharge to the ground-water system occurs principally at the margins of the valley, and ground water moves toward the center of the valley and toward a point of discharge near Cache Junction.

Total estimated withdrawal of water from wells in Cache Valley in 2000 was about 30,000 acre-feet, which is about 6,000 acre-feet more than was reported for 1999 and 3,000 acre-feet more than the average annual withdrawal for 1990-99 (tables 2 and 3). The increase in withdrawals mostly resulted from increased public supply use.

The location of wells in Cache Valley in which the water level was measured during March 2001 is shown in figure 4. The relation of the water level in selected wells to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (A-13-1)29bcd-1 is shown in figure 5. Water levels in most observation wells generally declined from March 1999 to March 2001 as a result of less-than-average precipitation. Water levels generally rose from about 1980 to 1985, corresponding to a period of greater-than-average precipitation, generally declined from 1985 to 1990, and generally have risen or remained stable from 1990 to 1999.

Total discharge of the Logan River (combined flow from the Logan River above State Dam, near Logan, and Logan, Hyde Park, and Smithfield Canal at Head, near Logan) during 2000 was about 132,700 acre-feet, which is 120,900 acre-feet less than 1999 and 51,400 acre-feet less than the 1941-2000 average annual discharge.

Precipitation at Logan, Utah State University, was 13.64 inches in 2000. This is 2.24 inches less than for 1999 and 5.07 inches less than the average annual precipitation for 1941-2000. The concentration of dissolved solids in water from well (A-13-1)29bcd-1 fluctuated during 1970-2000 with no apparent trend.

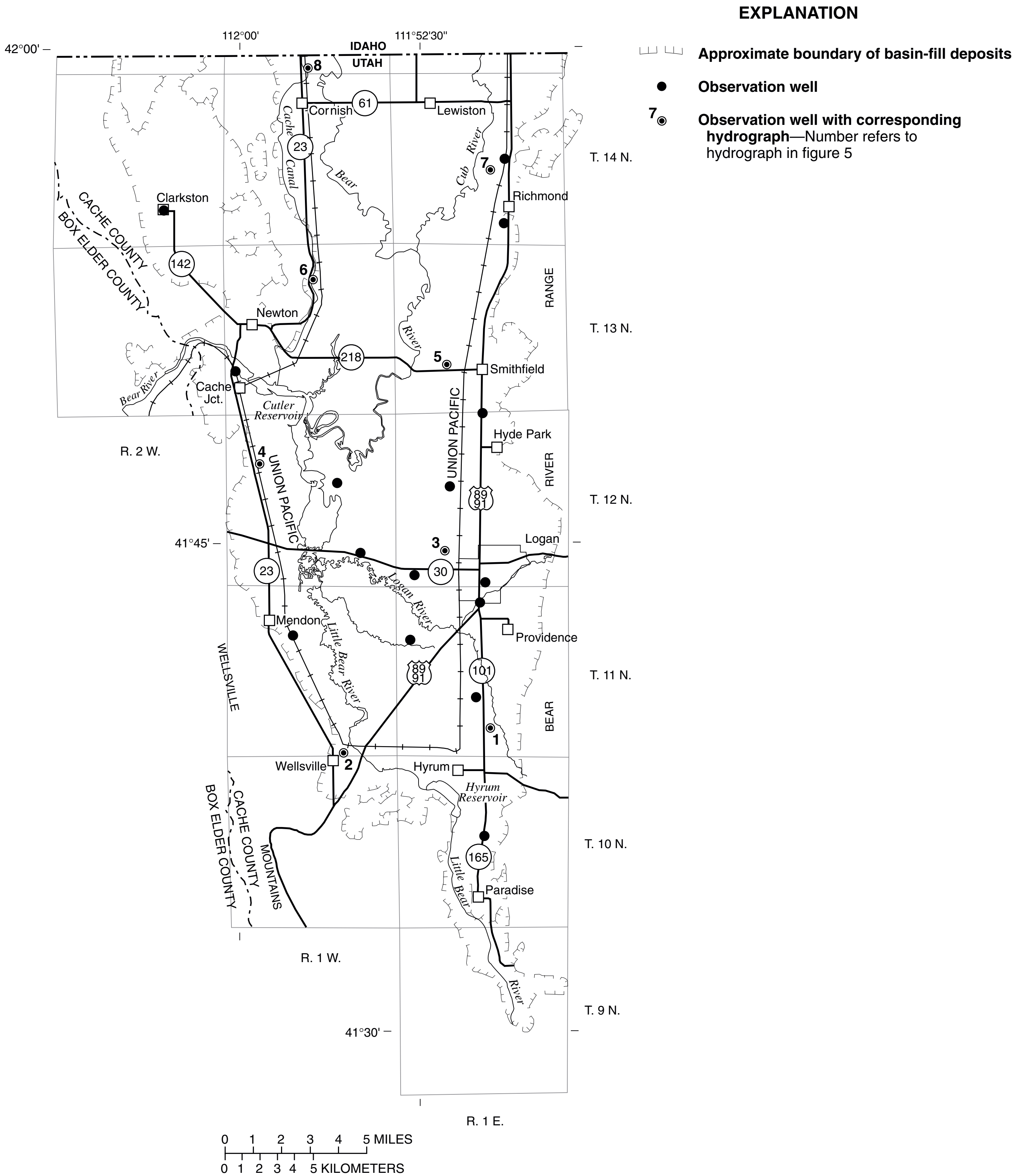


Figure 4. Location of wells in Cache Valley in which the water level was measured during March 2001.

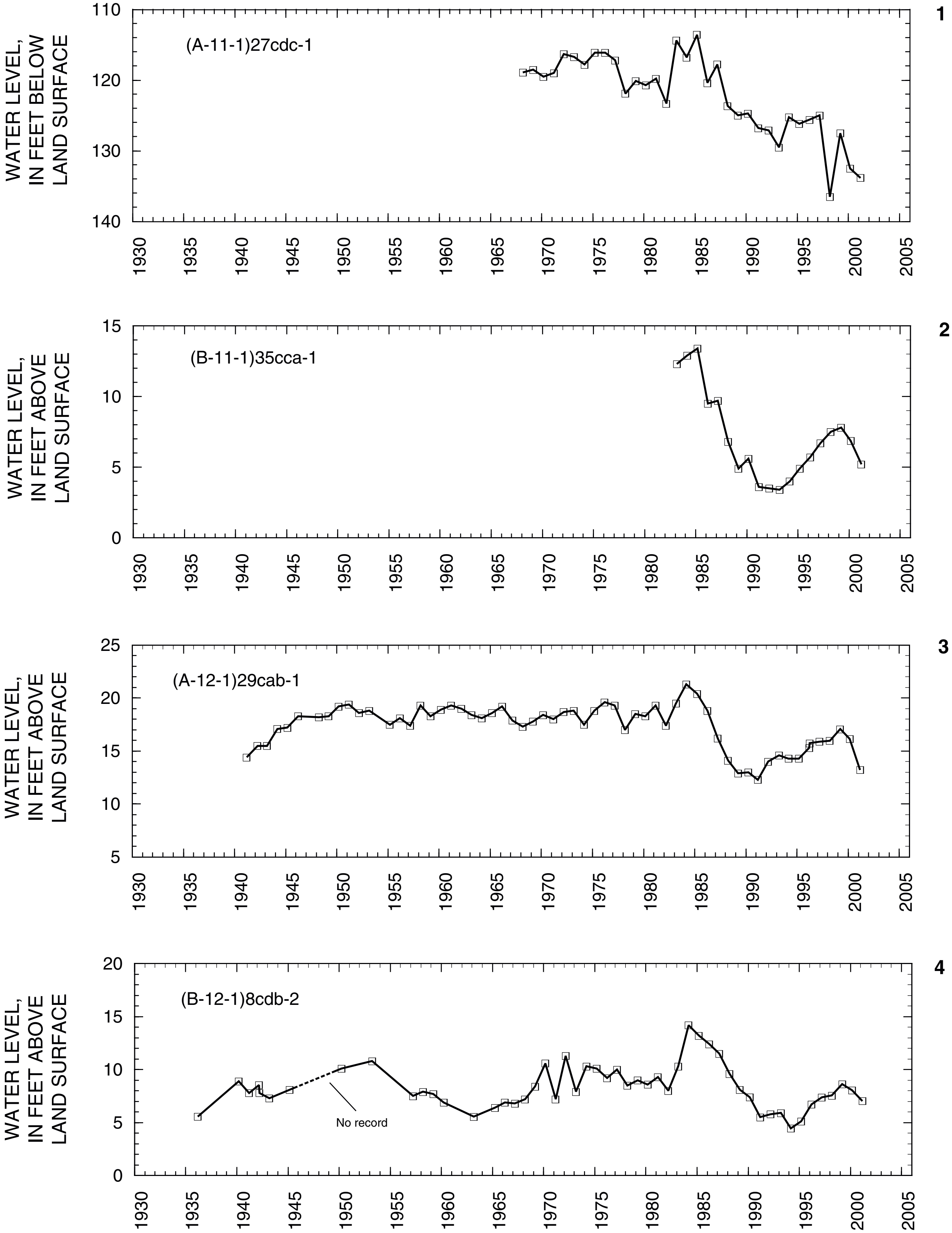


Figure 5. Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (A-13-1)29bcd-1.

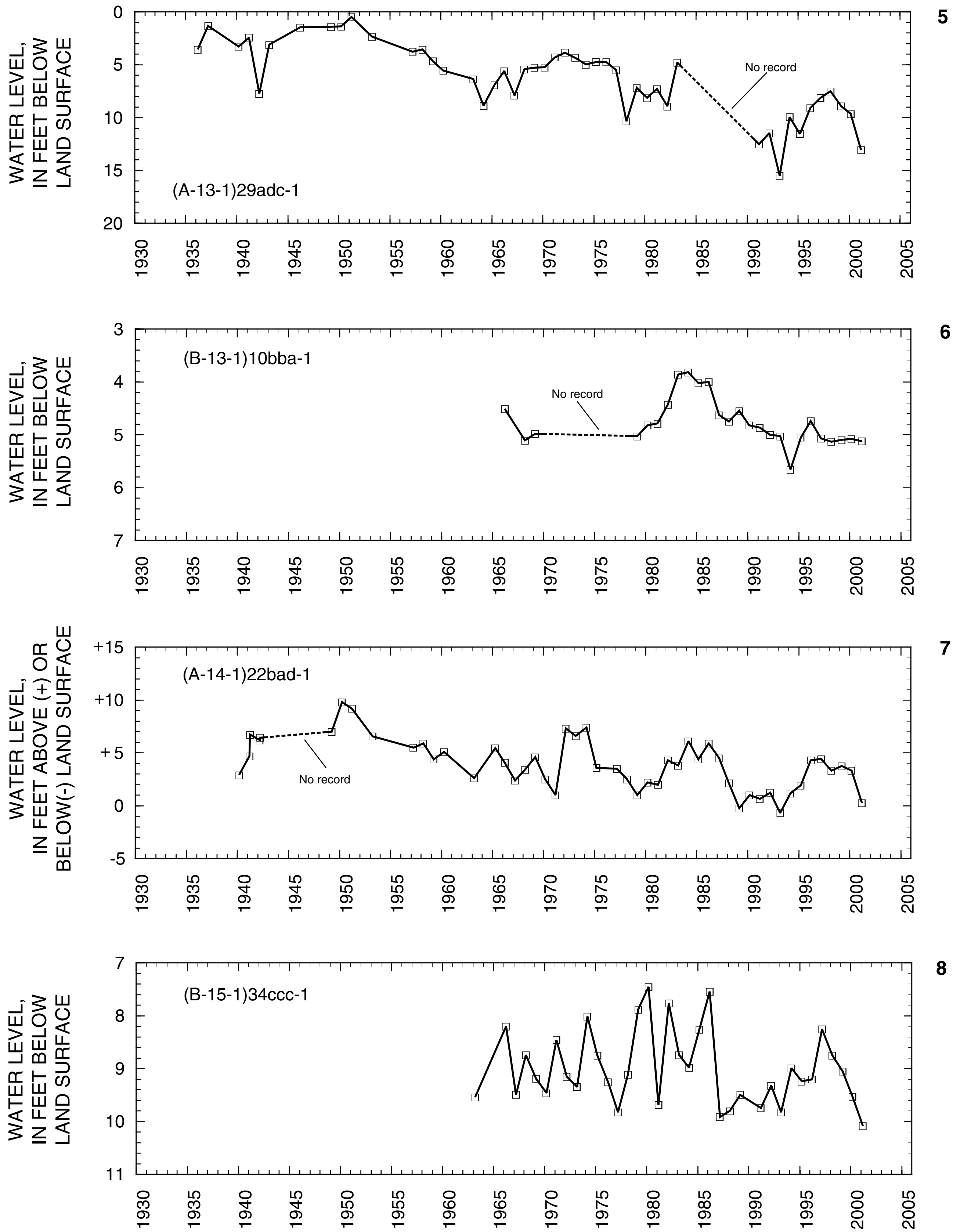


Figure 5. Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (A-13-1)29bcd-1—Continued.

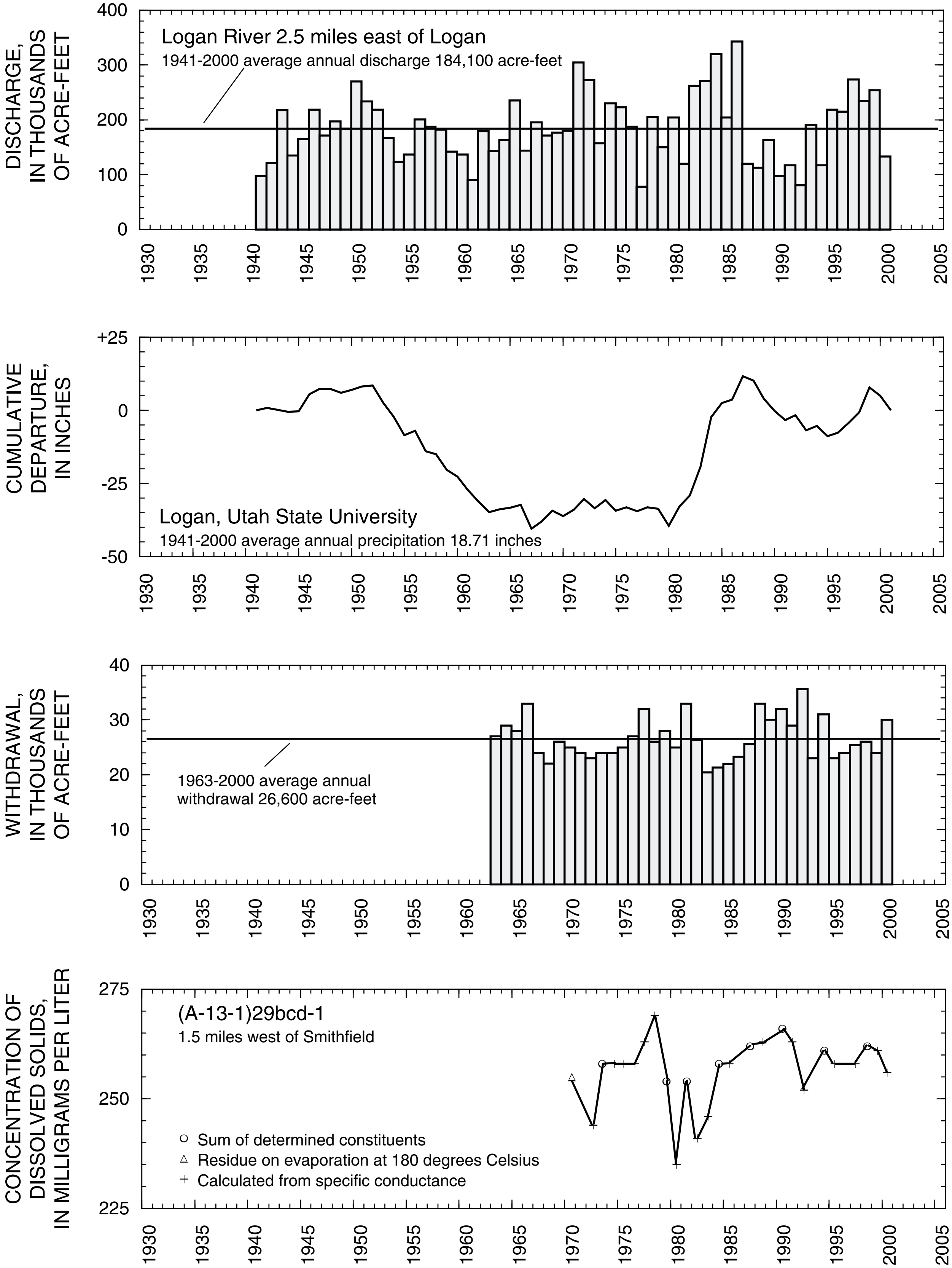


Figure 5. Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (A-13-1)29bcd-1—Continued.

EAST SHORE AREA

By M.J. Fisher

The East Shore area is in north-central Utah between the Wasatch Range and Great Salt Lake. Ground water occurs in unconsolidated deposits under both water-table and artesian conditions, but most of the water is withdrawn by wells from the artesian aquifers. Water enters the artesian aquifers along the east edge of the Weber Delta and Bountiful area and generally moves westward toward Great Salt Lake.

Total estimated withdrawal of water from wells in the East Shore area in 2000 was about 60,000 acre-feet, which is 1,000 acre-feet less than was reported for 1999 and the same as the average annual withdrawal for 1990-99 (tables 2 and 3). The decrease in withdrawals mostly resulted from decreased withdrawals for irrigation. Withdrawal for public supply was about 33,100 acre-feet, which is about 5,400 acre-feet more than in 1999. Industrial withdrawal decreased by about 300 acre-feet to 3,500 acre-feet, and irrigation withdrawal decreased by about 5,700 acre-feet to 18,600 acre-feet from 1999 to 2000.

The location of wells in the East Shore area in which the water level was measured during March 2001 is shown in figure 6. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1 is shown in figure 7. Water levels in the southern part of the East Shore area generally declined from 1984 to 1989 and generally have risen since 1989, although levels generally declined from March 1999 to March 2001. Water levels in the western part of the East Shore area generally have declined since the 1950s. Declines probably resulted from continued large withdrawal for public supply. Precipitation at the Ogden Pioneer Powerhouse in 2000 was 19.57 inches, which is 2.25 inches less than the average annual precipitation for 1937-2000, and 0.86 inch more than in 1999.

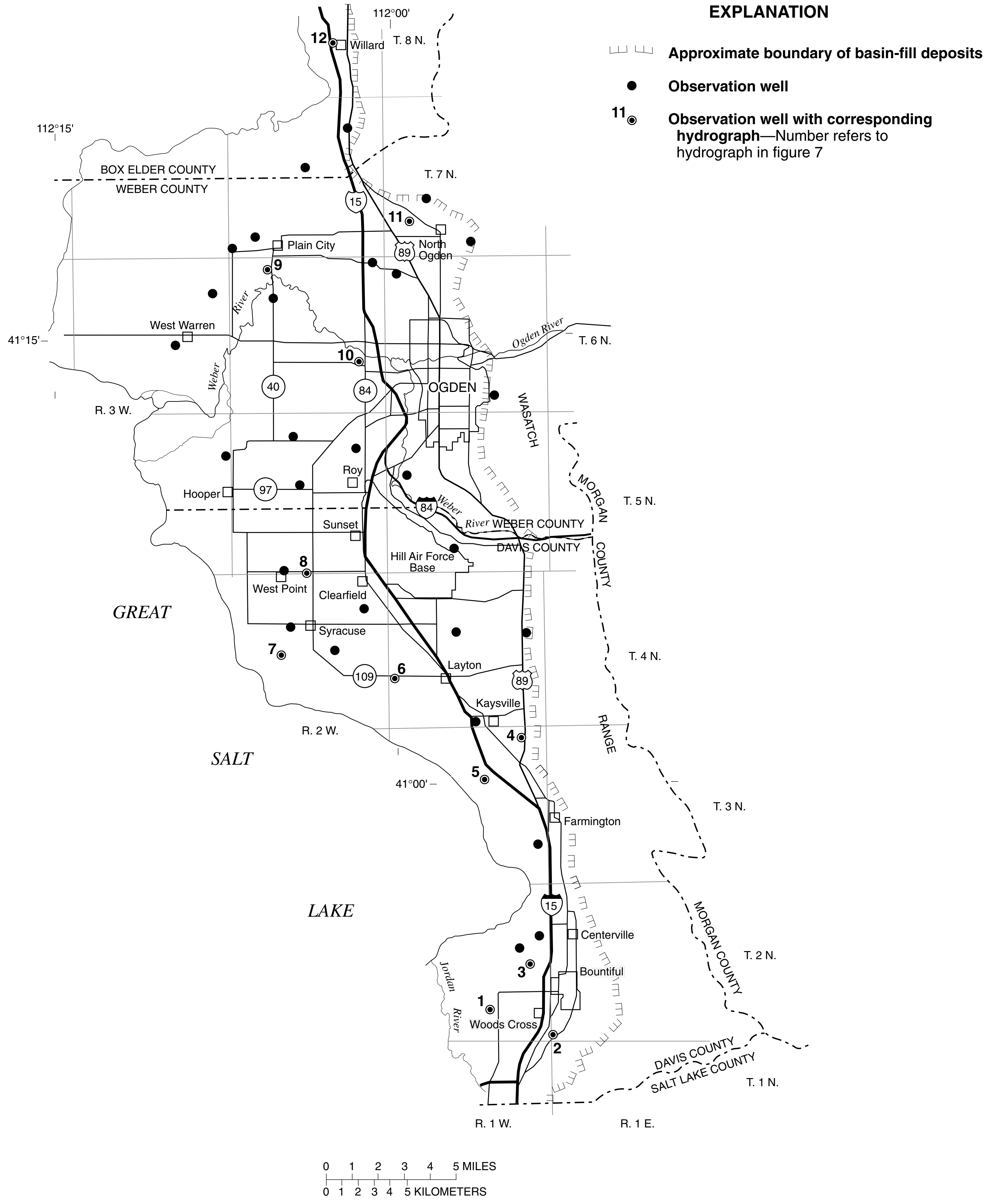


Figure 6. Location of wells in the East Shore area in which the water level was measured during March 2001.

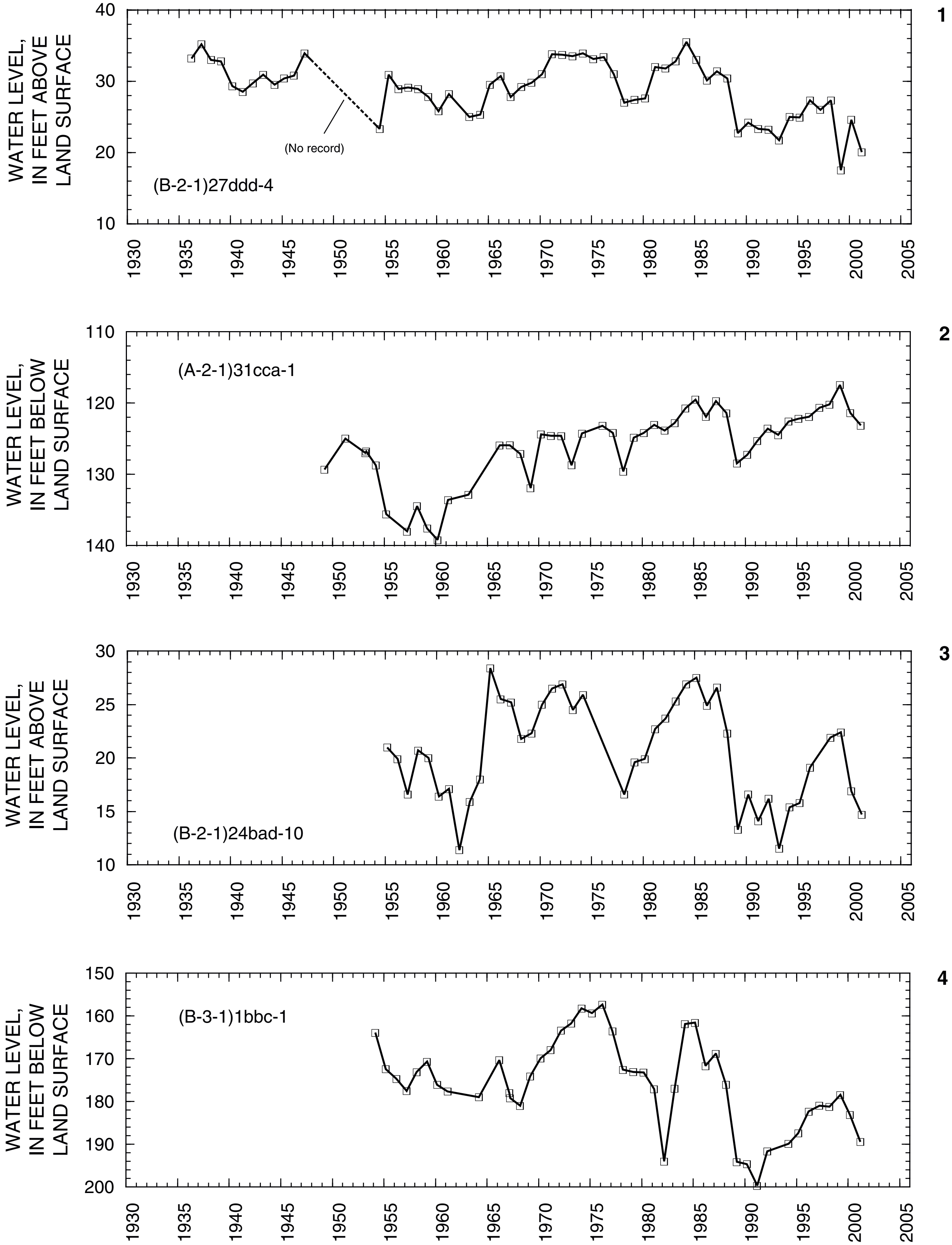
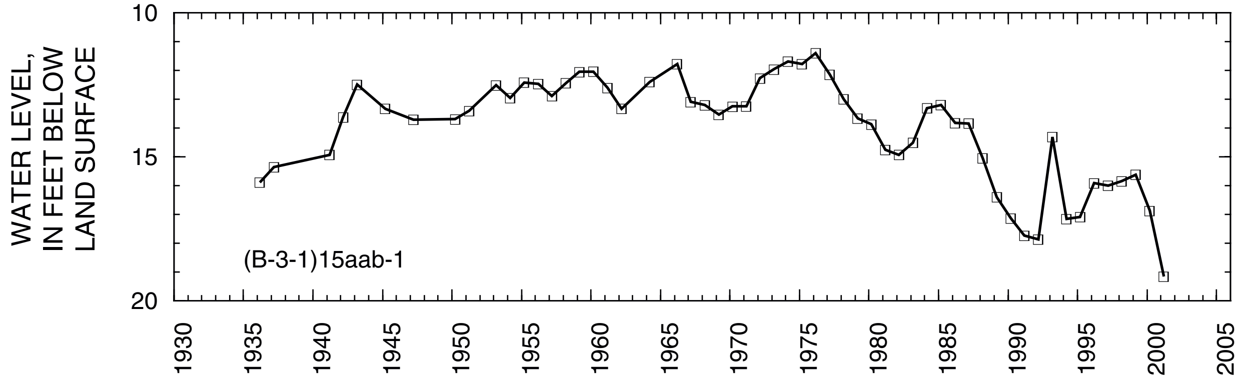
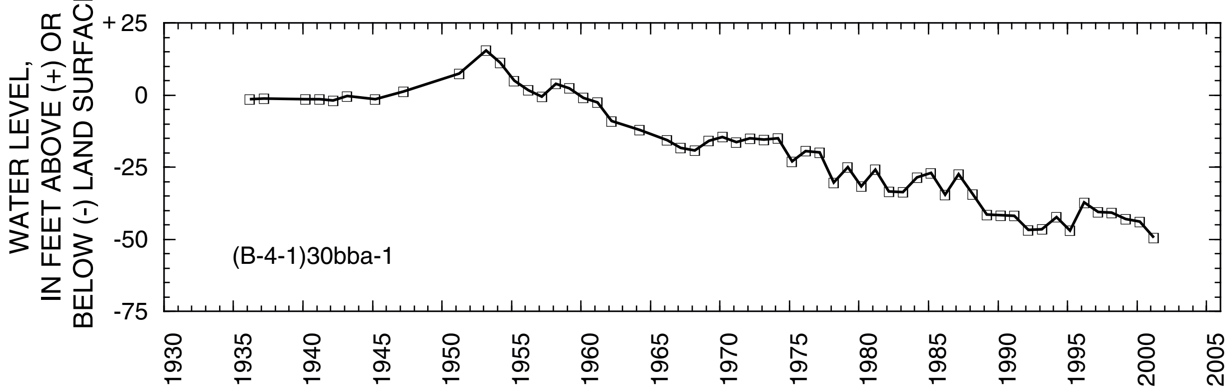


Figure 7. Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1.

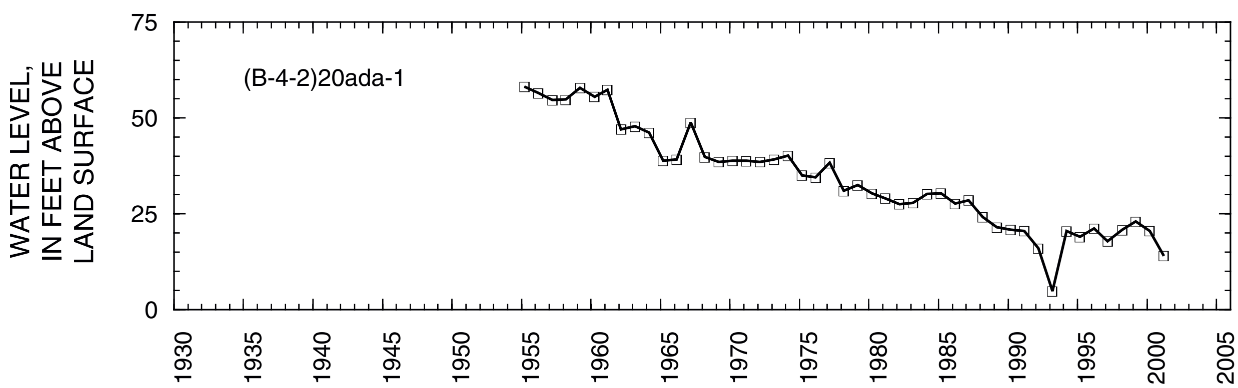
5



6



7



8

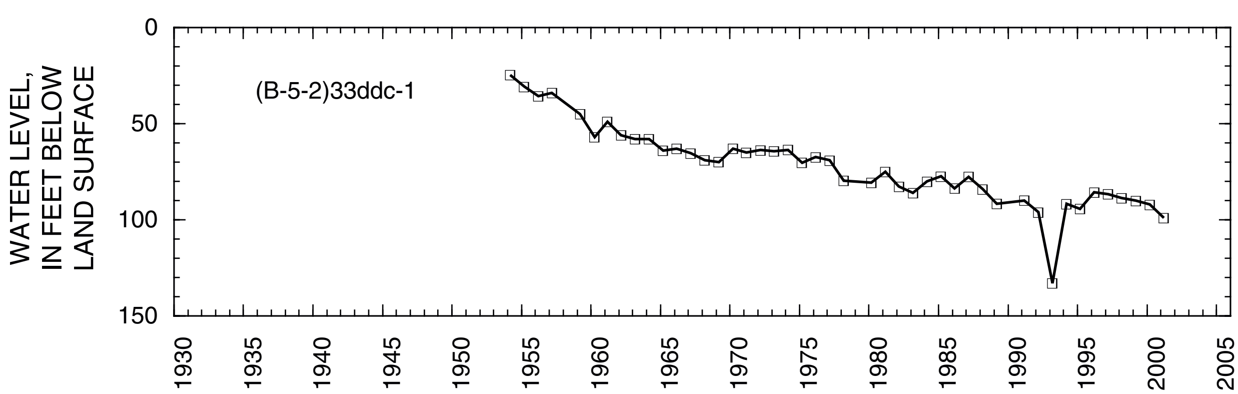


Figure 7. Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1—Continued.

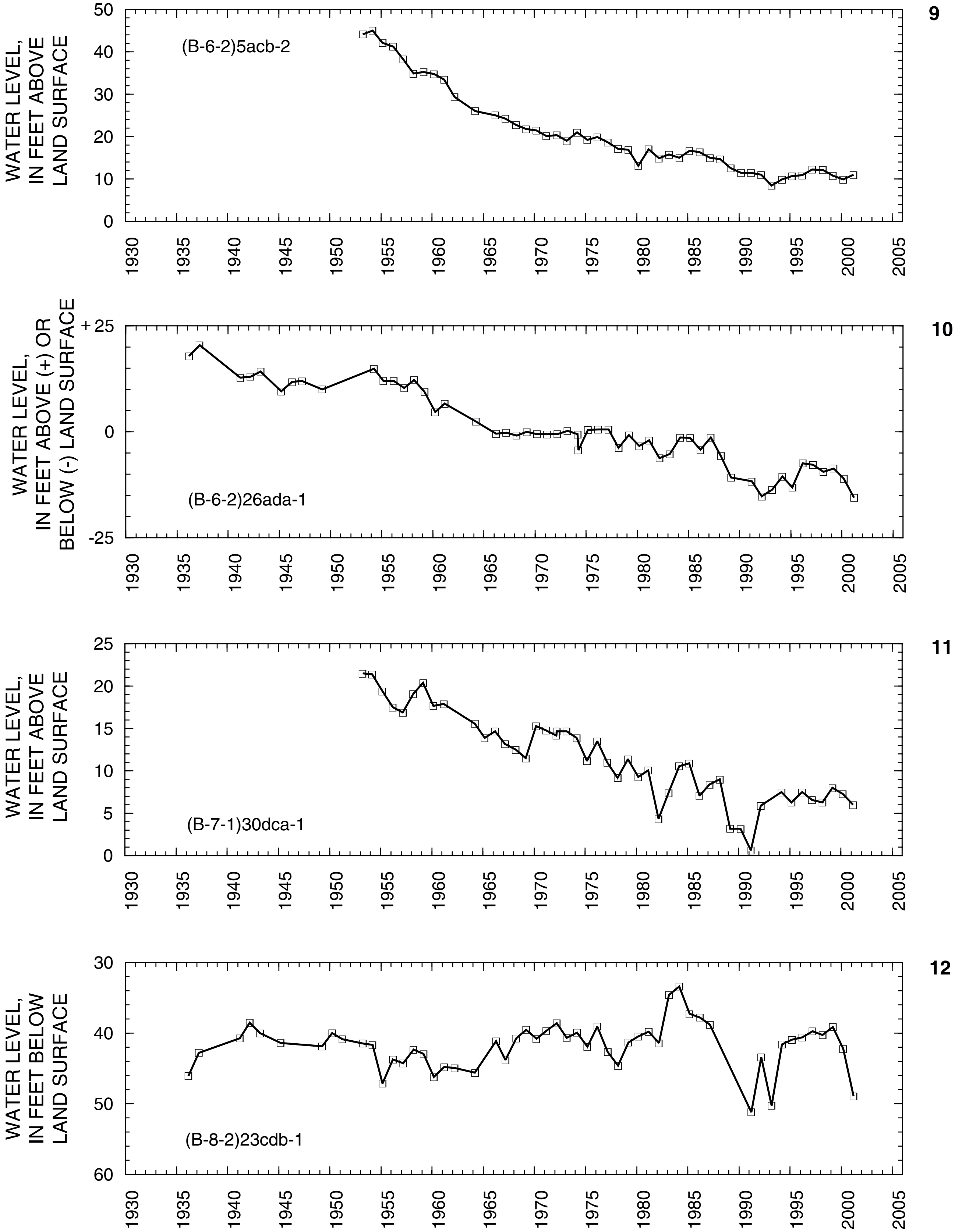


Figure 7. Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1—Continued.

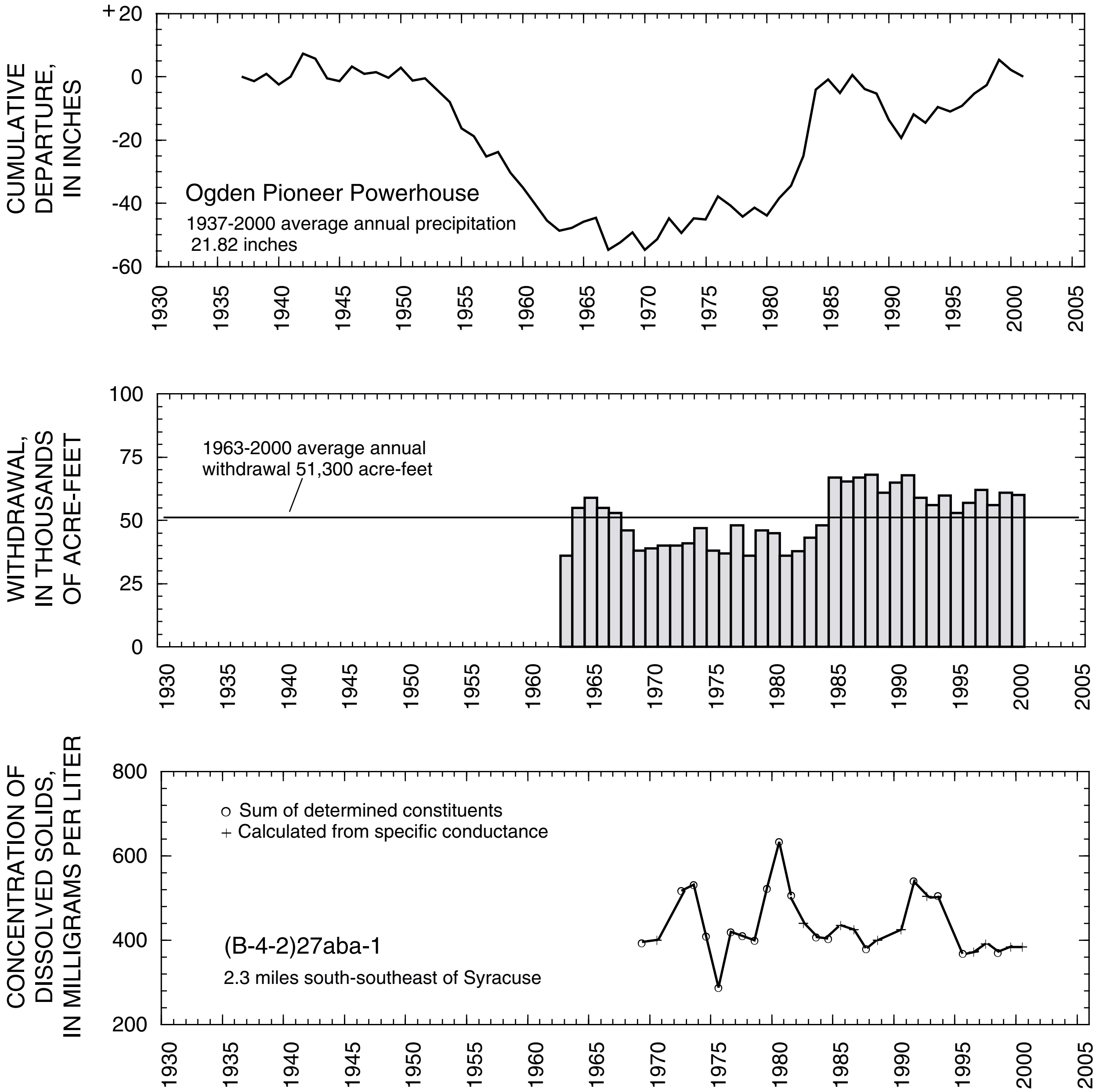


Figure 7. Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Ogden Pioneer Powerhouse, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1—Continued.

SALT LAKE VALLEY

By P.L. Haraden

Salt Lake Valley covers about 400 square miles in the lowlands of Salt Lake County. Ground water occurs in unconsolidated deposits in the valley under water-table and artesian conditions. Recharge to the aquifers is from the mountains that border the valley. In the southern two-thirds of the western half of the valley, ground water moves from the base of the Oquirrh Mountains eastward toward the Jordan River. In the northern one-third of the western half of the valley, the direction of movement is mostly toward Great Salt Lake. In the eastern half of the valley, ground water moves westward from the base of the Wasatch Range toward the Jordan River. The Jordan River drains both surface water and ground water from the valley.

Total estimated withdrawal of water from wells in Salt Lake Valley in 2000 was about 145,000 acre-feet, which is 19,000 acre-feet more than in 1999 and about 15,000 acre-feet more than the average annual withdrawal for 1990-99 (tables 2 and 3). Withdrawal for public supply was about 93,800 acre-feet, which is 21,100 acre-feet more than was reported in 1999. Withdrawal for industrial use was about 23,400 acre-feet, which is 1,200 acre-feet less than was reported for 1999.

The location of wells in Salt Lake Valley in which the water level was measured during spring 2001 is shown in figure 8. Estimated population of Salt Lake County, total annual withdrawal from wells, annual withdrawal for public supply, and average annual precipitation at Salt Lake City Weather Service Office (WSO) (International Airport) are shown in figure 9. Precipitation at Salt Lake City WSO during 2000 was 16.26 inches, 3.37 inches more than in 1999, and 0.96 inch more than the average annual precipitation for 1931-2000.

The relation of the water level in selected wells completed in the principal aquifer to cumulative departure from average annual precipitation at Silver Lake near Brighton, and the relation of the water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well are shown in figure 10. Precipitation at Silver Lake near Brighton was 39.90 inches in 2000, which is the same as in 1999 and 2.89 inches less than the average annual precipitation for 1931-2000.

Water levels generally declined from spring 2000 to spring 2001 in most of the observation wells in the principal aquifer of the Salt Lake Valley. The water level in most of the observation wells was highest during 1985-87, which corresponds to a period of much-greater-than-average precipitation during 1982-86. Levels have generally declined since 1987.

The chloride concentration from well (D-1-1) 7abd-6 (located in Artesian Well Park in Salt Lake City) was 150 milligrams per liter in July 2000; this is the same as was reported in 1999. Chloride and dissolved-solids concentration at this well have steadily increased since the 1960s.

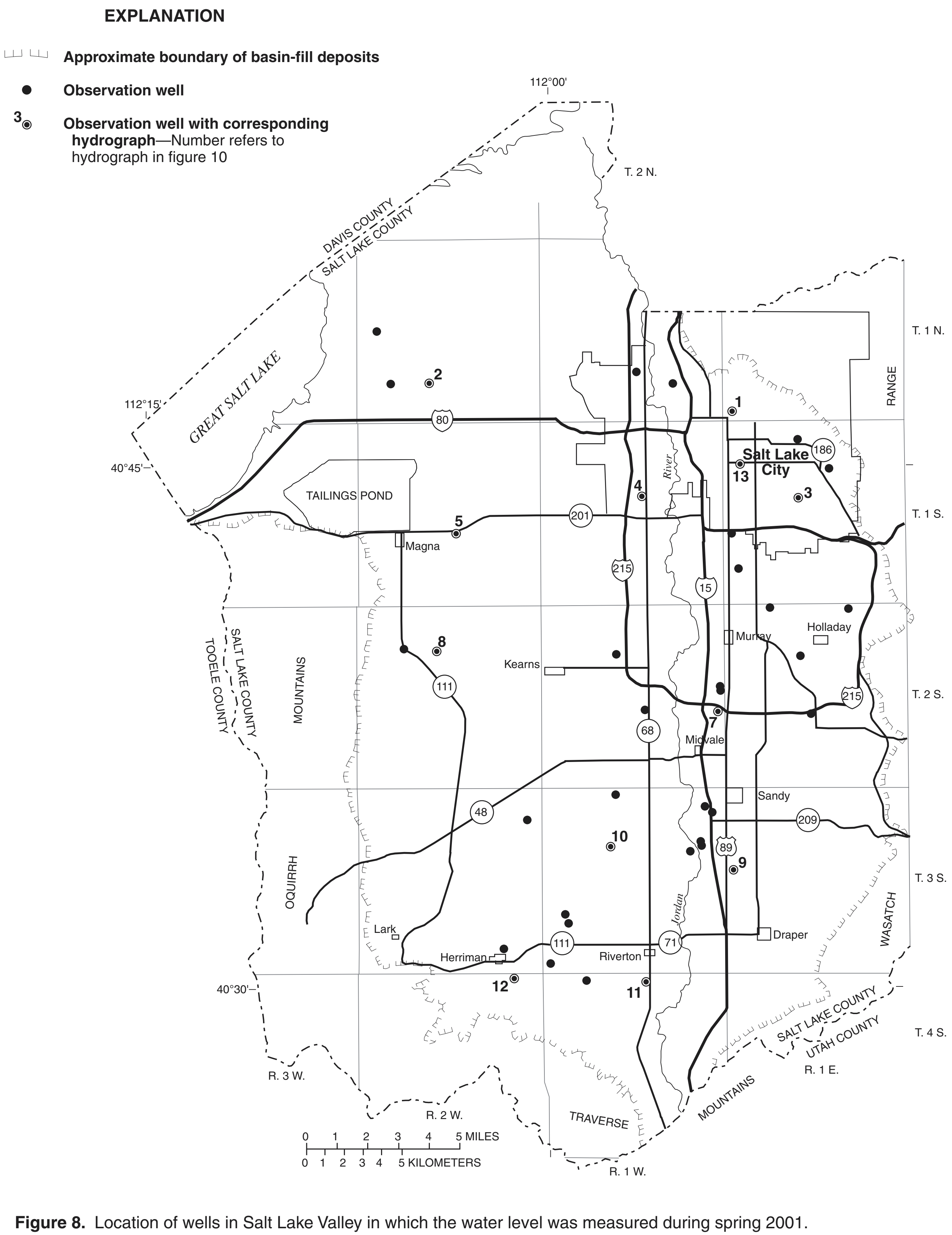


Figure 8. Location of wells in Salt Lake Valley in which the water level was measured during spring 2001.

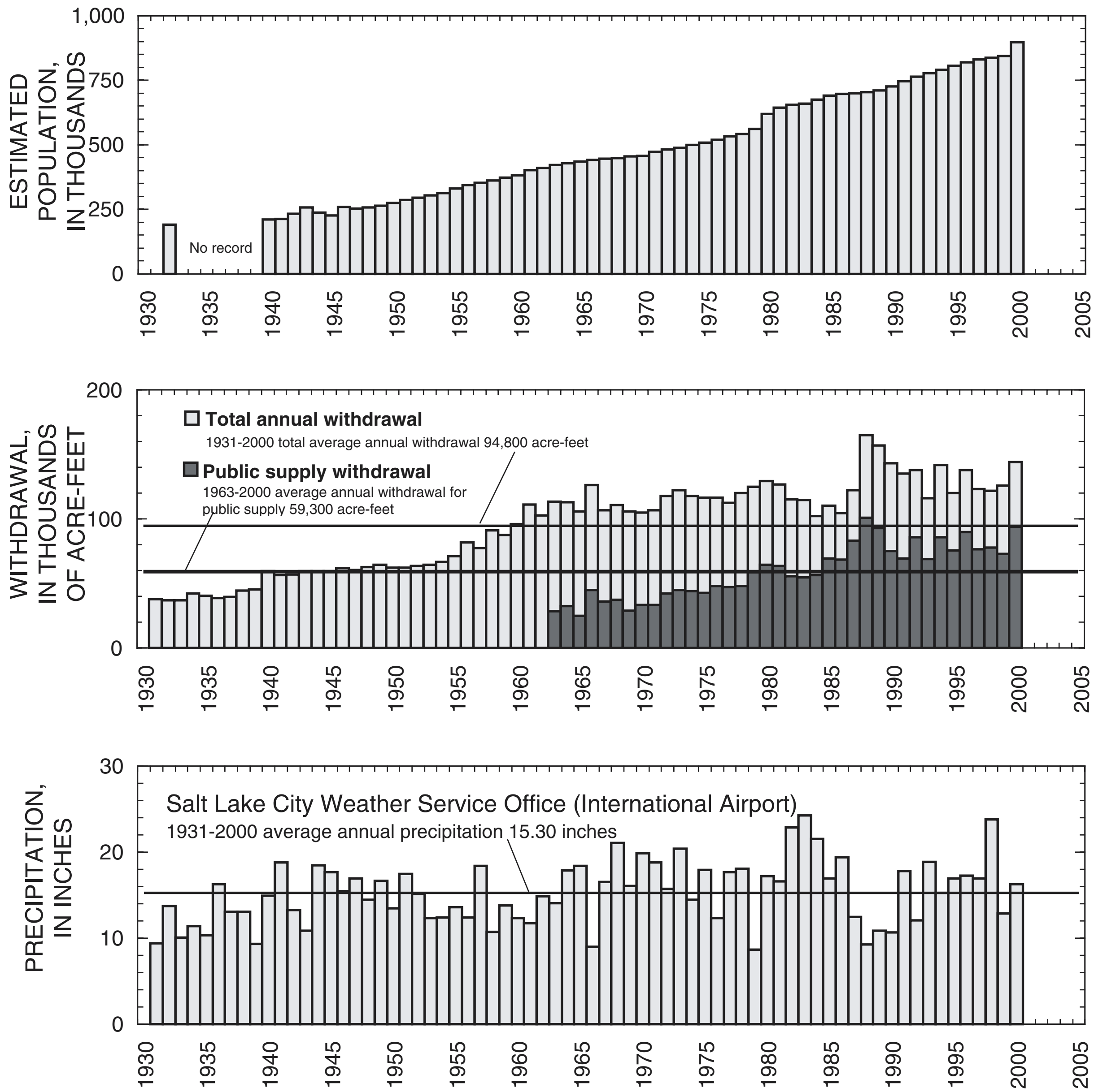


Figure 9. Estimated population of Salt Lake County, total annual withdrawal from wells, annual withdrawal for public supply, and average annual precipitation at Salt Lake City Weather Service Office (International Airport).

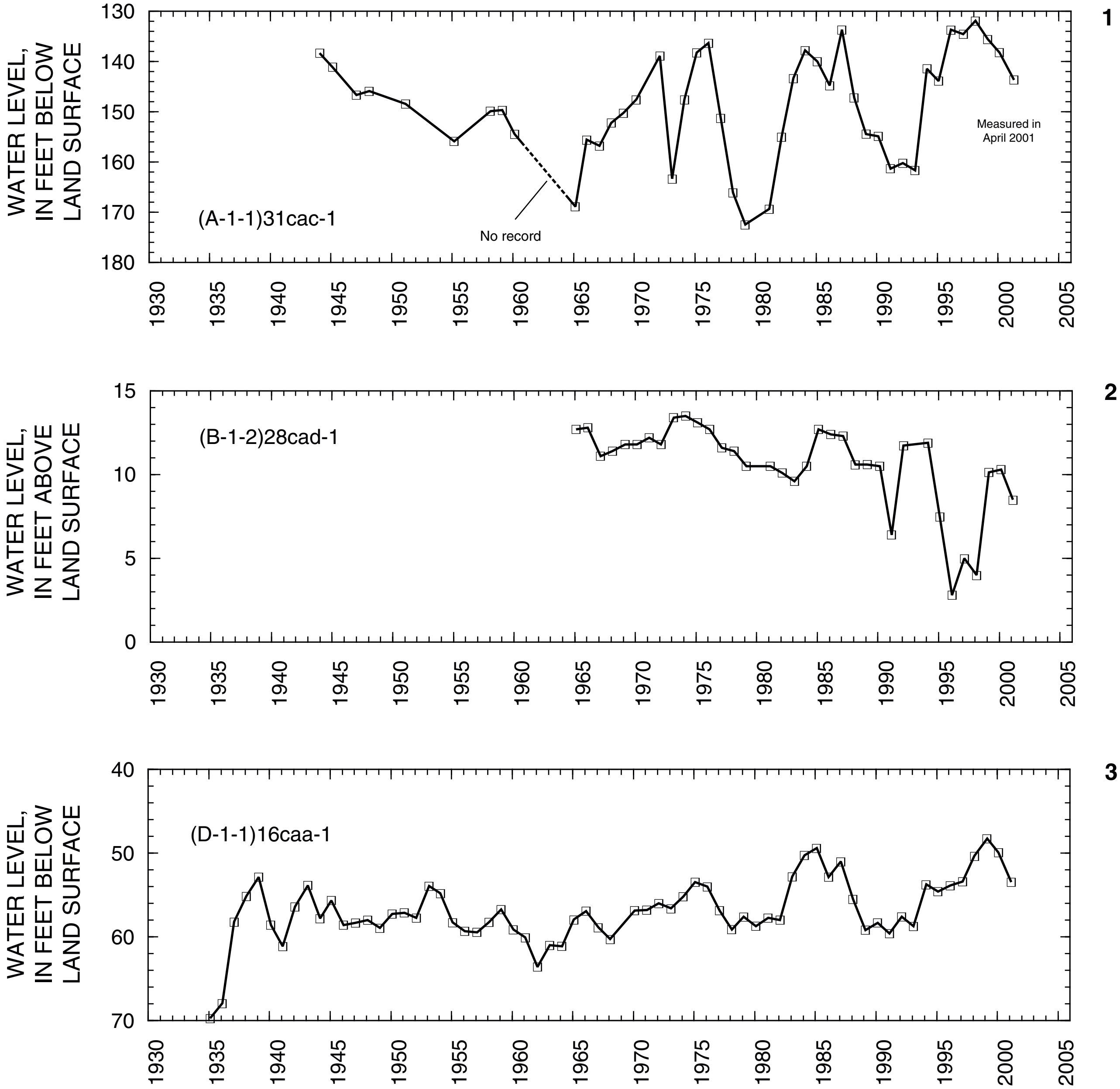


Figure 10. Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well.

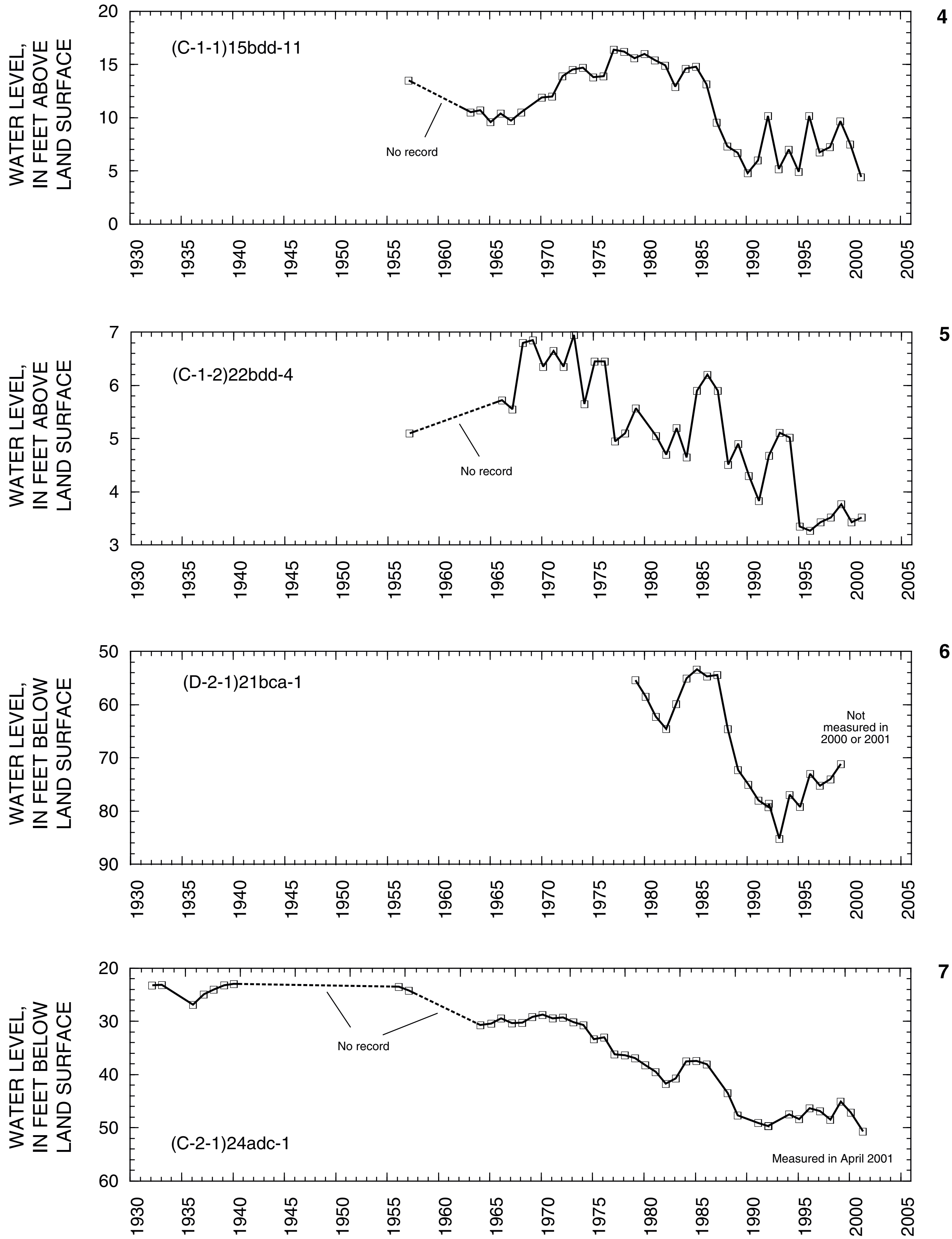


Figure 10. Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well—Continued.

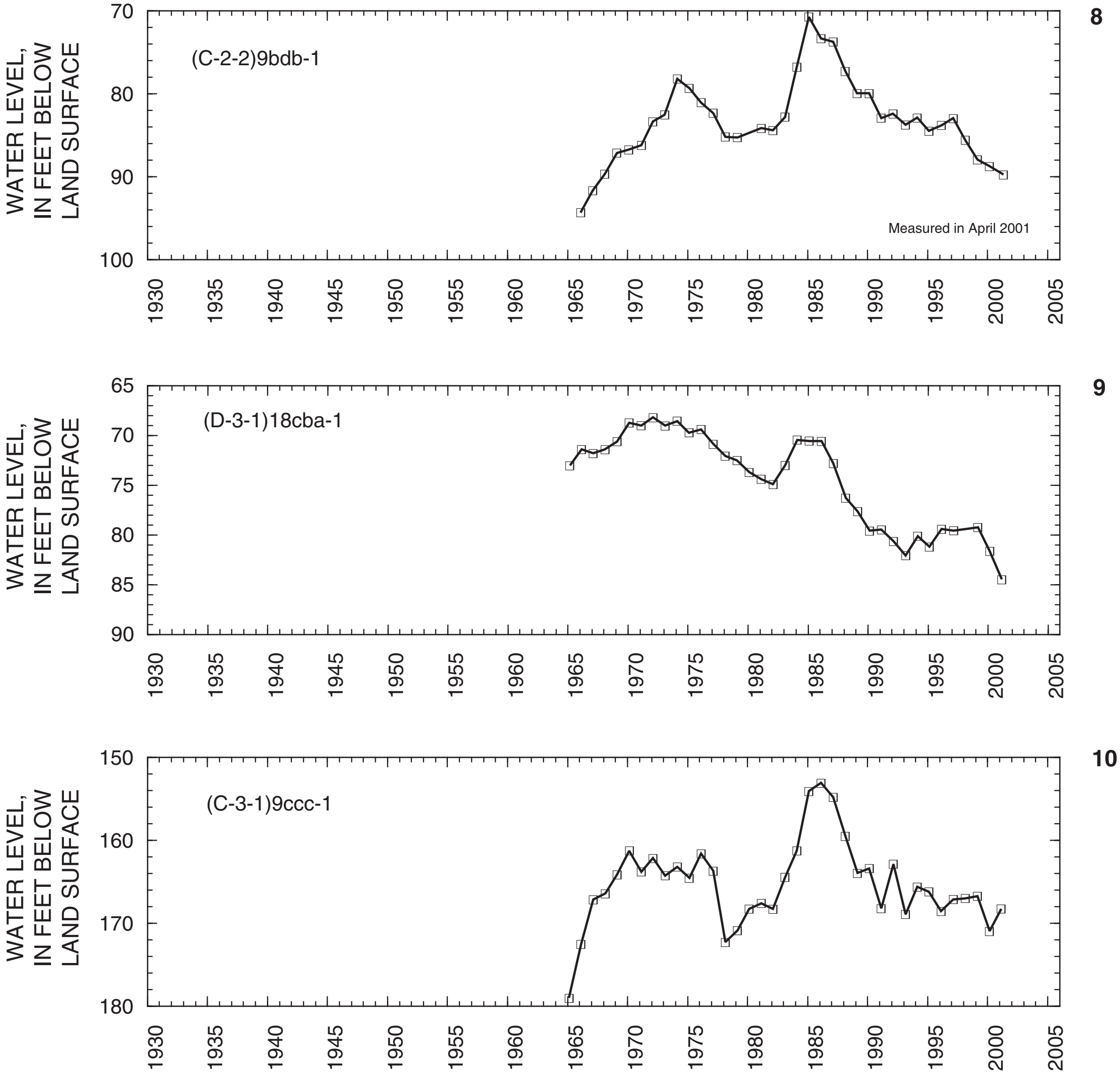
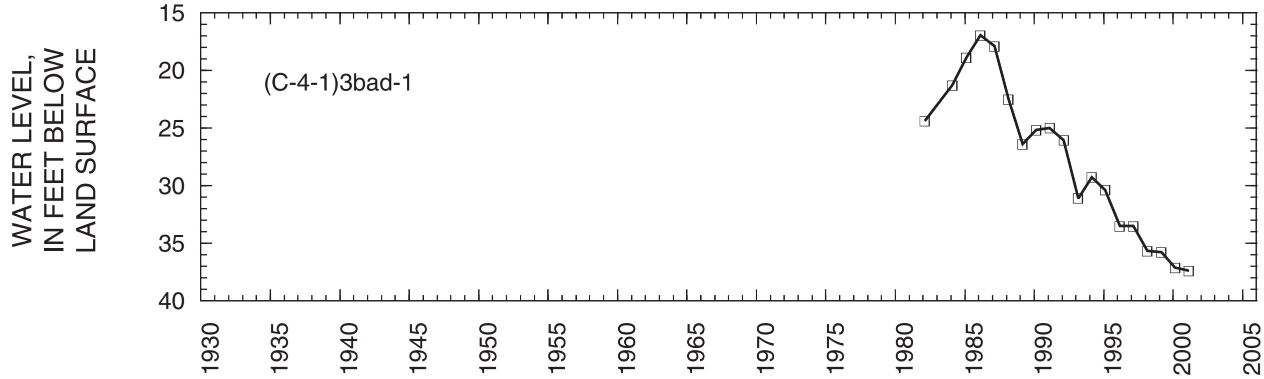


Figure 10. Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well—Continued.



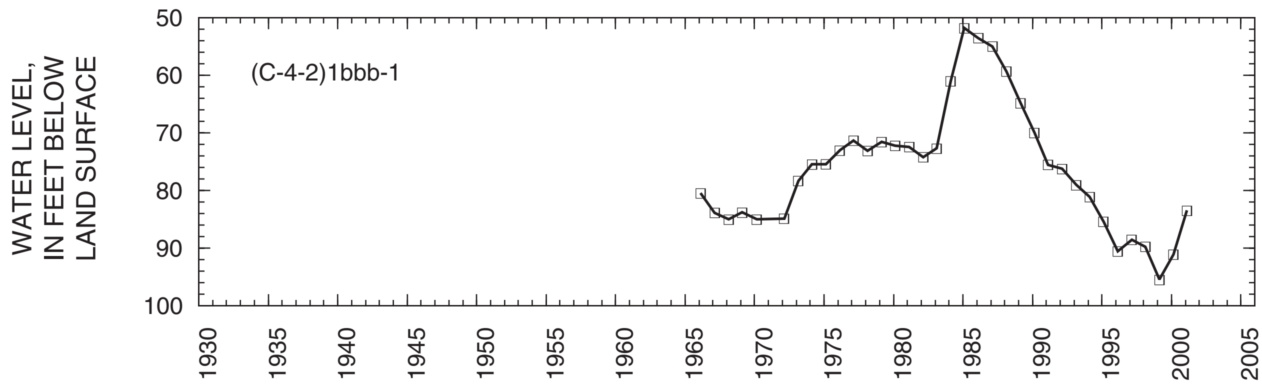


Figure 10. Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well—Continued.

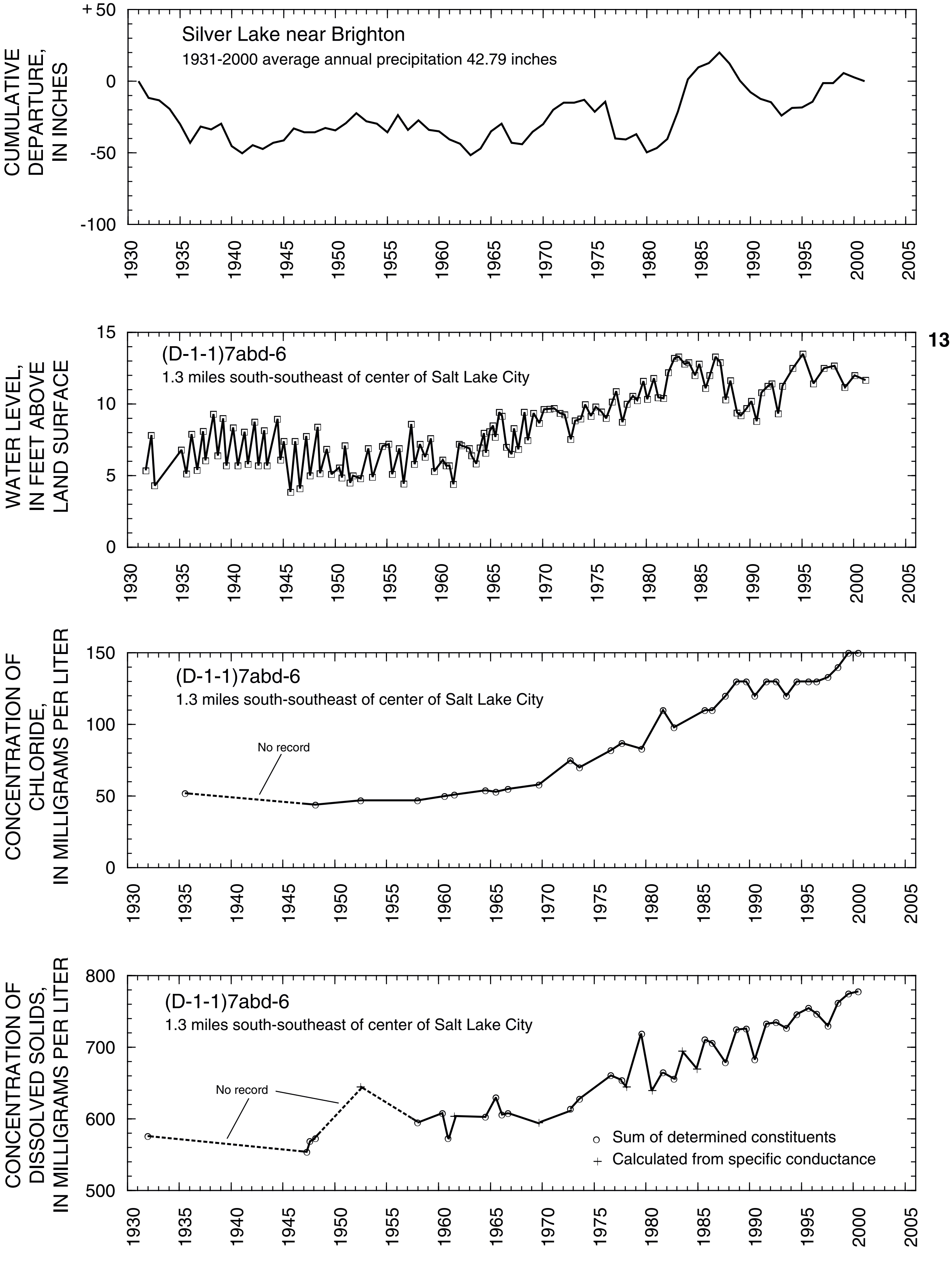


Figure 10. Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake near Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from the well—Continued.

TOOELE VALLEY

By T.A. Kenney

Tooele Valley is between the Stansbury Mountains and Oquirrh Mountains and extends from Great Salt Lake to a low ridge called South Mountain. The total area of the valley is about 250 square miles.

Ground water occurs in the unconsolidated deposits in Tooele Valley under both water-table and artesian conditions, but nearly all the water withdrawn by wells is from artesian aquifers.

Total estimated withdrawal of water from wells in Tooele Valley in 2000 was about 24,000 acre-feet, which is 3,000 acre-feet more than for 1999 and 2,000 acre-feet less than the average annual withdrawal for 1990-99 (tables 2 and 3). Although there was an increase in withdrawals from last year, less-than-average withdrawals were probably the result of greater-than-average precipitation. The increase in withdrawals from last year was mainly the result of increased irrigation. Withdrawal for public supply was about 4,500 acre-feet, which is 500 acre-feet more than the withdrawal for 1999. Withdrawal for irrigation use in 2000 was about 17,600 acre-feet, which is 1,900 acre-feet more than was reported for 1999.

The location of wells in Tooele Valley in which the water level was measured during March 2001 is shown in figure 11. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Tooele and to annual withdrawal from wells is shown in figure 12. Precipitation during 2000 at Tooele was 18.43 inches, 2.41 inches more than in 1999 and 0.57 inch more than the average annual precipitation for 1936-2000.

Water levels in wells (fig. 12) in Tooele Valley generally declined from March 2000 to March 2001. The decline in water levels is probably the result of increased withdrawals in the valley. Water levels generally rose during the previous 5 years as a result of greater-than-average precipitation.

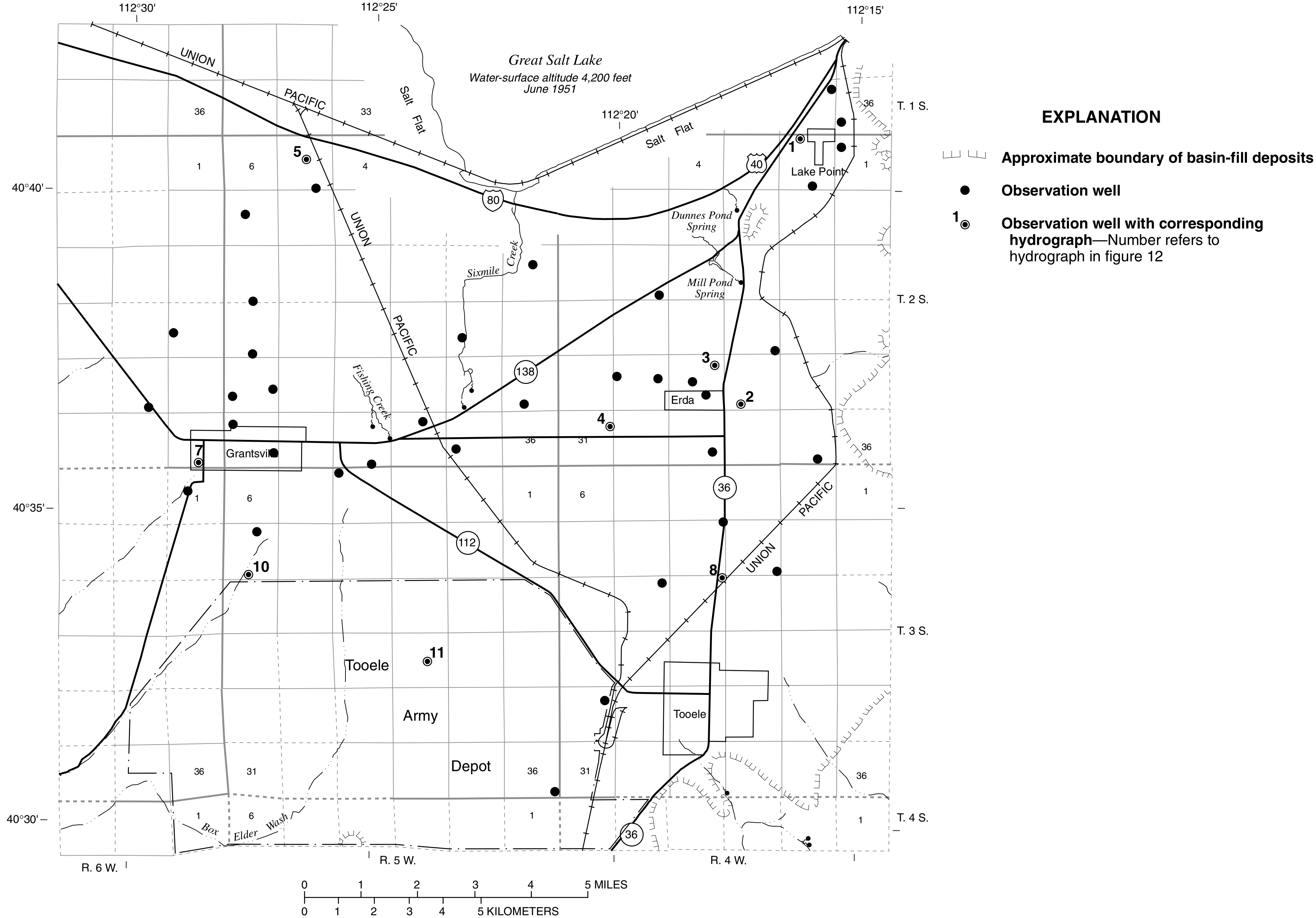


Figure 11. Location of wells in Tooele Valley in which the water level was measured during March 2001.

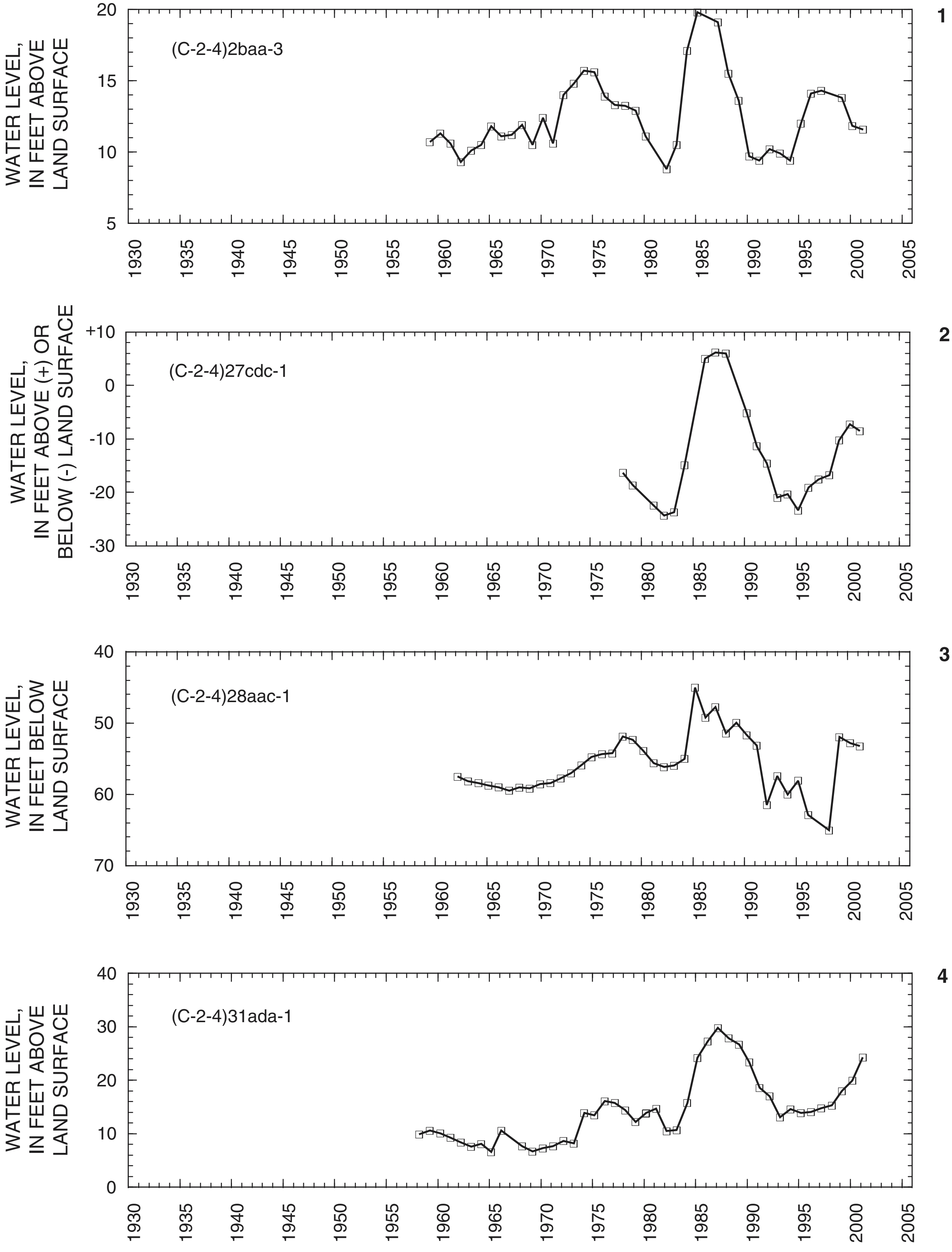


Figure 12. Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele and to annual withdrawal from wells.

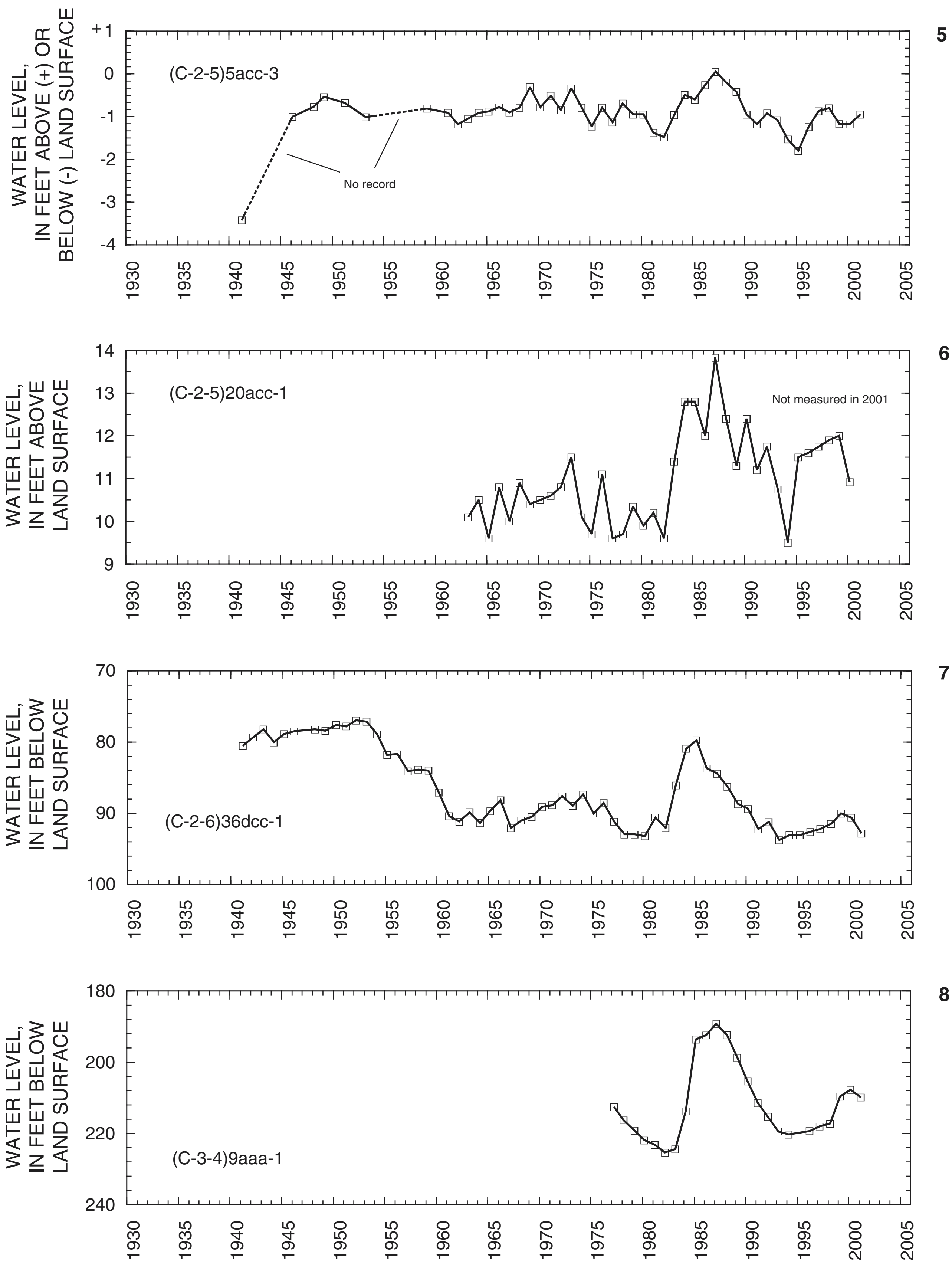
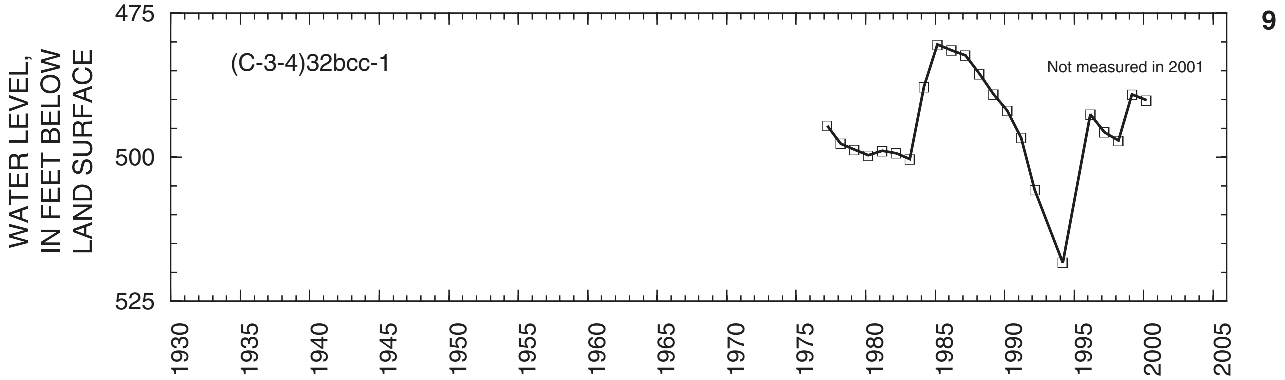
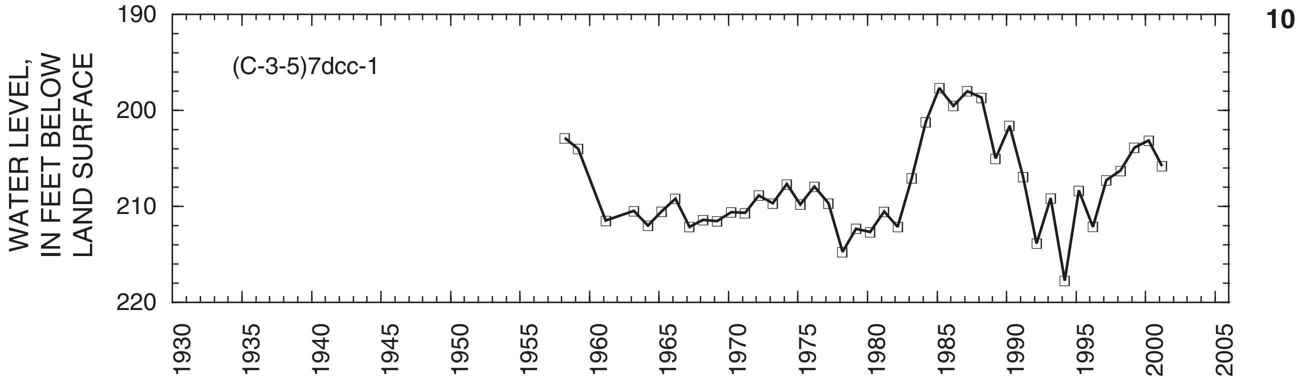


Figure 12. Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele and to annual withdrawal from wells—Continued.





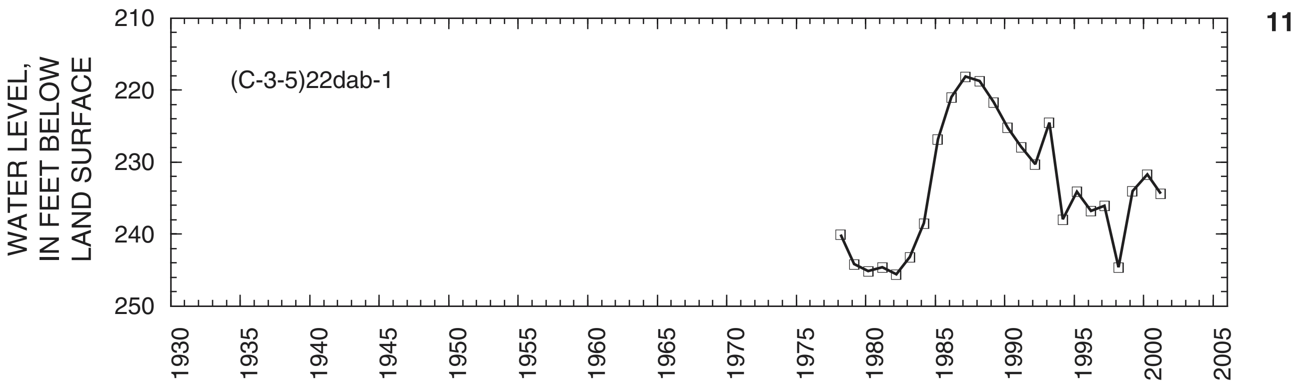


Figure 12. Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele and to annual withdrawal from wells—Continued.

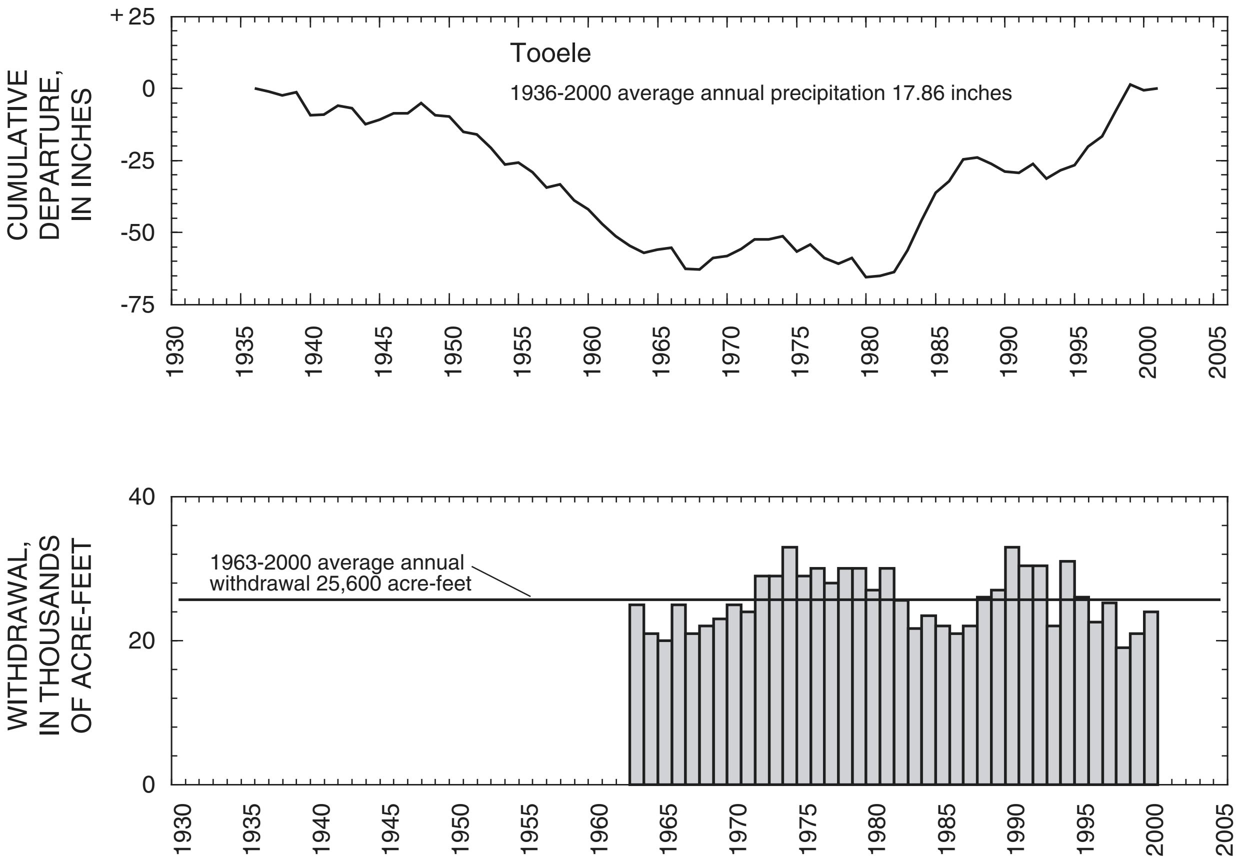


Figure 12. Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele and to annual withdrawal from wells—Continued.

UTAH AND GOSHEN VALLEYS

By M.J. Fisher

Northern Utah Valley is the part of Utah Valley that is north of Provo Bay. Ground water occurs in unconsolidated basin-fill deposits in the valley. The principal ground-water recharge area for the basin fill is in the eastern part of the valley, along the base of the Wasatch Range.

Southern Utah Valley is the part of Utah Valley south of Provo and bounded by the Wasatch Range, West Mountain, and the northern extension of Long Ridge. Goshen Valley is south of the latitude of Provo and is bounded by West Mountain, Long Ridge, and the East Tintic Mountains. Ground water occurs in the alluvium in the valleys under both water-table and artesian conditions, but most wells discharge from artesian aquifers.

Total estimated withdrawal of water from wells in Utah and Goshen Valleys in 2000 was about 132,000 acre-feet, which is 22,000 acre-feet more than the revised value for 1999, and 26,000 acre-feet more than the revised average annual withdrawal for 1990-99 (tables 2 and 3). Withdrawal in northern Utah Valley was about 85,000 acre-feet, which is 9,900 acre-feet more than the revised value for 1999; withdrawal in southern Utah Valley was about 32,700 acre-feet, which is 11,500 acre-feet more than the revised value for 1999; withdrawal in Goshen Valley was about 14,600 acre-feet, which is 1,300 acre-feet more than the revised value in 1999. Most of the total increase in withdrawal probably resulted from increased withdrawal for public supply and irrigation.

Water levels in Goshen Valley and in the northern and southern parts of Utah Valley generally rose in the early 1980s. The rise corresponds to a period of greater-than-average precipitation and recharge from surface water. Water levels generally declined from 1985 to 1993 in Utah Valley and generally rose from 1993 to 1999. This rise resulted from greater-than-average precipitation during this period. Water levels generally declined from spring 1999 to spring 2001. Water levels in Goshen Valley generally have declined since 1992.

The location of wells in Utah and Goshen Valleys in which the water level was measured during spring 2001 is shown in figure 13. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Silver Lake near Brighton and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of the Spanish Fork River at Castilla, and to concentration of dissolved solids in water from three wells is shown in figure 14. Discharge of the Spanish Fork River at Castilla in 2000 was 138,800 acre-feet, which is 29,300 acre-feet less than the 1933-2000 annual average. Precipitation at Silver Lake near Brighton in 2000 was 39.90 inches, which is 2.89 inches less than the 1931-2000 annual average and the same as in 1999. Precipitation at Spanish Fork Powerhouse in 2000 was 20.06 inches, which is 0.43 inch more than the 1937-2000 annual average and 1.32 inches more than in 1999. Concentrations of dissolved solids in water from three wells have generally increased since 1975.

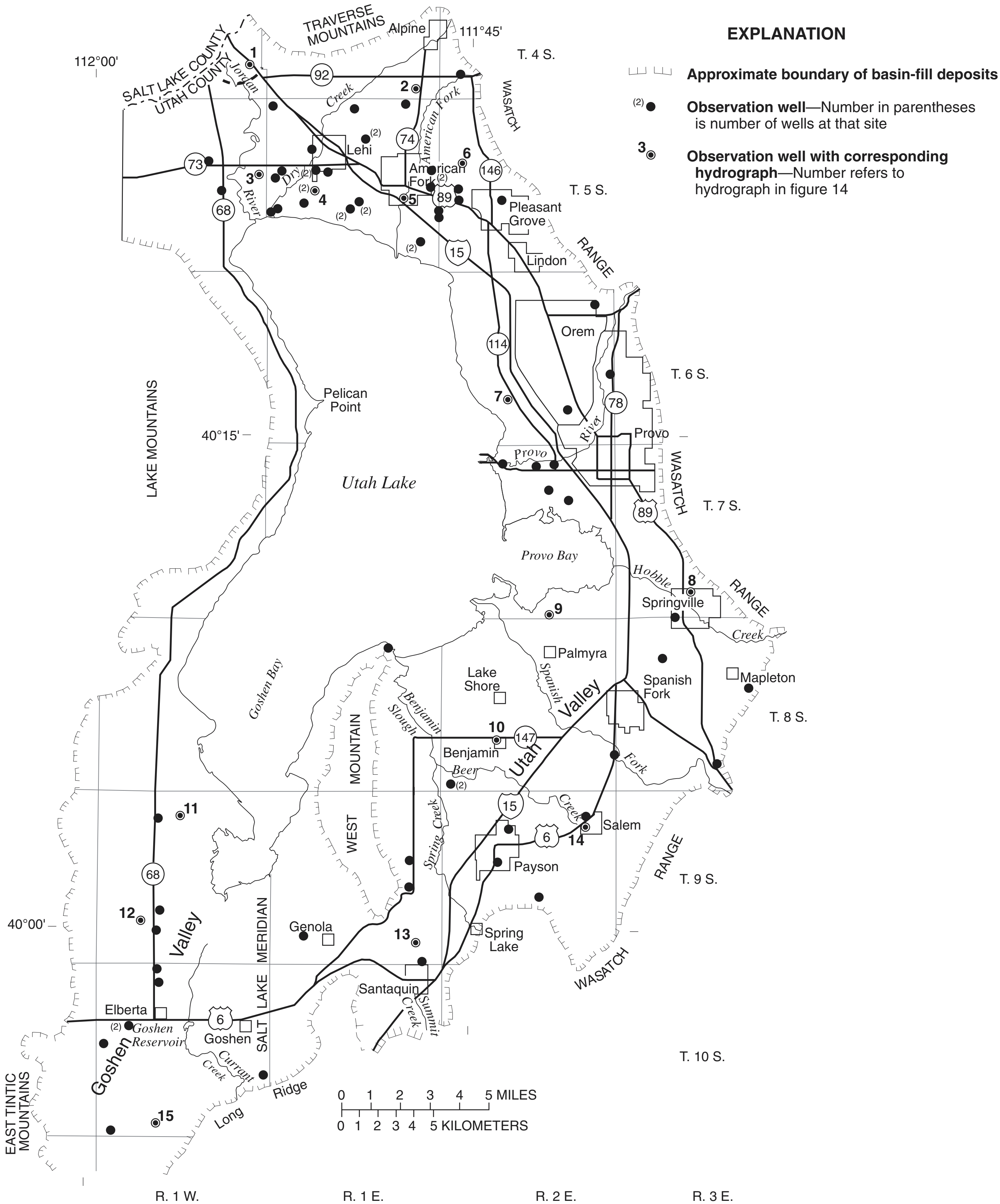


Figure 13. Location of wells in Utah and Goshen Valleys in which the water level was measured during spring 2001.

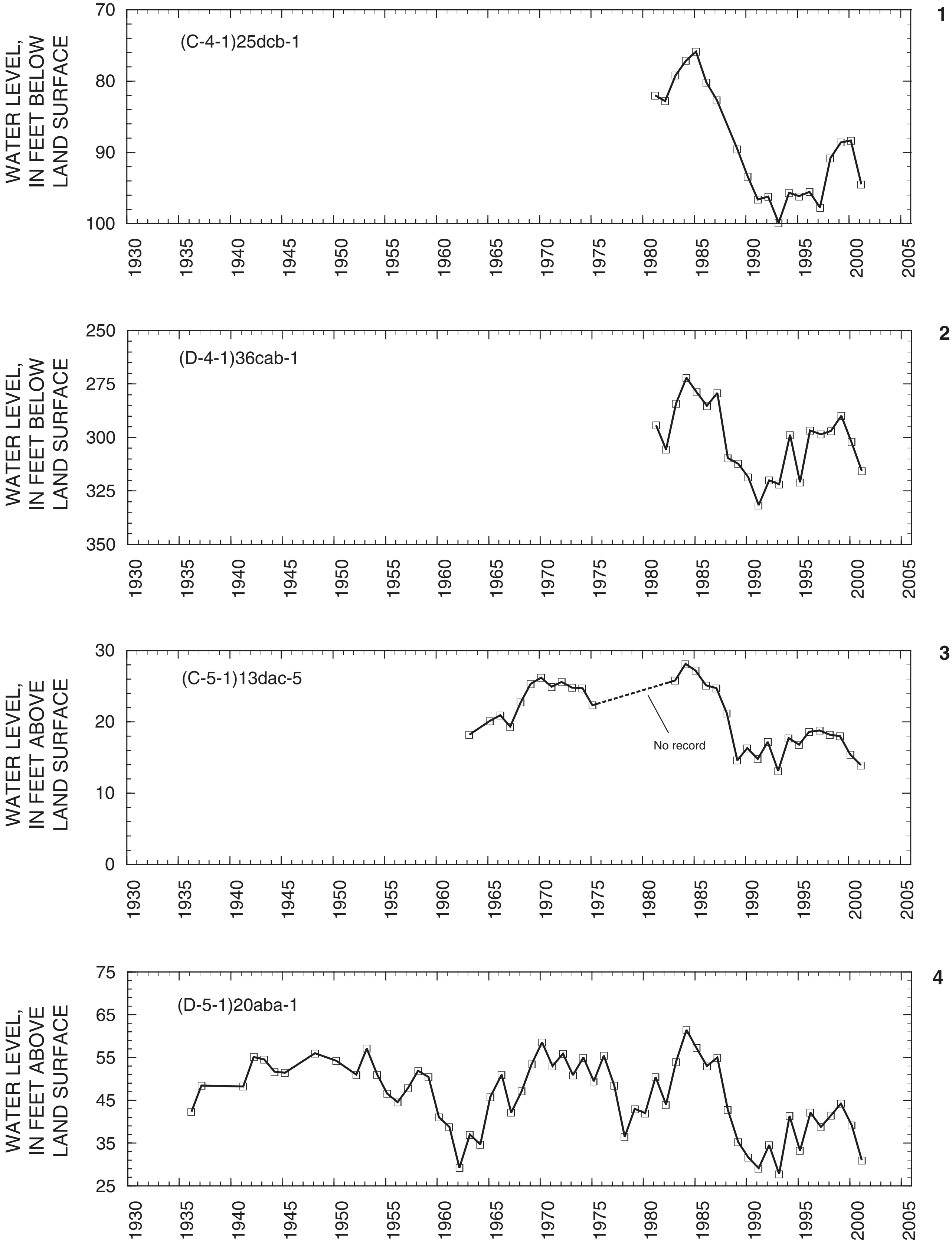
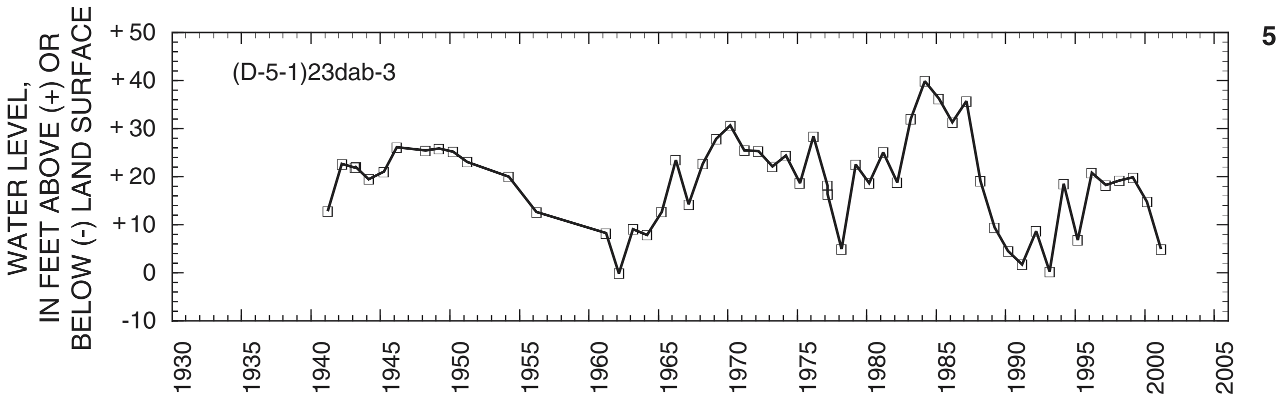
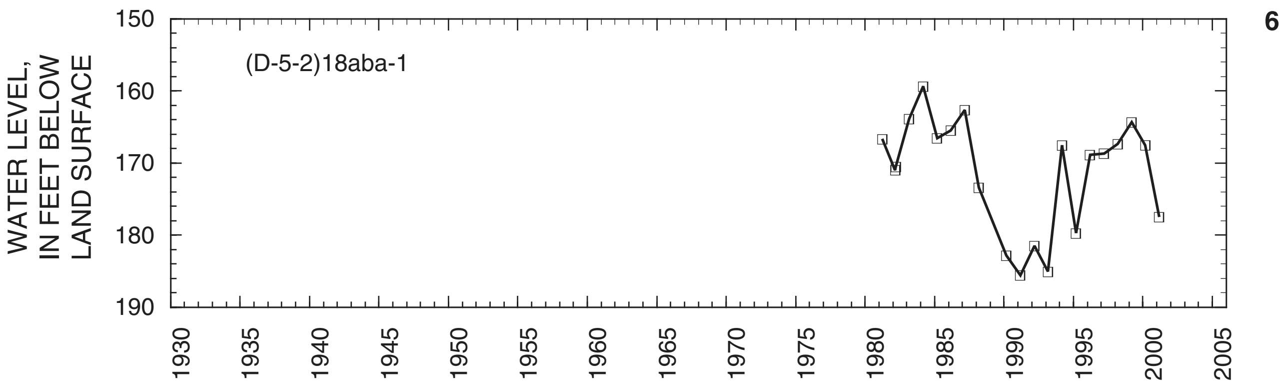
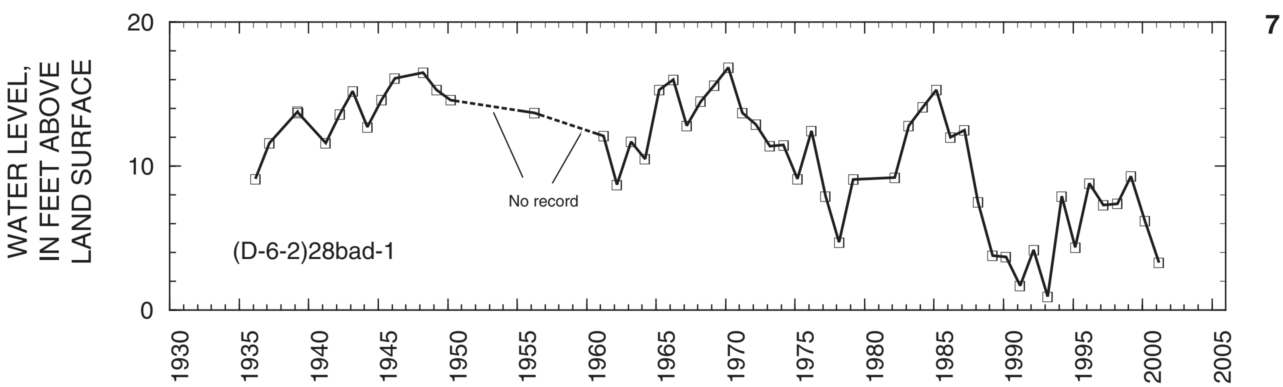


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake near Brighton and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from three wells.







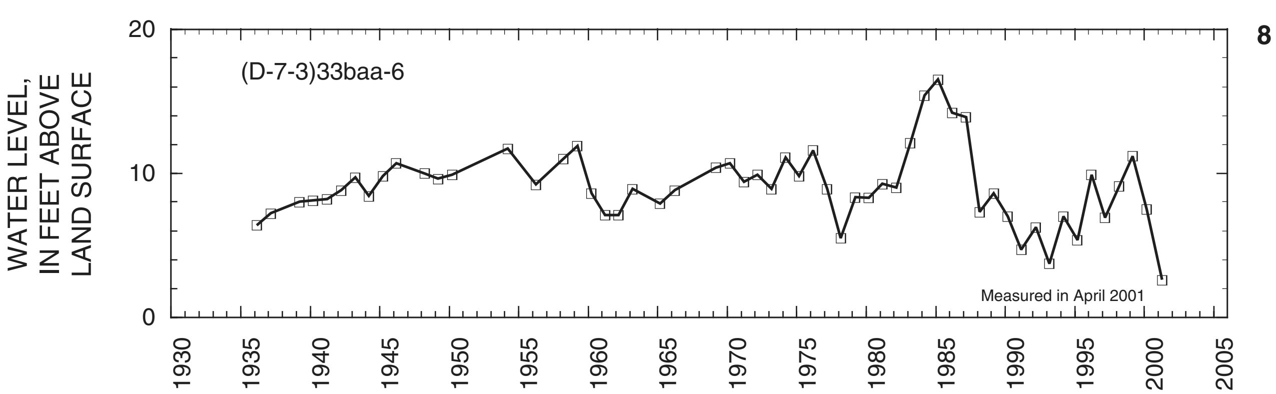


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake near Brighton and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from three wells—Continued.

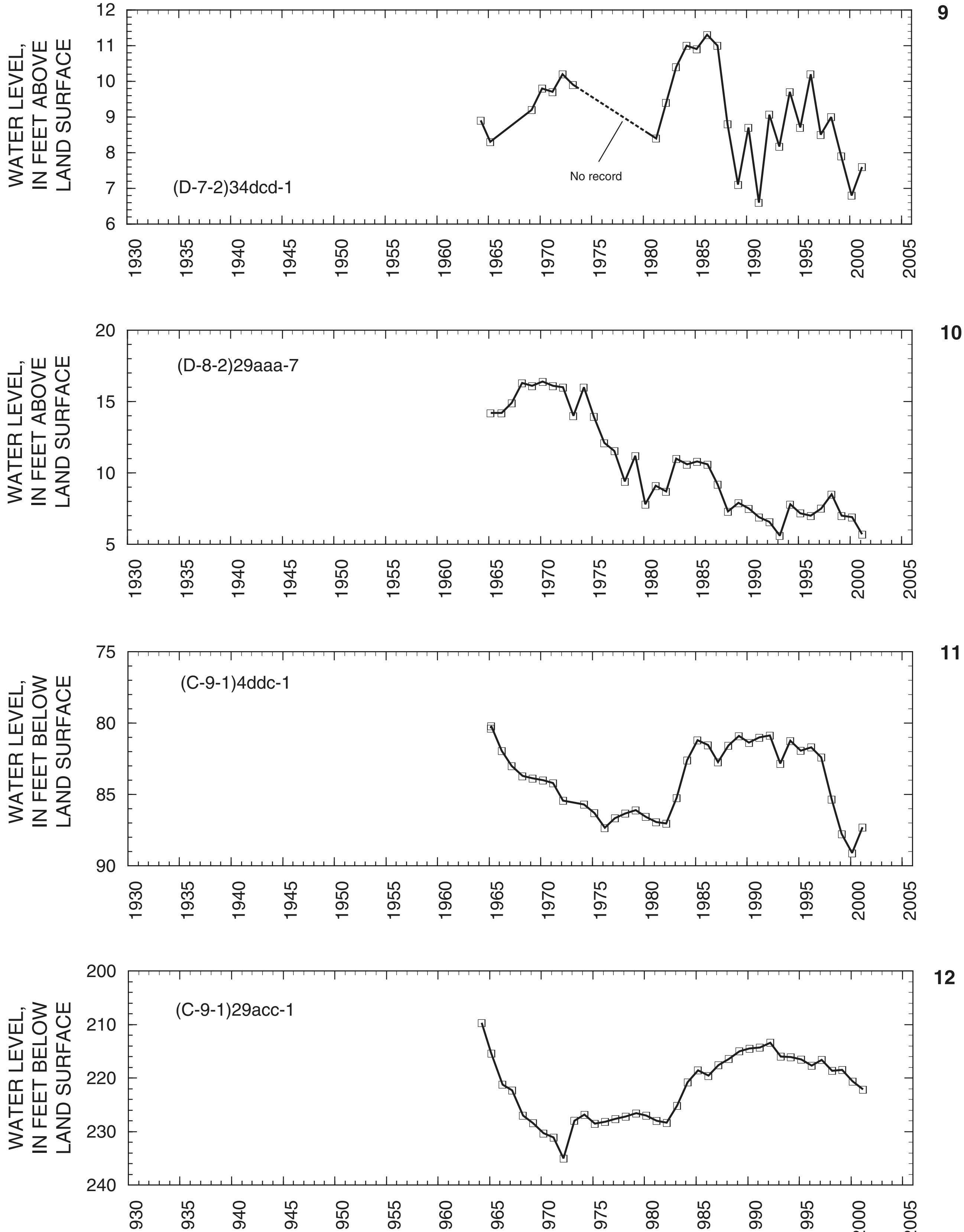
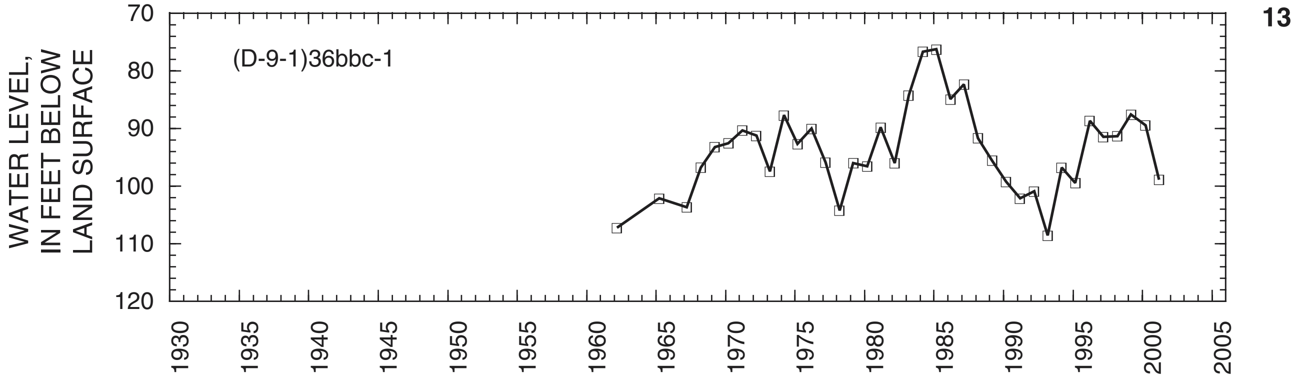
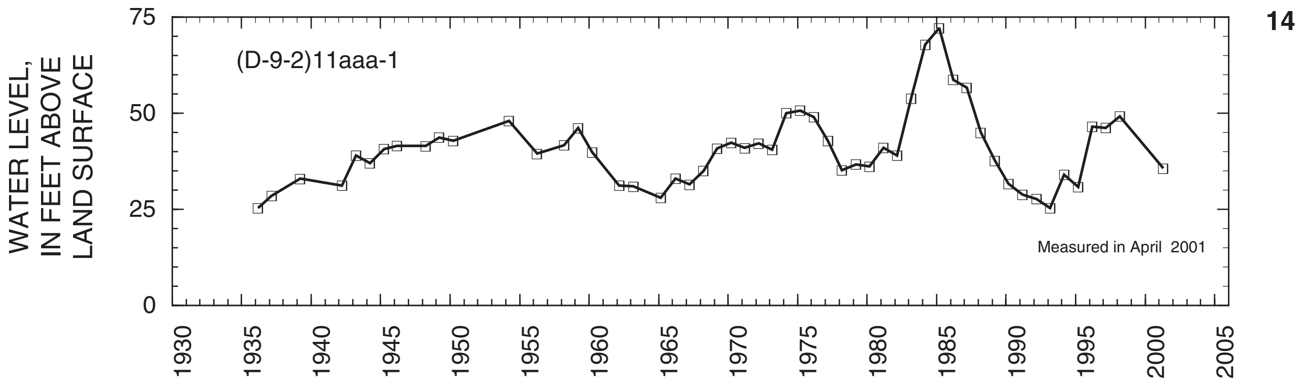


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake near Brighton and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from three wells—Continued.





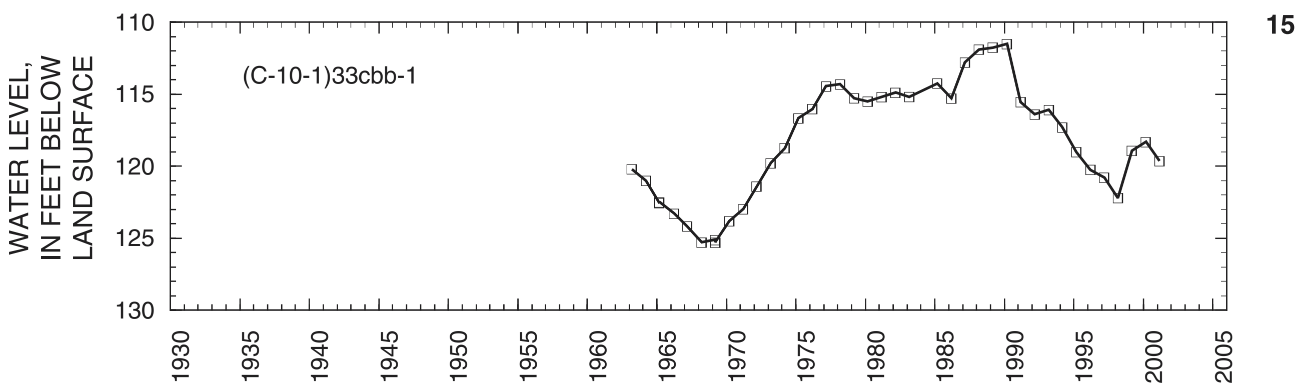


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake near Brighton and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from three wells—Continued.

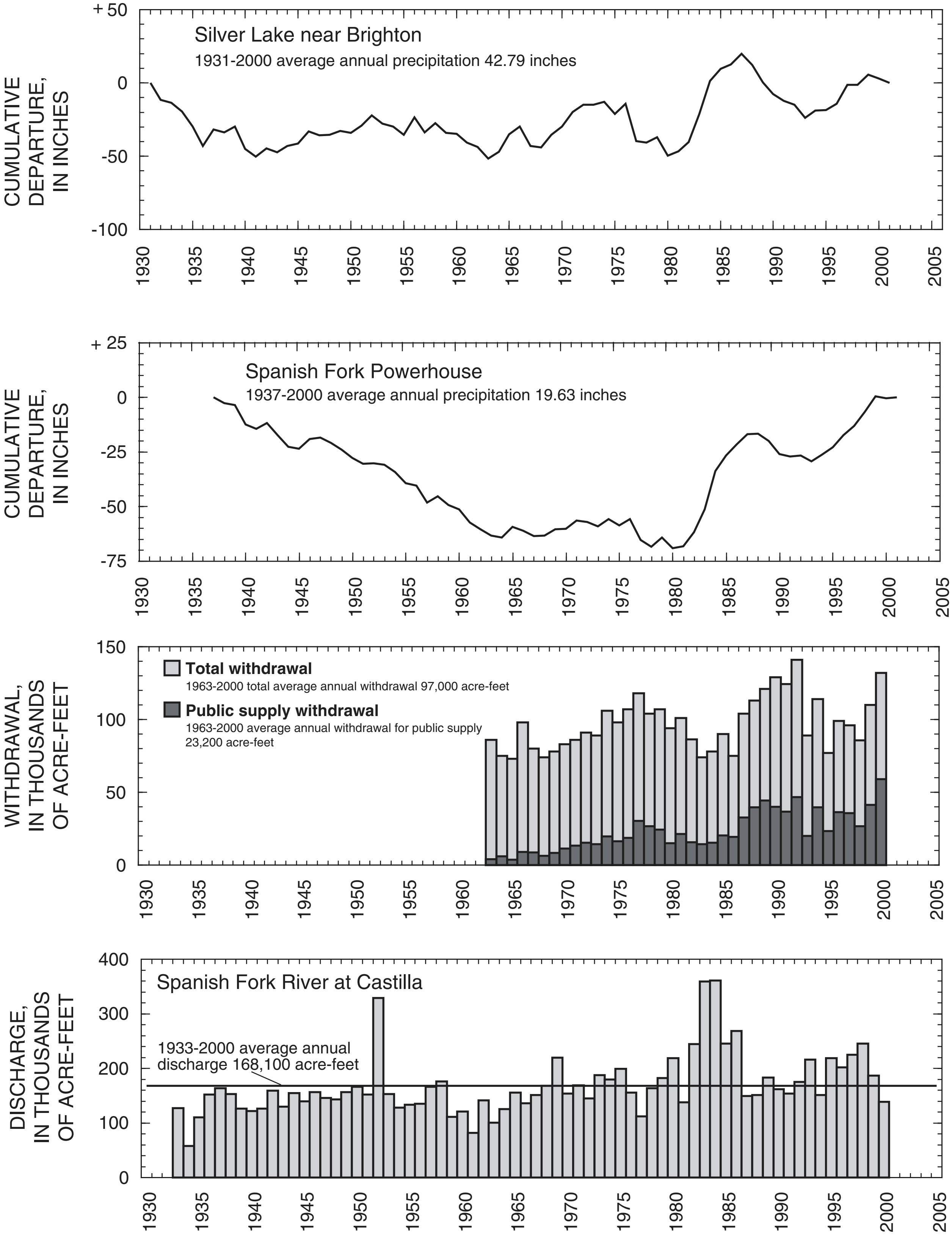


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake near Brighton and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from three wells—Continued.

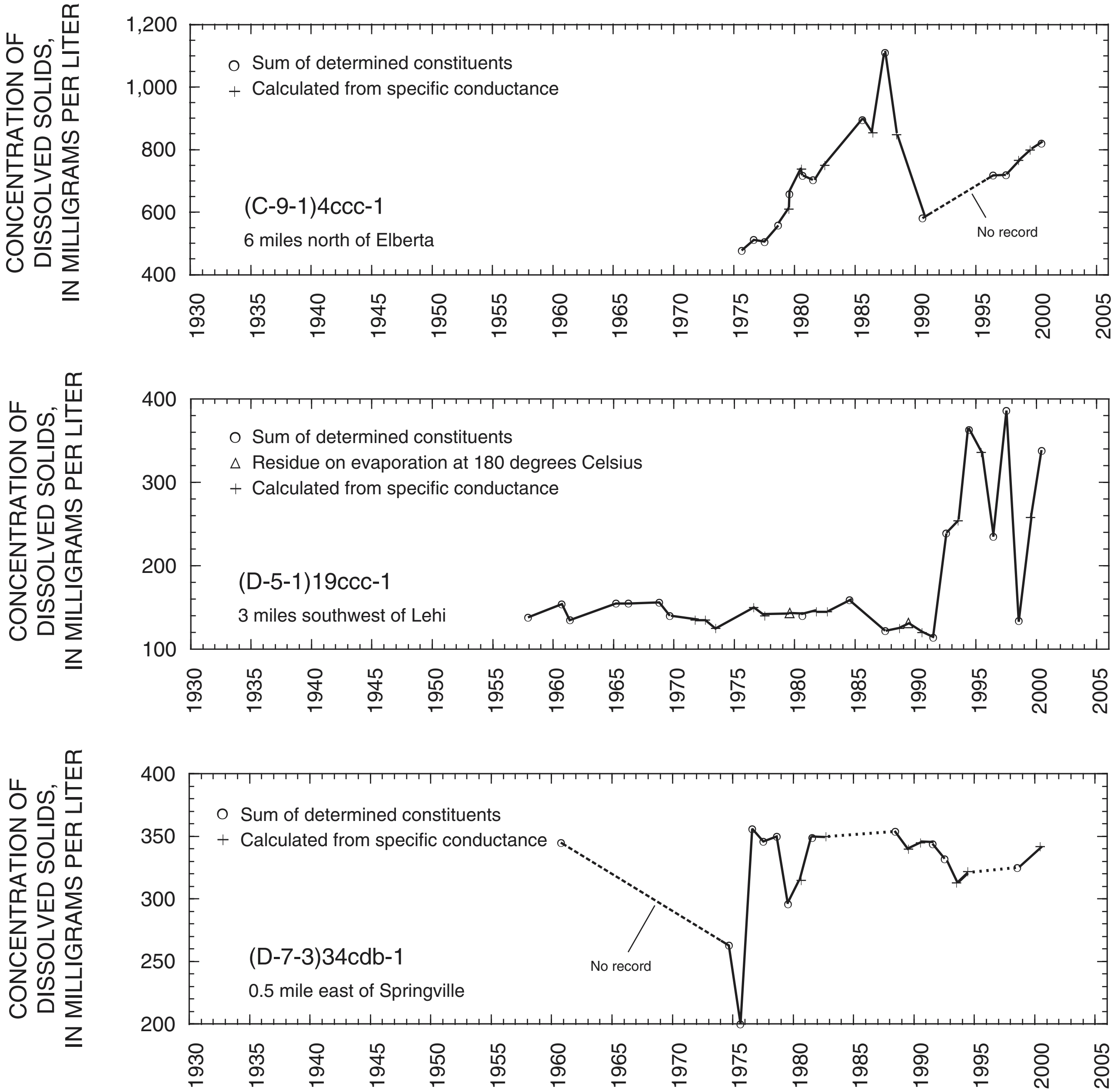


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake near Brighton and Spanish Fork Powerhouse, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork River at Castilla, and to concentration of dissolved solids in water from three wells—Continued.

JUAB VALLEY

By R.J. Eacret

Juab Valley, which is about 30 miles long and averages about 4 miles wide, is in central Utah along the west side of the Wasatch Range and the San Pitch Mountains. The valley drains near both its northern and southern ends—in northern Juab Valley via Currant Creek into Utah Lake, and in southern Juab Valley via Chicken Creek into the Sevier River. The northern and southern parts of Juab Valley are separated topographically by Levan Ridge, a gentle rise near the midpoint of the valley floor.

The principal water-bearing formation in Juab Valley is the unconsolidated basin-fill deposits. Most of the recharge to the ground-water reservoir occurs on the eastern side of the valley along the Wasatch Range and the San Pitch Mountains. Ground water moves to the lower part of the valley and to eventual discharge points at the northern and southern ends of the valley. The ground-water divide between the northern and southern parts of Juab Valley is near Levan Ridge.

Ground water occurs in the basin-fill deposits under both water-table and artesian conditions; artesian conditions are prevalent in the lower part of the valley. The greatest depths to water are along the eastern margin of the valley, where permeable alluvial fans extend from the mountains into the valley.

Total estimated withdrawal of water from wells in Juab Valley in 2000 was about 27,000 acre-feet, which is 13,000 acre-feet more than was reported for 1999 and 7,000 acre-feet more than the average annual withdrawal for 1990-99 (tables 2 and 3).

Water levels from March 1999 to March 2001 generally declined in most of the valley. The decline in water levels probably resulted from increased withdrawals and less-than-average precipitation during the irrigation season. Water levels in March generally rose from 1978 to their highest level in 1985. This rise corresponds to a period of greater-than-average precipitation during 1978-86. Water levels generally declined from 1986 to 1993 and generally have risen since 1993.

The location of wells in Juab Valley in which the water level was measured during March 2001 is shown in figure 15. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1 is shown in figure 16. Precipitation at Nephi during 2000 was 16.76 inches, which is 2.21 inches more than the average annual precipitation for 1935-2000, and 2.63 inches more than in 1999. The concentration of dissolved solids in water from well (D-13-1)7dbc-1 fluctuated during 1964-2000 with a slight upward trend.

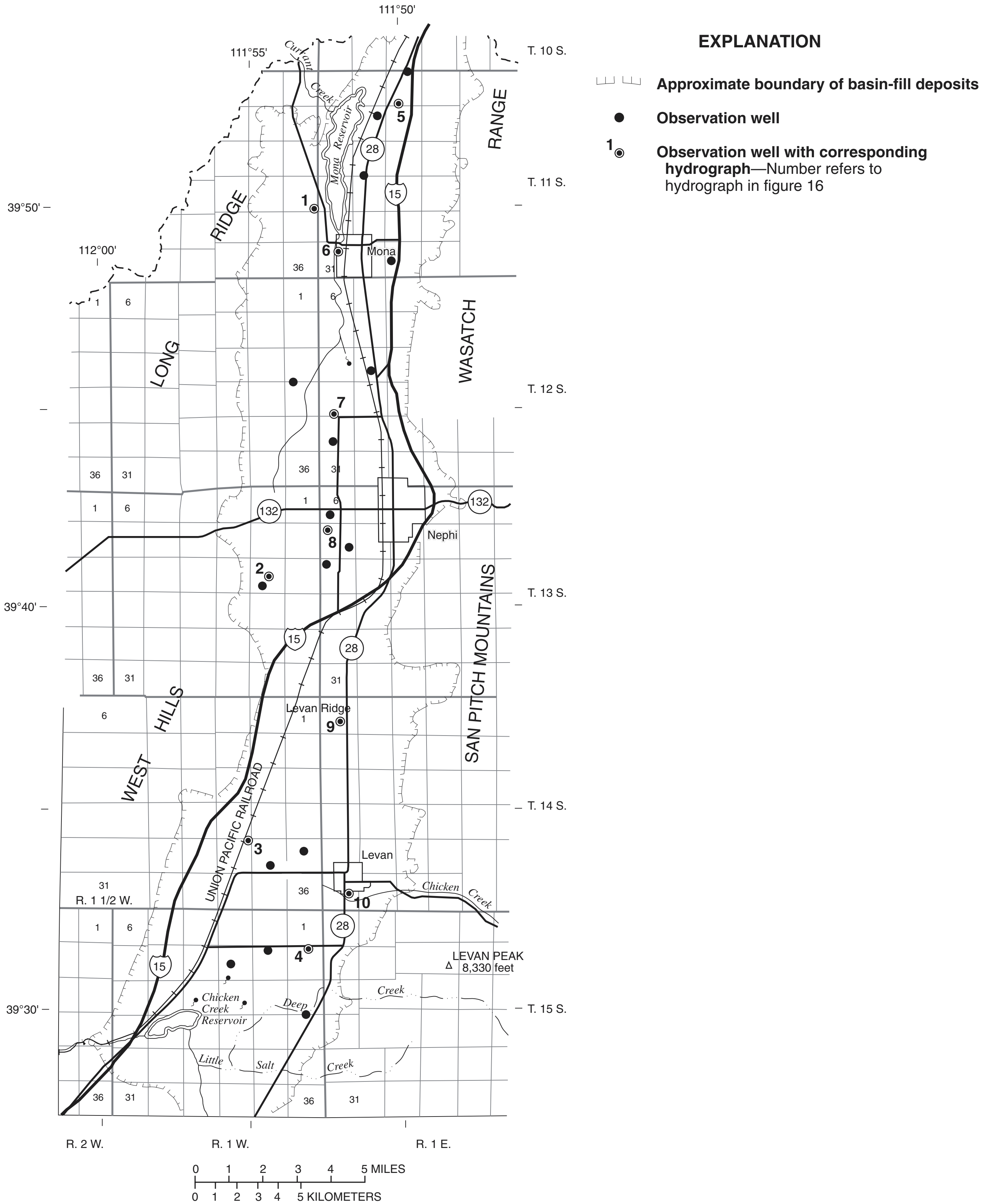


Figure 15. Location of wells in Juab Valley in which the water level was measured during March 2001.

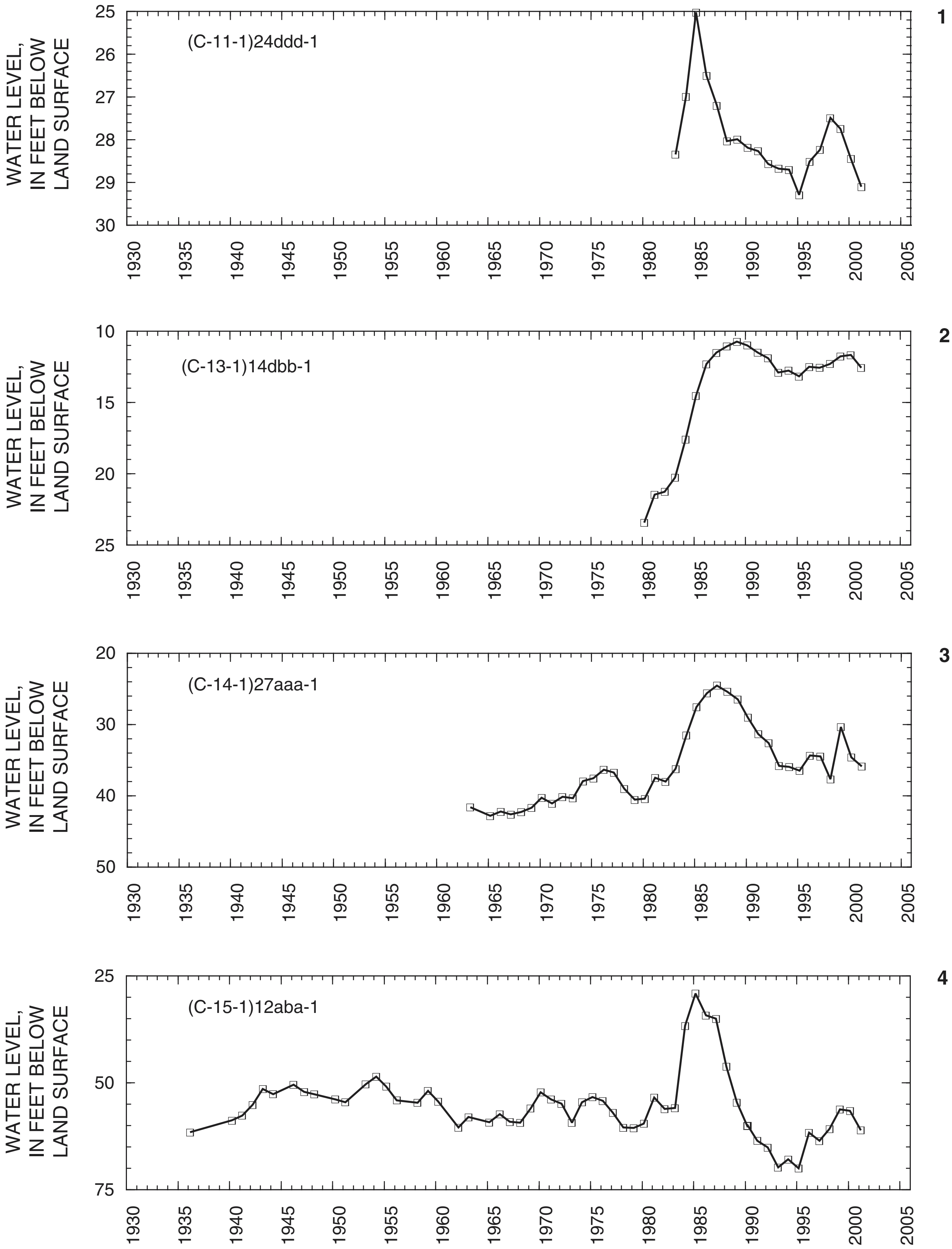


Figure 16. Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1.

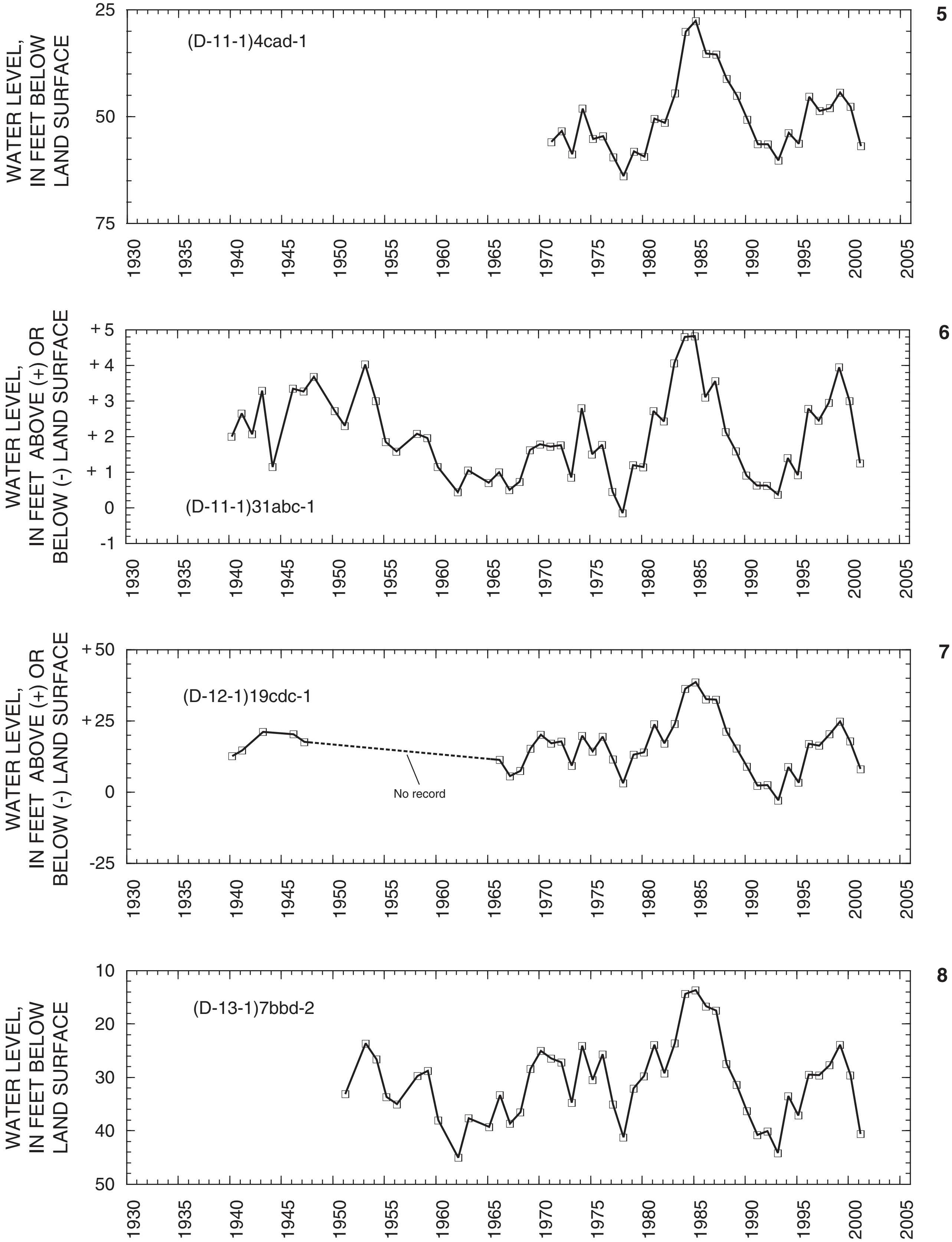
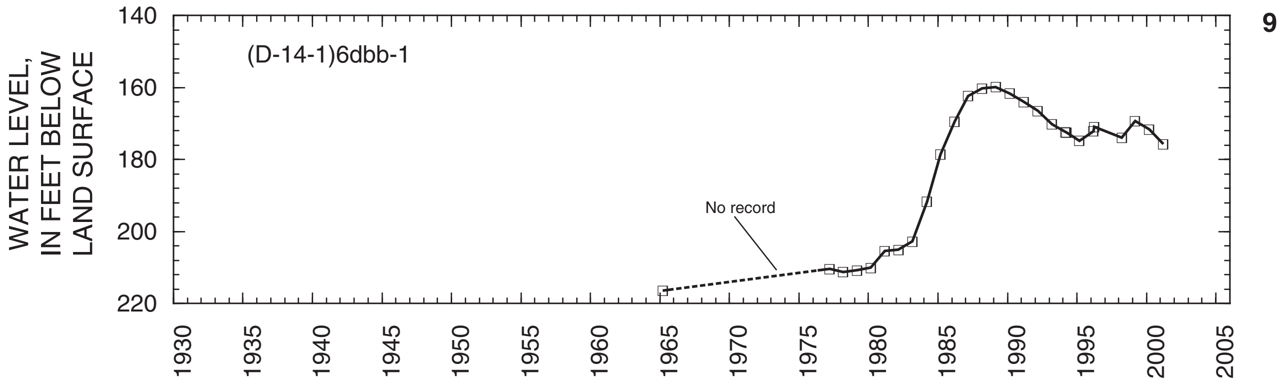


Figure 16. Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1—Continued.



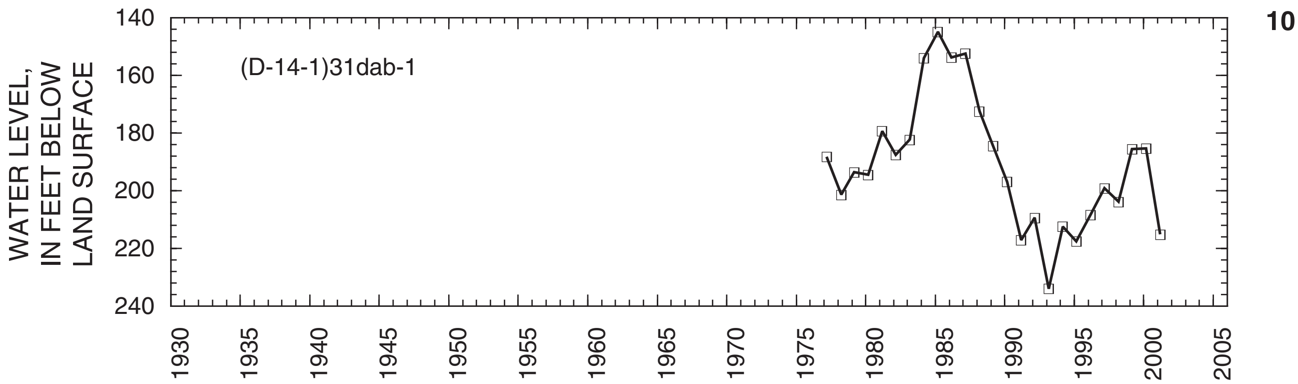


Figure 16. Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1—Continued.

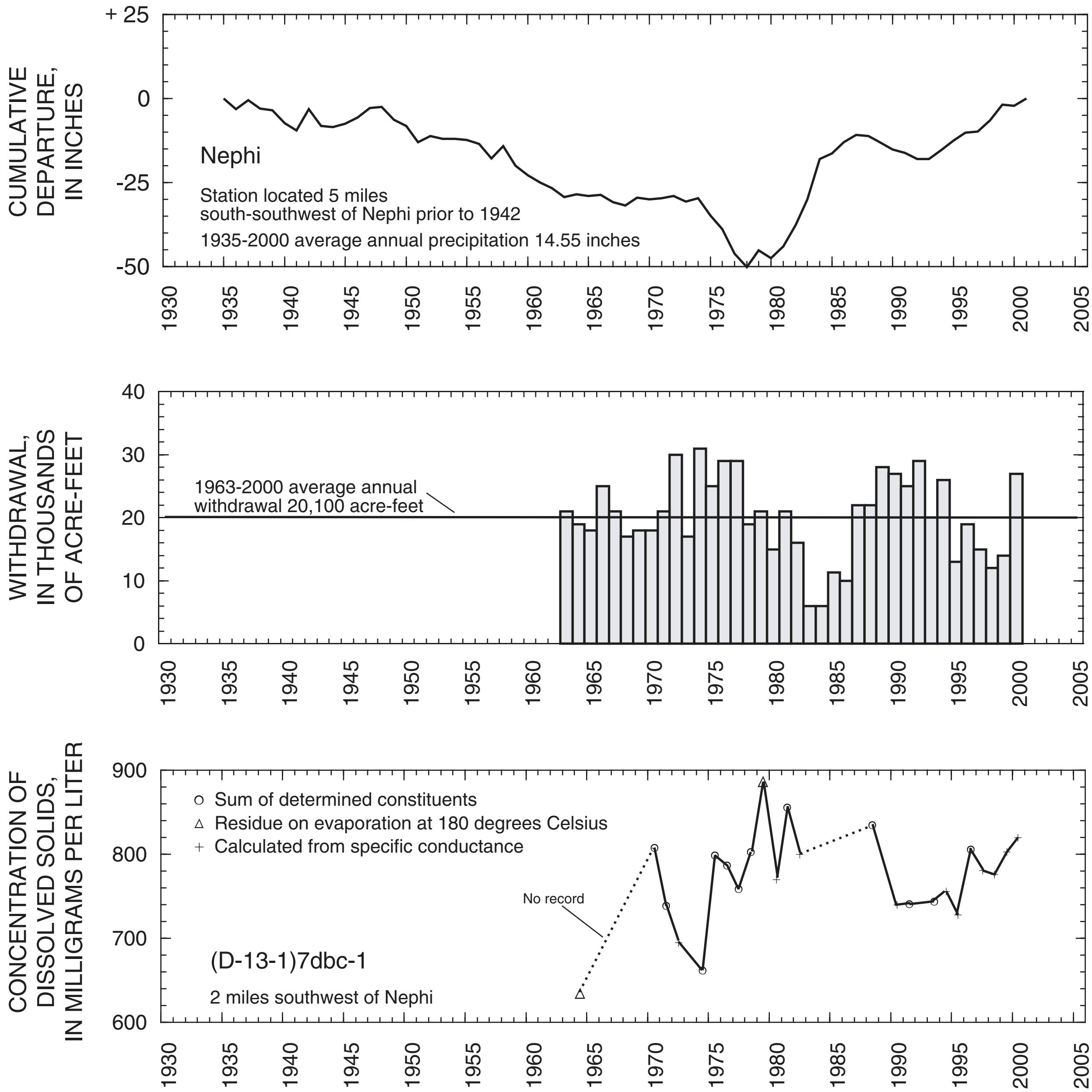


Figure 16. Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (D-13-1)7dbc-1—Continued.

SEVIER DESERT

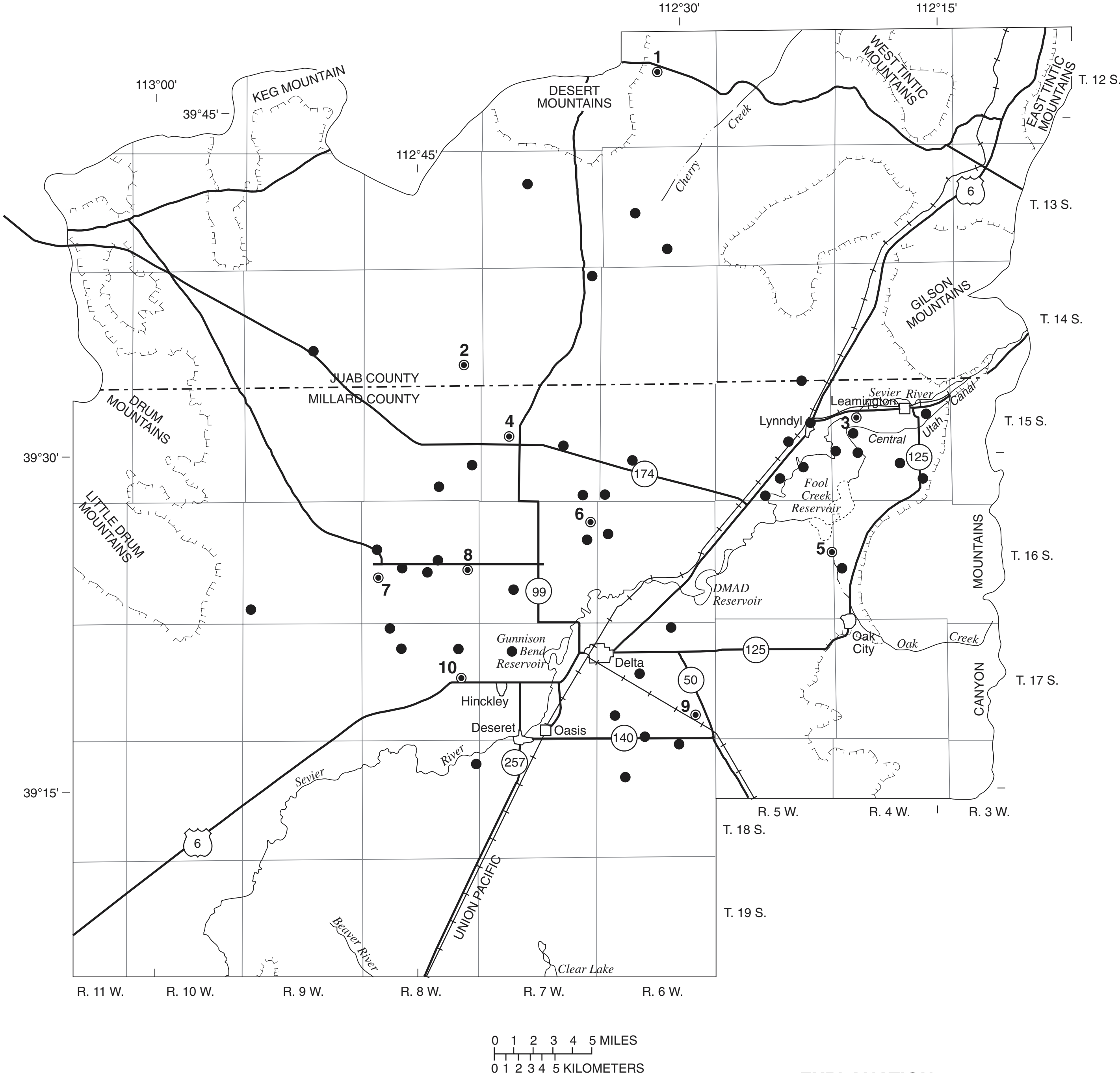
By Paul Downhour

The part of the Sevier Desert described here covers about 2,000 square miles. It is principally the broad, gently sloping area, between about Townships 12 South and 19 South, and Ranges 3 West and 11 West. Ground water occurs in the Sevier Desert in unconsolidated deposits under water-table and artesian conditions. Most of the ground water is discharged from wells tapping either of two artesian aquifers—the shallow or deep artesian aquifer.

Total estimated withdrawal of water from wells in the Sevier Desert in 2000 was about 15,000 acre-feet, which is 3,000 acre-feet more than in 1999 and about 9,000 acre-feet less than the 1990-99 average annual withdrawal (tables 2 and 3). The increase in total withdrawal was mainly a result of increased withdrawal for irrigation.

The location of wells in the Sevier Desert in which the water level was measured during March 2001 is shown in figures 17 and 18. The relation of the water level in selected wells to annual discharge of the Sevier River near Juab, to cumulative departure from the average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1 is shown in figure 19. Water levels in both the shallow and deep aquifers in the Sevier Desert rose from 1980 to 1987, which corresponds to a period of greater-than-average precipitation and less-than-average withdrawal. Water levels in both aquifers began declining during 1987-90 and continued to decline until 1995. Levels have generally risen or remained stable since 1995. Rises since 1995 probably resulted from decreased withdrawal, greater-than-average precipitation, and more available surface water for irrigation. Water levels generally declined from March 2000 to March 2001, probably as a result of increased withdrawals in 2000.

Discharge of the Sevier River near Juab in 2000 was 231,100 acre-feet, 2,400 acre-feet more than in 1999 and 45,900 acre-feet more than the long-term average (1935-2000). Precipitation at Oak City was 16.62 inches in 2000, 3.53 inches more than the 1935-2000 average annual precipitation and 2.92 inches more than in 1999. The concentration of dissolved solids in water from well (C-15-4)18daa-1, near Lynndyl, has increased from about 900 milligrams per liter in 1958 to about 1,900 milligrams per liter in 1996.



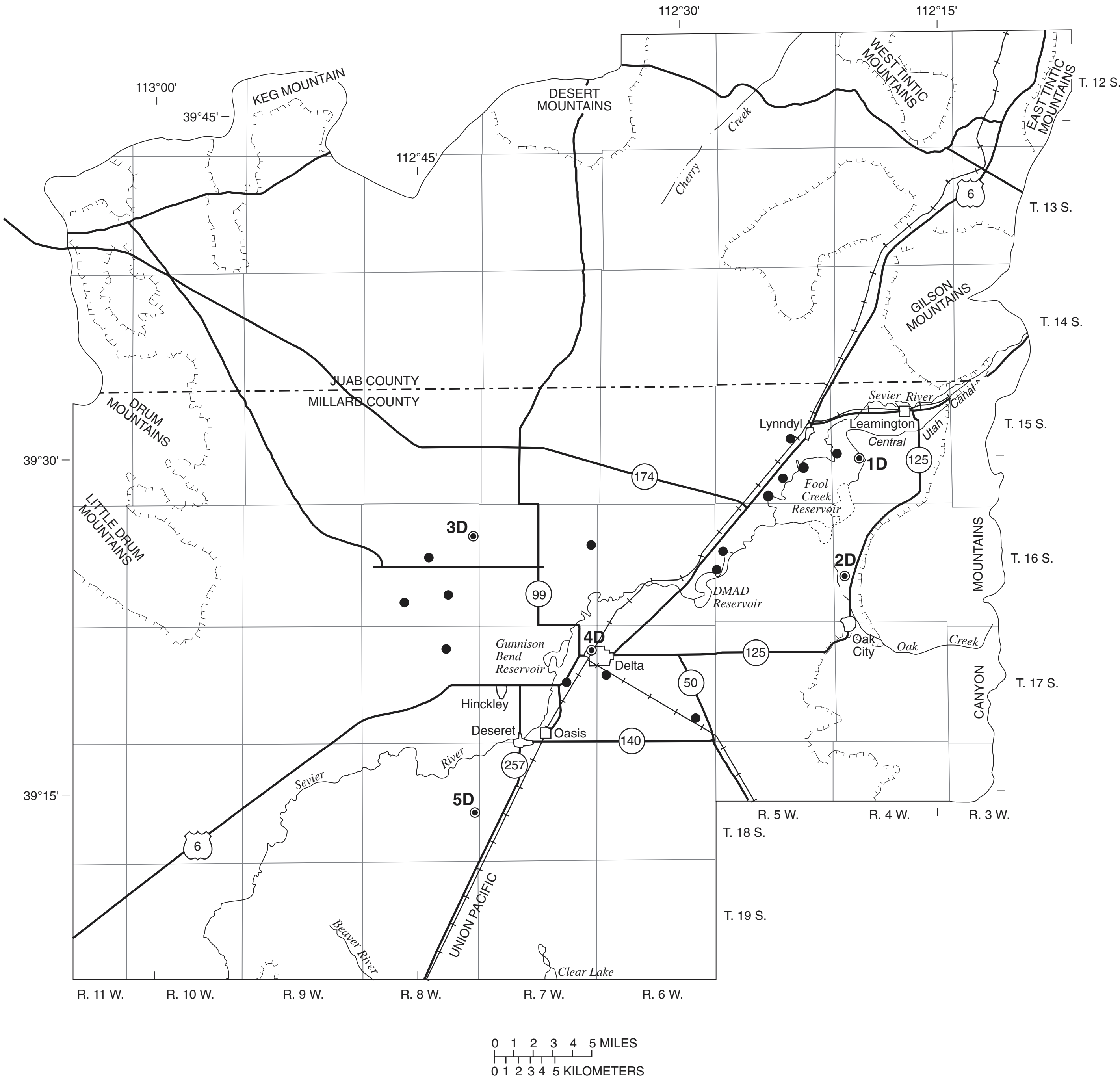
EXPLANATION

Approximate boundary of basin-fill deposits

Observation well

9 **Observation well with corresponding hydrograph**—Number refers to hydrograph in figure 19

Figure 17. Location of wells in the shallow artesian aquifer in part of the Sevier Desert in which the water level was measured during March 2001.



EXPLANATION

Approximate boundary of basin-fill deposits

Observation well

5D **Observation well with corresponding hydrograph**—Number with letter D refers to deep artesian aquifer hydrograph in figure 19

Figure 18. Location of wells in the deep artesian aquifer in part of the Sevier Desert in which the water level was measured during March 2001.

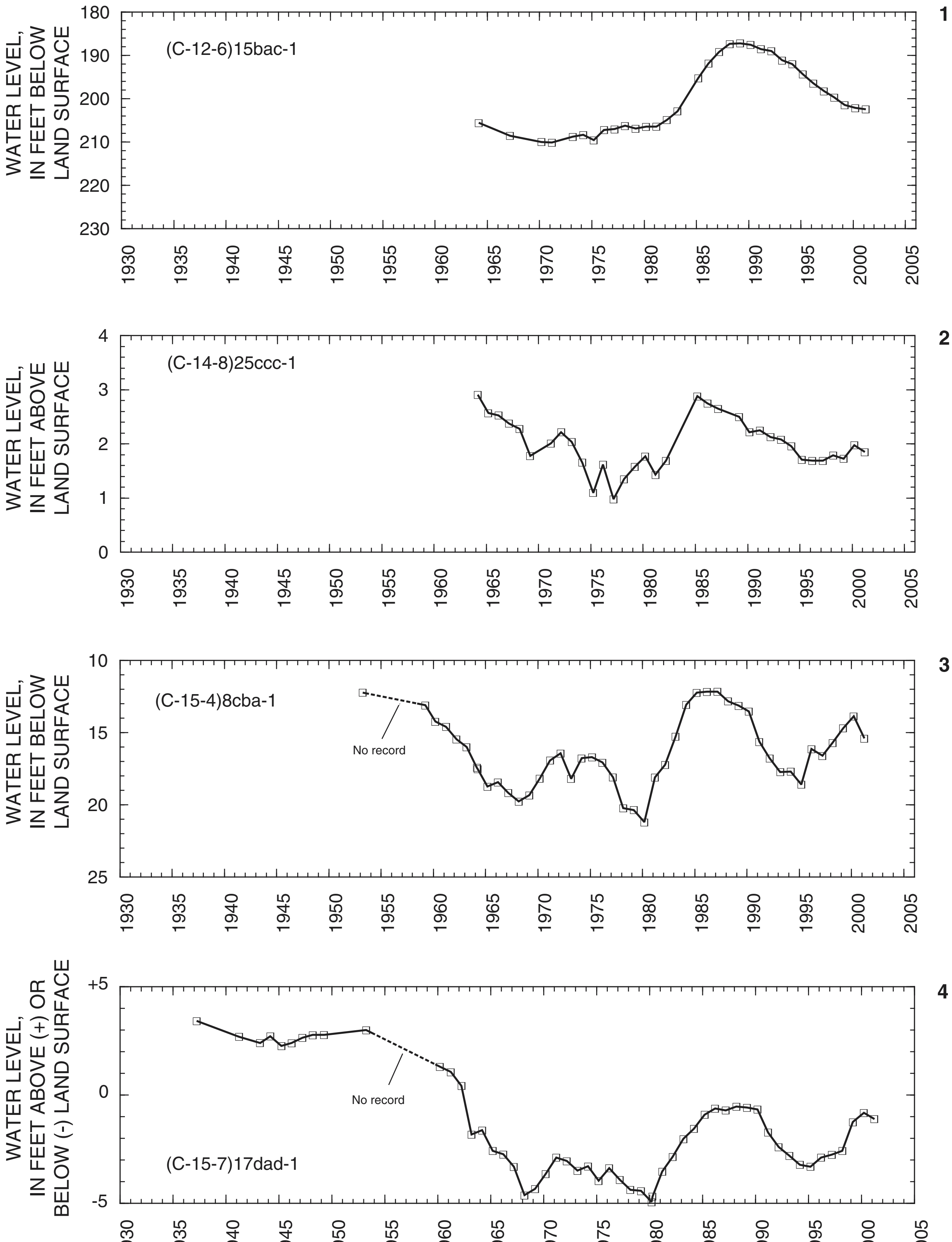


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1.

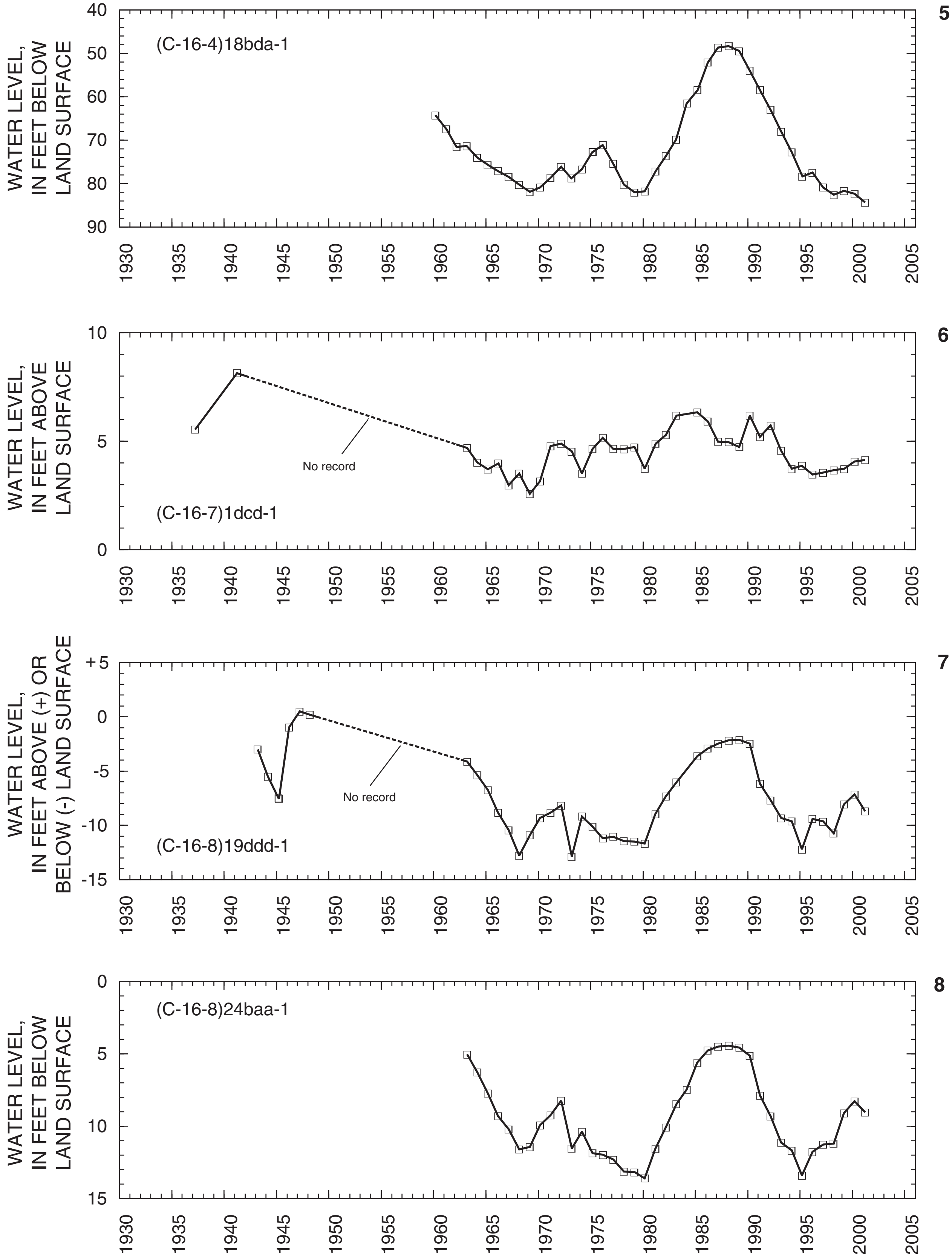


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1—Continued.

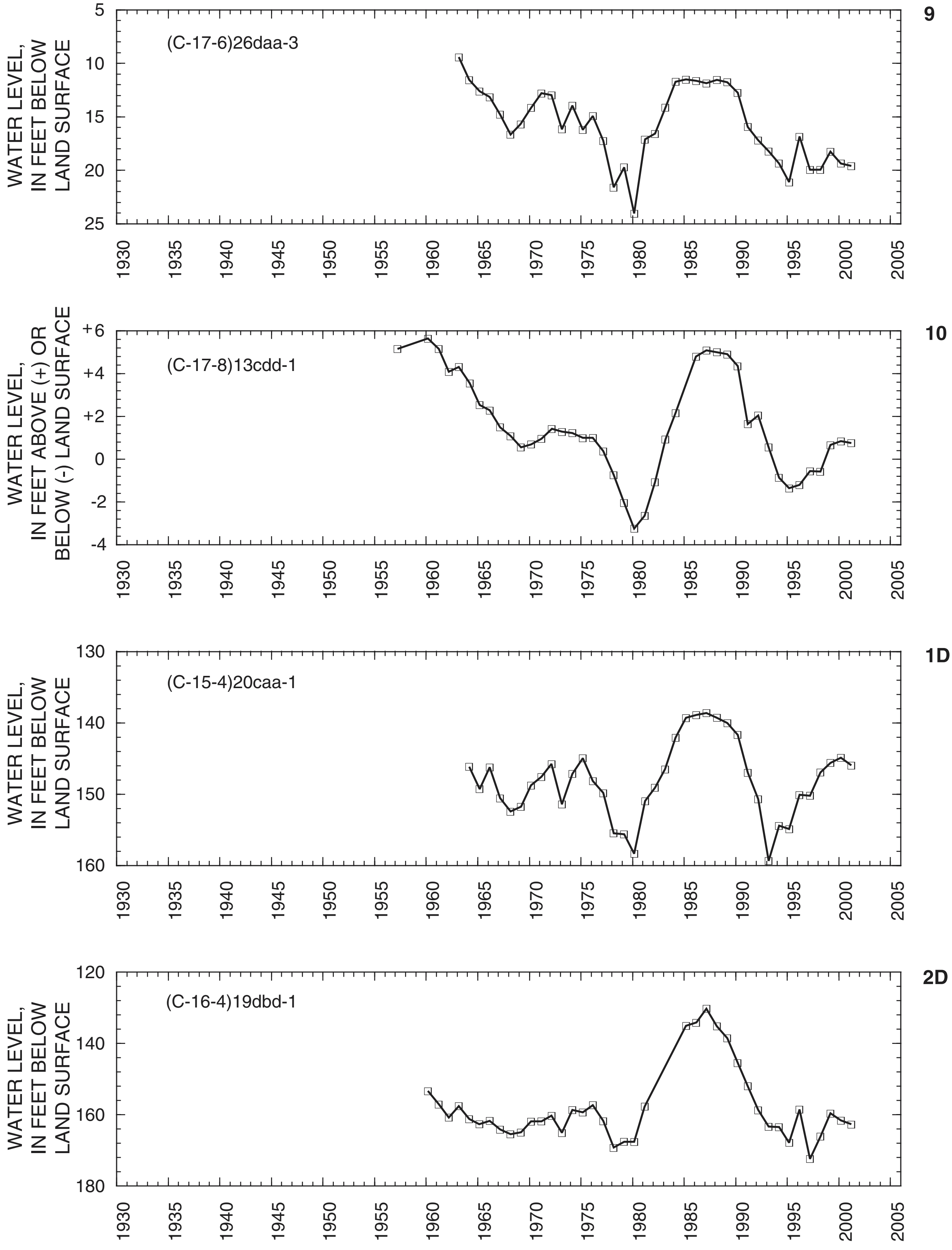


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1—Continued.

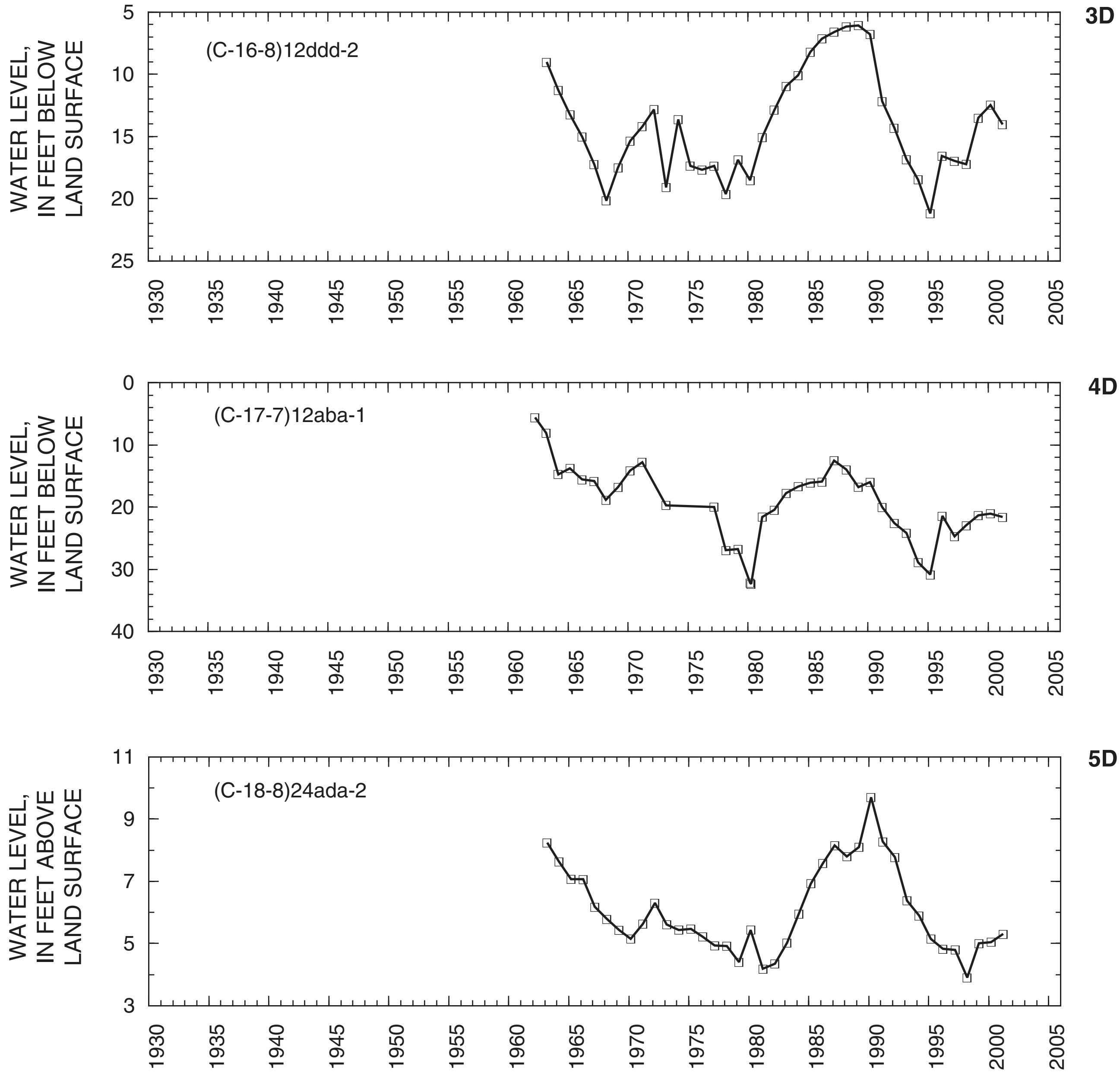


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1—Continued.

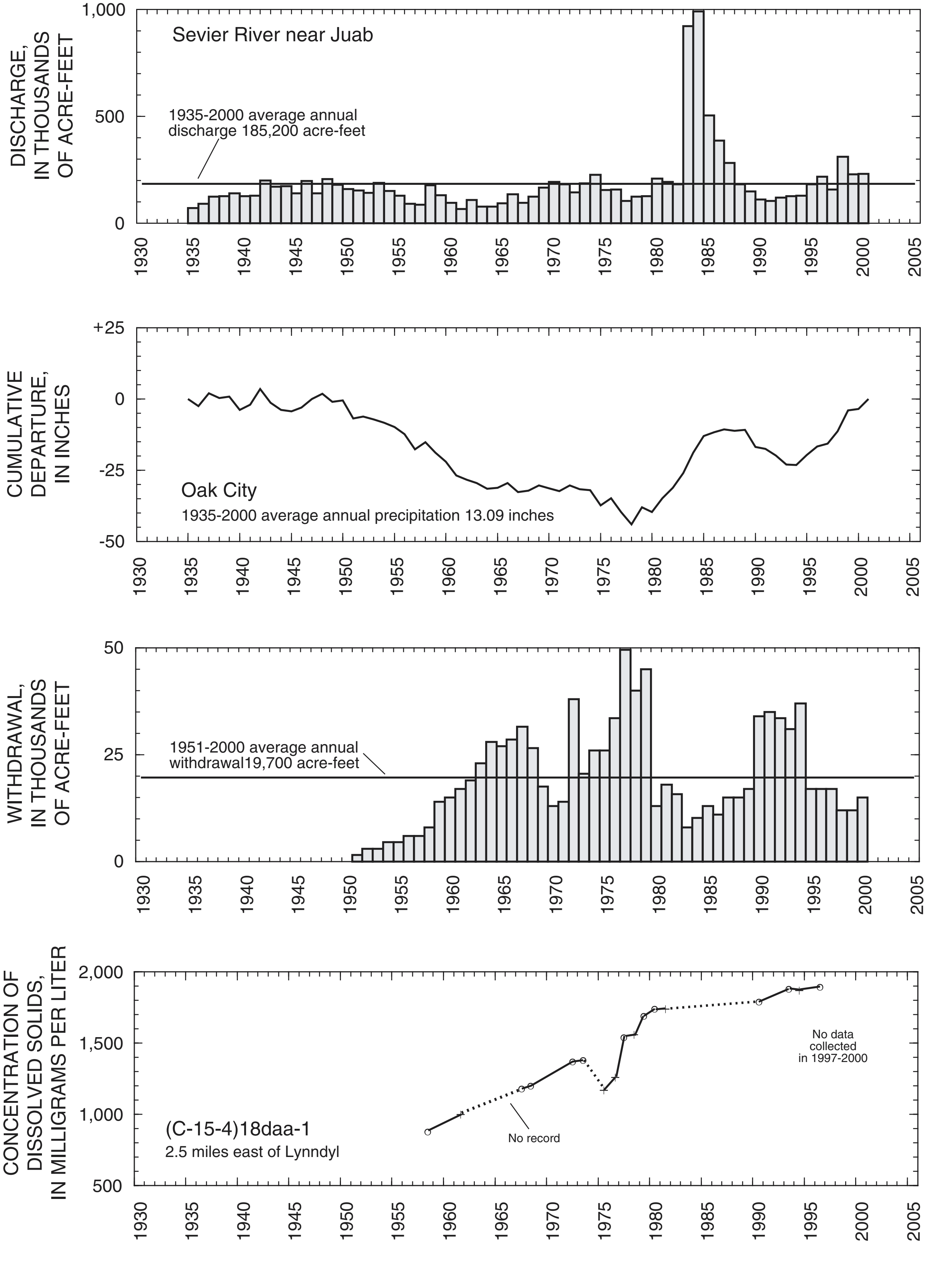


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)18daa-1—Continued.

CENTRAL SEVIER VALLEY

By B.A. Slaugh

The central Sevier Valley is in south-central Utah, surrounded by the Sevier and Wasatch Plateaus to the east and the Tushar Mountains, Pahvant Range, and Valley Mountains to the west. Altitude ranges from 5,100 feet on the valley floor at the north end of the valley near Gunnison to about 12,000 feet in the Tushar Mountains.

Total estimated withdrawal of water from wells in central Sevier Valley in 2000 was about 13,000 acre-feet, which is 7,000 acre-feet less than was reported for 1999, and 7,000 acre-feet less than the average annual withdrawal for 1990-99 (tables 2 and 3). The decrease was mainly a result of decreased withdrawals for irrigation.

The location of wells in the central Sevier Valley in which the water level was measured during March 2001 is shown in figure 20. The relation of the water level in selected wells to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4 is shown in figure 21.

Water levels generally declined from March 1999 to March 2000 in the central Sevier Valley. Water levels generally rose from about 1978 to 1985 and declined from 1985 to about 1993. From 1993 to 1999, water levels generally rose, although they fluctuated depending upon the amount and timing of precipitation and the potential for recharge from snowmelt runoff.

Discharge of the Sevier River at Hatch in 2000 was about 49,600 acre-feet. This is about 20,800 acre-feet less than the 70,400 acre-feet for 1999 and about 29,600 acre-feet less than the 1940-2000 average annual discharge. Precipitation at Richfield was 8.56 inches in 2000, which is 0.40 inch more than the 1950-2000 average annual precipitation and 0.57 inch more than in 1999. Concentration of dissolved solids in water from well (C-23-2)15dcb-4 decreased from about 600 milligrams per liter to about 400 milligrams per liter during 1987-95, which was the average concentration during 1955-59. The concentration of dissolved solids in 2000 was about 460 milligrams per liter.

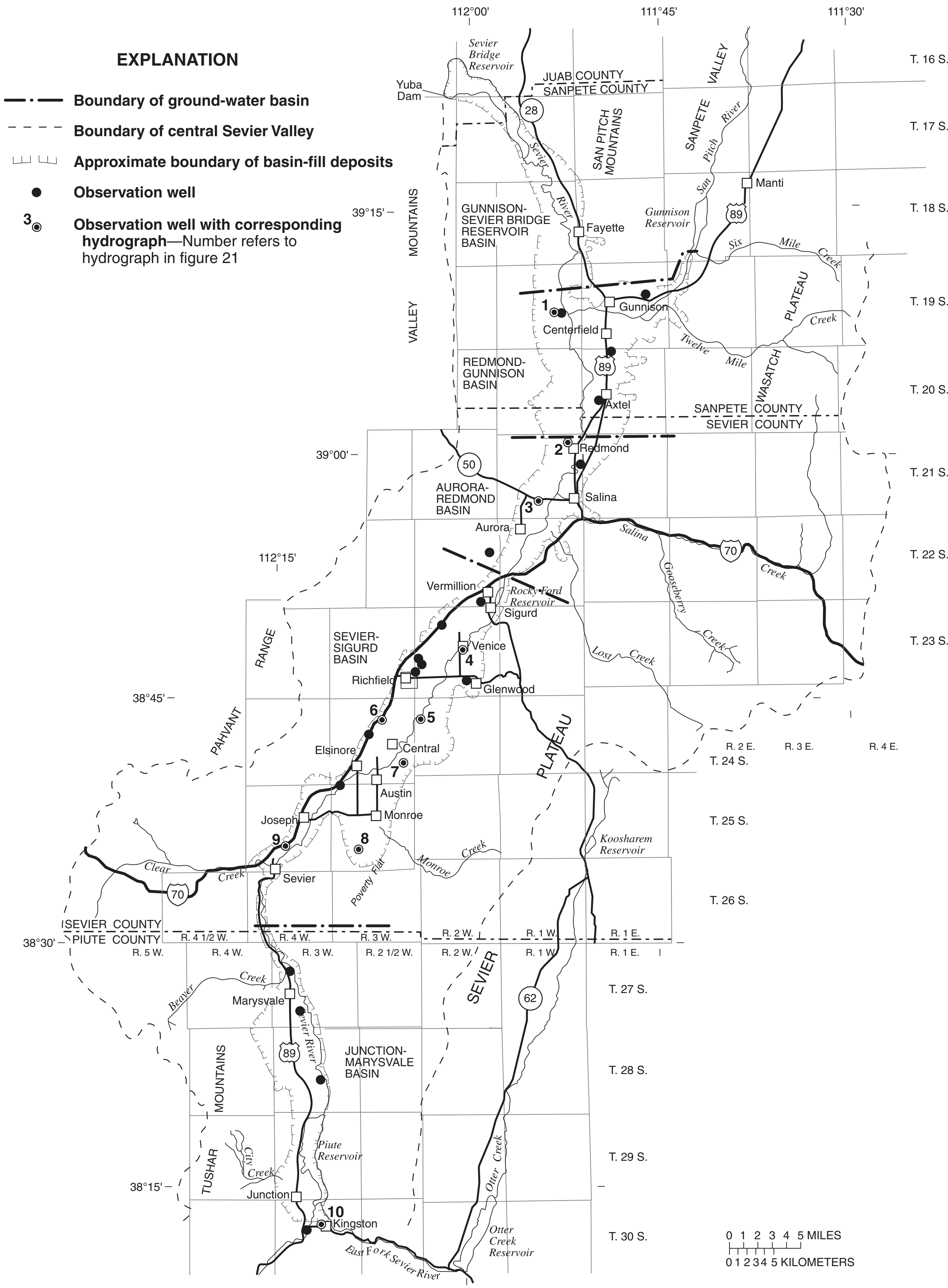


Figure 20. Location of wells in central Sevier Valley in which the water level was measured during March 2001.

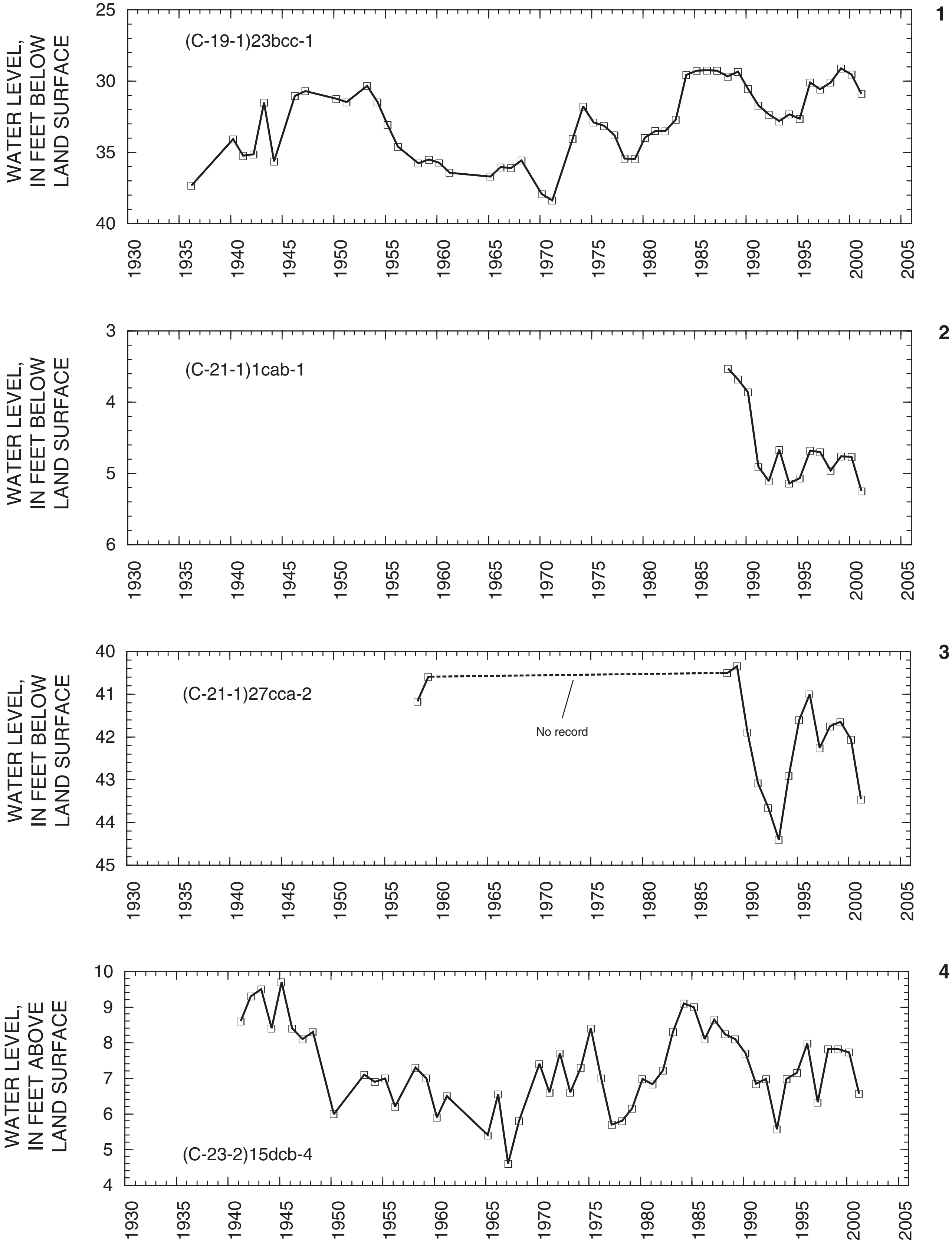


Figure 21. Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4.

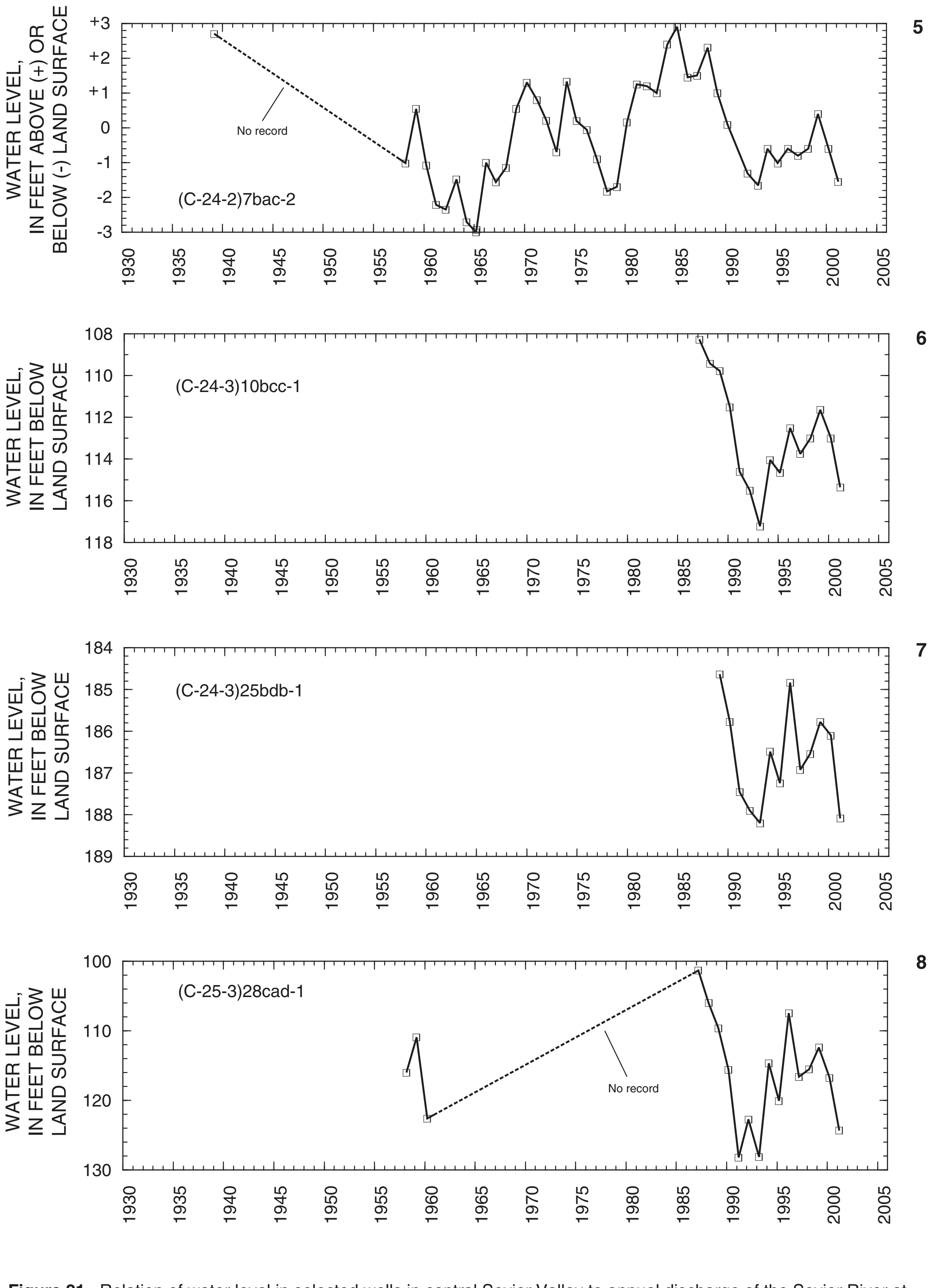
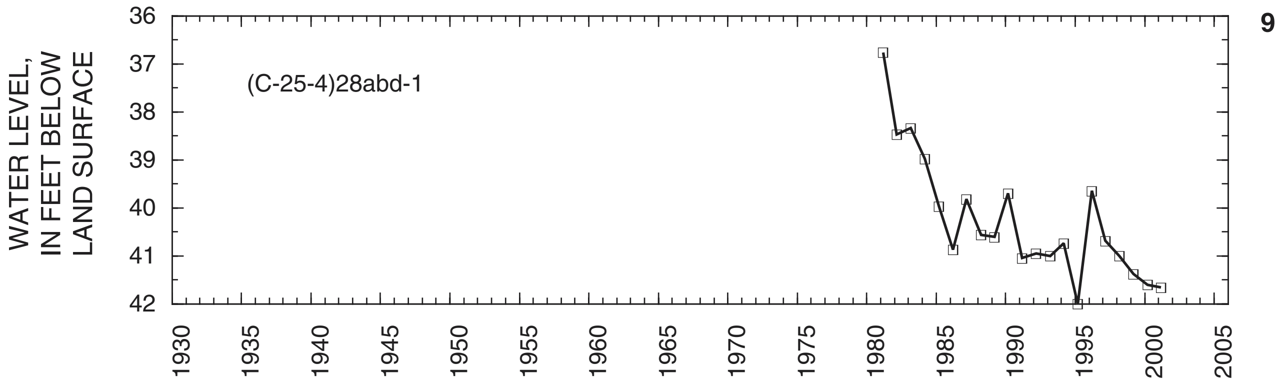


Figure 21. Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4—Continued.



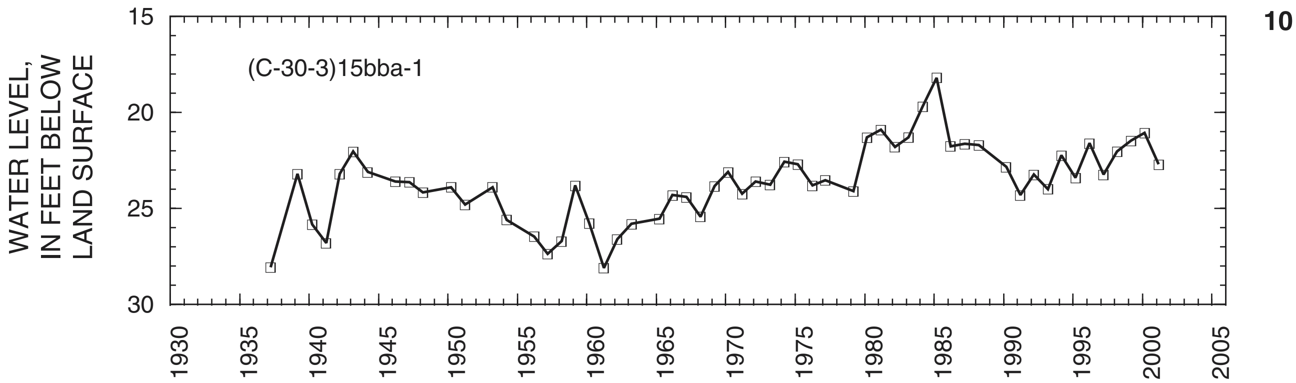


Figure 21. Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4—Continued.

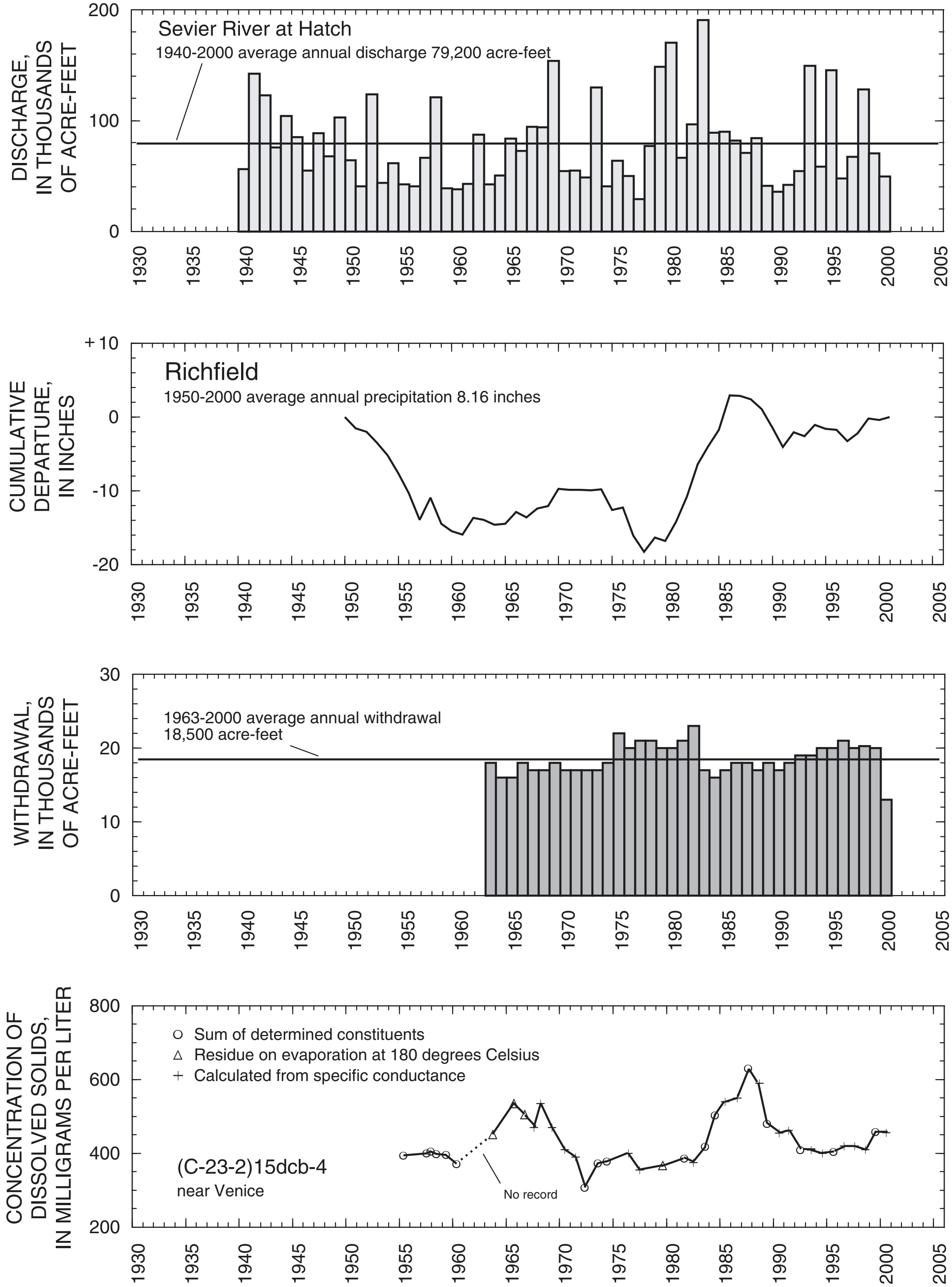


Figure 21. Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, to cumulative departure from average annual precipitation at Richfield, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-23-2)15dcb-4—Continued.

PAHVANT VALLEY

By R.L. Swenson

Pahvant Valley, in southeast Millard County, extends from the vicinity of McCornick on the north to Kanosh on the south, from the Pahvant Range and Canyon Mountains on the east and northeast to a low basalt ridge on the west. The area of the valley is about 300 square miles, and water drains to the valley from about 500 square miles of the mountainous terrain. The valley is undrained on the surface south of the southern edge of Township 20 South; north of this line, the surface is an undulating plain covered with sand dunes from which there is little or no surface drainage.

Total estimated withdrawal of water from wells in Pahvant Valley in 2000 was about 80,000 acre-feet, which is 4,000 acre-feet more than was reported in 1999 and 1,000 acre-feet more than the average annual withdrawal for 1990-99 (tables 2 and 3). Withdrawal for irrigation in 2000 was about 78,800 acre-feet, which is 4,300 acre-feet more than was reported in 1999, and most likely resulted from a decreased availability of surface water. Withdrawal for geothermal power generation was about 540 acre-feet and is reported as industrial withdrawal.

The location of wells in Pahvant Valley in which water levels were measured during March 2001 is shown in figure 22. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells is shown in figure 23.

Water levels generally declined from March 2000 to March 2001 due to decreased ground-water recharge and increased withdrawals for irrigation. Water levels generally declined from the early 1950s until 1982 as a result of generally less-than-average precipitation and increased withdrawals. Water levels generally rose from 1982 to 1985, and were generally higher than in the early1950s because of greater-than-average precipitation and decreased withdrawal for irrigation. Levels generally have declined since 1985 because of continued large withdrawals for irrigation.

Precipitation at Fillmore during 2000 was 18.57 inches, which is 3.42 inches more than the average annual precipitation for 1931-2000 and 3.75 inches less than in 1999 (revised). The concentration of dissolved solids in water from wells near Flowell and west of Kanosh is shown in figure 23. The concentration of dissolved solids in water from well (C-21-5)7cdd-3, northwest of Flowell, has shown little change since 1983. The concentration of dissolved solids in water from well (C-23-6)21bdd-1, west of Kanosh, generally has increased since the late 1950s.

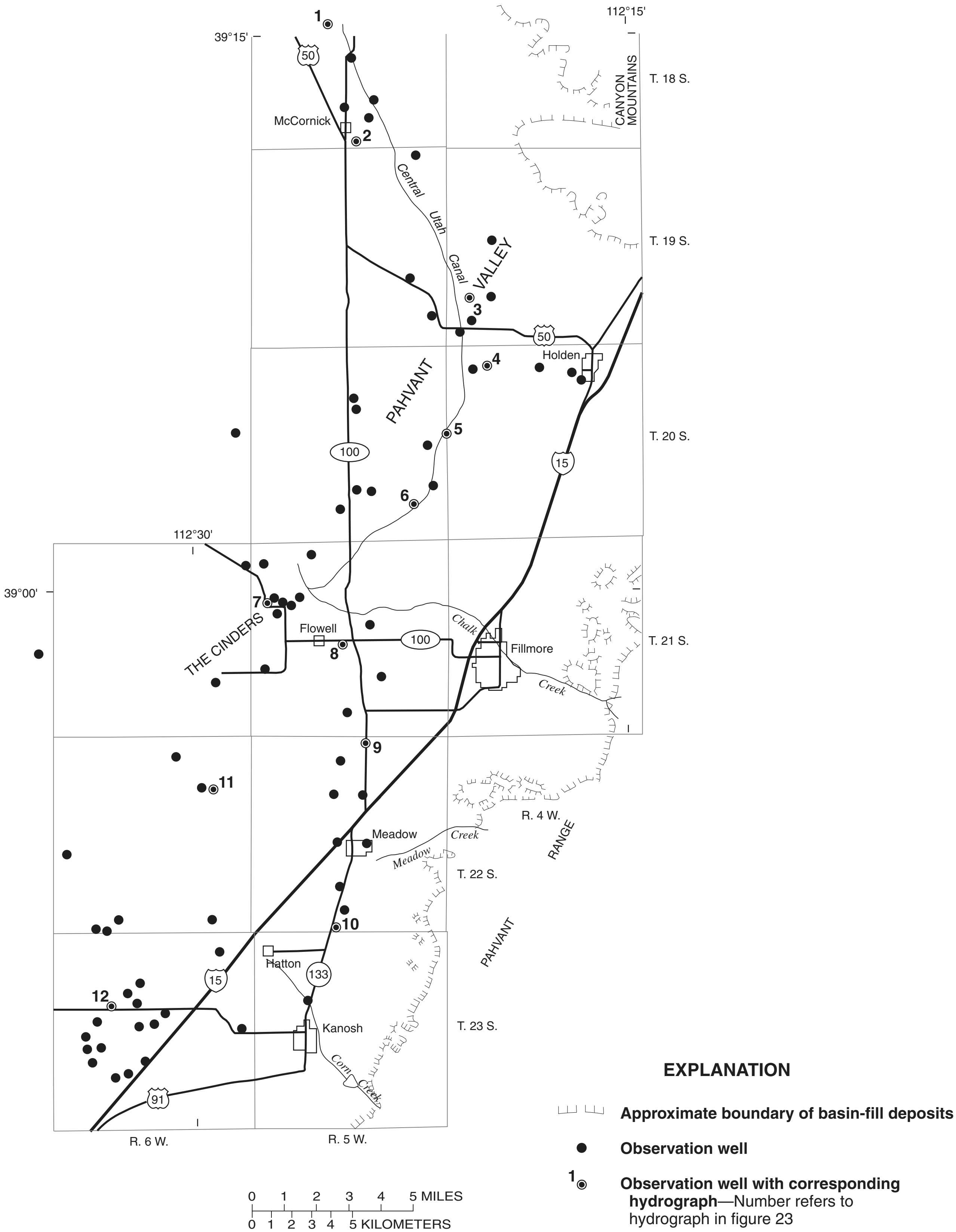


Figure 22. Location of wells in Pahvant Valley in which the water level was measured during March 2001.

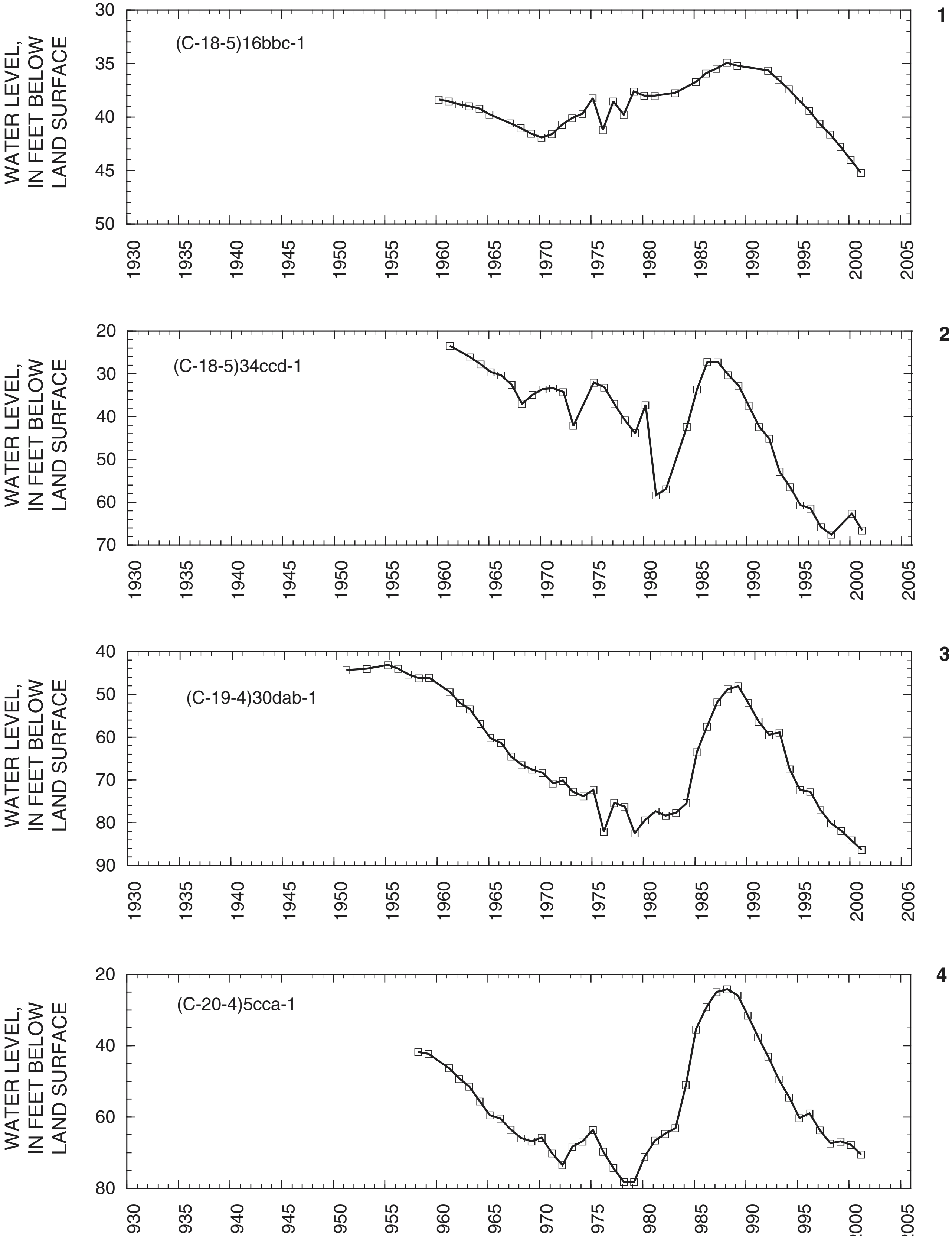


Figure 23. Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.

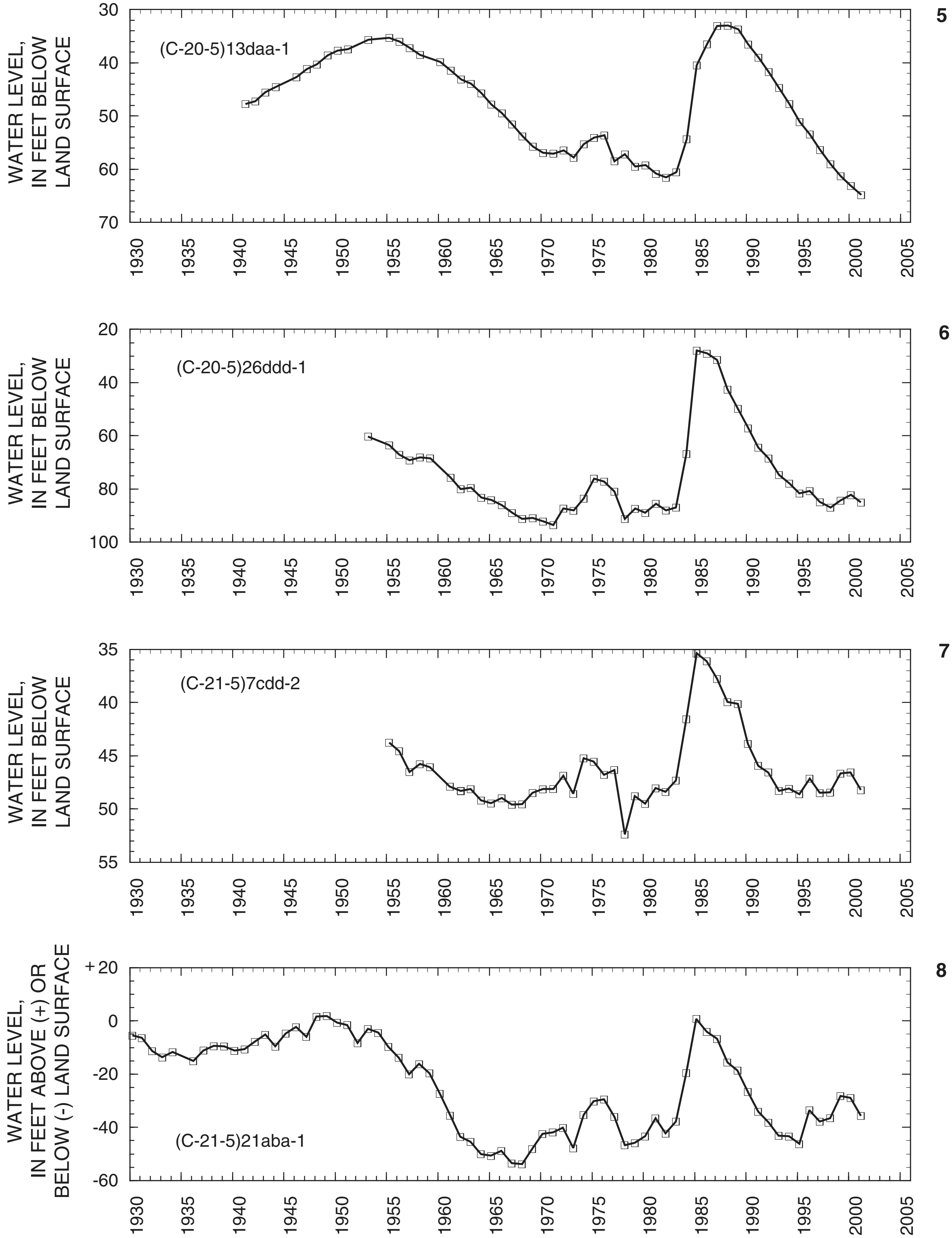


Figure 23. Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.

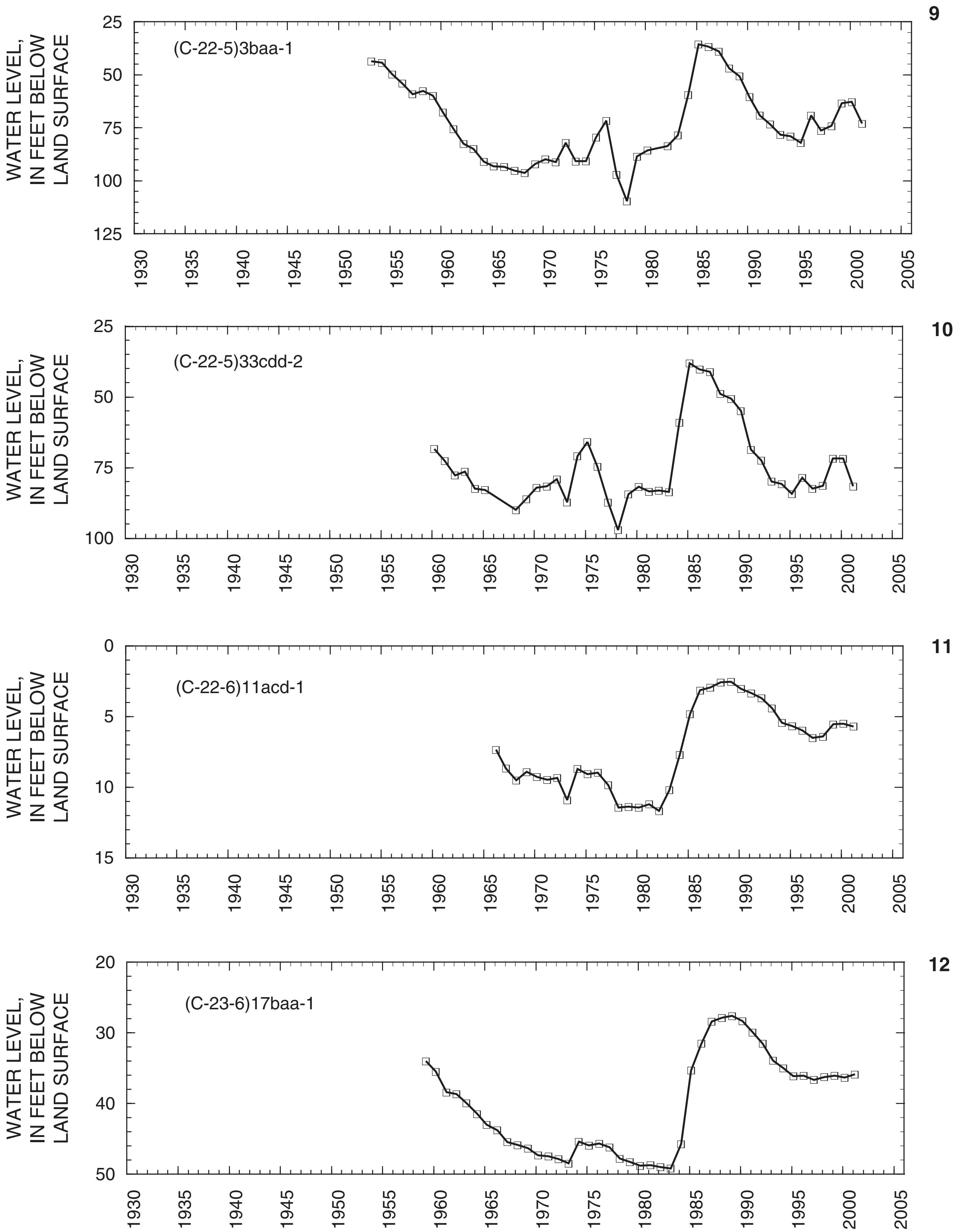


Figure 23. Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.

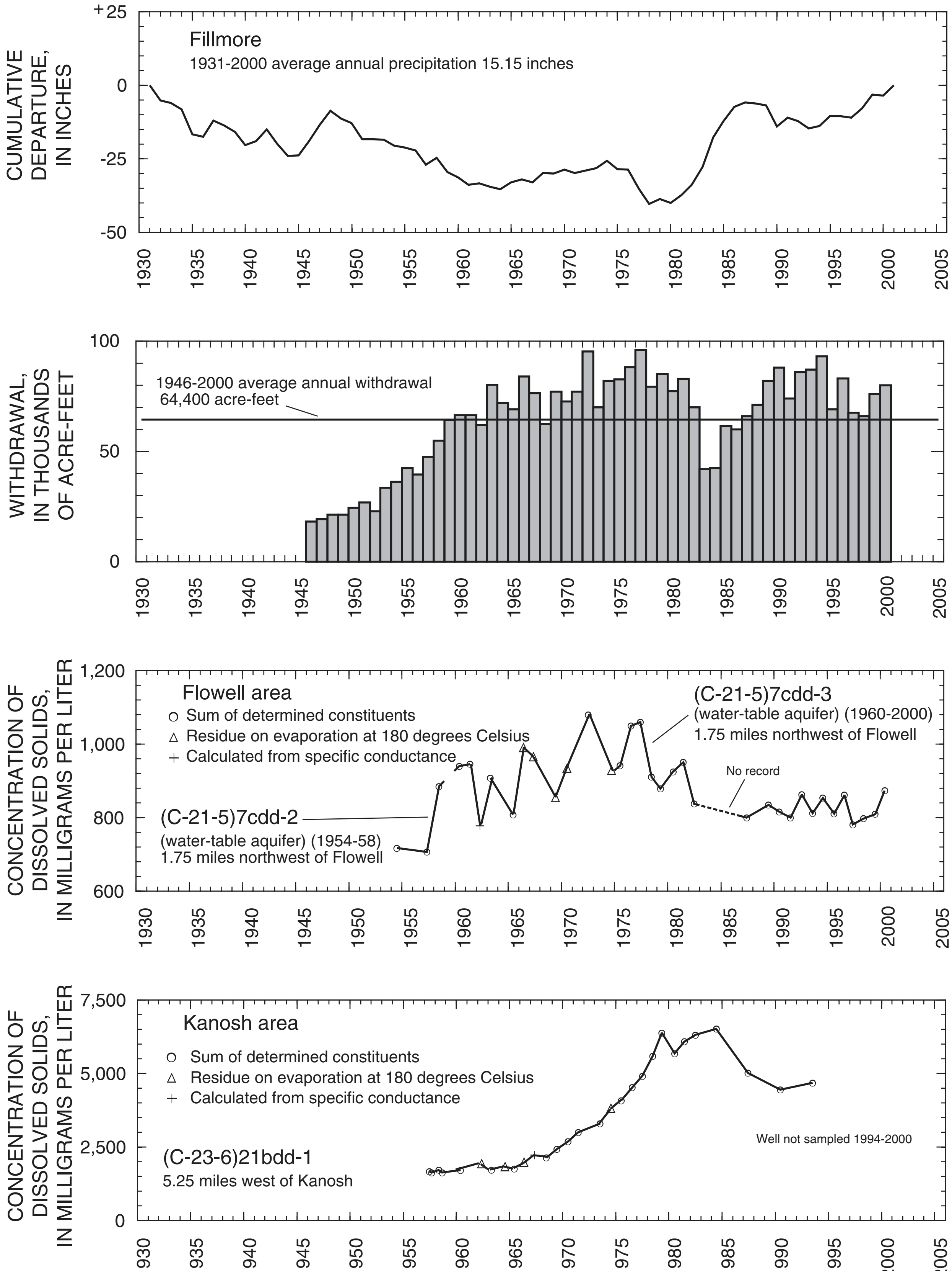


Figure 23. Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells—Continued.

CEDAR VALLEY, IRON COUNTY

By J.H. Howells

Cedar Valley is in eastern Iron County, southwestern Utah. The valley is about 170 square miles in area, from about Townships 34 South to 37 South and Ranges 10 West to 12 West. Ground water in Cedar Valley occurs in unconsolidated deposits, mostly under water-table conditions. The principal source of recharge to aquifers is water from Coal Creek, which seeps directly from the stream channel into the ground after being diverted for irrigation.

Total estimated withdrawal of water from wells in Cedar Valley in 2000 was about 36,000 acre-feet, which is 4,000 acre-feet more than was reported for 1999 and 3,000 acre-feet more than the average annual withdrawal for 1990-99 (tables 2 and 3).

The location of wells in Cedar Valley, Iron County, in which the water level was measured during March 2001 is shown in figure 24. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells is shown in figure 25.

Ground-water levels generally declined from March 1999 to March 2001 in most of Cedar Valley. Water-level declines probably resulted from continued large withdrawals for irrigation and public supply and less-than-average streamflow. Wells in the northern part of Cedar Valley show that water levels generally declined through 1992 and rose slightly from 1993-99. Water levels in the central and southern parts of the valley generally rose in the 1980s and generally have declined since 1989.

Precipitation at Cedar City Federal Aviation Administration Airport in 2000 was 12.97 inches, which is 5.91 inches more than for 1999 and 2.16 inches more than the average annual precipitation for 1951-2000. The discharge of Coal Creek was about 17,400 acre-feet in 2000, which is 4,400 acre-feet less than the 21,800 acre-feet for 1999, and 6,800 acre-feet less than the average annual discharge for 1936, 1939-2000. The concentrations of dissolved solids in wells (C-35-11)31dbd-1, (C-37-12)23acb-1, and (C-37-12)23abd-1 have ranged between 300 and 600 milligrams per liter.

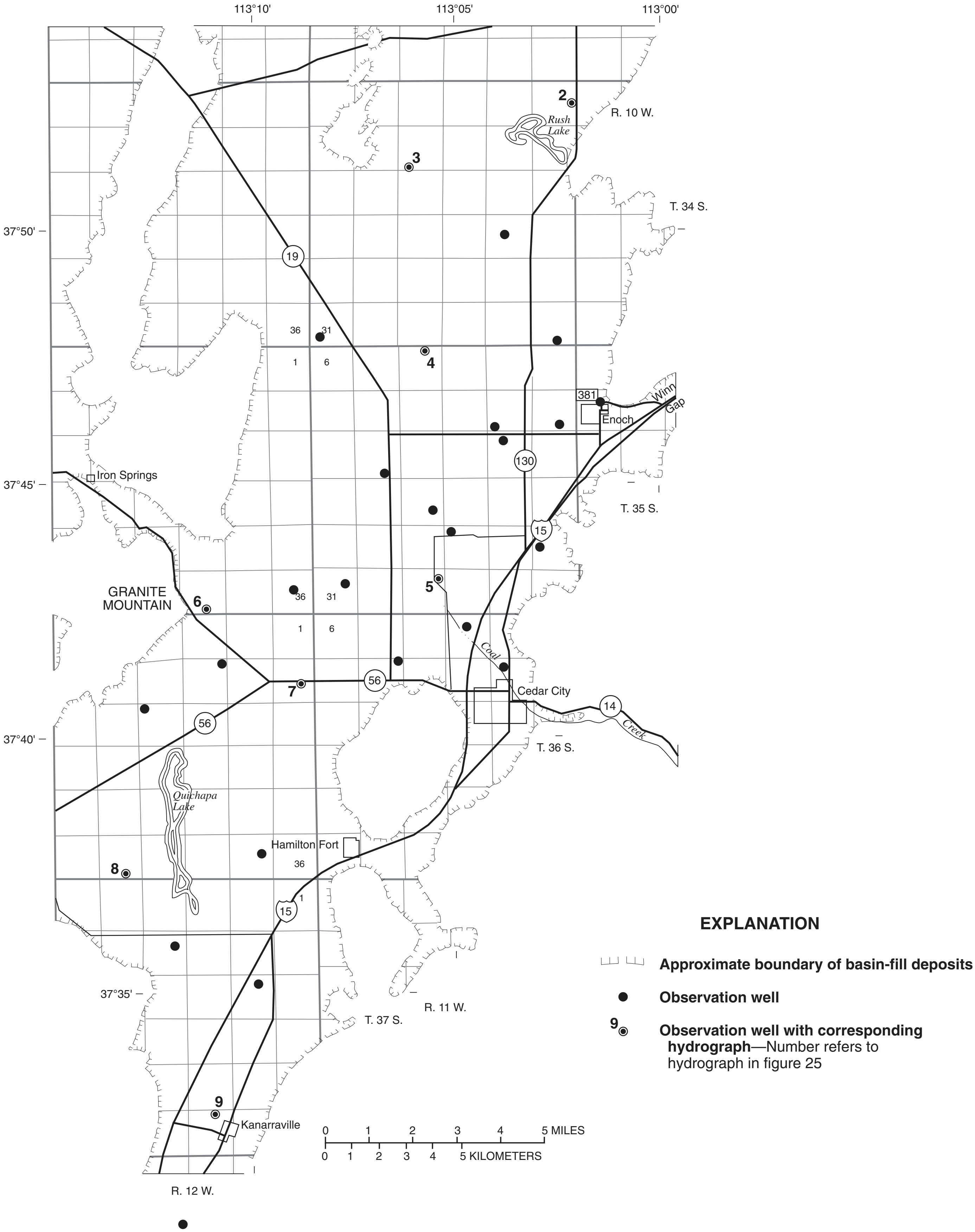


Figure 24. Location of long-term monitoring wells in Cedar Valley, Iron County, in which the water level was measured during March 2001.

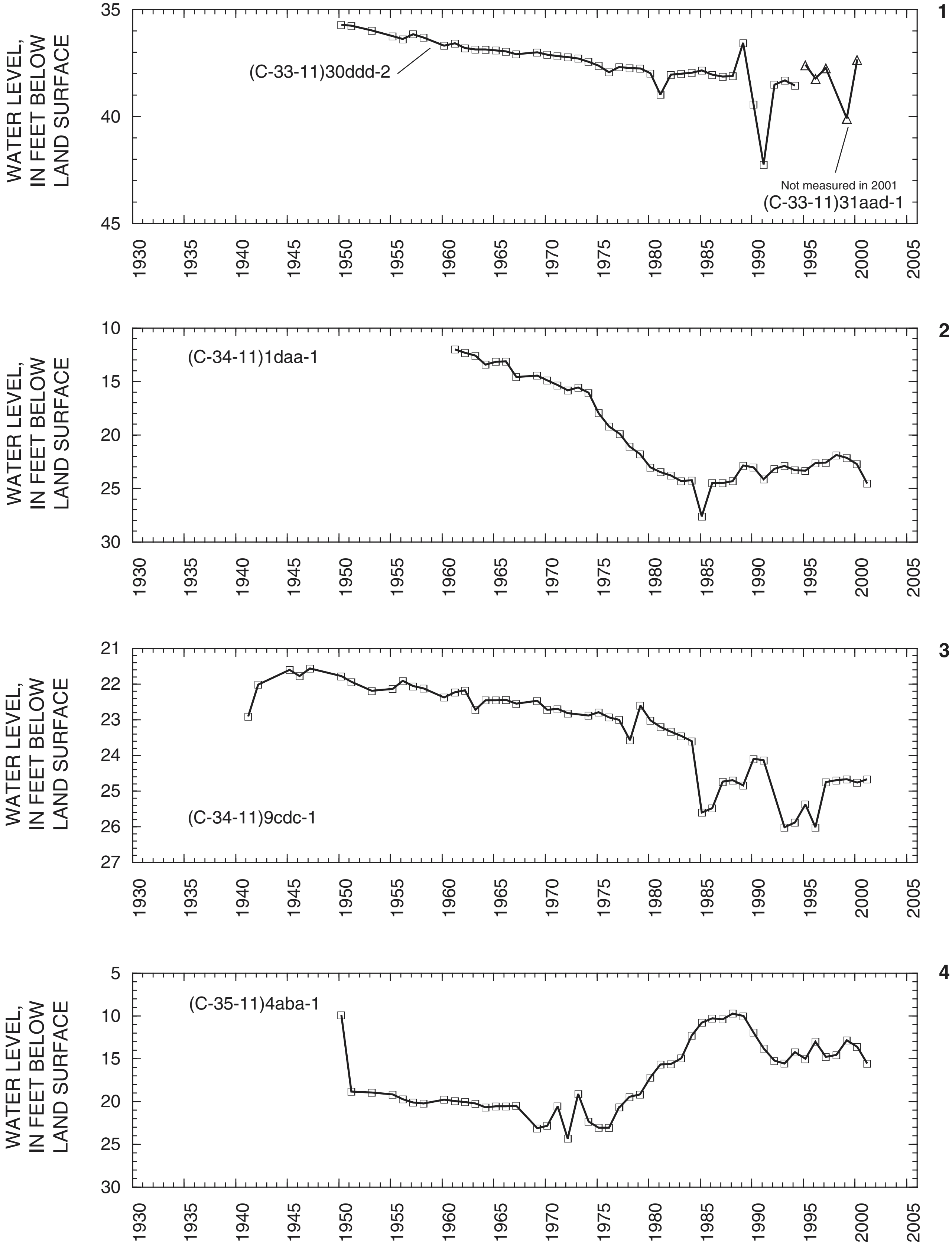


Figure 25. Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.

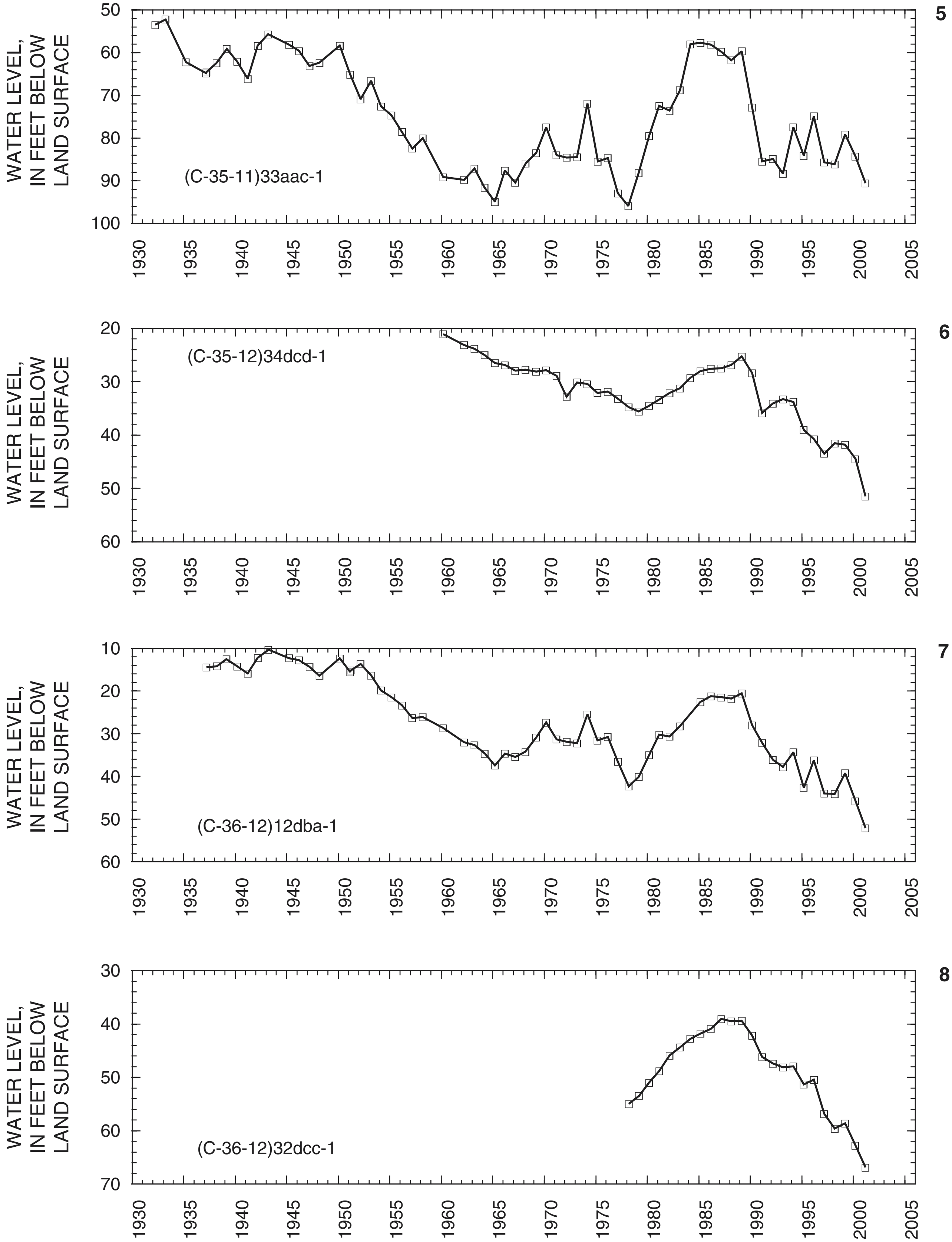


Figure 25. Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells–Continued.

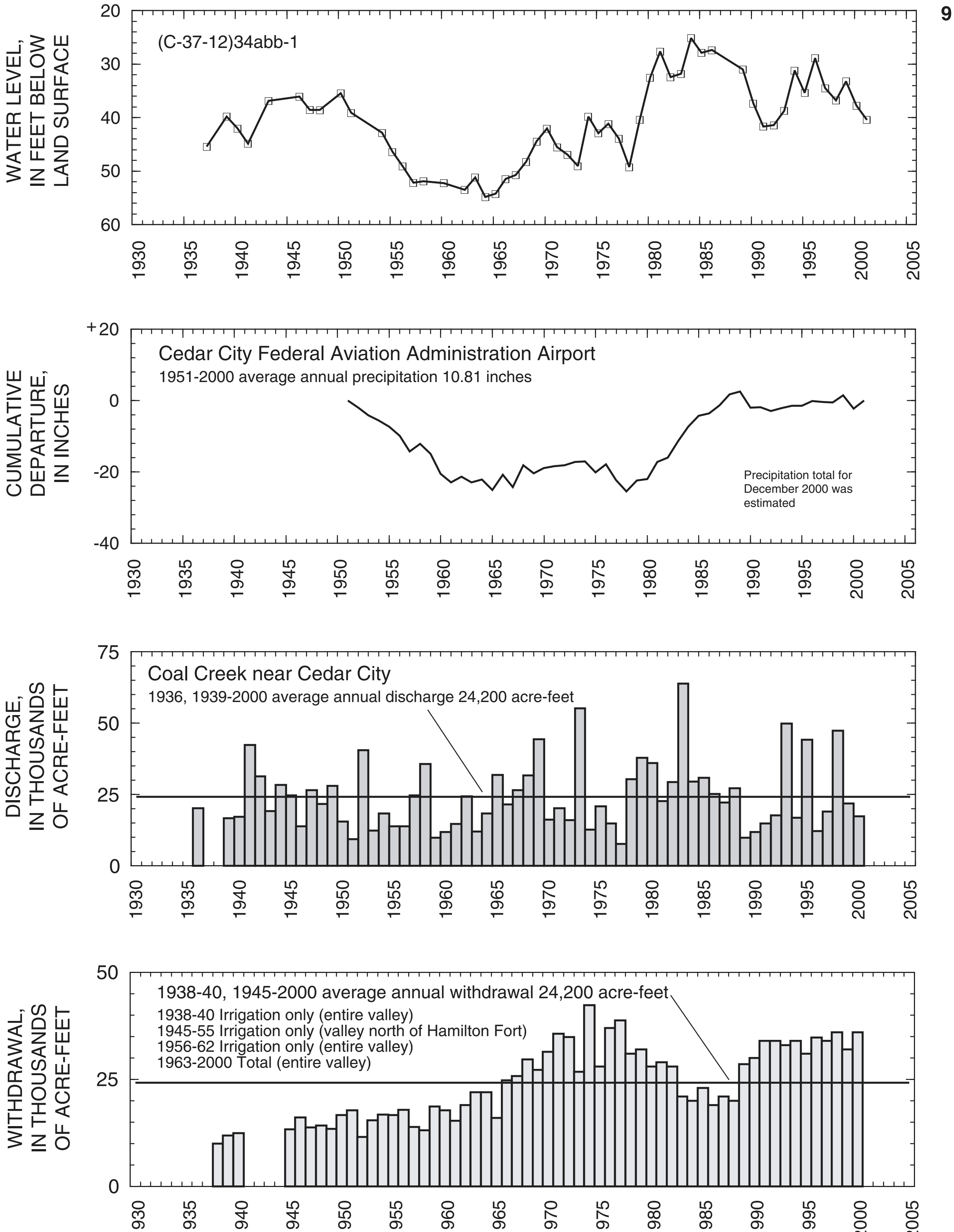


Figure 25. Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells–Continued.

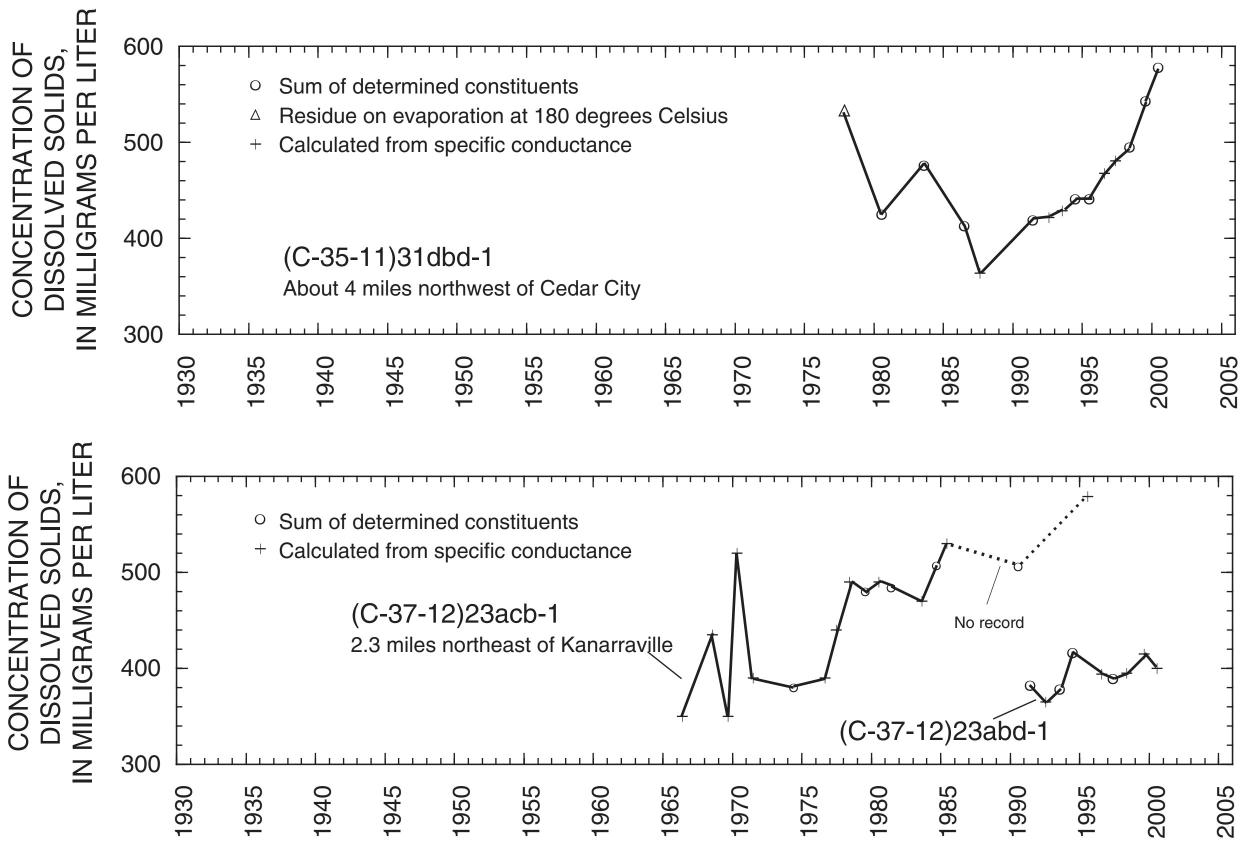


Figure 25. Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells–Continued.

PAROWAN VALLEY

By J.H. Howells

Parowan Valley is in northern Iron County, southwestern Utah. The valley is about 160 square miles in area, between about Townships 32 South and 34 South and Ranges 7 West and 10 West. Ground water occurs in unconsolidated deposits under both water-table and artesian conditions.

Total estimated withdrawal of water from wells in Parowan Valley in 2000 was about 30,000 acre-feet, which is about 4,000 acre-feet more than the revised value for 1999 and 2,000 acre-feet more than the revised average annual withdrawal for 1990-99 (tables 2 and 3).

The location of wells in Parowan Valley in which the water level was measured during March 2001 is shown in figure 26. The relation of the water level in selected wells to cumulative departure from the average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1 is shown in figure 27.

Water levels generally declined from March 2000 to March 2001 in Parowan Valley. Declines probably resulted from greater-than-average withdrawals for irrigation. Water levels in Parowan Valley generally have declined since 1950, although rises have occurred during 1973-74, 1983-85, and 1996-99. The rises are probably the result of greater-than-average precipitation during those periods.

Precipitation at Parowan Power Plant in 2000 was 13.02 inches, which is 0.47 inch more than the average annual precipitation for 1935-2000 and 5.93 inches more than in 1999. The concentration of dissolved solids in water from well (C-33-8)31ccc-1 has shown little change since 1976 (fig. 27).

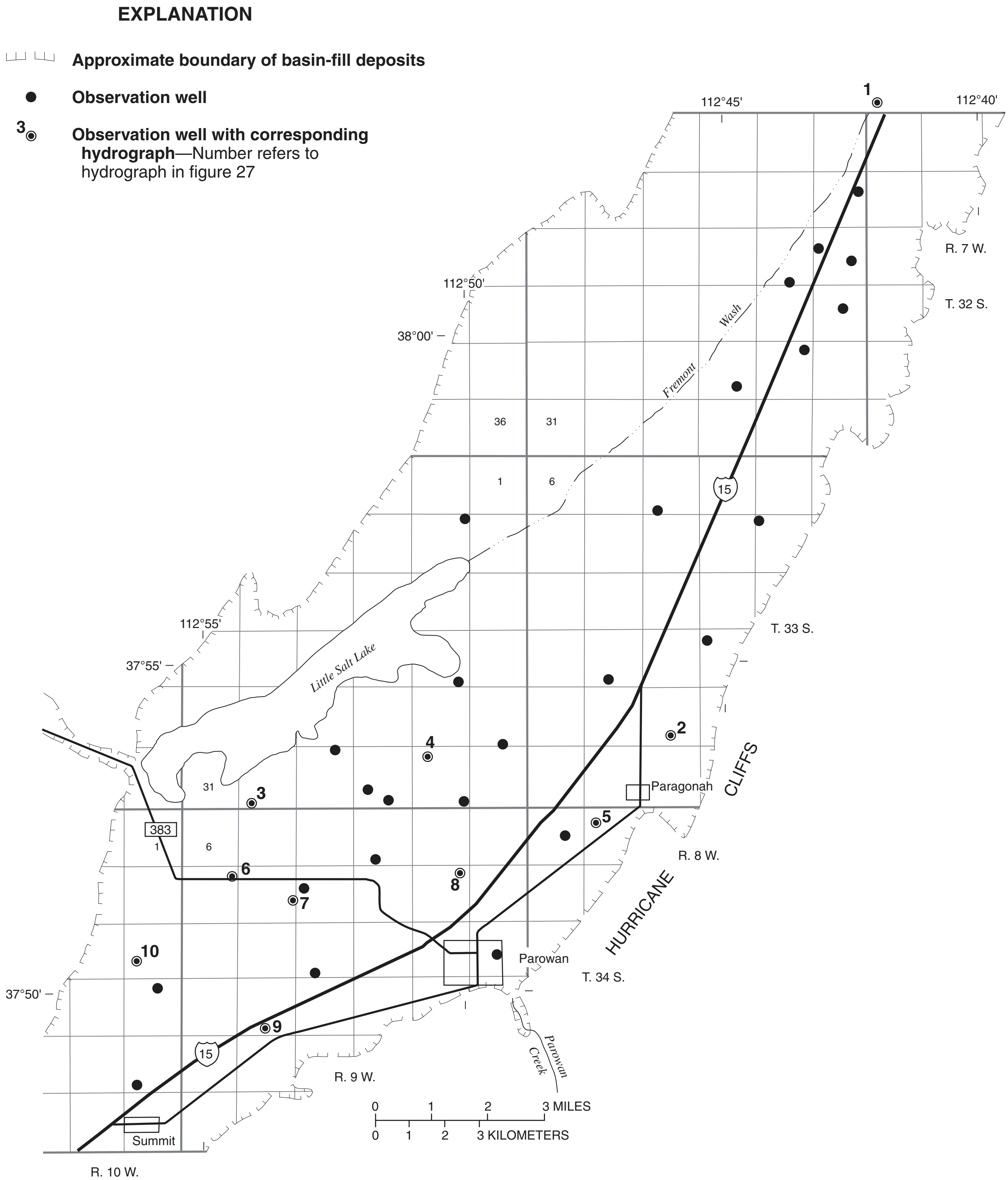


Figure 26. Location of wells in Parowan Valley in which the water level was measured during March 2001.

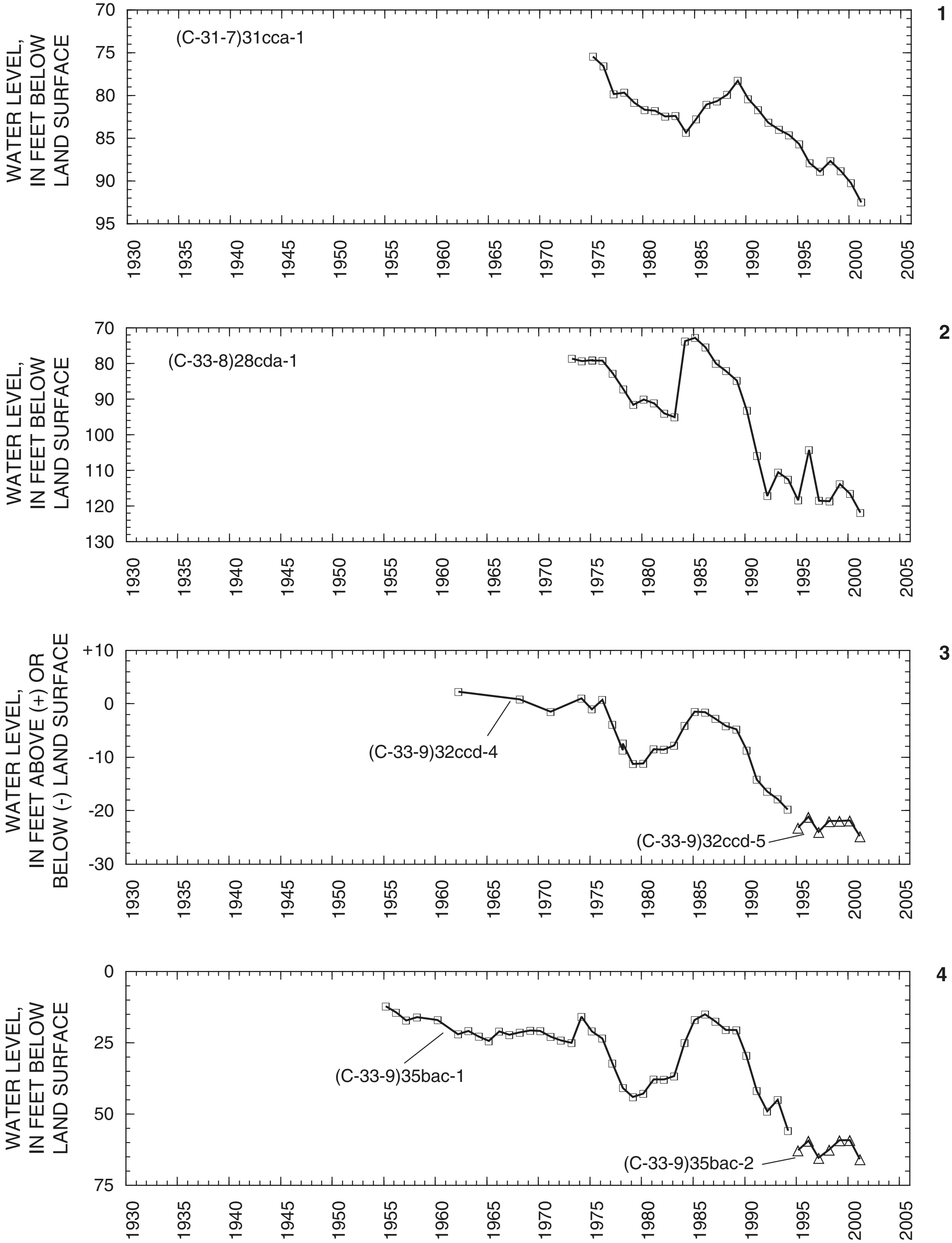


Figure 27. Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1.

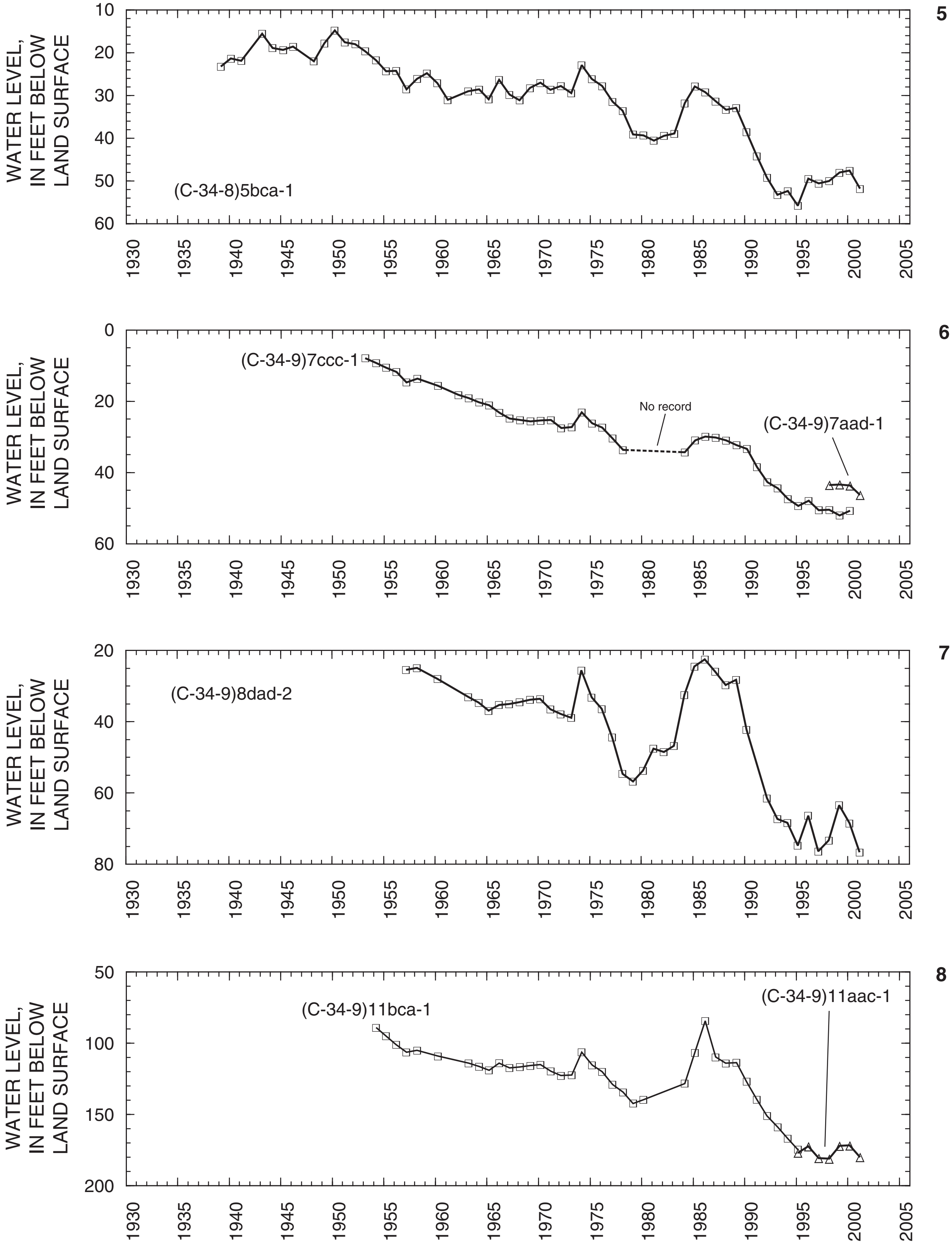
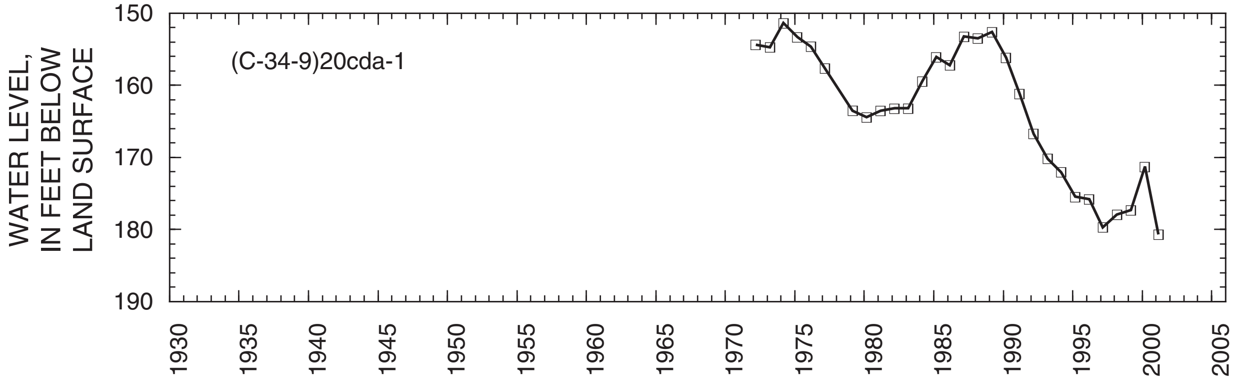


Figure 27. Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1—Continued.

9



10

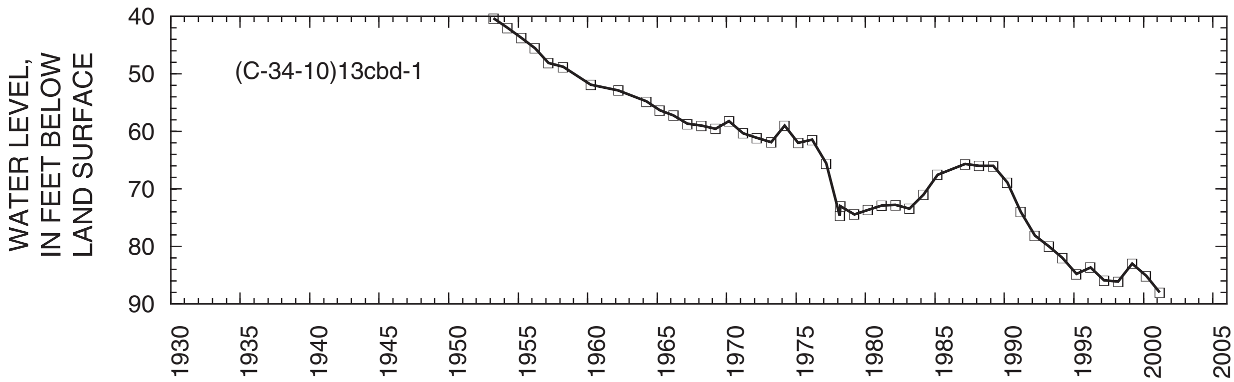


Figure 27. Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1—Continued.

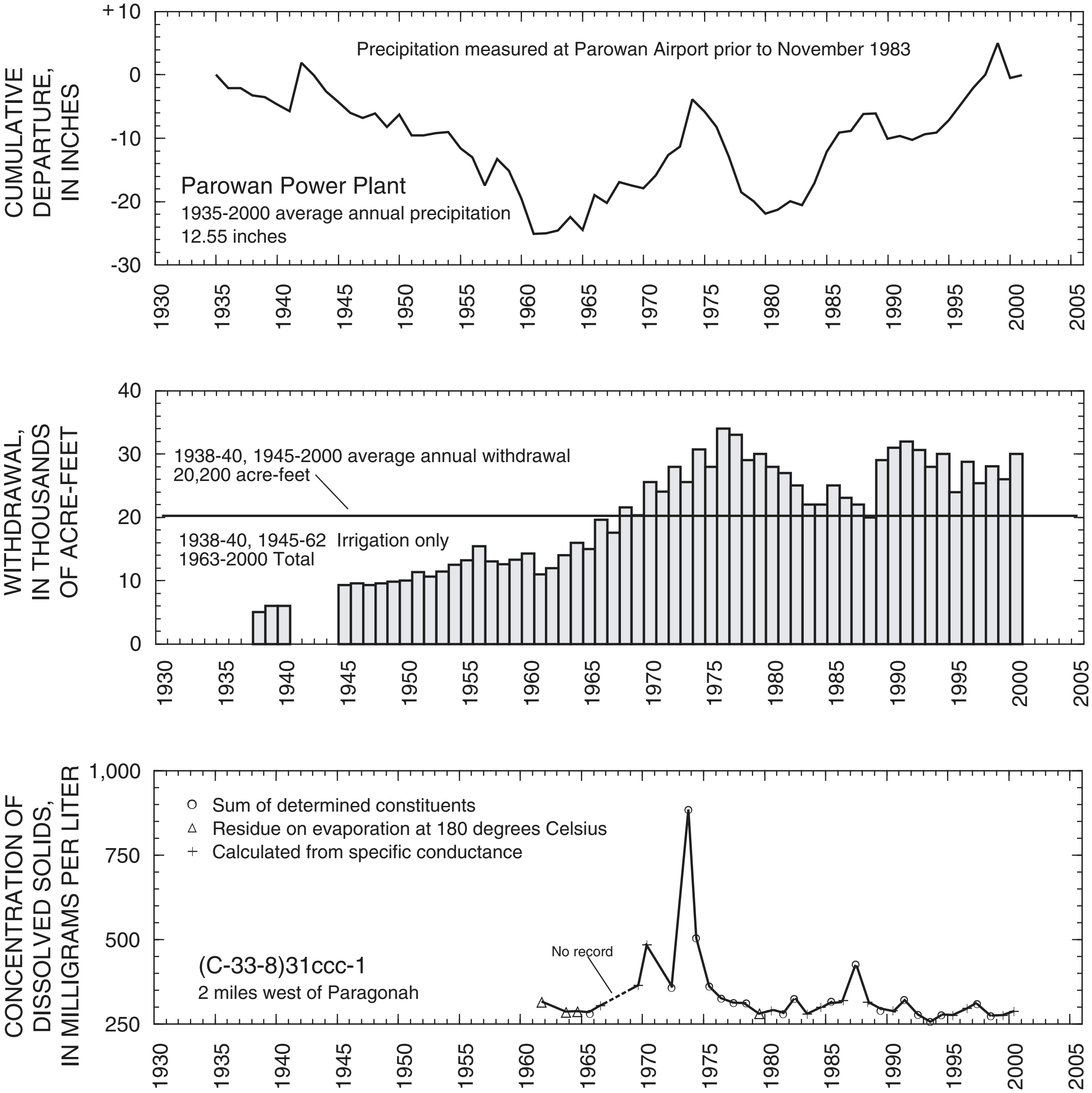


Figure 27. Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Parowan Power Plant, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1—Continued.

ESCALANTE VALLEY

Milford Area

By B.A. Slaugh

The Milford area is in southwest Utah in parts of Millard, Beaver, and Iron Counties, between about Townships 24 South and 31 South and Ranges 10 West and 14 West.

Total estimated withdrawal of water from wells in the Milford area of the Escalante Valley in 2000 was about 49,000 acre-feet, which is 8,000 acre-feet more than was reported for 1999 and the same as the average annual withdrawal for 1990-99 (tables 2 and 3). The increase in withdrawals was mainly the result of increased irrigation.

The location of wells measured in the Milford area during March 2001 is shown in figure 28. The relation of water levels in selected wells to cumulative departure from the average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11) 25dcd-1 is shown in figure 29.

Water levels from March 2000 to March 2001 generally declined in most of the Milford area as a result of increased withdrawals for irrigation. Rises occurred in the extreme north and south areas of the valley because of less demand for water use. Hydrographs for selected wells show that water levels generally have declined since the early 1950s in the south-central Milford area in response to long-term increased withdrawal. Water-level rises during 1983-85 resulted from greater-than-average precipitation during 1982-85 and increased recharge from record flow in the Beaver River during 1983-84.

Precipitation at Black Rock in 2000 was 11.44 inches, 5.20 inches more than in 1999 and 2.34 inches more than the 1952-2000 average annual precipitation. Most of the increase resulted from precipitation in October and November 2000.

Discharge of the Beaver River in 2000 was about 13,000 acre-feet, which is 16,200 acre-feet less than the 1931-35, 1938-2000 average annual discharge. From 1950 to 1983, the concentration of dissolved solids in water from well (C-28-11)25dcd-1 increased from about 500 to almost 2,000 milligrams per liter. Since 1983, concentrations have decreased to about 400 milligrams per liter in 2000.

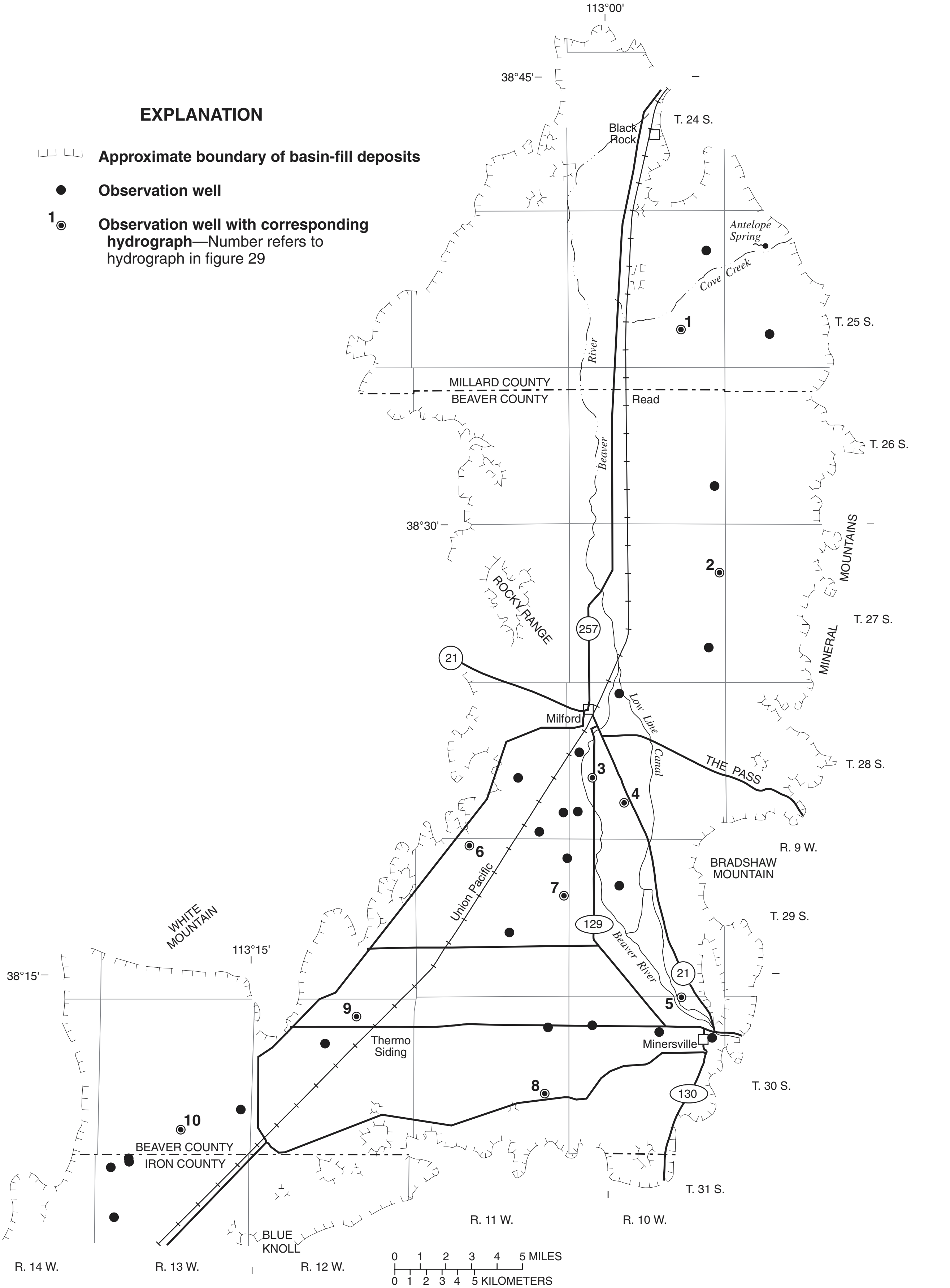


Figure 28. Location of wells in the Milford area in which the water level was measured during March 2001.

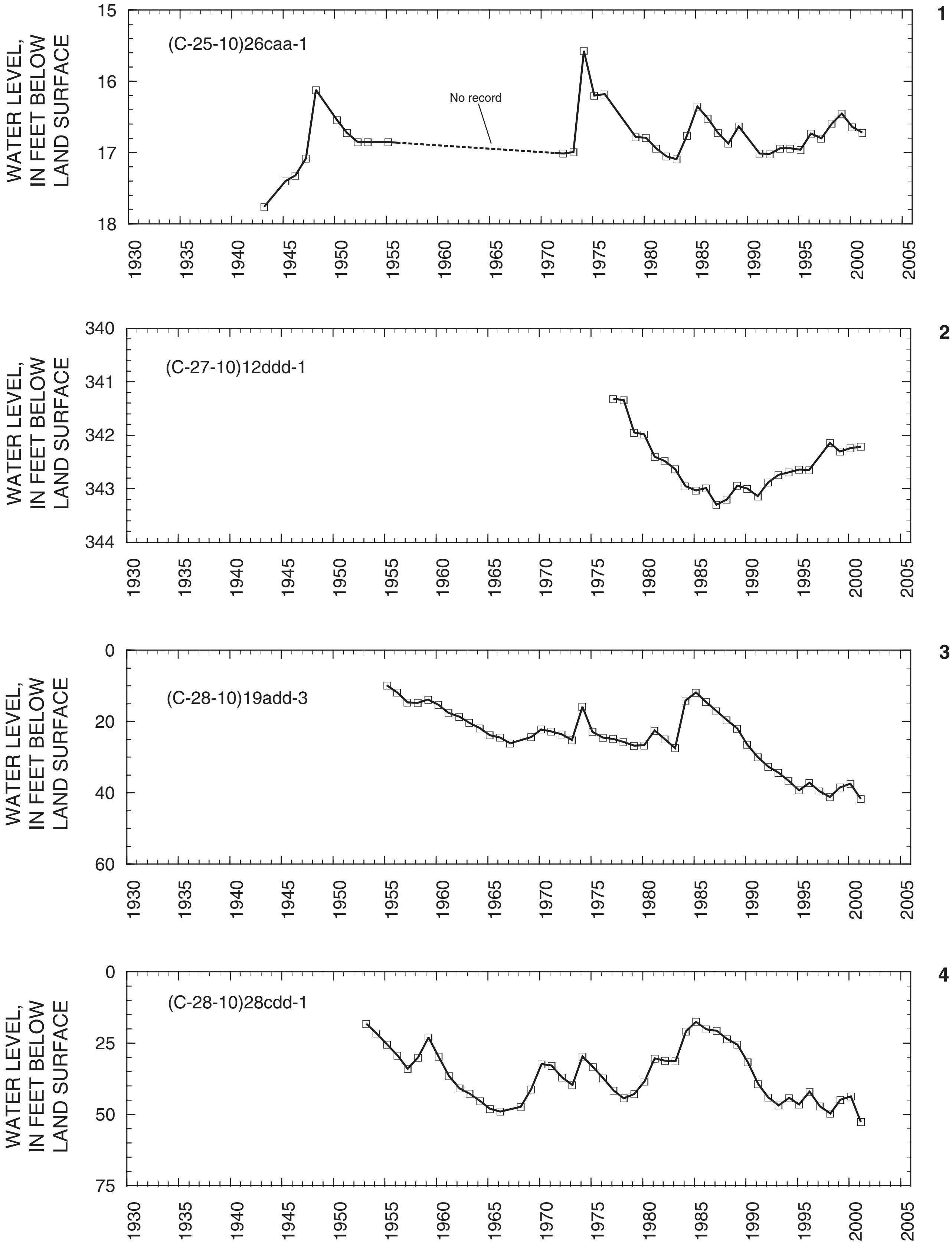


Figure 29. Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1.

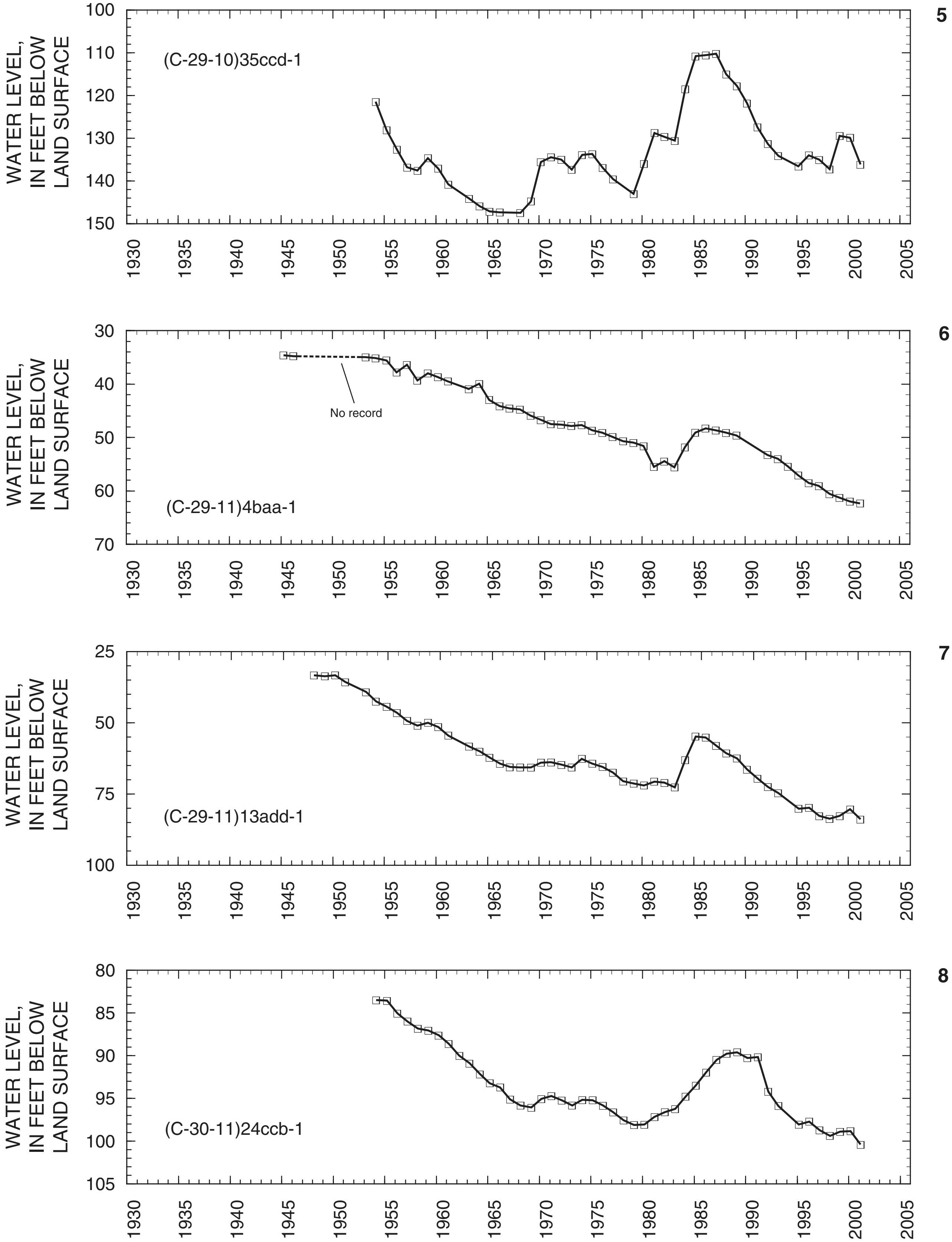
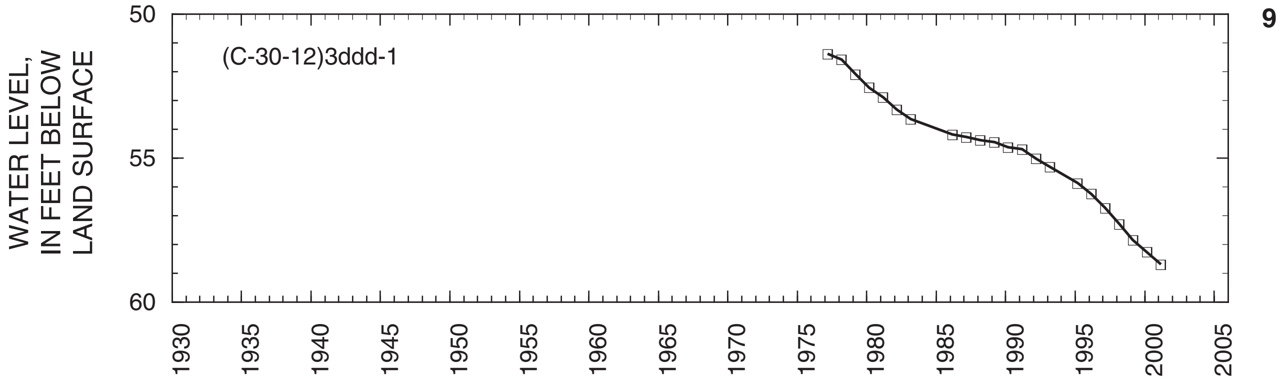


Figure 29. Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1—Continued.



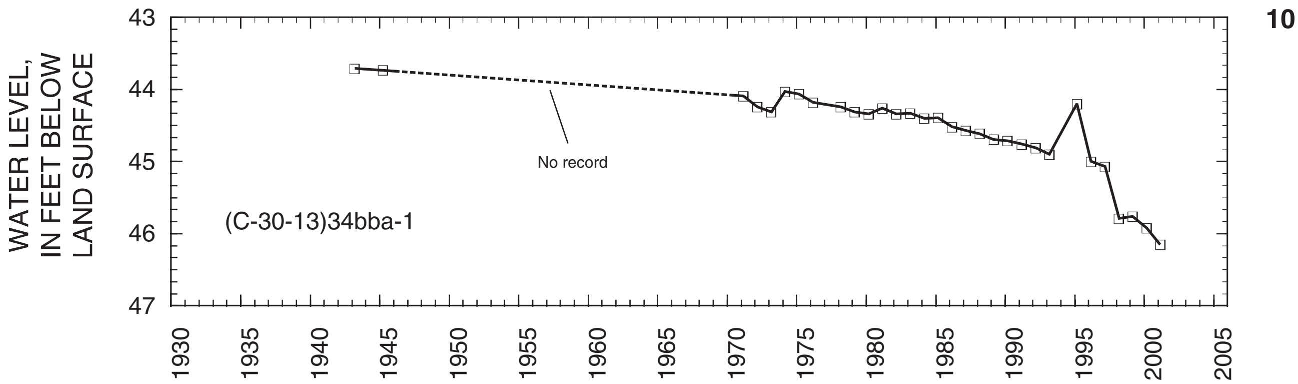


Figure 29. Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1—Continued.

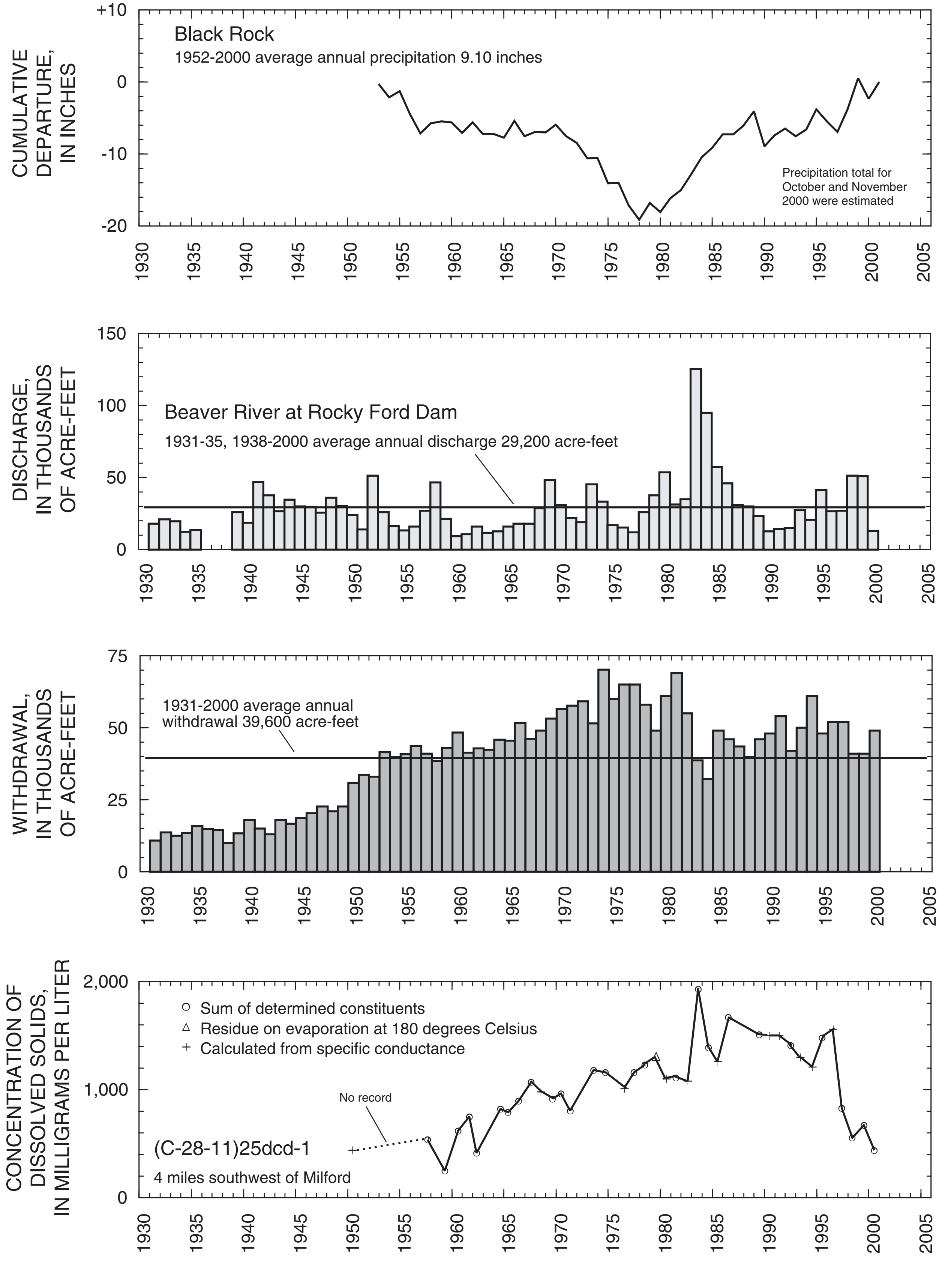


Figure 29. Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual discharge of the Beaver River at Rocky Ford Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-28-11)25dcd-1—Continued.

ESCALANTE VALLEY

Beryl-Enterprise Area

By H.K. Christiansen

The Beryl-Enterprise area covers about 800 square miles in the southern end of Escalante Valley, between about Townships 31 South and 37 South and Ranges 12 West and 18 West.

Total estimated withdrawal of water from wells in the Beryl-Enterprise area in 2000 was about 84,000 acre-feet, which is 5,000 acre-feet more than in 1999 and 4,000 acre-feet more than the average annual withdrawal for 1990-99 (tables 2 and 3). The increase was mainly the result of increased withdrawals for irrigation.

The location of wells in the Beryl-Enterprise area in which the water level was measured during March 2001 is shown in figure 30. The relation of the water level in selected wells to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2 is shown in figure 31.

Water levels generally declined from March 1999 to 2001 in the Beryl-Enterprise area. There has been a general decline in water levels throughout the valley since 1950. The declines are a result of continued large withdrawal for irrigation since 1950. A decline of about 100 feet since 1948 is shown in well (C-36-16)29daa-1, about 5 miles northeast of Enterprise. A rise in water level is shown in well (C-36-15)5ccc-1 located about 2 miles northwest of Newcastle. The rise is probably the result of recharge from greater-than-average precipitation.

Precipitation at Modena in 2000 was 12.73 inches, which is 2.29 inches more than the average annual precipitation for 1936-2000 and 5.91 inches more than in 1999. Concentration of dissolved solids in water from well (C-34-16)28dcc-2 has increased from about 460 milligrams per liter in 1967 to about 660 milligrams per liter in 2000.

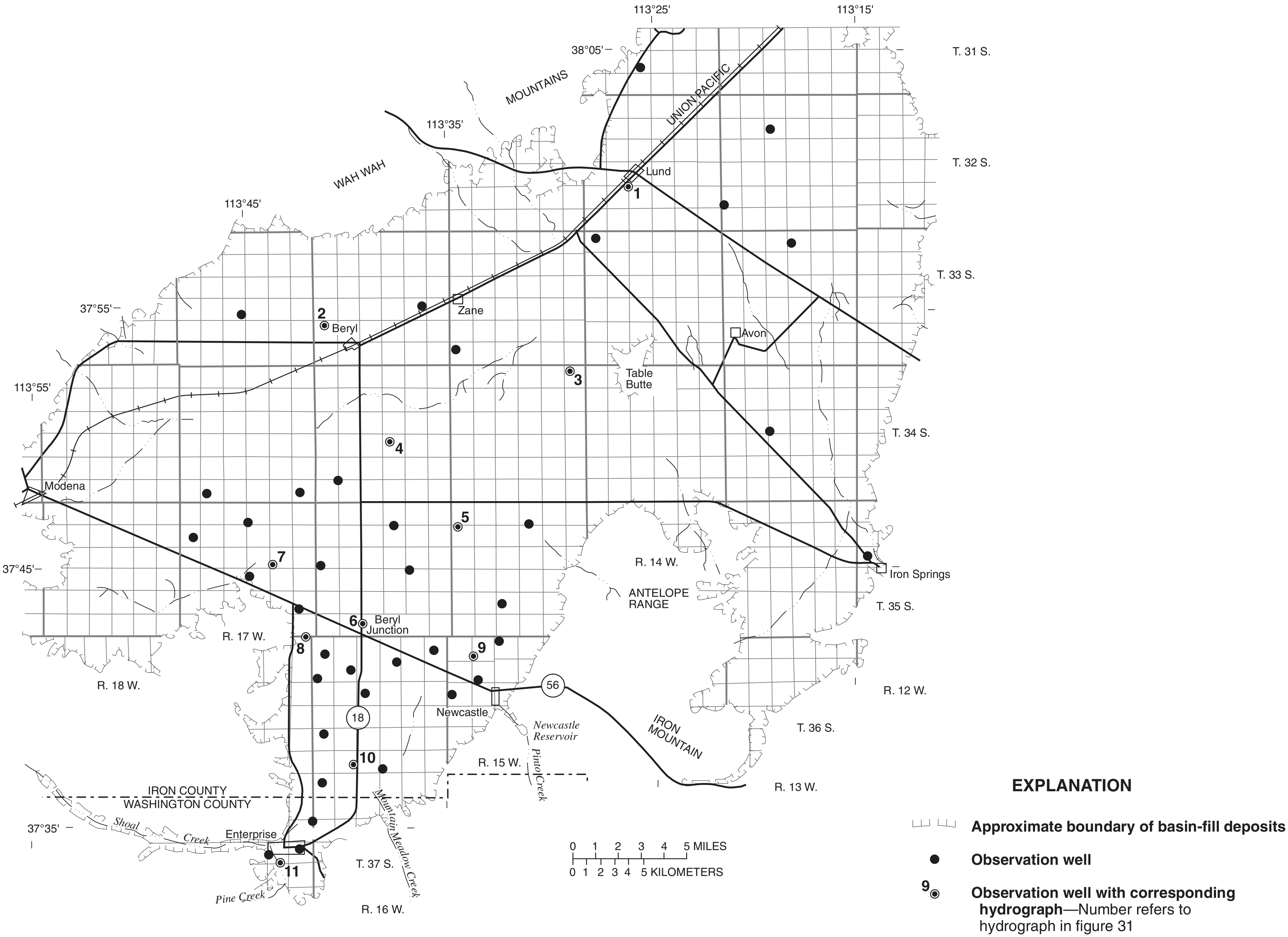


Figure 30. Location of wells in the Beryl-Enterprise area in which the water level was measured during March 2001.

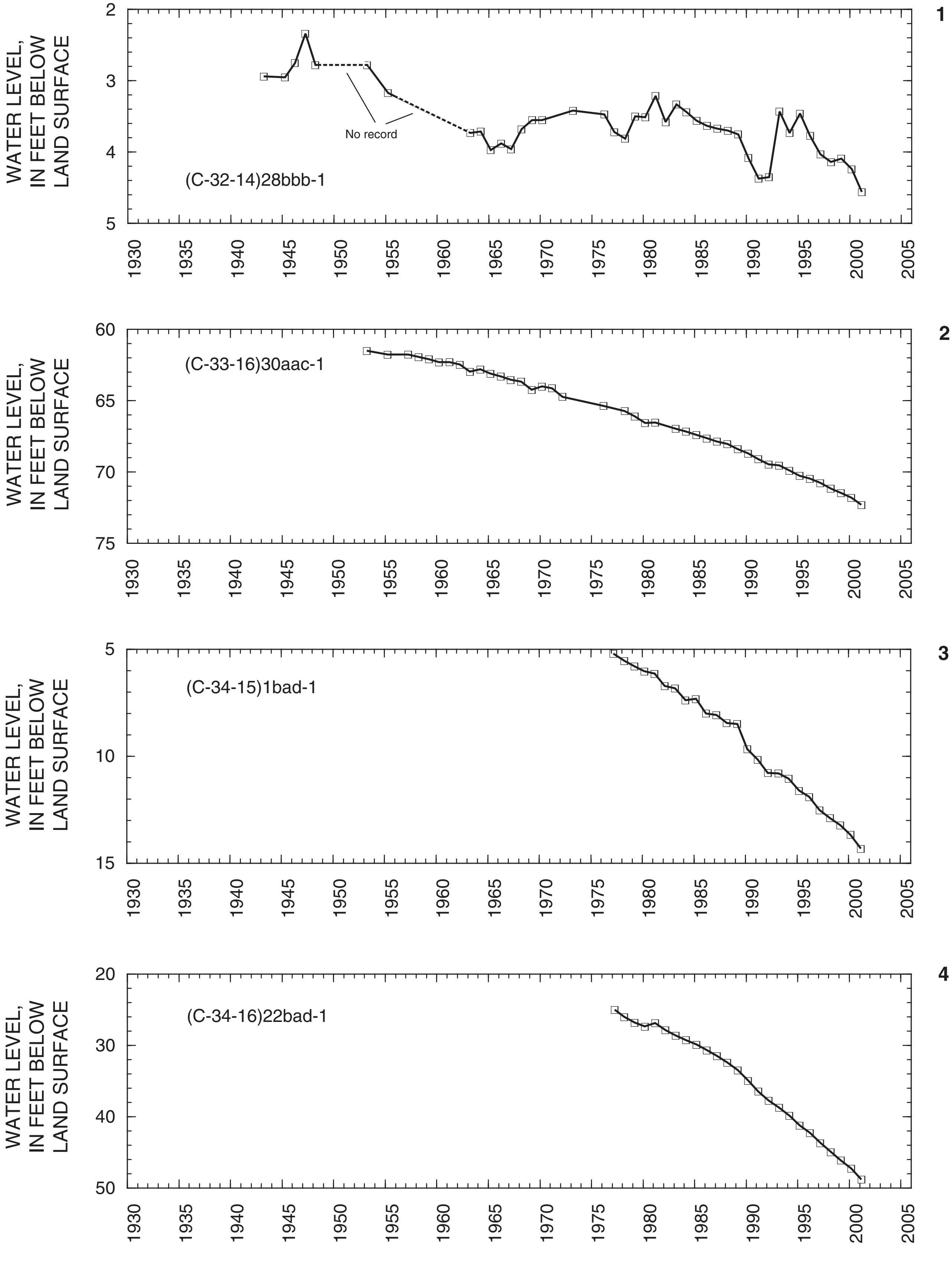


Figure 31. Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2.

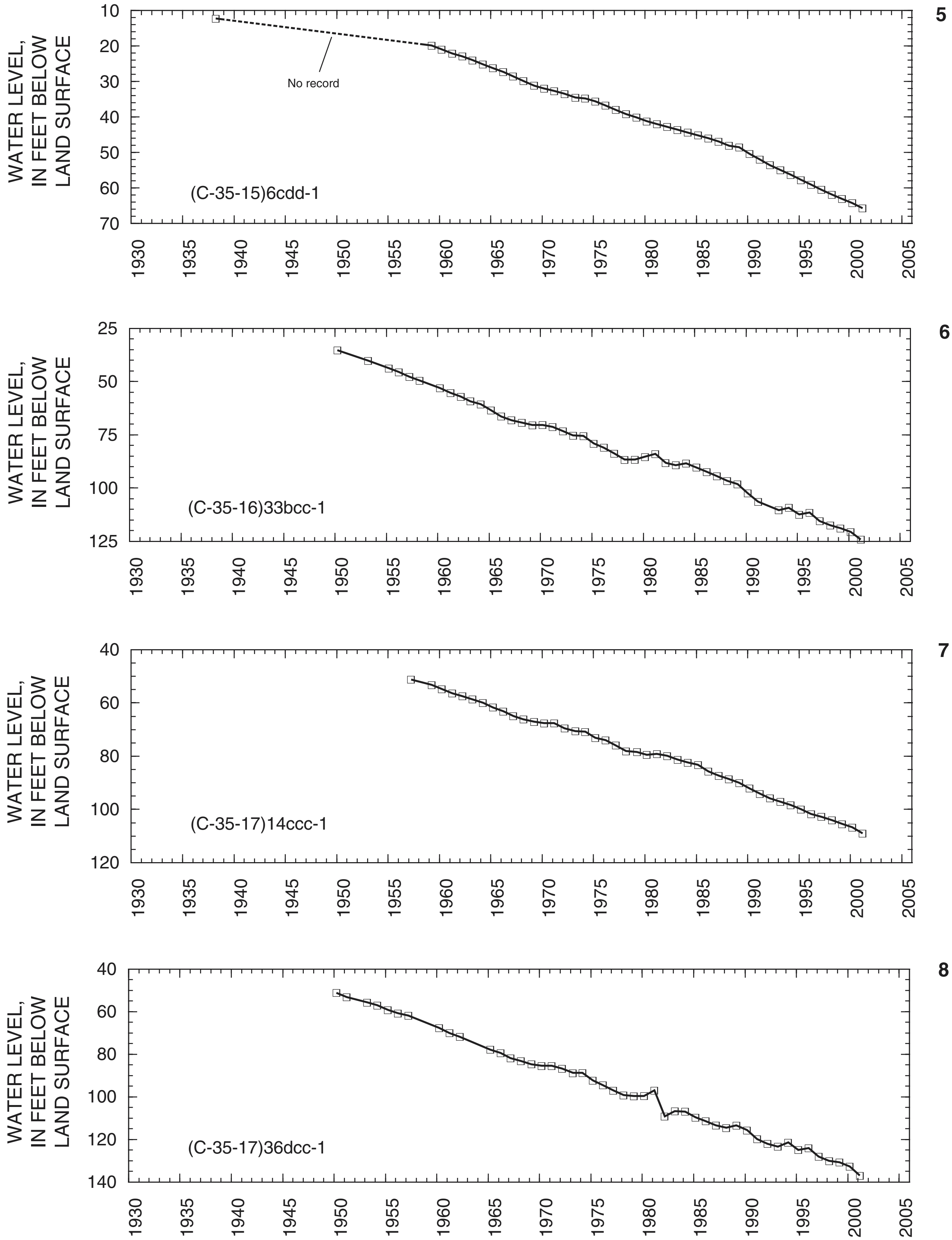
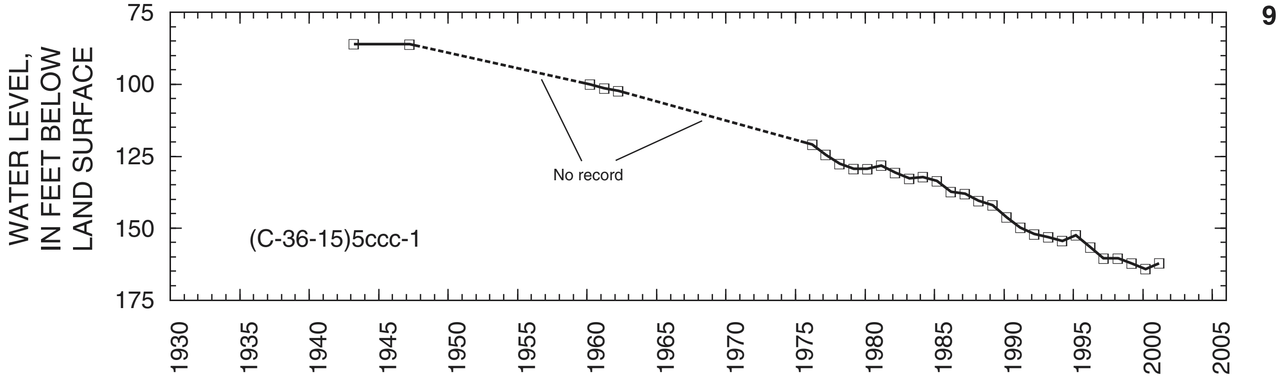
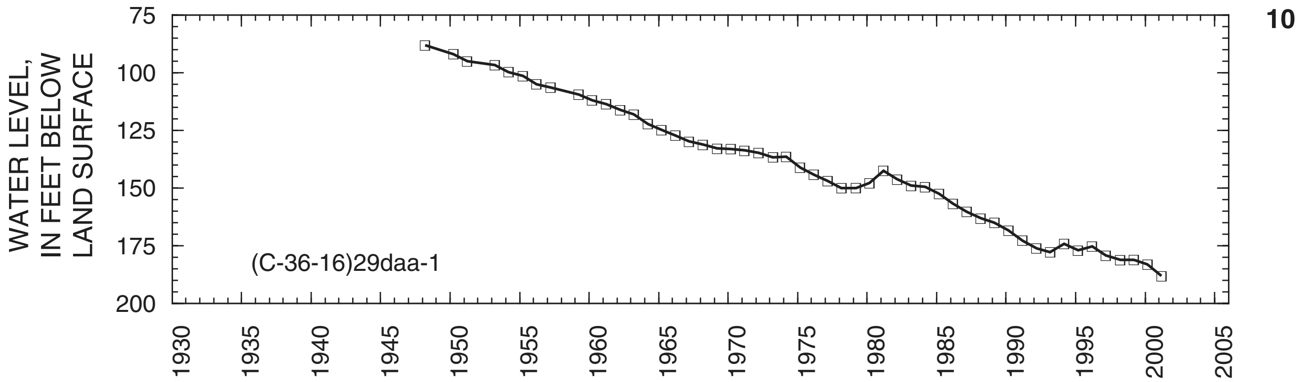


Figure 31. Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2—Continued.





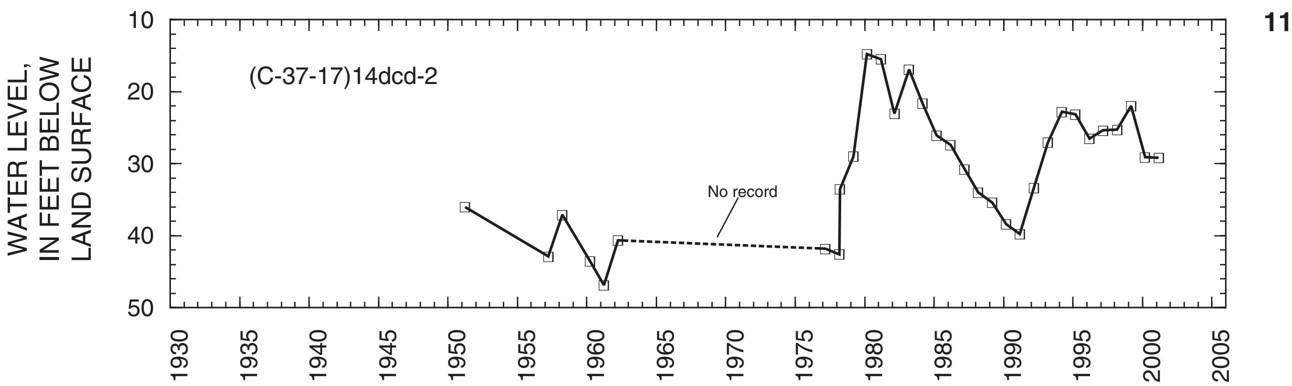


Figure 31. Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2—Continued.

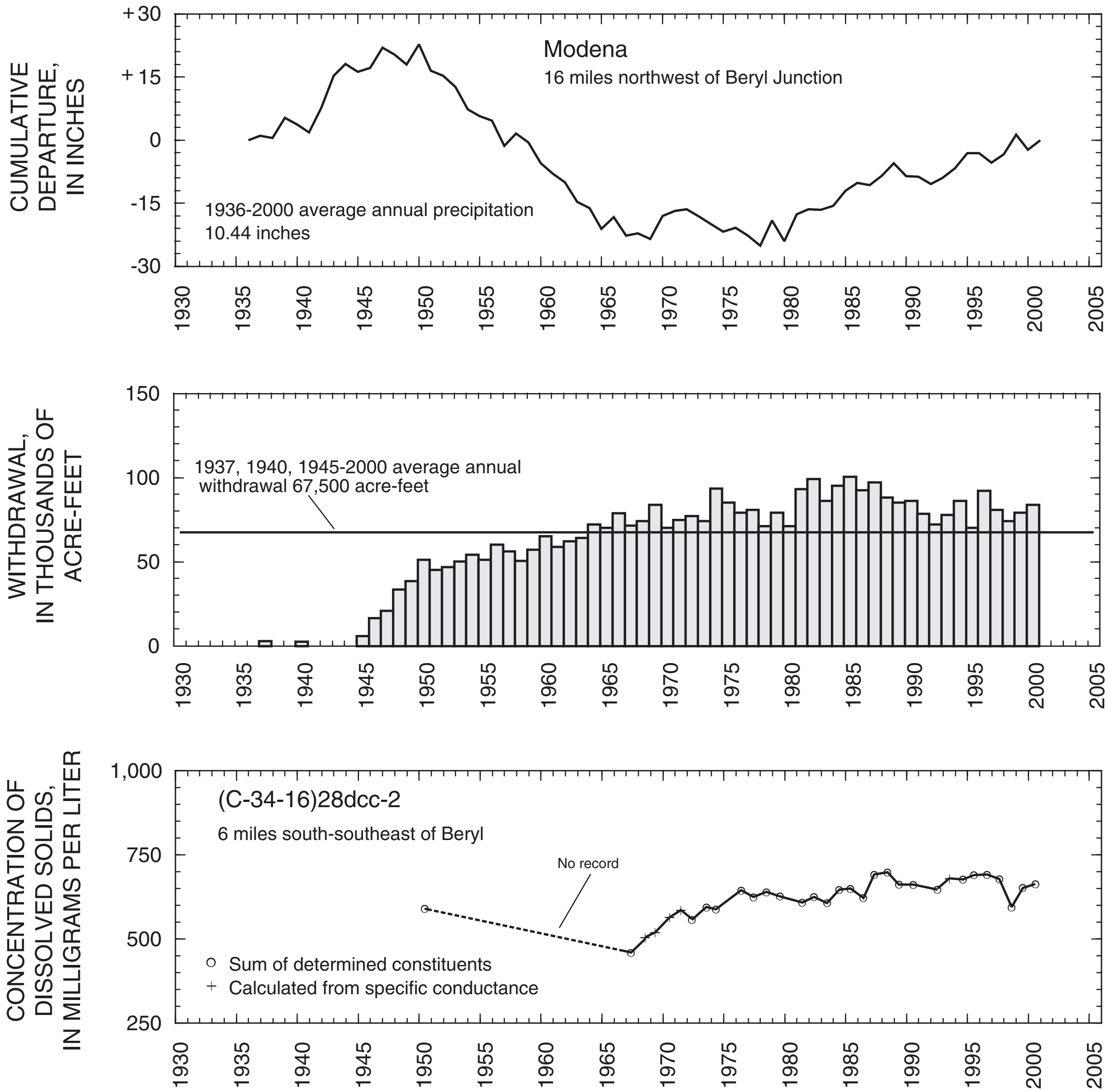


Figure 31. Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Modena, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-2—Continued.

CENTRAL VIRGIN RIVER AREA

By H.K. Christiansen

The central Virgin River area is between the south end of the Pine Valley Mountains and the Hurricane Cliffs to the east and the Beaver Dam Mountains to the southwest. Major ground-water development includes water from valley-fill aquifers used primarily for irrigation and water from consolidated rock and valley fill, which is used primarily for public supply. Most of the wells measured are near the Virgin and Santa Clara Rivers.

Total estimated withdrawal of water from wells in the central Virgin River area in 2000 was about 35,000 acre-feet, which is 7,000 acre-feet more than was reported for 1999 and 17,000 acre-feet more than the average annual withdrawal for 1990-99 (tables 2 and 3). Withdrawal for irrigation increased by about 2,500 acre-feet from 1999 to 2000 in part because estimates for irrigated areas east of Hurricane and in the Harmony Basin east of New Harmony are included. Withdrawal for industry in 2000 was the same as in 1999. Withdrawal for public supply was 4,400 acre-feet more than in 1999.

The location of wells in the central Virgin River area in which the water level was measured during February 2001 is shown in figure 32. The relation of the water level in selected wells to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1 is shown in figure 33.

Water levels from February 2000 to February 2001 in the central Virgin River area generally declined in the Santa Clara River drainage and most of the Virgin River drainage. Some rises were observed near Hurricane and St. George in the Virgin River drainage. Data from wells along the Santa Clara River and the Virgin River indicate that water-level fluctuations have shown the same general trend as discharge of the rivers. Water levels in the Fort Pierce Wash area have continued to decline since 1961. The declines are probably the result of increased withdrawals for public supply and irrigation.

Discharge of the Virgin River at Virgin in 2000 was about 94,100 acre-feet, which is 2,500 acre-feet more than the revised value of 91,600 acre-feet for 1999 and about 40,400 acre-feet less than the long-term average for 1931-70, 1979-2000. Precipitation at St. George in 2000 was 6.95 inches, which is 1.12 inches less than the average annual precipitation for 1947-2000 and 1.43 inches more than in 1999. The concentration of dissolved solids in water from well (C-41-17)17cba-1 indicates little overall change since 1966.

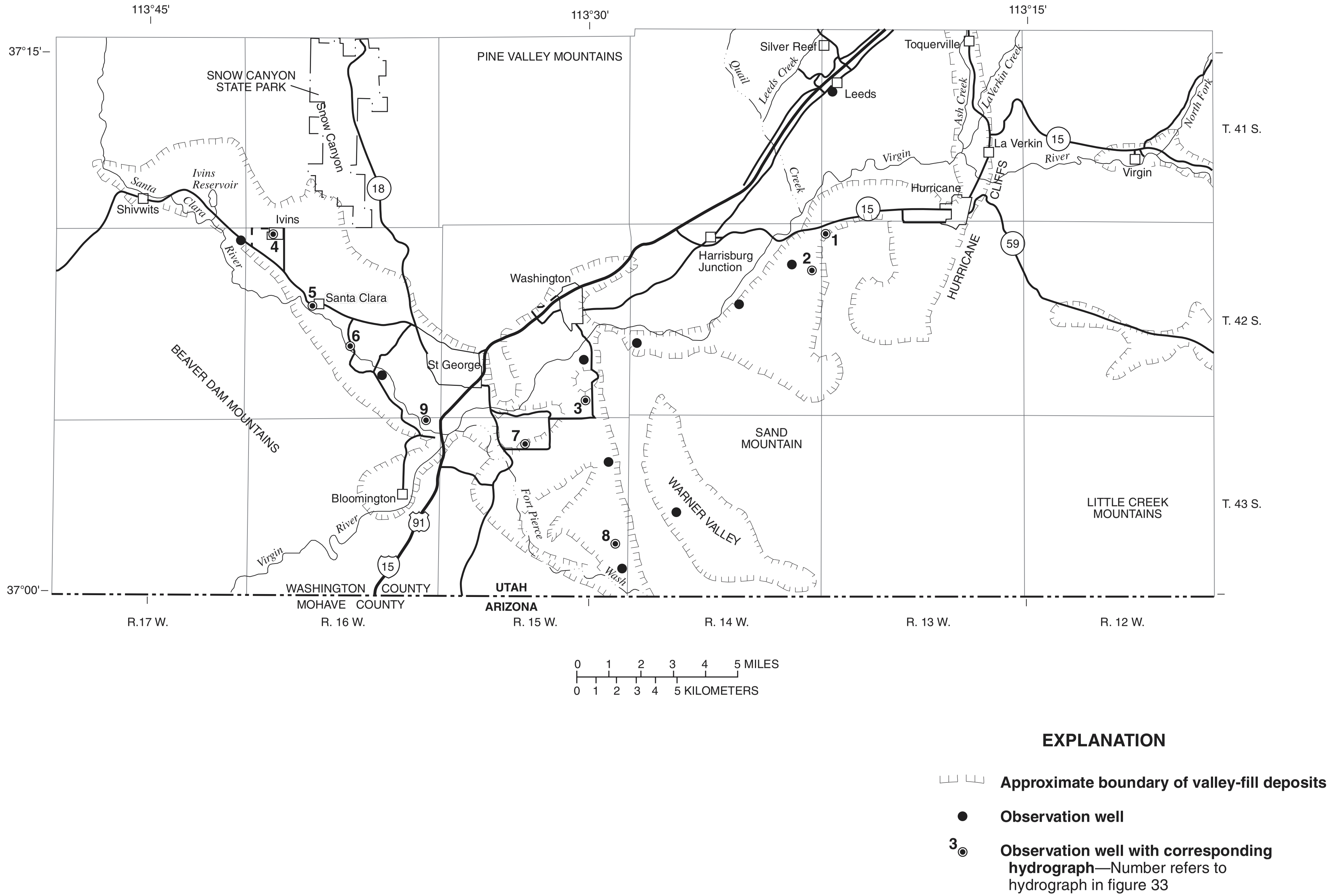


Figure 32. Location of wells in the central Virgin River area in which the water level was measured during February 2001.

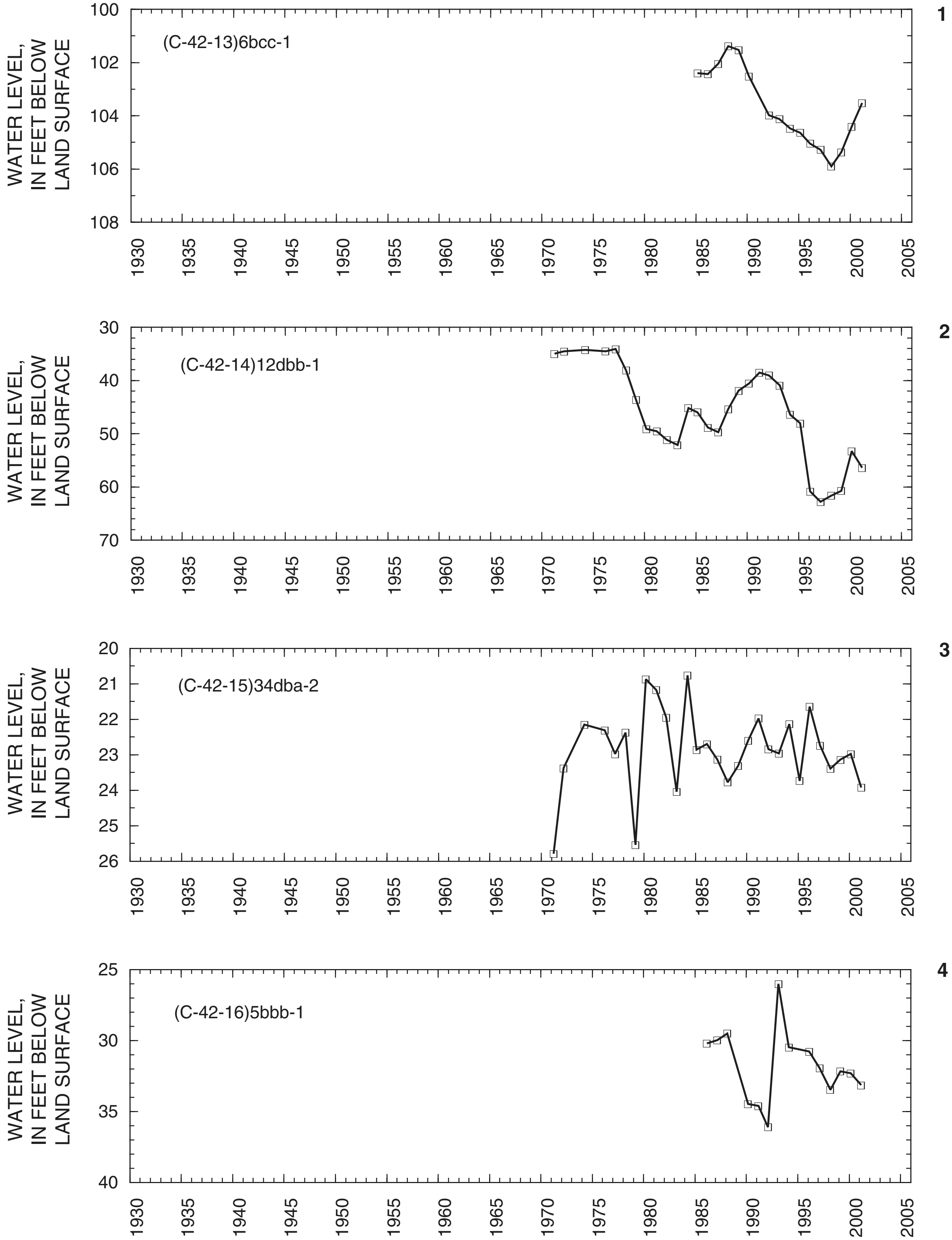


Figure 33. Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1.

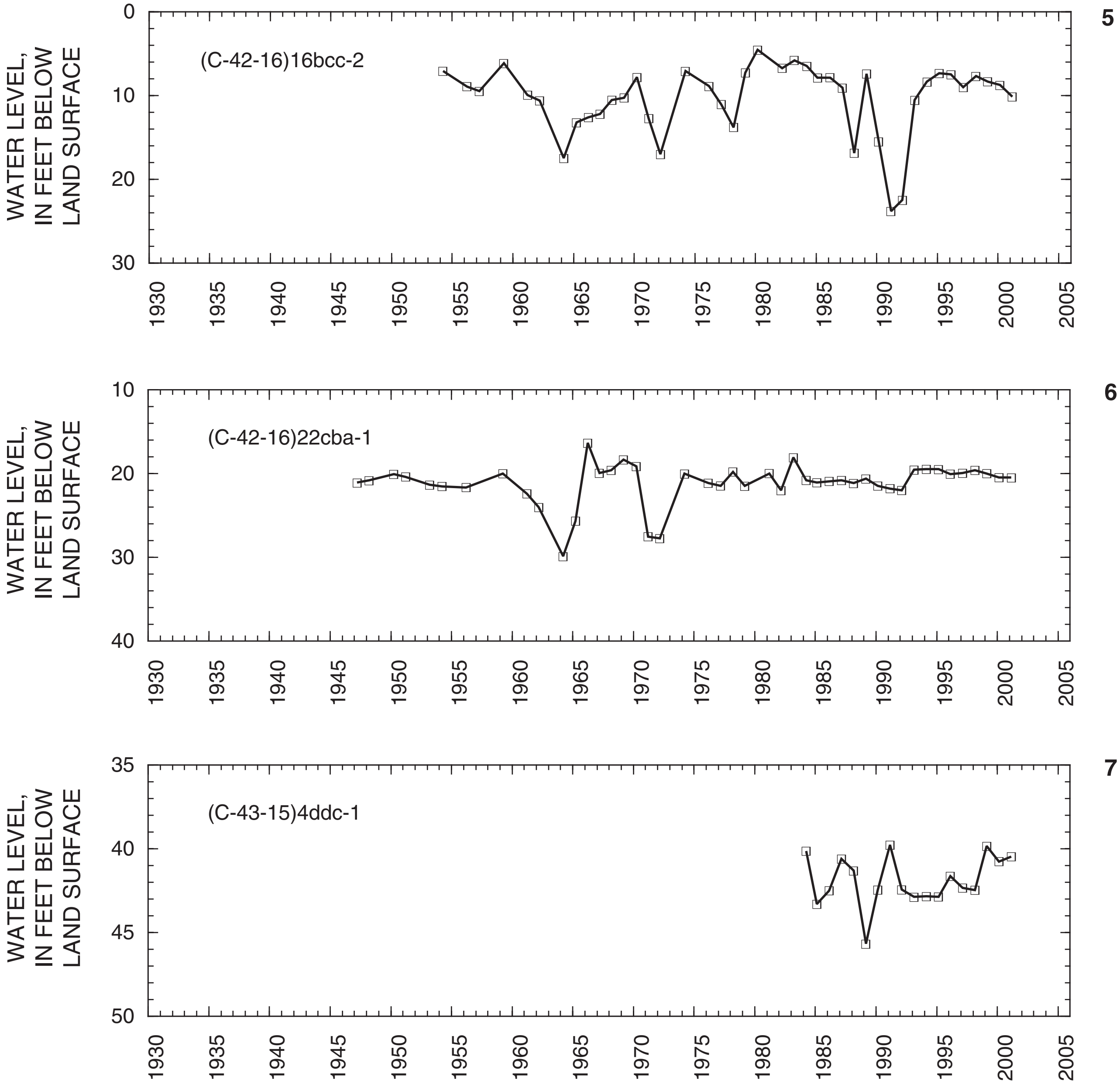
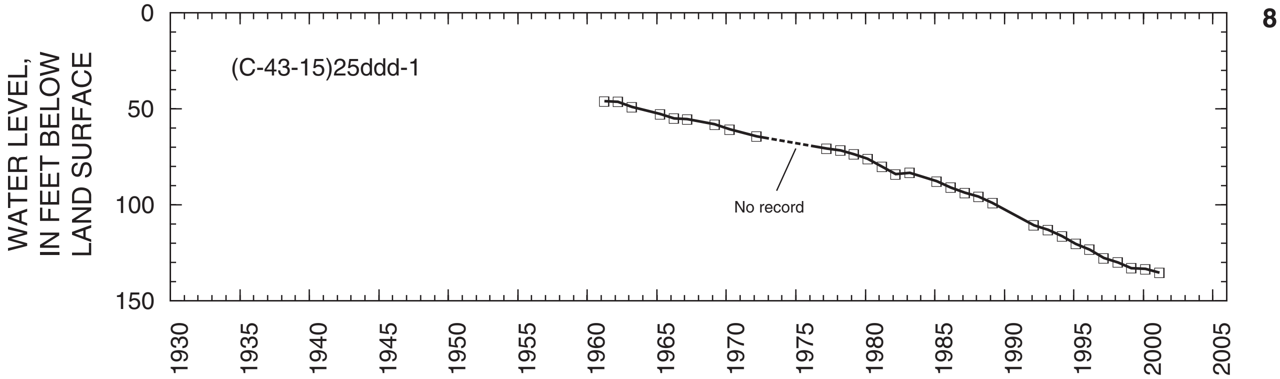


Figure 33. Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1—Continued.



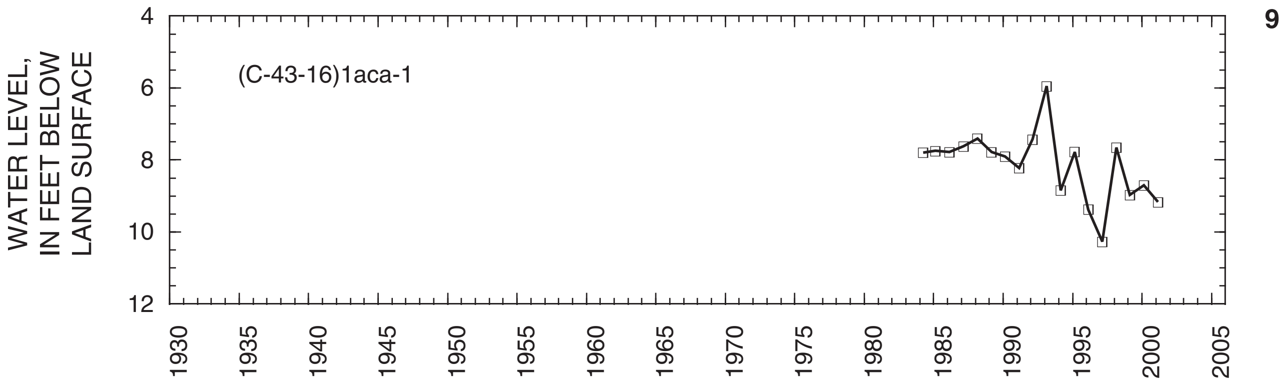


Figure 33. Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1—Continued.

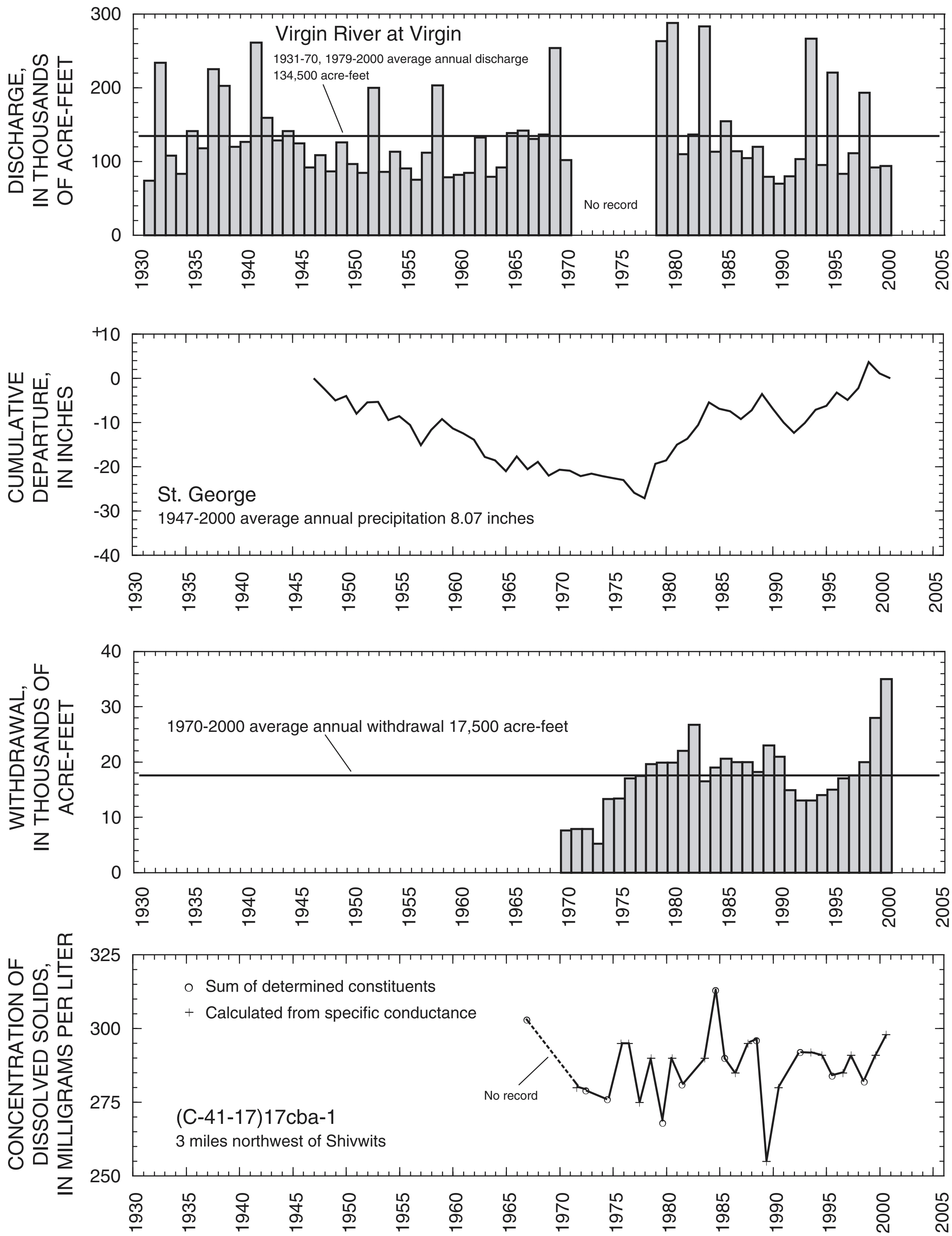


Figure 33. Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, to cumulative departure from average annual precipitation at St. George, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-17)17cba-1—Continued.

OTHER AREAS

By M.J. Fisher

Total estimated withdrawal of water from wells in the areas of Utah listed below in 2000 was about 140,000 acre-feet, which is 34,000 acre-feet more than the estimate for 1999 and 33,000 acre-feet more than the average annual withdrawal for 1990-99 (tables 2 and 3). In the areas listed below, withdrawal in 2000 was greater than in 1999 except in the Dugway area, Skull Valley, and Old River Bed. The increase in withdrawal resulted from increased irrigation, industrial, and public supply use.

The location of wells in Cedar Valley, Utah County, in which the water level was measured during March 2001 is shown in figure 34. The relation of the water level in wells in Cedar Valley, Utah County, to cumulative departure from average annual precipitation at Fairfield is shown in figure 35. Water levels in the selected wells generally rose during the 1970s. Water levels rose sharply from the early to mid-1980s as a result of greater-than-average precipitation, but generally have declined since the mid-1980s because of continued withdrawal and less precipitation. Water levels rose in most of the selected wells from 1998-2001. The rises probably resulted from greater-than-average precipitation.

The location of wells in Sanpete Valley in which the water level was measured during March 2001 is shown in figure 36. The relation of the water level in wells in Sanpete Valley to cumulative departure from average annual precipitation at Manti is shown in figure 37. Water levels in many of the selected wells rose from the late 1970s to the mid-1980s as a result of greater-than-average precipitation and have declined since the mid-1980s. Water levels declined in most of the selected wells from 1999 to 2001. The declines probably resulted from increased withdrawal for irrigation and public supply use.

The relation of the water level in wells in selected areas of Utah (see accompanying table) to cumulative departure from average annual precipitation at sites in or near those areas is shown in figure 38. Water levels generally declined in most of the selected observation wells from 1999 to 2001. The declines probably resulted from increased withdrawals for public supply, industry, and local irrigation. Water-level rises in some of the areas from 2000 to 2001 probably resulted from greater-than-average precipitation and (or) increased local recharge from surface water.

Number in figure 1	Area	Estimated withdrawal (acre-feet)					
		2000					1999 total (rounded)
		Irrigation	Industrial	Public supply	Domestic and stock	2000 total (rounded)	
1	Grouse Creek Valley	4,100	0	0	20	4,100	3,900
2	Park Valley	2,600	0	0	10	2,600	2,200
4	Malad-lower Bear River Valley	5,400	900	5,400	200	11,900	8,200
8	Ogden Valley	0	0	15,900	20	15,900	11,600
13	Rush Valley	4,800	280	290	30	5,400	4,900
14	Dugway area, Skull Valley, and Old River Bed	2,600	3,500	1,500	10	7,600	8,400
15	Cedar Valley, Utah County	5,500	0	570	40	6,100	5,100
20	Sanpete Valley	5,400	530	640	4,000	10,600	8,100
25	Snake Valley	11,400	0	90	50	11,500	6,900
27	Beaver Valley	12,400	20	480	410	13,300	9,600
	Remainder of State	14,300	19,000	15,100	2,500	50,900	37,500
Total (rounded)		68,500	24,200	40,000	7,300	140,000	106,000

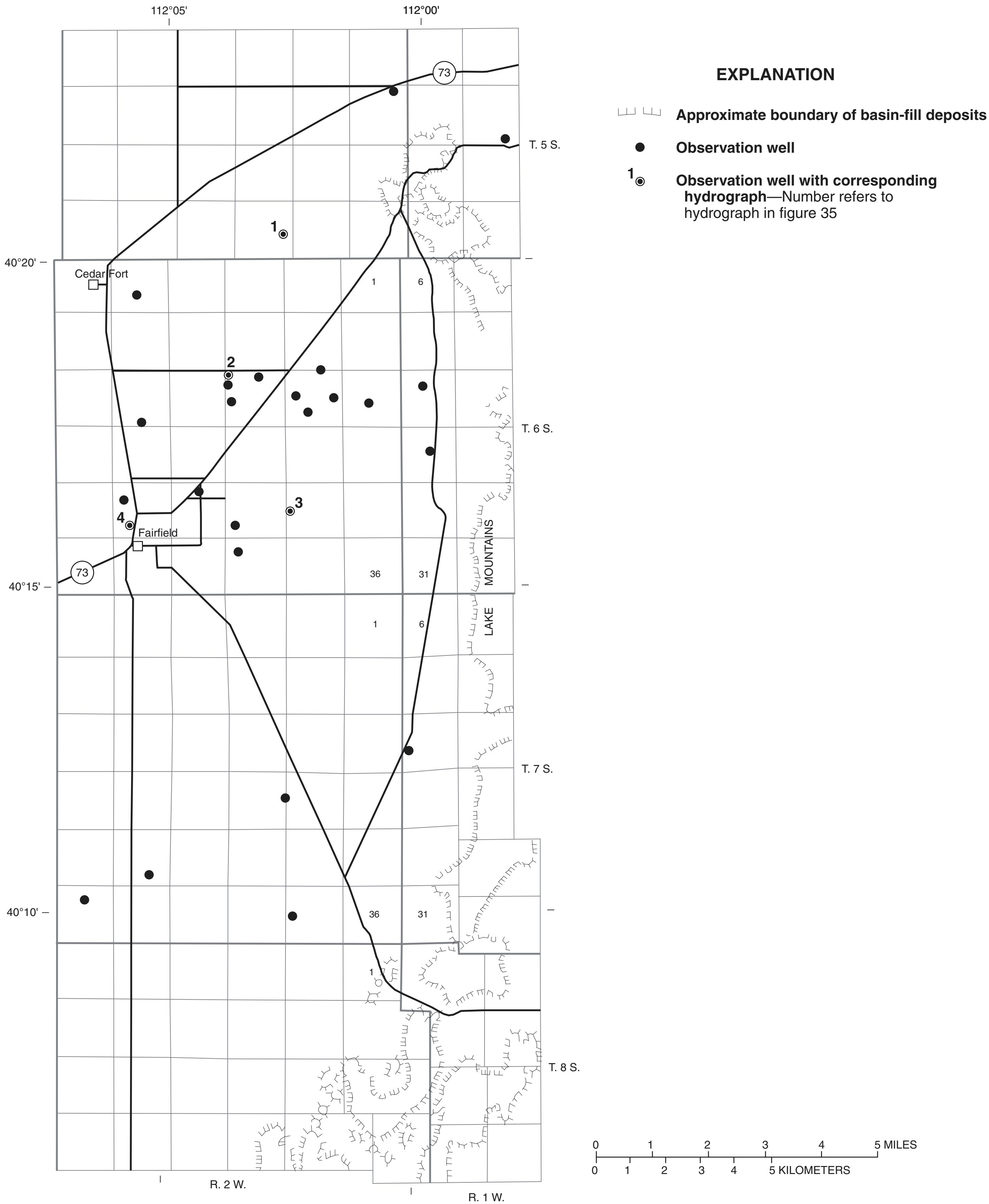


Figure 34. Location of wells in Cedar Valley, Utah County, in which the water level was measured during March 2001.

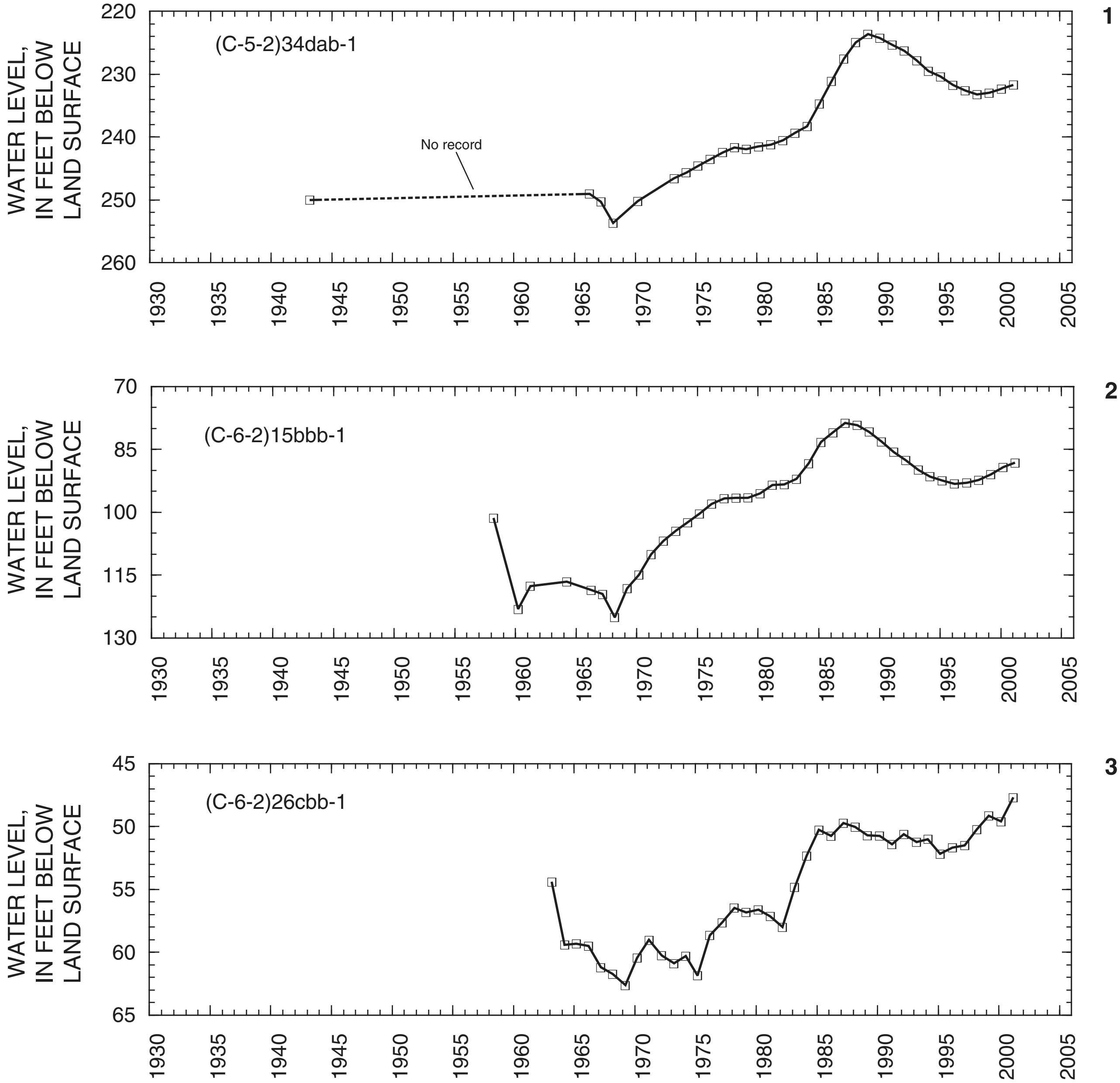


Figure 35. Relation of water level in selected wells in Cedar Valley, Utah County, to cumulative departure from average annual precipitation at Fairfield.

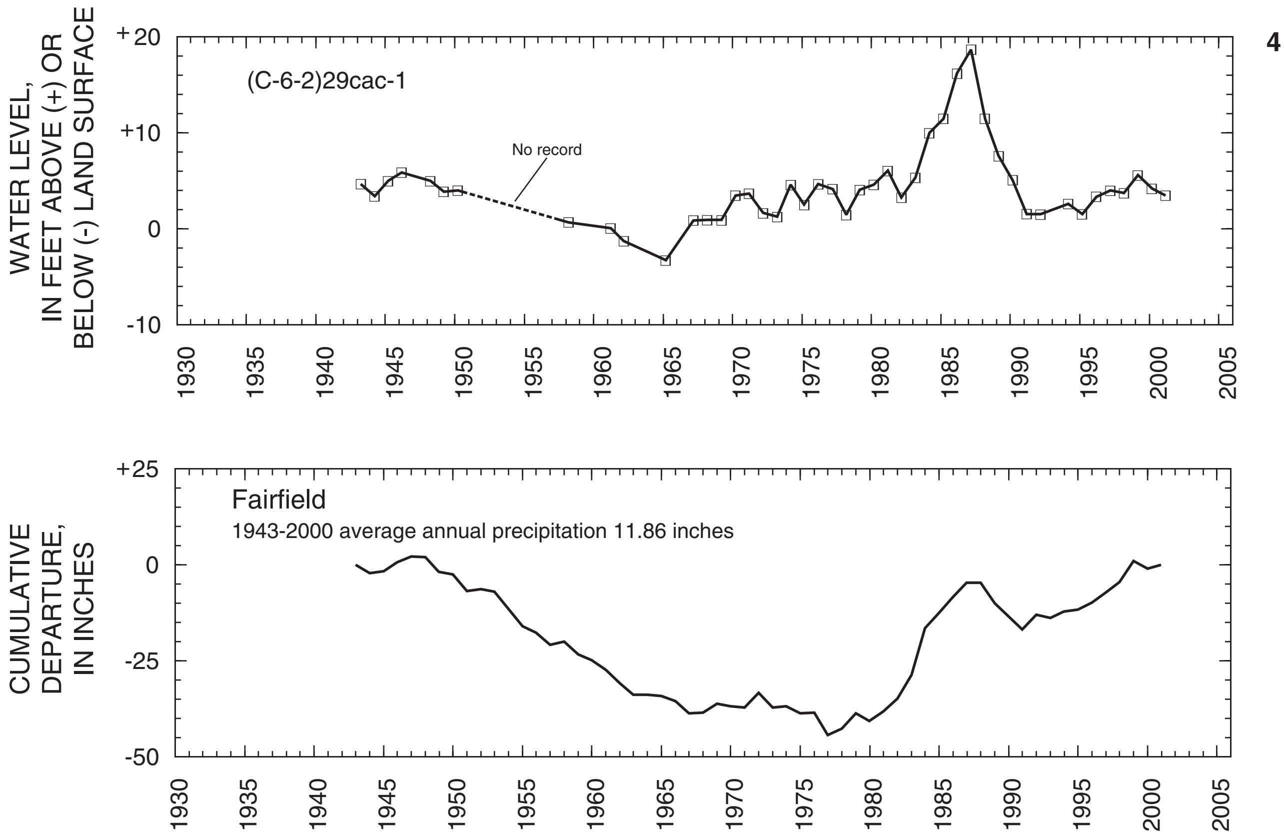


Figure 35. Relation of water level in selected wells in Cedar Valley, Utah County, to cumulative departure from average annual precipitation at Fairfield—Continued.

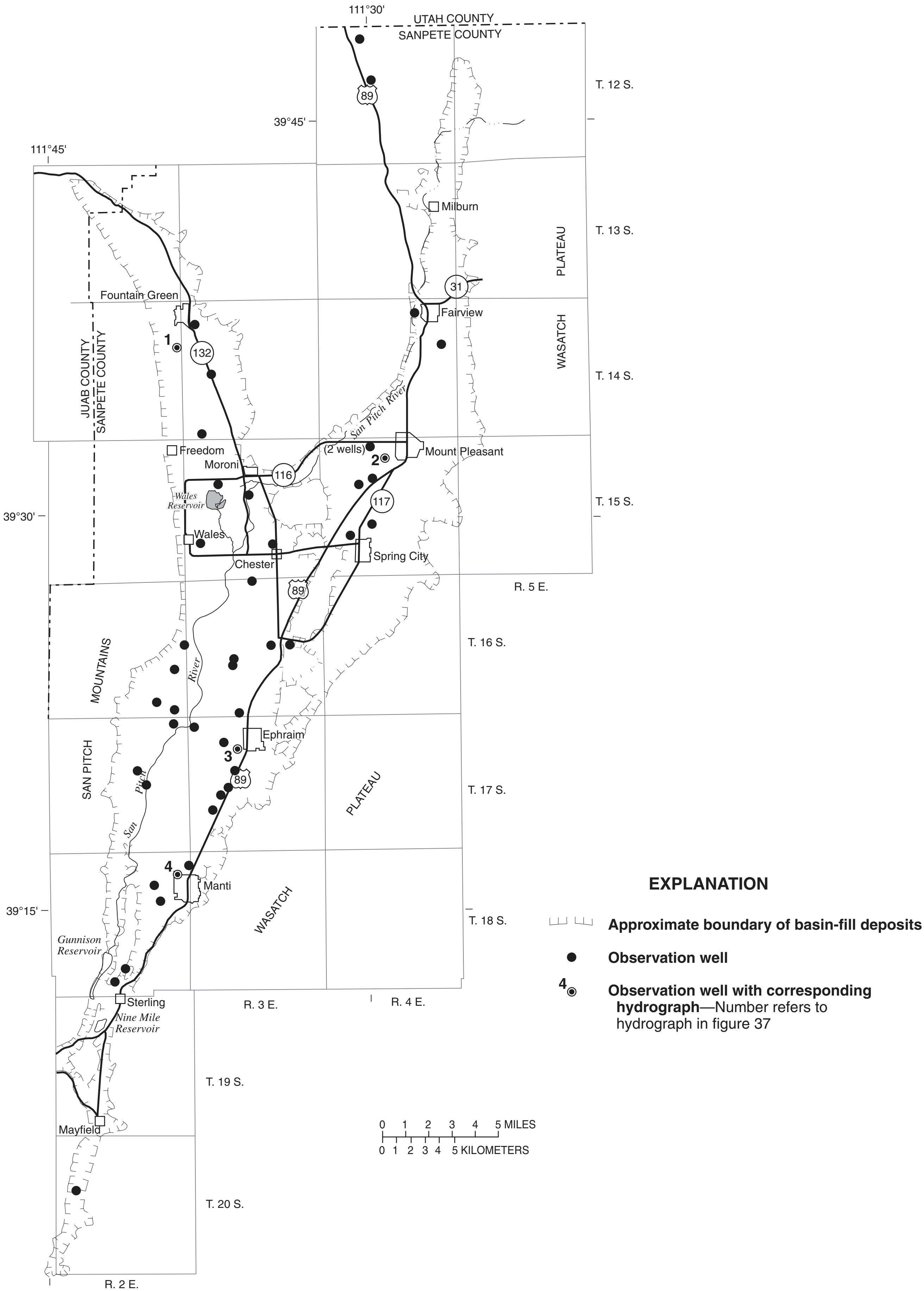


Figure 36. Location of wells in Sanpete Valley in which the water level was measured during March 2001.

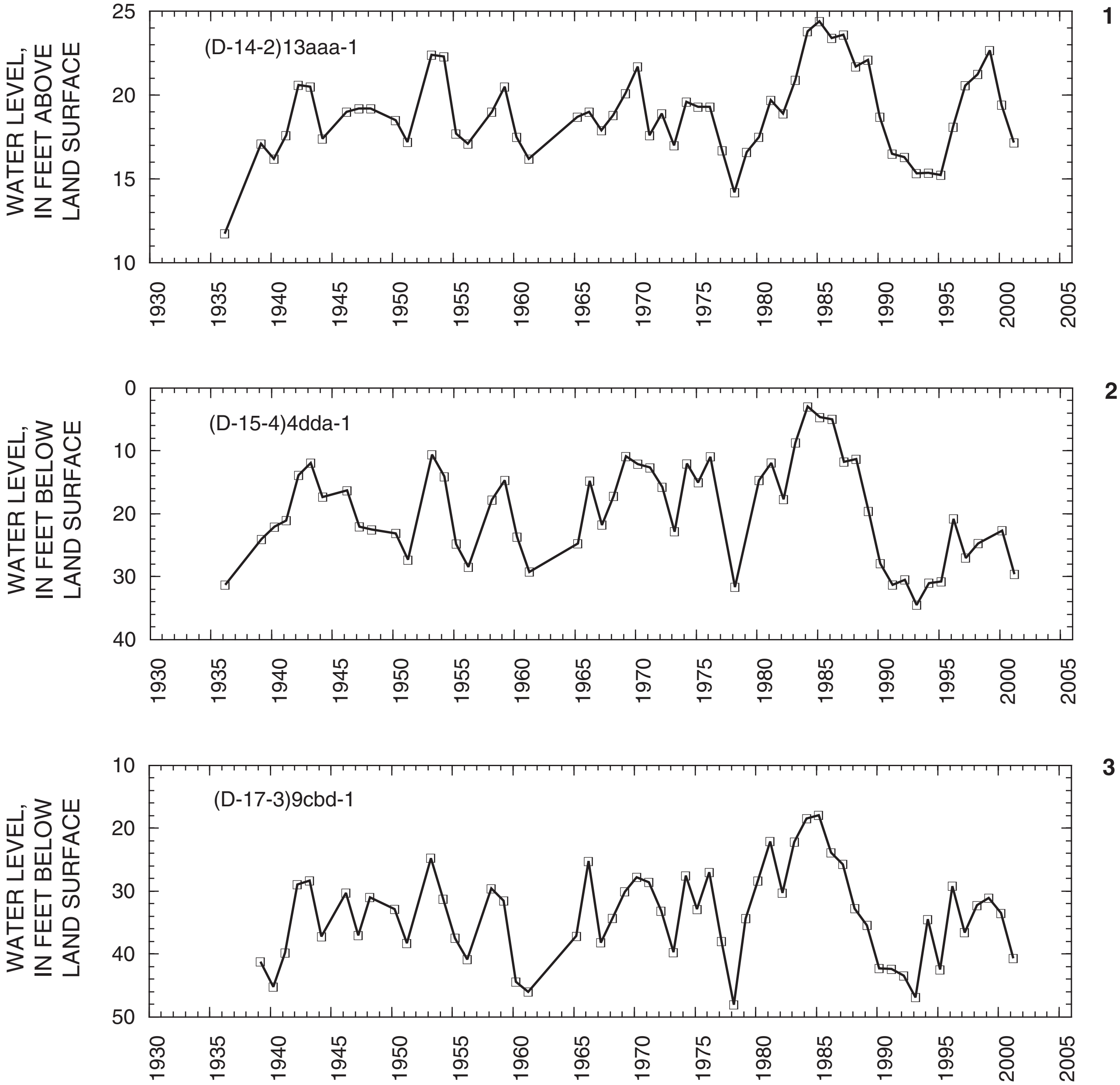


Figure 37. Relation of water level in selected wells in Sanpete Valley to cumulative departure from average annual precipitation at Manti.

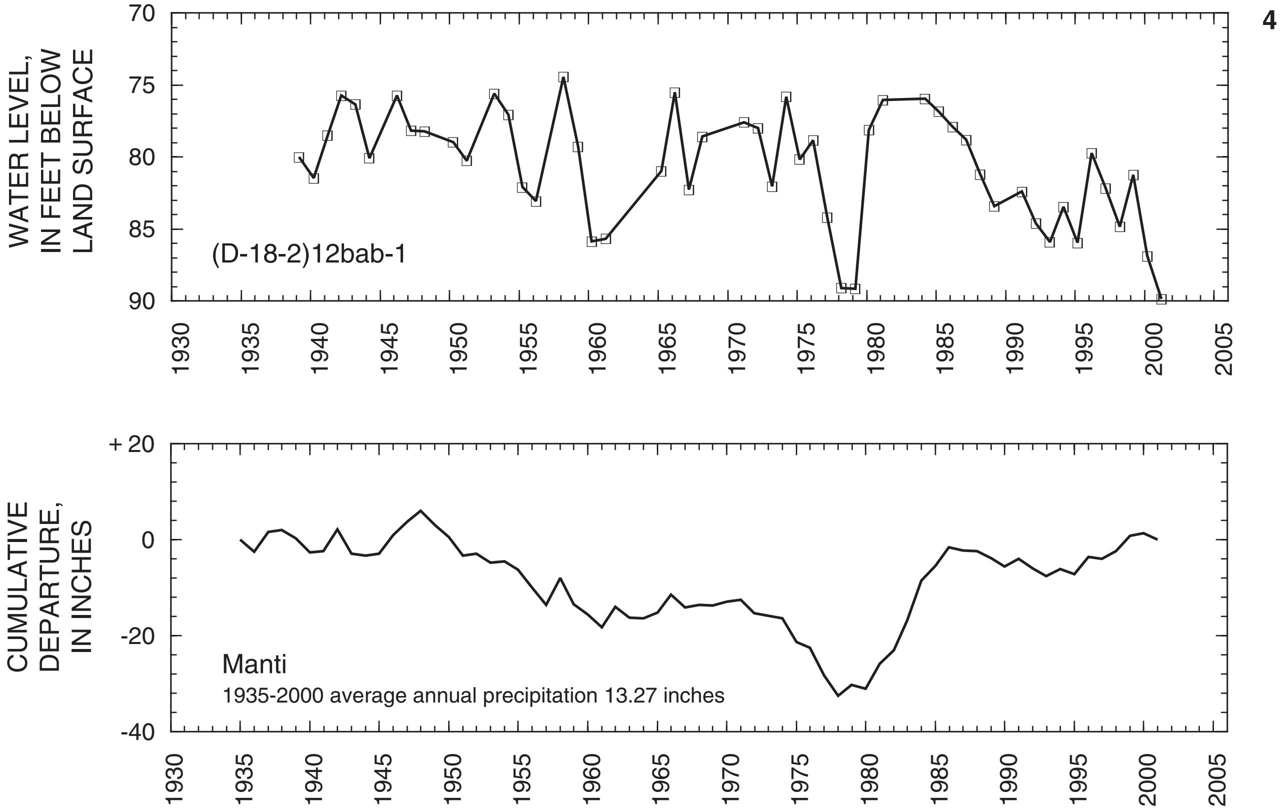


Figure 37. Relation of water level in selected wells in Sanpete Valley to cumulative departure from average annual precipitation at Manti–Continued.

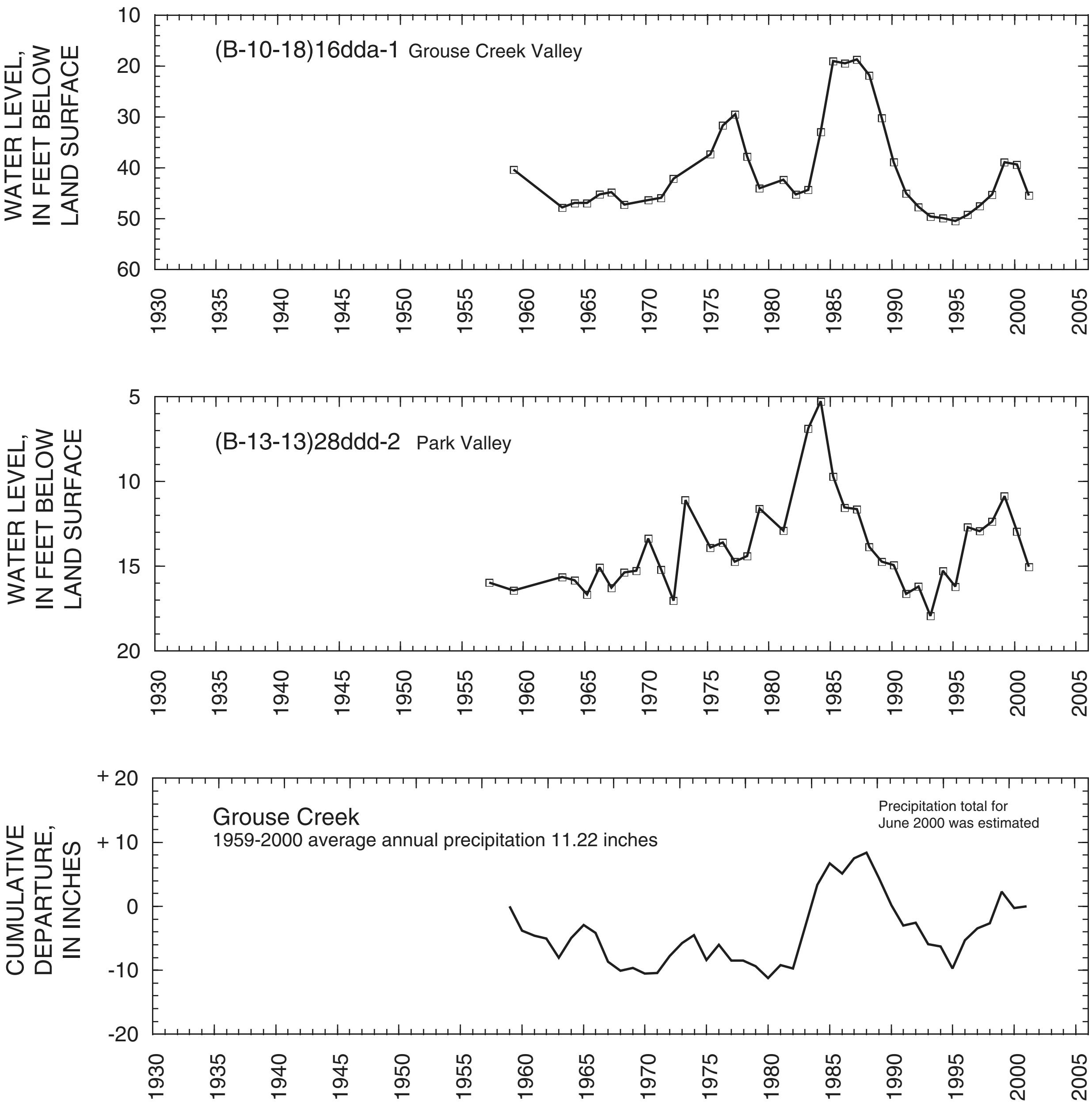


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.

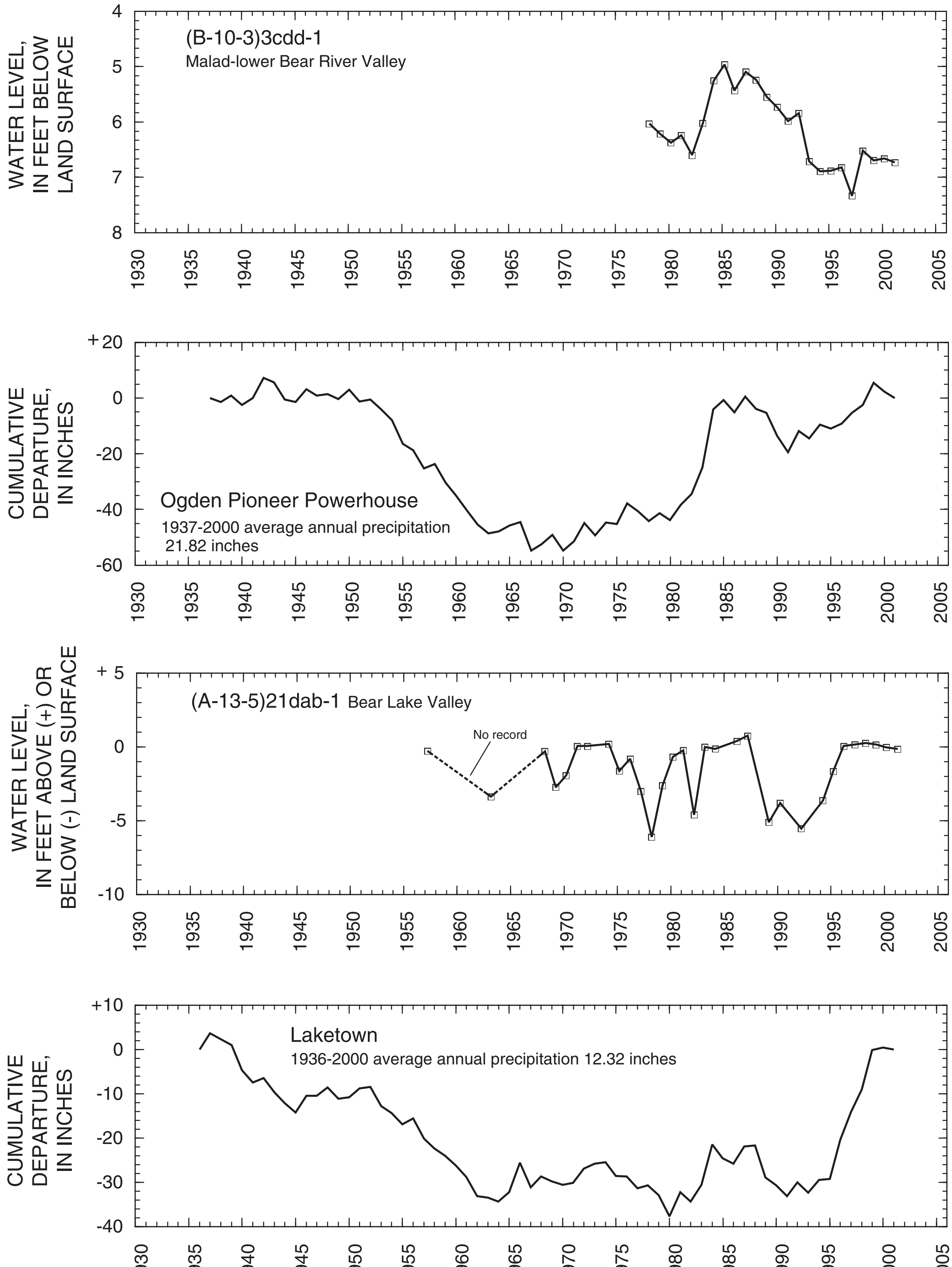


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

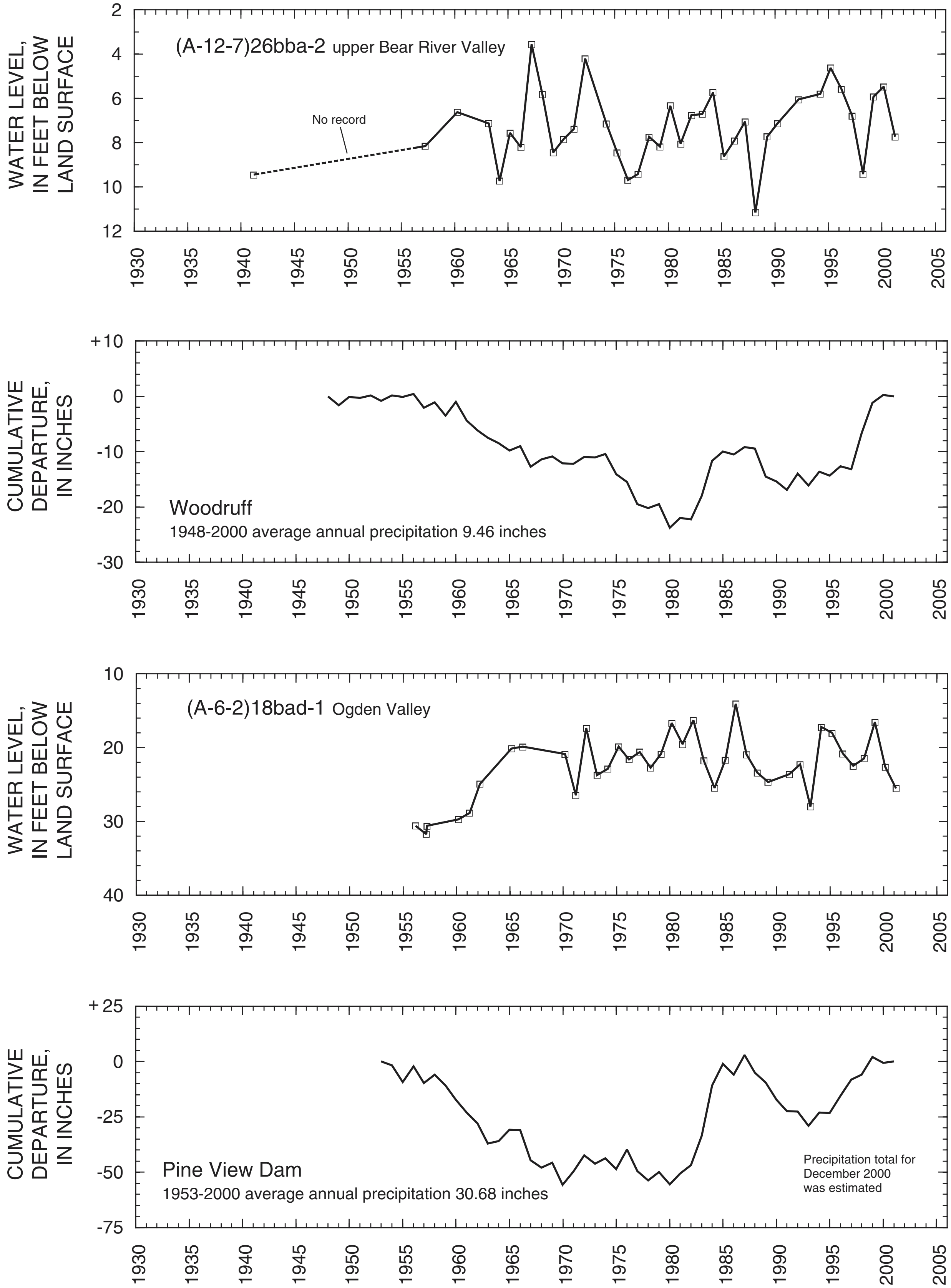


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

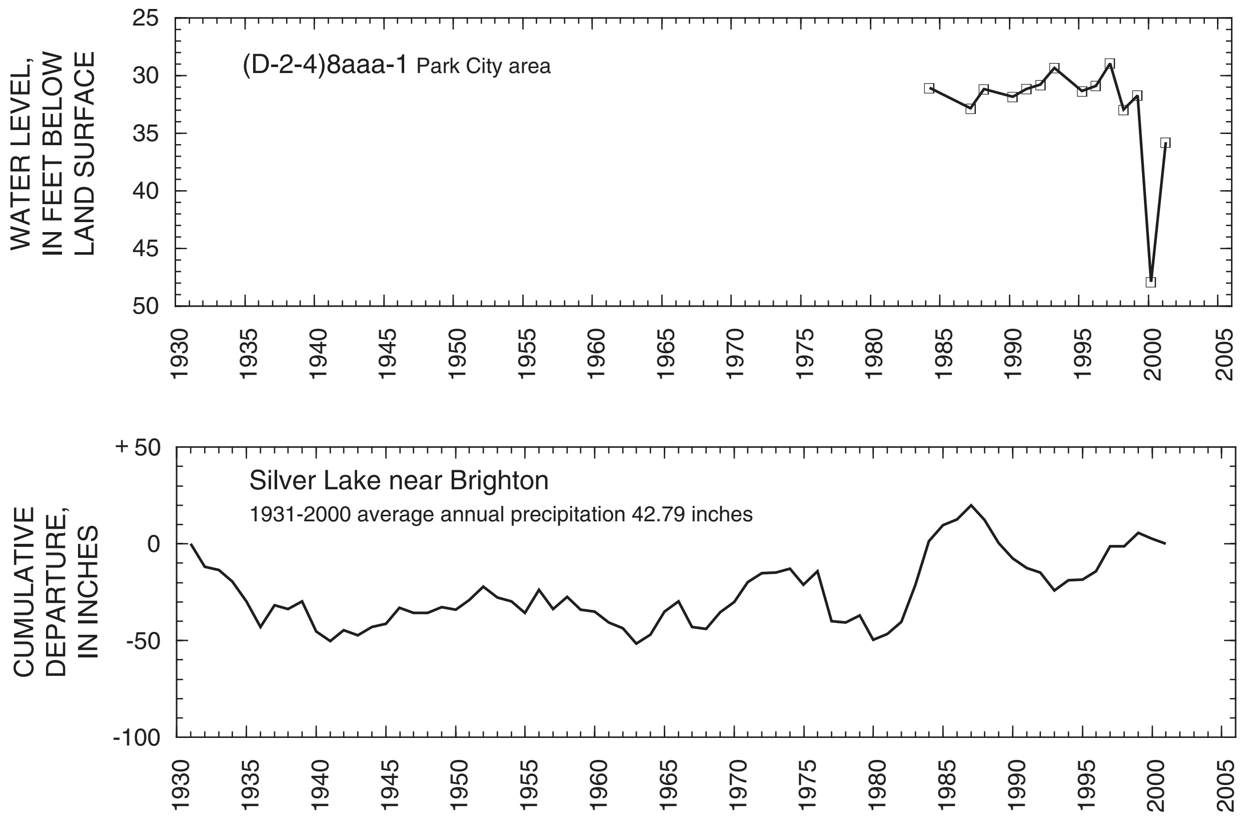


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

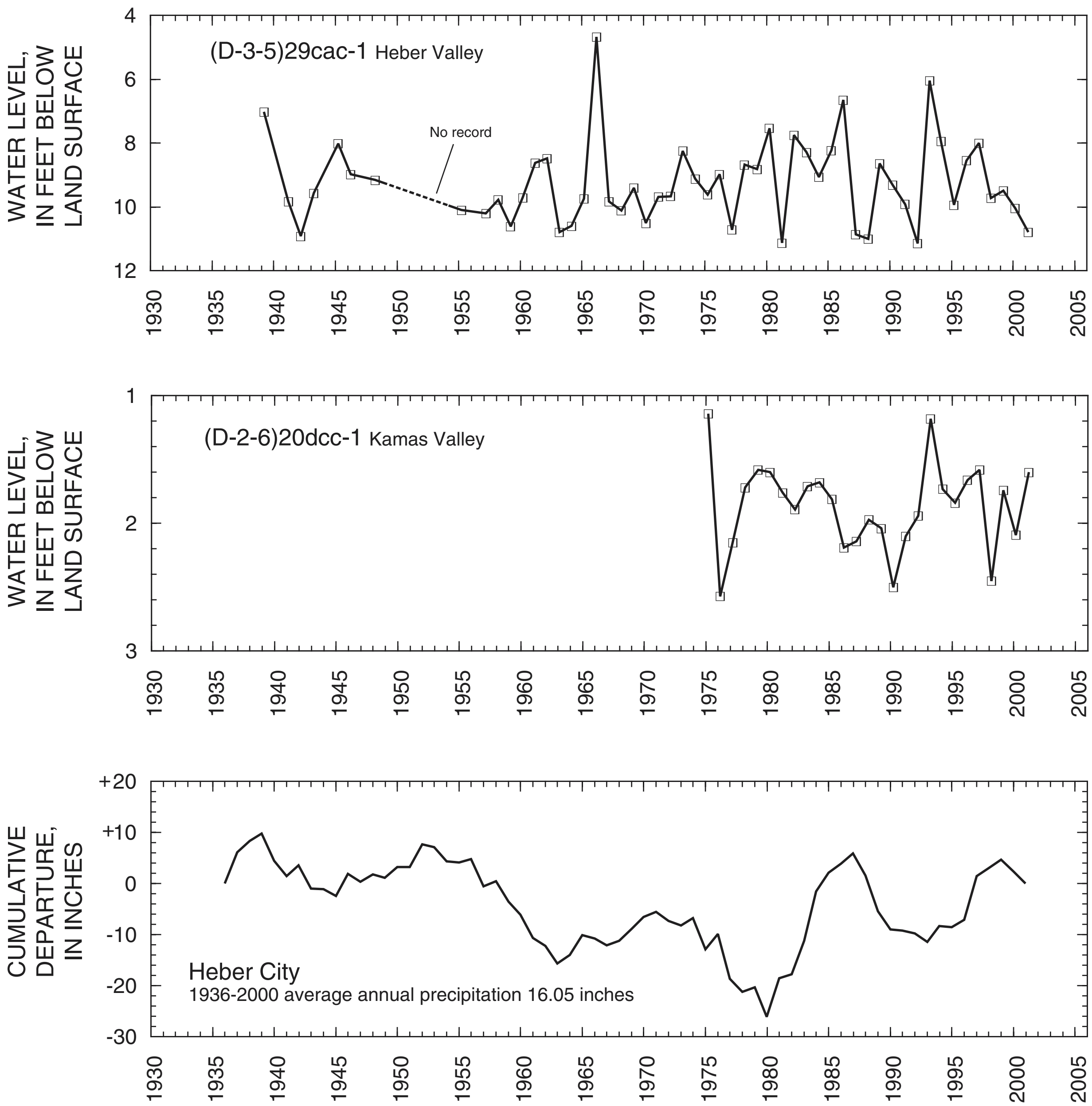


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

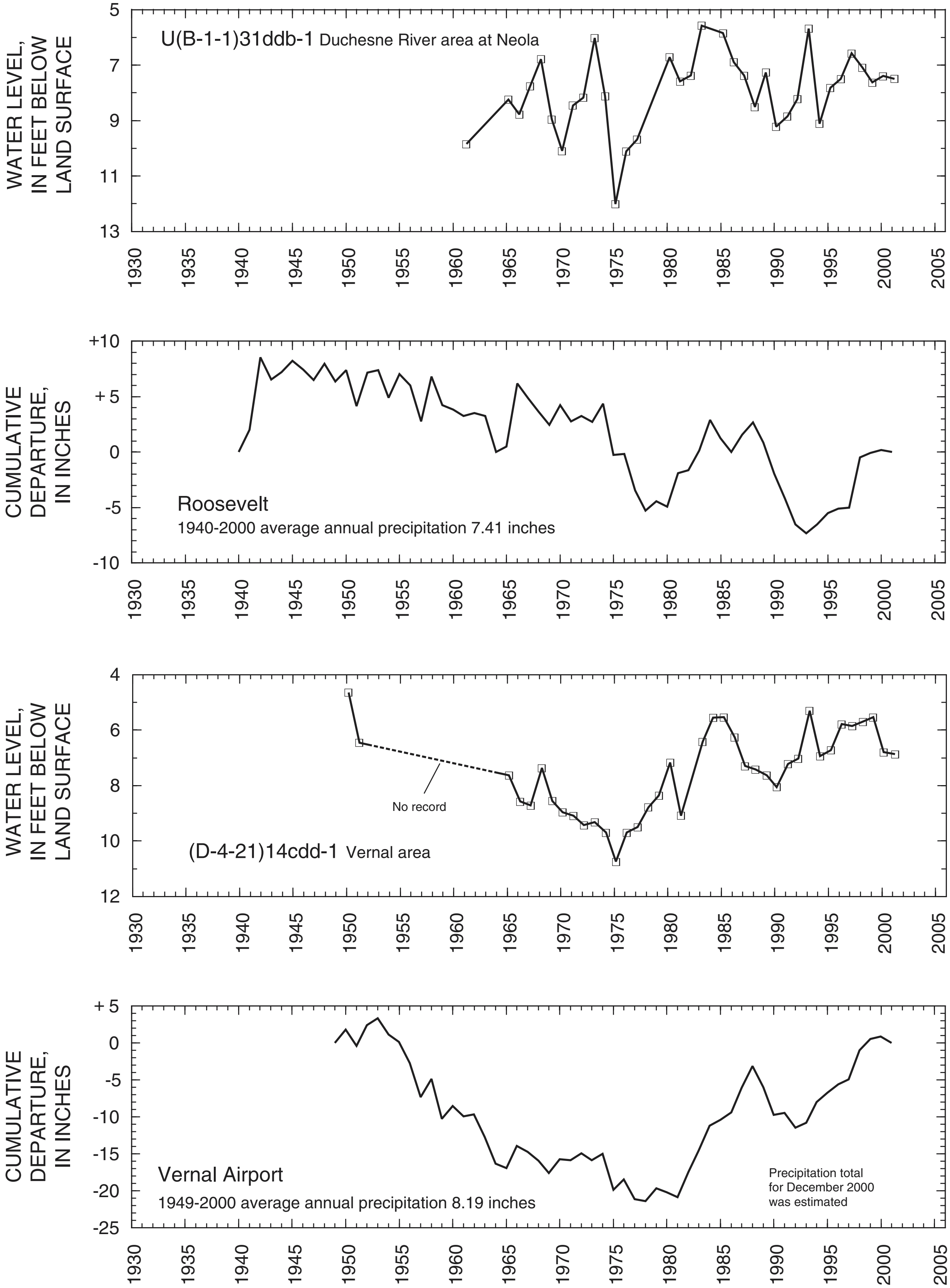


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

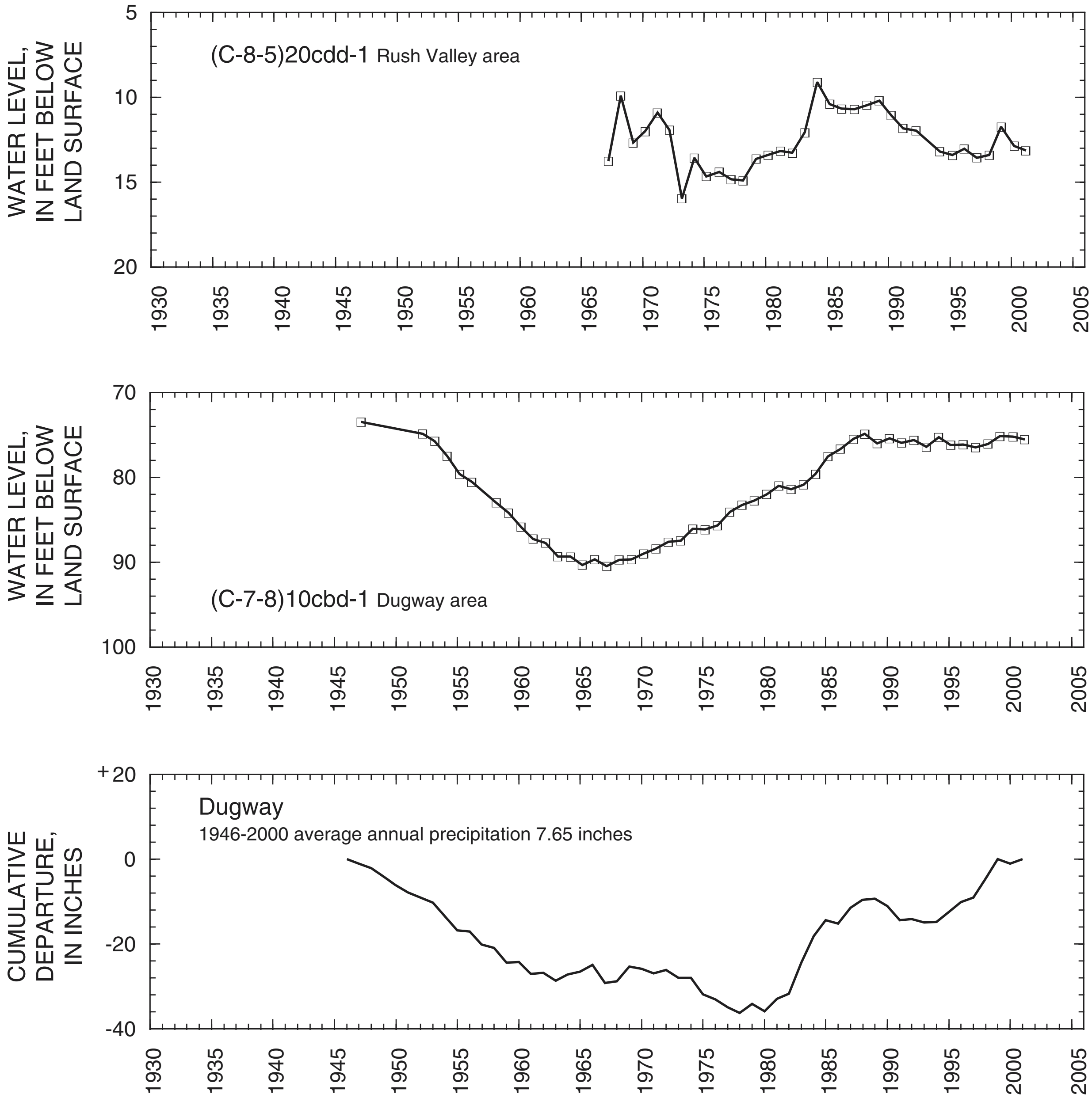


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

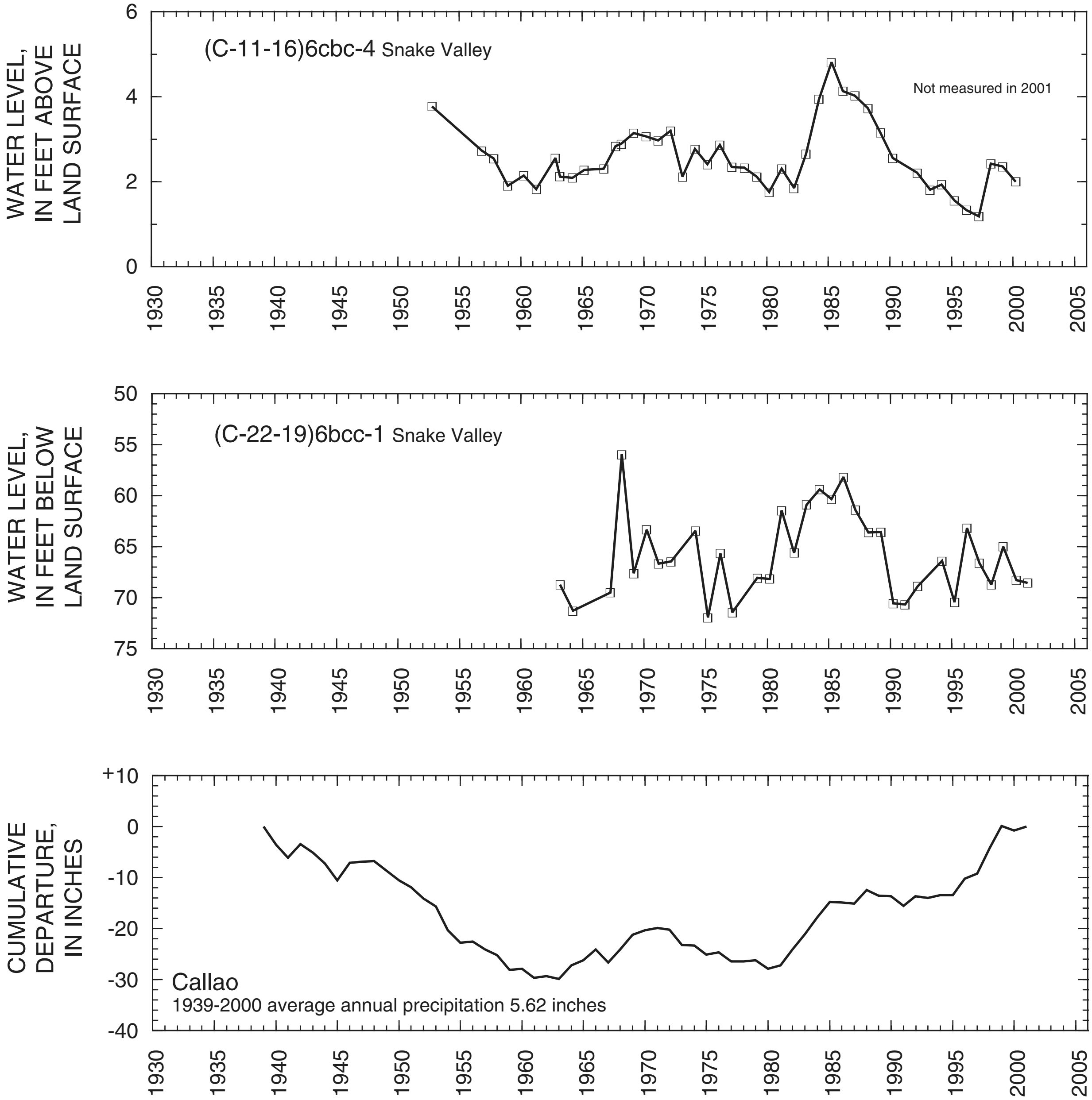


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

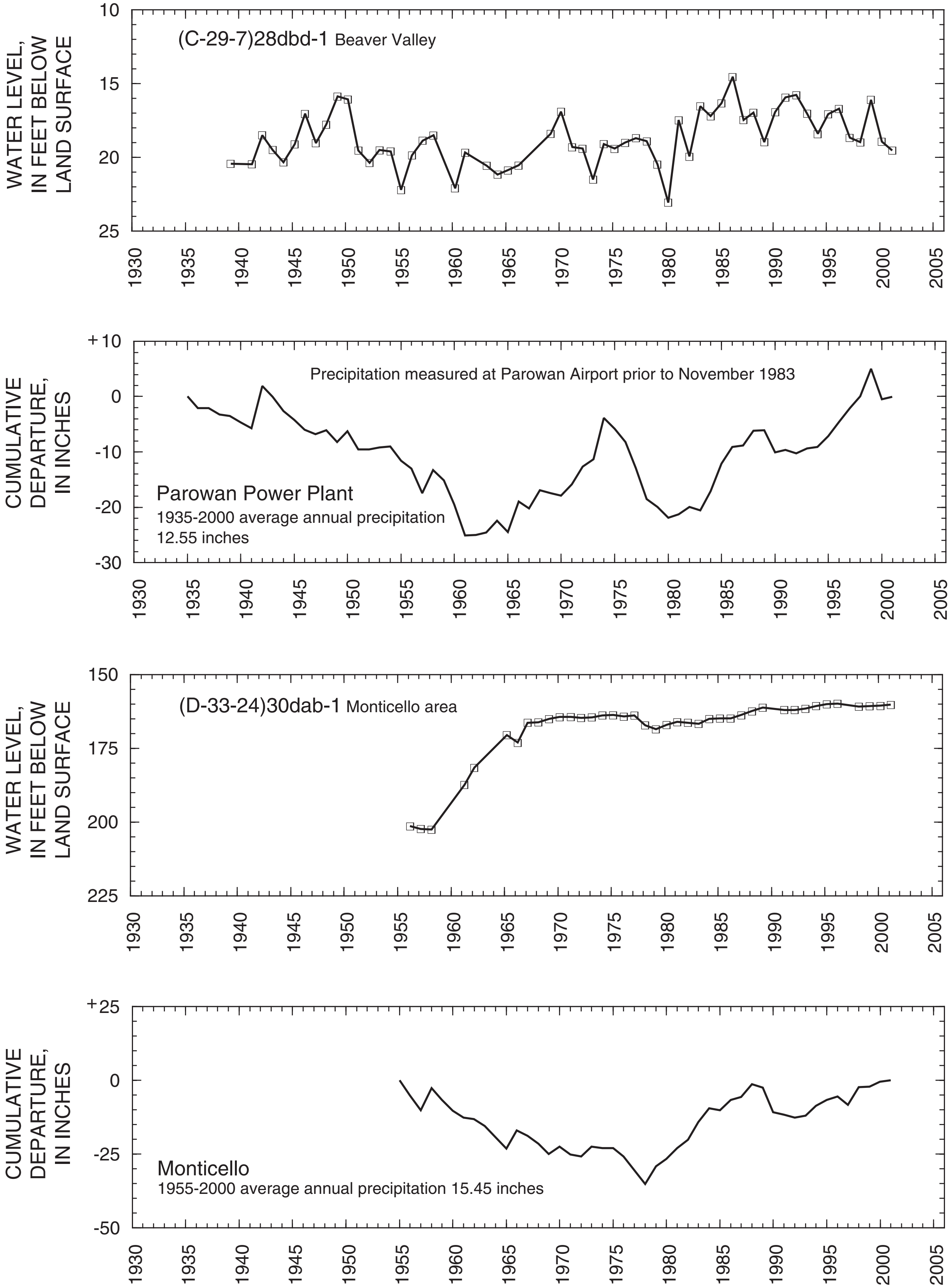


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

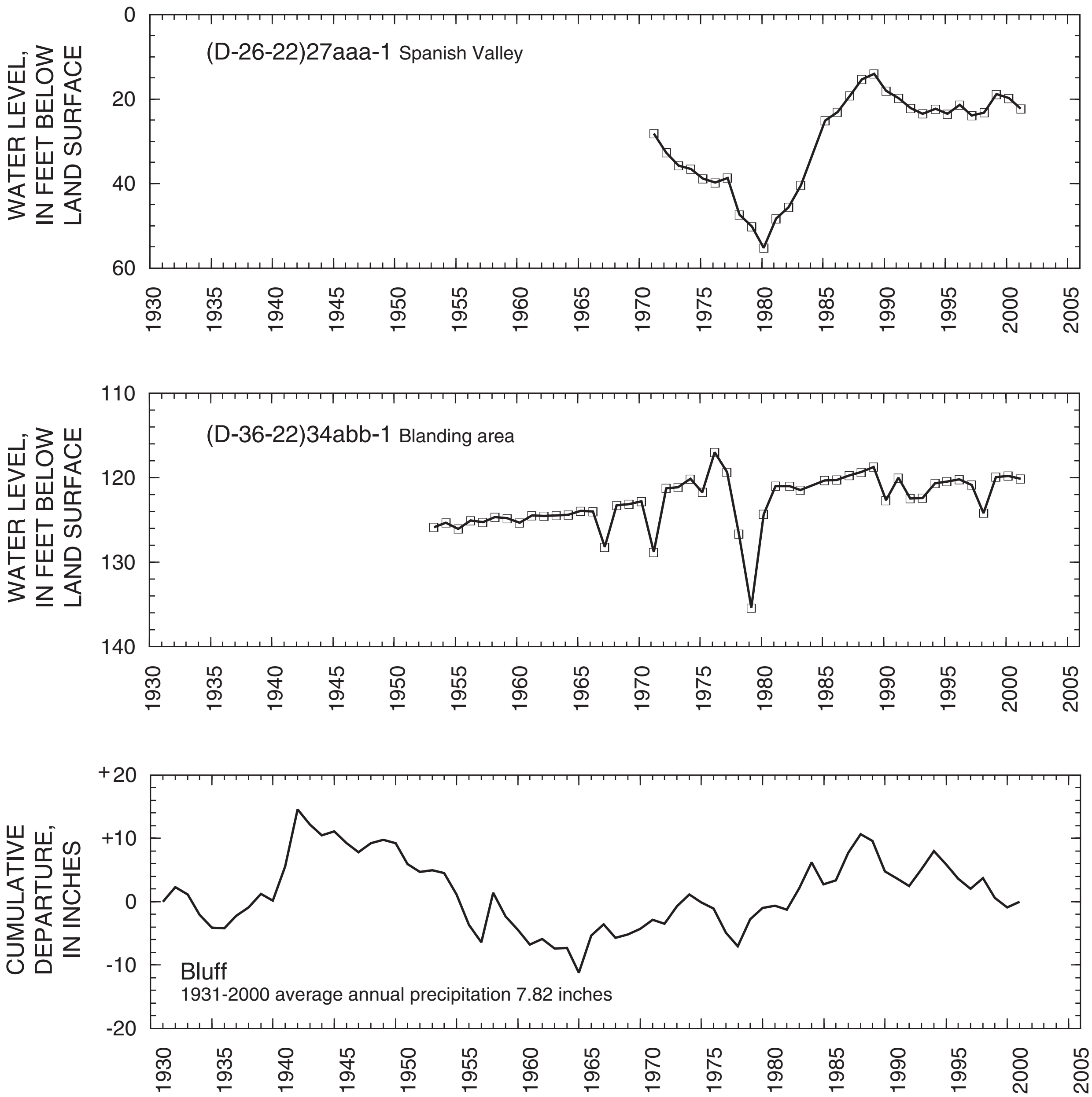


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

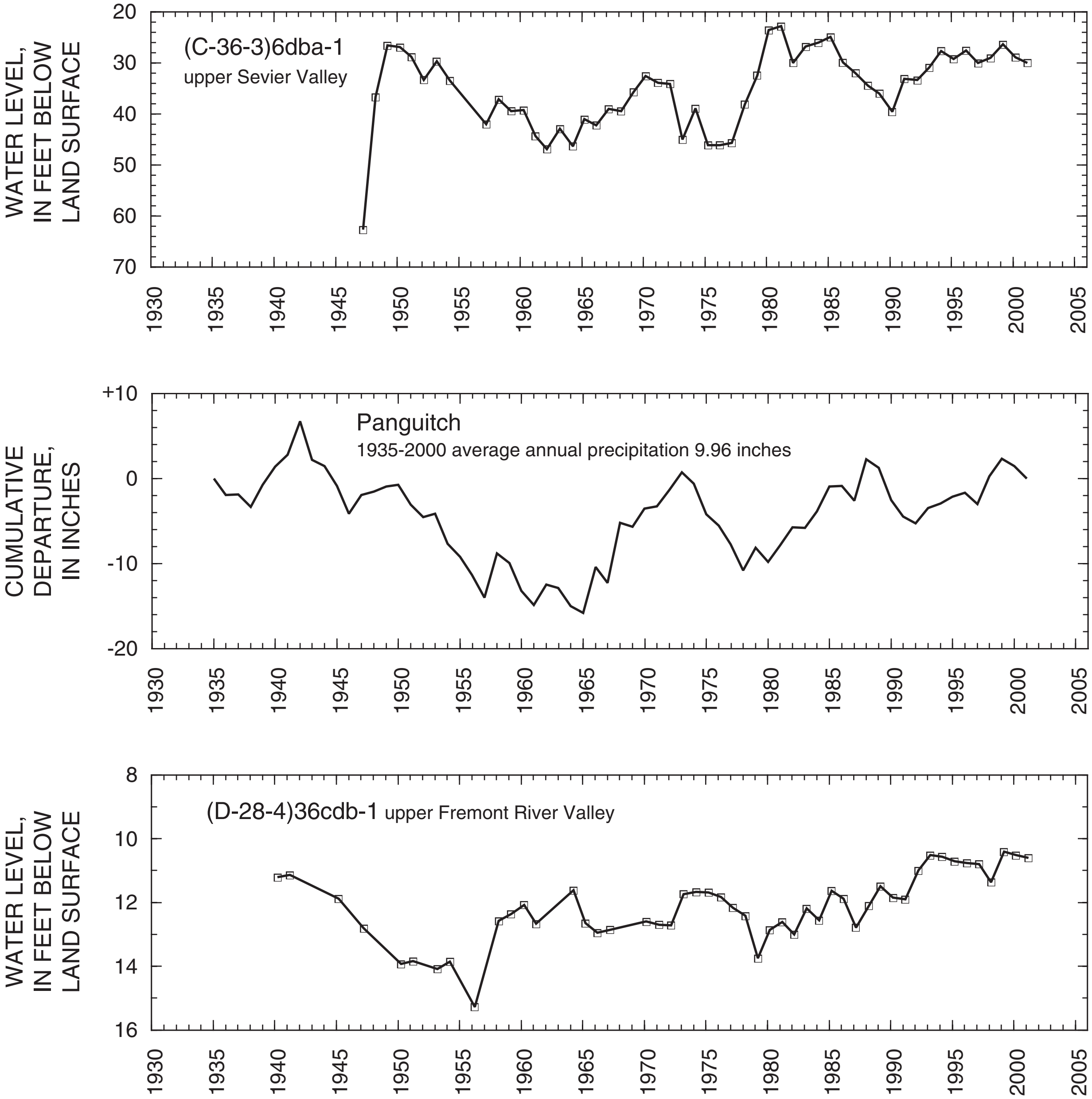


Figure 38. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas—Continued.

REFERENCES

National Oceanic and Atmospheric Administration, 2000, Climatological data, Utah: Asheville, N.C., National Climatic Data Center, v. 100, no. 1-12, [variously paged].

Burden, C.B., and others, 2000, Ground-water conditions in Utah, Spring of 2000: Utah Division of Water Resources Cooperative Investigations Report No. 41, 140 p.