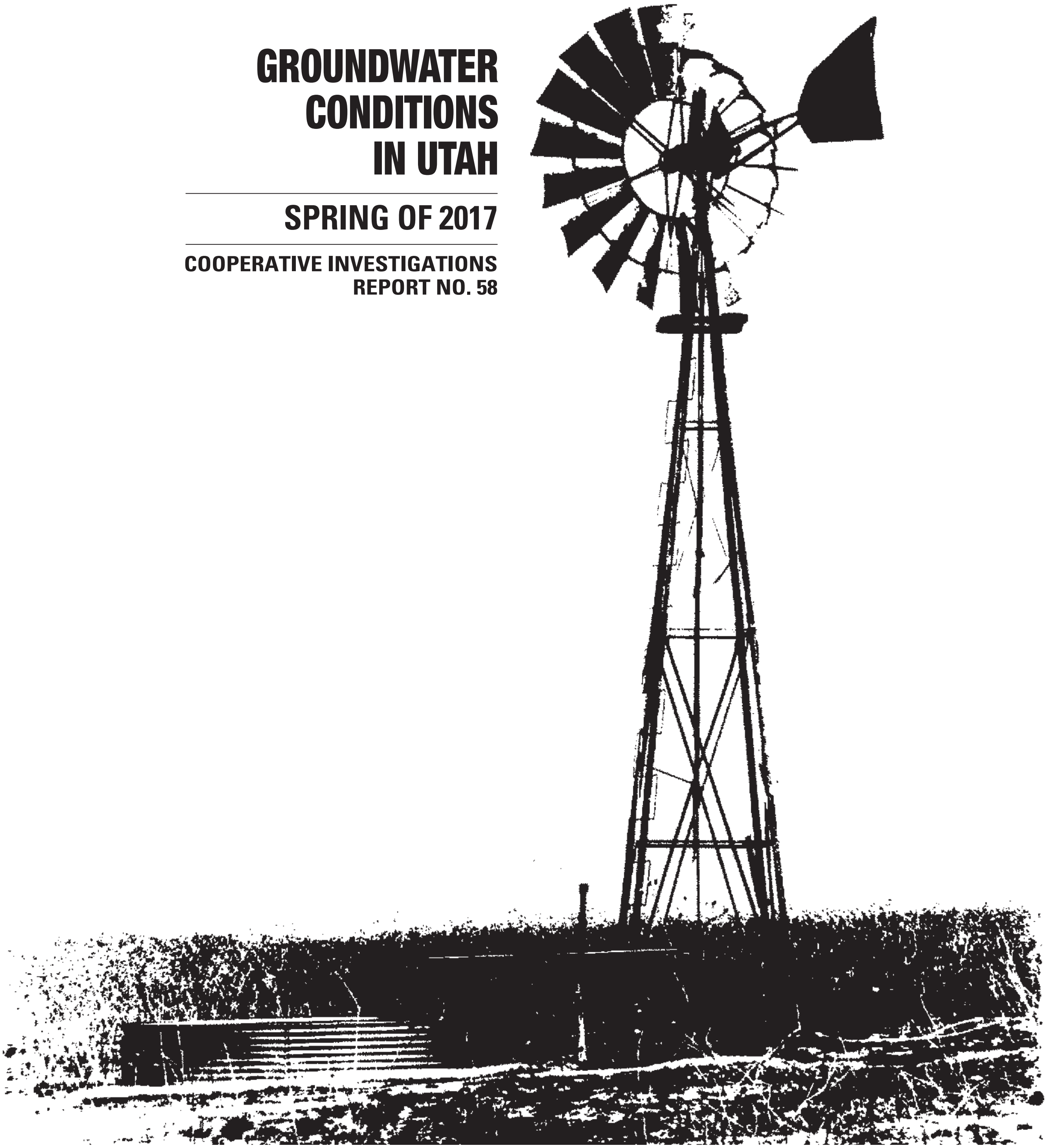
GROUNDWATER CONDITIONS IN UTAH

SPRING OF 2017

COOPERATIVE INVESTIGATIONS REPORT NO. 58



UTAH DEPARTMENT OF NATURAL RESOURCES and
UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY

U.S. GEOLOGICAL SURVEY

GROUNDWATER CONDITIONS IN UTAH, SPRING OF 2017

By
Carole 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 Rights, and
Utah Department of Environmental Quality, Division of Water Quality

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Conversion Factors, Datums, and Water-Quality Units

Multiply	By	To obtain
acre-foot	1,233	cubic meter
foot	0.3048	meter
gallon per minute	0.06301	liter per second
inch	2.54	centimeter
mile	1.609	kilometer
square mile	2.59	square kilometer

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Chemical concentration is reported only in metric units. Chemical concentration in water is reported in milligrams per liter (mg/L) or micrograms per liter (μg/L), which express the solute mass per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram 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.

Specific conductance is 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 in 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.

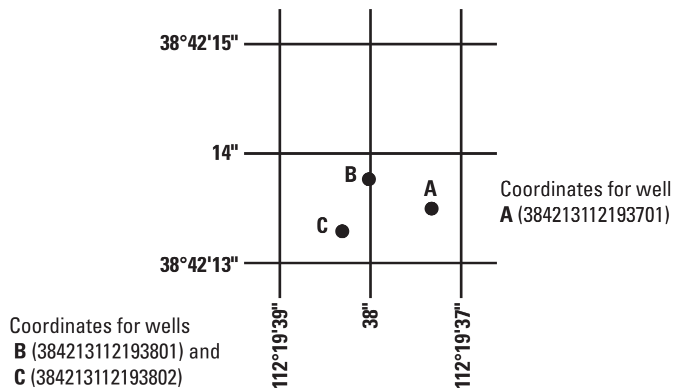
Definition of Terms

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.
Average annual withdrawal—Calculated average from estimated withdrawals, rounded to the nearest thousand acre-feet.
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 groundwater 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.
Dissolved—Material in a representative water sample that passes through a 0.45–micron 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 groundwater observation well.
Precipitation—The total annual precipitation in inches, rounded to tenths of an inch. For selected locations, it is computed from monthly total precipitation (rain, sleet, hail, snow, etc.). Data are supplied by the National Oceanic and Atmospheric Administration (NOAA) and the Western Regional Climate Center (WRCC). Data may be provisional and/or estimated when used to compute annual total and long-term average precipitation values.

Numbering System for Wells and Surface-Water Sites

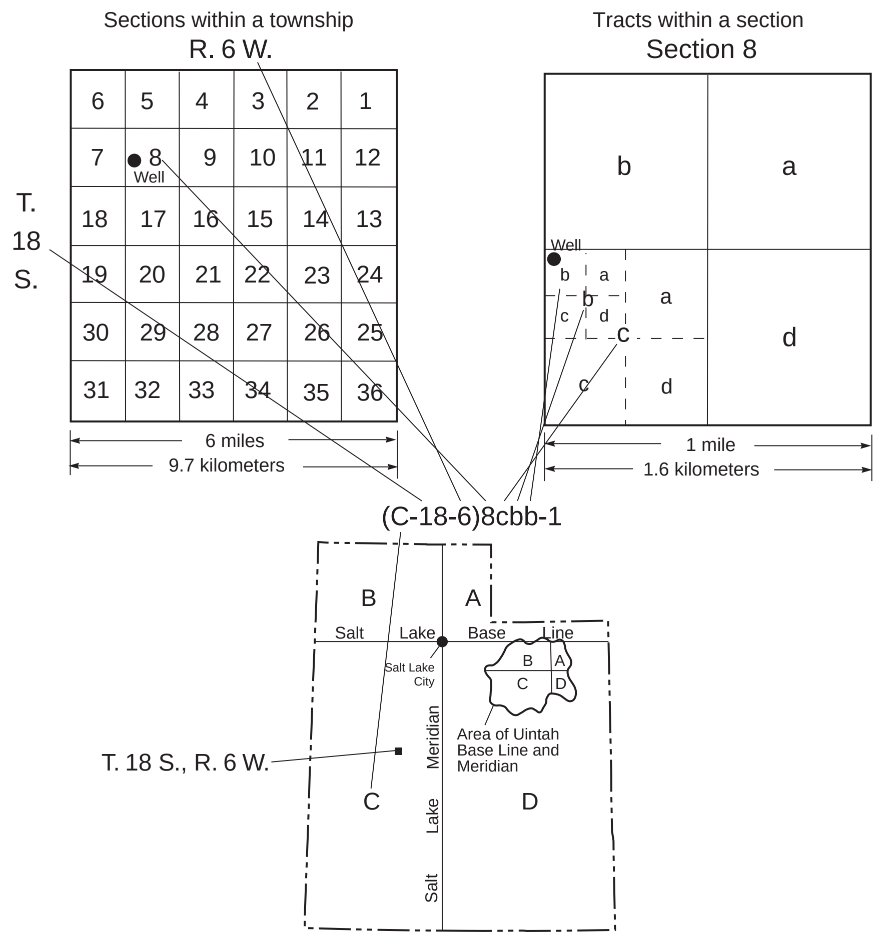
Wells by Latitude and Longitude

The U.S. Geological Survey well-numbering system is based on the grid system of latitude and longitude. The system provides the geographic location of the well and a unique number for each site. The number consists of 15 digits. The first six digits denote the degrees, minutes, and seconds of latitude, and the next seven digits denote degrees, minutes, and seconds of longitude; the last two digits are a sequential number for wells within a 1-second grid. In the event that the latitude-longitude coordinates for more than one well are the same, a sequential number such as "01," "02," and so forth, would be assigned. Even though the site number is based on latitude and longitude, it may not reflect the accurate location of the site. When error corrections or new technology locate a site more accurately, latitude-longitude coordinates will change but the site number will not. In addition to the well number that is based on latitude and longitude for each well, another well number is assigned based on the Cadastral system of land subdivision.



Wells by the Cadastral System of Land Subdivision

The well-numbering system used in Utah is based on the Cadastral 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 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 a "U" preceding the parentheses. Well numbers for wells located in half ranges will have an "R" preceding the parentheses.



Surface-Water Sites—Downstream Order and Station Number

Since October 1, 1950, hydrologic-station records in U.S. Geological Survey reports have been listed in order of downstream direction along the mainstem. All stations on a tributary entering upstream from a mainstem station are listed before that station. A station on a tributary entering between two mainstem stations is listed between those stations.

As an added means of identification, each hydrologic station and partial-record station has been assigned a station number. These station numbers are in the same downstream order used in this report. In assigning a station number, no distinction is made between partial-record stations and other stations; therefore, the station number for a partial-record station indicates downstream-order position in a list composed of both types of stations. Gaps are consecutive. The complete 8-digit (or 10-digit) number for each station such as 09004100, which appears just to the left of the station name, includes a 2-digit part number "09" plus the 6-digit (or 8-digit) downstream order number "004100." In areas of high station density, an additional two digits may be added to the station identification number to yield a 10-digit number. The stations are numbered in downstream order as described above between stations of consecutive 8-digit numbers.

Groundwater Conditions in Utah, Spring of 2017

By Carole B. Burden and others
U.S. Geological Survey

Introduction

This is the fifty-fourth in a series of annual reports that describe groundwater 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 Rights, and the Utah Department of Environmental Quality, Division of Water Quality, provide data to enable interested parties to maintain awareness of changing groundwater conditions.

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

This report includes individual discussions of selected significant areas of groundwater development in the State for calendar year 2016. 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 the Utah Department of Environmental Quality, Division of Water Quality. This report is also available online at

http://www.waterrights.utah.gov/techinfo/ and
http://ut.water.usgs.gov/publications/GW2017.pdf.

Groundwater conditions in Utah for calendar year 2015 are reported in Burden and others (2016) and are available online at http://ut.water.usgs.gov/publications/GW2016.pdf.

Utah's Groundwater Reservoir

Small amounts of groundwater 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 groundwater development discussed in this report are shown on figure 1 and in table 1. Relatively few wells outside of these areas yield large amounts of groundwater of suitable chemical quality for the uses listed above, although some basins in western Utah and many areas in eastern Utah have not been explored sufficiently to determine their potential for groundwater development.

Most wells in Utah yield water from unconsolidated basin-fill deposits. These deposits 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-grained 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 materials eroded from adjacent mountains.

A small percentage of wells in Utah yield water from consolidated-rock (bedrock) aquifers. Consolidated rocks that have the highest yields are basalt, which contains interconnected vesicular openings, fractures, or permeable weathered zones at the tops of lava flows; limestone, which contains fractures or other openings enlarged by solution; and sandstone, which may contain open fractures. Most wells that yield water from consolidated-rock aquifers are in the eastern and southern parts of the State in areas where water cannot be obtained readily from unconsolidated deposits.

Summary of Conditions

The total estimated withdrawal of water from wells in Utah during 2016 was about 1,036,000 acre-feet (table 2), which is about 19,000 acre-feet more than the total for 2015 and 56,000 acre-feet more than the 2006–2015 average annual withdrawal (table 3). The increase in withdrawal resulted mostly from increased withdrawals for public supply use. The total estimated withdrawal for public supply use was about 311,300 acre-feet, which is about 26,800 acre-feet more than the estimate for 2015 (Burden and others, 2016). Withdrawal for irrigation was about 586,900 acre-feet, which is about 3,600 acre-feet less than in 2015. Withdrawal for industrial use was about 118,200 acre-feet, which is about 6,300 acre-feet less than the value for 2015. Withdrawal for domestic and stock use was about 19,900 acre-feet, which is 400 acre-feet more than in 2015.

From 2015 to 2016, groundwater withdrawals increased in 11 of the 16 areas of groundwater development discussed in this report (table 2). Withdrawal in Utah and Goshen Valleys increased about 17,000 acre-feet, the largest increase in any of the groundwater development areas shown on figure 1. Withdrawal in Pahvant Valley decreased about 14,000 acre-feet, the largest decrease in any of the areas. The 2016 total withdrawal was more than the average annual withdrawal for 2006–2015 in 11 of the 16 areas (table 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 2016 at 13 of 26 weather stations included in this report (Western Regional Climate Center, accessed July 1, 2017, at http://www.wrcc.dri.edu), was more than the long-term average. The greatest increase in precipitation from average was 7.3 inches at Logan Utah State University. The greatest decrease in precipitation from average was 4.7 inches at Provo BYU.

During February and March 2017, about 610 water-level measurements were made in wells for areas included in this report. Most water-level data included in the hydrographs for these wells are from measurements made during February and March, but may include some water-level measurements made in April and May. Many of the wells have additional water-level measurements made throughout the year which are not included in this report. All water-level data are available online at http://nwis.waterdata.usgs.gov/ut/nwis/gwlevels.

In 2016, 408 new wells were constructed, as determined by the Utah Division of Water Rights (table 2); this is 16 more wells than the total reported for 2015 (Burden and others, 2016). In 2016, 25 large-diameter wells (12 inches or more) were constructed (table 2), which is 10 fewer than the total reported for 2015. These new wells are used principally for withdrawal of water for public supply, irrigation, and industrial purposes.

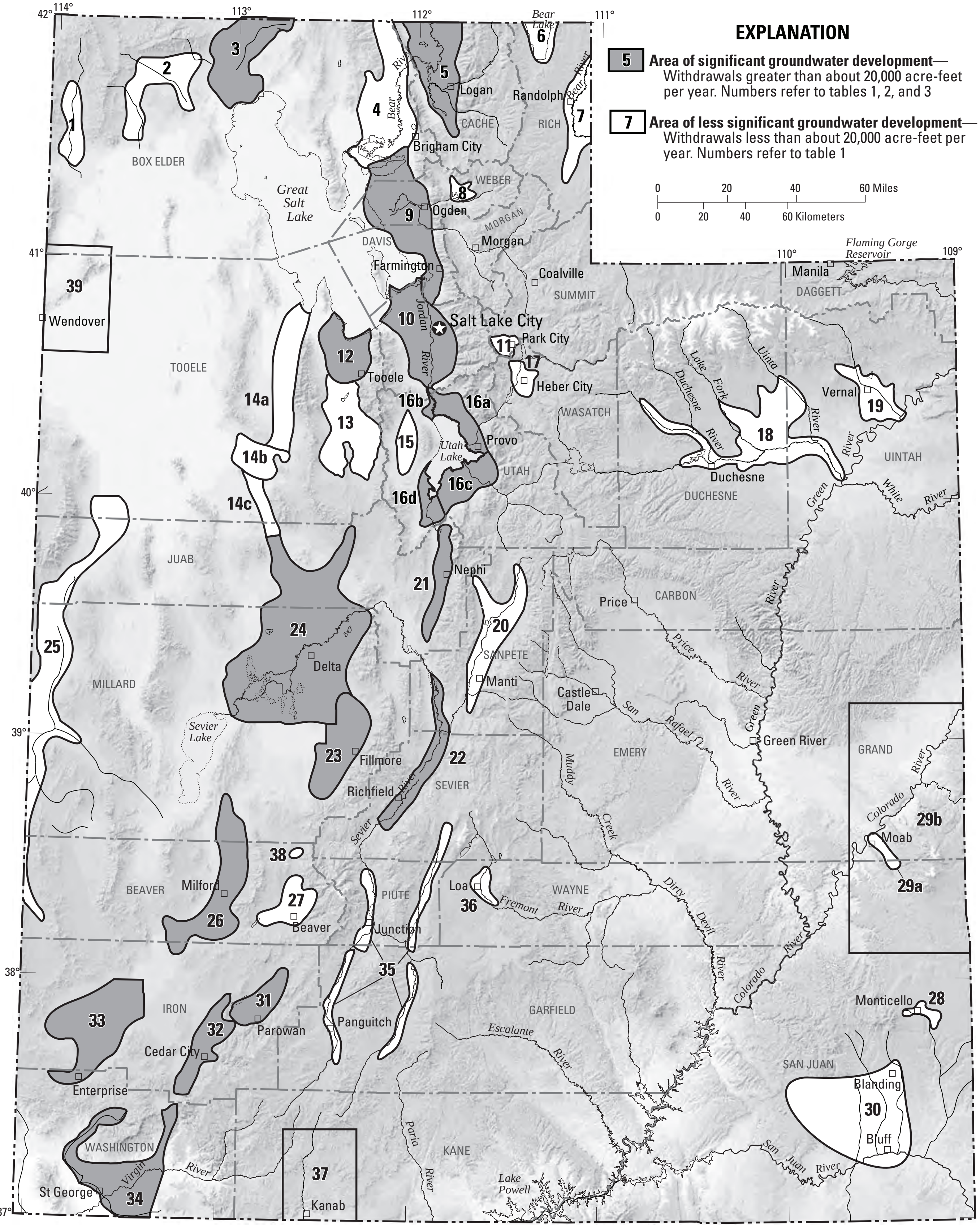


Figure 1. Areas of groundwater development in Utah specifically referred to in this report.

Table 1. Areas of groundwater development in Utah specifically referred to in this report and principal types of water-bearing lithologies.

Number in figure 1	Area	Principal types of water-bearing lithologies
1	Grouse Creek Valley	Unconsolidated deposits
2	Park Valley area	Ditto
3	Curlew Valley	Unconsolidated deposits and consolidated rock
4	Lower Bear River area	Unconsolidated deposits
5	Cache Valley	Ditto
6	Bear Lake Valley	Ditto
7	Upper Bear River area	Ditto
8	Ogden Valley	Ditto
9	East Shore area	Ditto
10	Salt Lake Valley	Ditto
11	Park City area	Unconsolidated deposits and consolidated rock
12	Tooele Valley	Ditto
13	Rush Valley	Ditto
14a	Skull Valley	Unconsolidated deposits
14b	Dugway area	Ditto
14c	Old River Bed	Ditto
15	Cedar Valley, Utah County	Ditto
16a	Northern Utah Valley-east	Ditto
16b	Northern Utah Valley-west	Ditto
16c	Southern Utah Valley	Ditto
16d	Goshen Valley	Ditto
17	Heber Valley	Ditto
18	Duchesne River area	Unconsolidated deposits and consolidated rock
19	Vernal area	Ditto
20	Sanpete Valley	Ditto
21	Juab Valley	Unconsolidated deposits
22	Central Sevier Valley	Ditto
23	Pahvant Valley	Unconsolidated deposits and consolidated rock
24	Sevier Desert	Unconsolidated deposits
25	Snake Valley	Ditto
26	Escalante Valley, Milford area	Ditto
27	Beaver Valley	Ditto
28	Monticello area	Consolidated rock
29a	Spanish Valley	Unconsolidated deposits and consolidated rock
29b	Upper Colorado River area	Ditto
30	Blanding-Bluff area	Consolidated rock
31	Parowan Valley	Unconsolidated deposits and consolidated rock
32	Cedar Valley, Iron County	Unconsolidated deposits
33	Escalante Valley, Beryl-Enterprise area	Ditto
34	Central Virgin River area	Unconsolidated deposits and consolidated rock
35	Upper Sevier River area	Unconsolidated deposits
36	Upper Fremont River Valley	Unconsolidated deposits and consolidated rock
37	Kanab area	Consolidated rock
38	Cove Fort area	Unconsolidated deposits
39	Wendover area	Ditto

Table 2. Number of wells constructed and estimated withdrawal of water from wells in Utah, 2016.

Area	Number in figure 1	Number of wells[1] constructed in 2016		Estimated withdrawal from wells, in acre-feet (rounded)					
				2016					
		Total	Diameter of 12 inches or more	Irrigation	Industrial[1]	Public supply[1]	Domestic and stock	Total	2015 total[2]
Curlew Valley	3	0	0	34,000	0	200	100	34,300	34,000
Cache Valley	5	24	0	13,600	4,500	10,400	[3] 1,500	30,000	31,000
East Shore area	9	6	2	2,800	3,000	29,600	[3] 1,100	36,500	36,000
Salt Lake Valley	10	7	1	100	[4] 42,400	94,300	[3] 490	137,300	132,000
Tooele Valley	12	8	0	[5, 6] 11,800	550	12,700	[3] 910	26,000	25,000
Utah and Goshen Valleys	16	50	1	34,700	11,500	70,800	[3] 1,800	118,800	102,000
Northern Utah Valley-east[7]	16a	(6)	(0)	(2,200)	(8,800)	(48,800)	(600)	(60,400)	(49,300)
Northern Utah Valley-west[7]	16b	(1)	(0)	(0)	(0)	(5,000)	(200)	(5,200)	(2,600)
Southern Utah Valley[7]	16c	(36)	(0)	(8,900)	(2,700)	(16,600)	(900)	(29,100)	(28,300)
Goshen Valley[7]	16d	(7)	(1)	(23,600)	(0)	(400)	(100)	(24,100)	(22,100)
Juab Valley	21	10	1	30,300	130	[8] 1,600	480	32,500	31,000
Sevier Desert	24	7	1	43,600	9,100	2,900	890	56,500	55,000
Central Sevier Valley	22	13	1	28,000	90	3,500	840	32,400	30,000
Pahvant Valley	23	13	6	113,000	0	1,000	320	114,300	128,000
Cedar Valley, Iron County	32	14	1	29,200	100	7,600	2,500	39,400	40,000
Parowan Valley	31	8	2	[9] 35,400	610	260	360	36,600	34,000
Escalante Valley									
Milford area	26	3	3	45,000	[10] 19,200	740	130	65,100	68,000
Beryl-Enterprise area	33	11	1	90,000	[11] 3,700	670	650	95,000	93,000
Central Virgin River area	34	7	1	8,600	400	25,000	2,400	36,400	34,000
Other areas[12, 13]		227	4	66,800	22,900	50,000	5,400	145,100	144,000
Total (rounded)		408	25	586,900	118,200	311,300	19,900	1,036,000	1,017,000

[1] Data provided by Utah Department of Natural Resources, Division of Water Rights.

[2] From Burden and others (2016, table 2).

[3] From Maupin and others, 2014.

[4] Includes some use for air conditioning, about 1,800 acre-feet, of which about 92 percent was injected back into the aquifer.

[5] Includes some domestic and stock use.

[6] Includes some flowing well discharge.

[7] Numbers for Northern Utah Valley-east, Northern Utah Valley-west, Southern Utah Valley, and Goshen Valley, presented within parentheses, are a subtotal of withdrawal.

[8] Previously included some springs.

[9] Includes some stock use.

[10] Includes 16,200 acre-feet for geothermal power generation, of which about 99 percent was injected back into the aquifer.

[11] Includes 3,710 acre-feet for heating greenhouses, of which 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 (table 4).

[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 groundwater development in Utah, 2006–2015.

Area	Number in figure 1	Thousands of acre-feet[1] (rounded)											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2006–2015 average (rounded)	2016
Curlew Valley	3	31	38	44	34	39	32	42	40	35	34	37	34
Cache Valley	5	31	36	34	31	33	30	38	38	27	31	33	30
East Shore area	9	46	52	54	46	43	37	46	49	40	36	45	37
Salt Lake Valley	10	131	151	135	137	140	126	167	153	145	132	142	137
Tooele Valley	12	[2]21	[2]27	[2]28	25	24	21	30	25	22	25	25	26
Utah and Goshen Valleys	16	[2]99	126	[2]120	[2]105	[2]106	[2]90	[2]113	[2]115	107	102	108	119
Northern Utah Valley[3]	(16a, b)	(58)	(72)	[2](67)	[2](60)	[2](58)	[2](45)	[2](62)	(60)	(54)	(52)	(59)	(66)
Southern Utah Valley[3]	(16c)	(29)	(38)	(34)	(30)	(31)	(28)	[2](35)	(35)	(31)	(28)	(32)	(29)
Goshen Valley[3]	(16d)	(12)	(16)	(19)	(15)	(17)	(17)	[2](16)	[2](20)	(22)	(22)	(18)	(24)
Juab Valley	21	21	26	26	21	22	15	28	27	29	31	25	33
Sevier Desert	24	20	34	44	48	46	20	24	[2]46	53	55	39	57
Central Sevier Valley	22	16	19	24	27	26	31	28	28	31	30	26	32
Pahvant Valley	23	86	89	94	104	106	89	114	103	118	128	103	114
Cedar Valley, Iron County	32	35	40	40	38	38	34	40	39	43	40	39	39
Parowan Valley	31	33	34	38	37	34	32	38	32	38	34	35	37
Escalante Valley													
Milford area	26	45	49	51	56	62	53	67	68	67	68	59	65
Beryl-Enterprise area	33	79	92	93	93	90	84	91	93	103	93	91	95
Central Virgin River area	34	32	33	29	33	29	28	29	29	31	34	31	36
Other areas		130	155	144	130	134	123	156	145	159	144	142	145
Total (rounded)		[2]856	[2]1,001	[2]998	[2]965	[2]972	[2]845	[2]1,051	[2]1,030	1,048	1,017	980	1,036

[1] From previous reports in this series.
[2] Revised.
[3] Numbers for Northern Utah Valley, Southern Utah Valley, and Goshen Valley, presented within parentheses, are a subtotal of withdrawal.

Major Areas of Groundwater Development

Curlew Valley

By Adam S. Birken

The Curlew Valley drainage basin extends across the Utah-Idaho state line and includes the communities of Cedar Creek, Kelton, and Snowville (fig. 2). The valley is bounded on the west and east by the Raft River and Hansel Mountains, which range in altitude from about 6,500 to nearly 10,000 feet. The Utah part of Curlew Valley (Utah subbasin) covers about 550 square miles in Box Elder County. It is an arid to semiarid, largely uninhabited area, with a community center at Snowville. Water generally moves south toward Locomotive Springs and Great Salt Lake.

The principal source of water in Curlew Valley is groundwater, which is used mainly for irrigation (table 2). The groundwater reservoir consists primarily of confined artesian aquifers in alluvial and lacustrine basin-fill deposits and some water-table (unconfined) conditions in volcanic rocks. These formations 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 2016 was about 34,000 acre-feet, which is the same as the value for 2015 and 3,000 acre-feet less than the average annual withdrawal for 2006–2015 (tables 2 and 3).

The location of wells in Curlew Valley in which the water level was measured during March 2017 is shown in figure 2. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Oakley, Idaho (62 miles northwest of Snowville), to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells is shown in figure 3. Precipitation at Oakley, Idaho in 2016 was about 17.0 inches, which is 3.8 inches more than in 2015 and 5.9 inches more than the average annual precipitation for 1930–2016.

Water levels in Curlew Valley generally rose, or declined slightly, from March 2016 to March 2017. The largest rise, about 6 feet, occurred in a well about 11 miles west of Snowville. The largest decline, about 0.6 foot, occurred in a well about 3 miles west of Snowville. These rises and declines are most likely the result of changes in localized withdrawals for irrigation. The long-term declining water-level trend in most wells is likely due to continued large withdrawals for irrigation.

The concentration of dissolved solids in water samples collected from well (B-12-11)8abb-1, located 3 miles north of Kelton, and well (B-14-9)5bbb-1, located 10 miles west of Snowville, from 1972–2016 and 1971–2016, respectively, is shown in figure 3. Dissolved-solids concentrations in water from both wells have generally increased since the early 1970s.

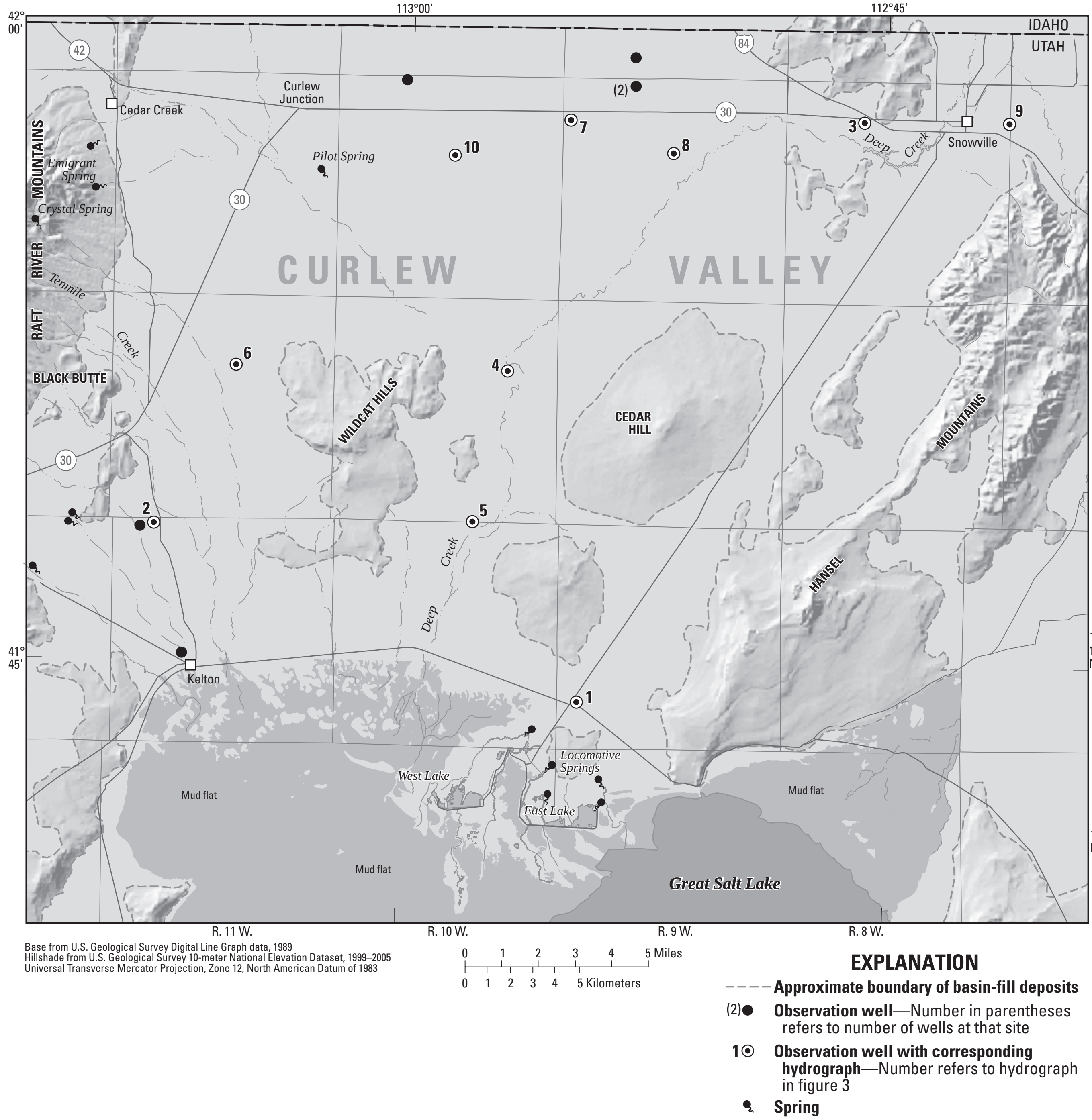


Figure 2. Location of wells in Curlew Valley in which the water level was measured during March 2017.

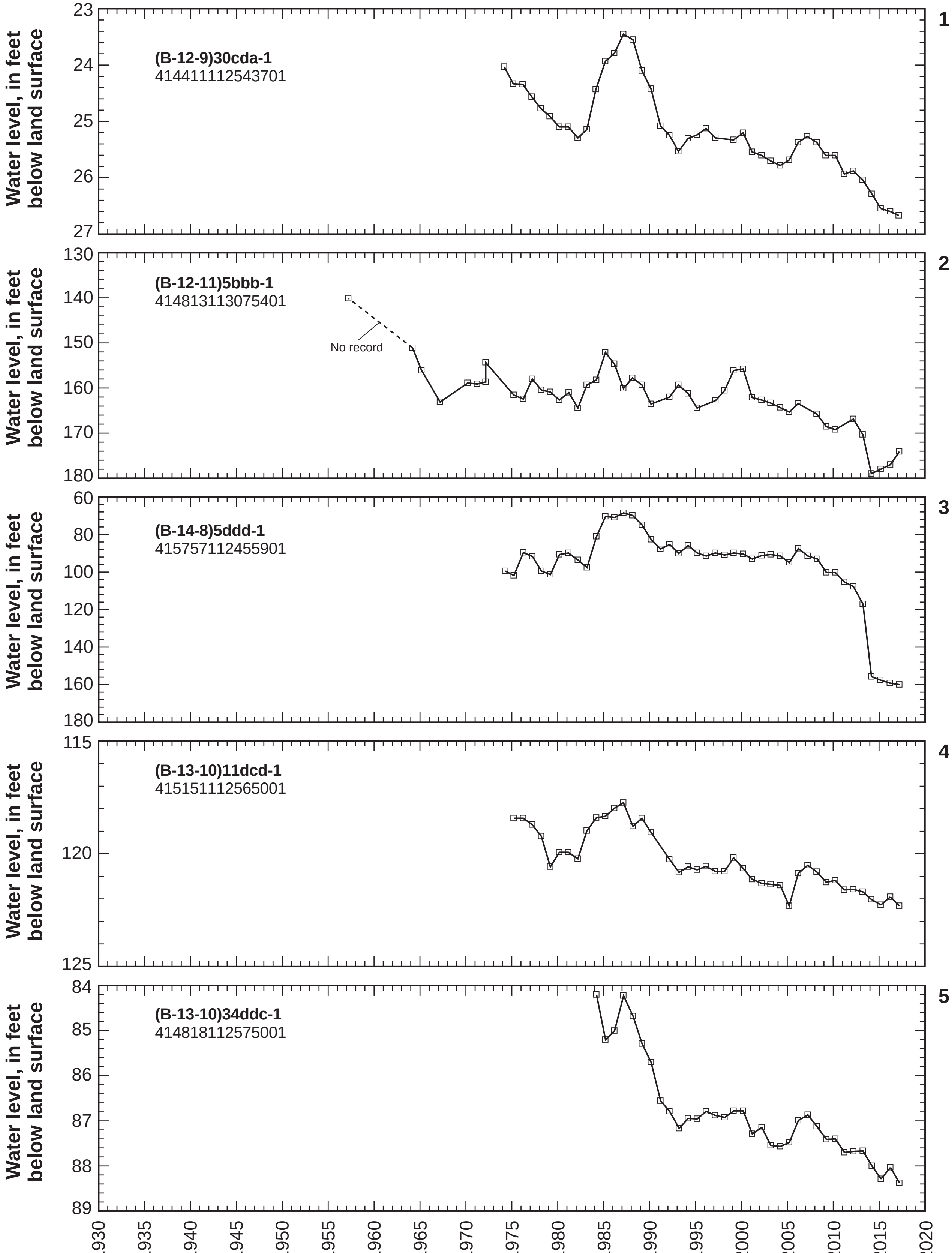


Figure 3. Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Oakley, Idaho, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.

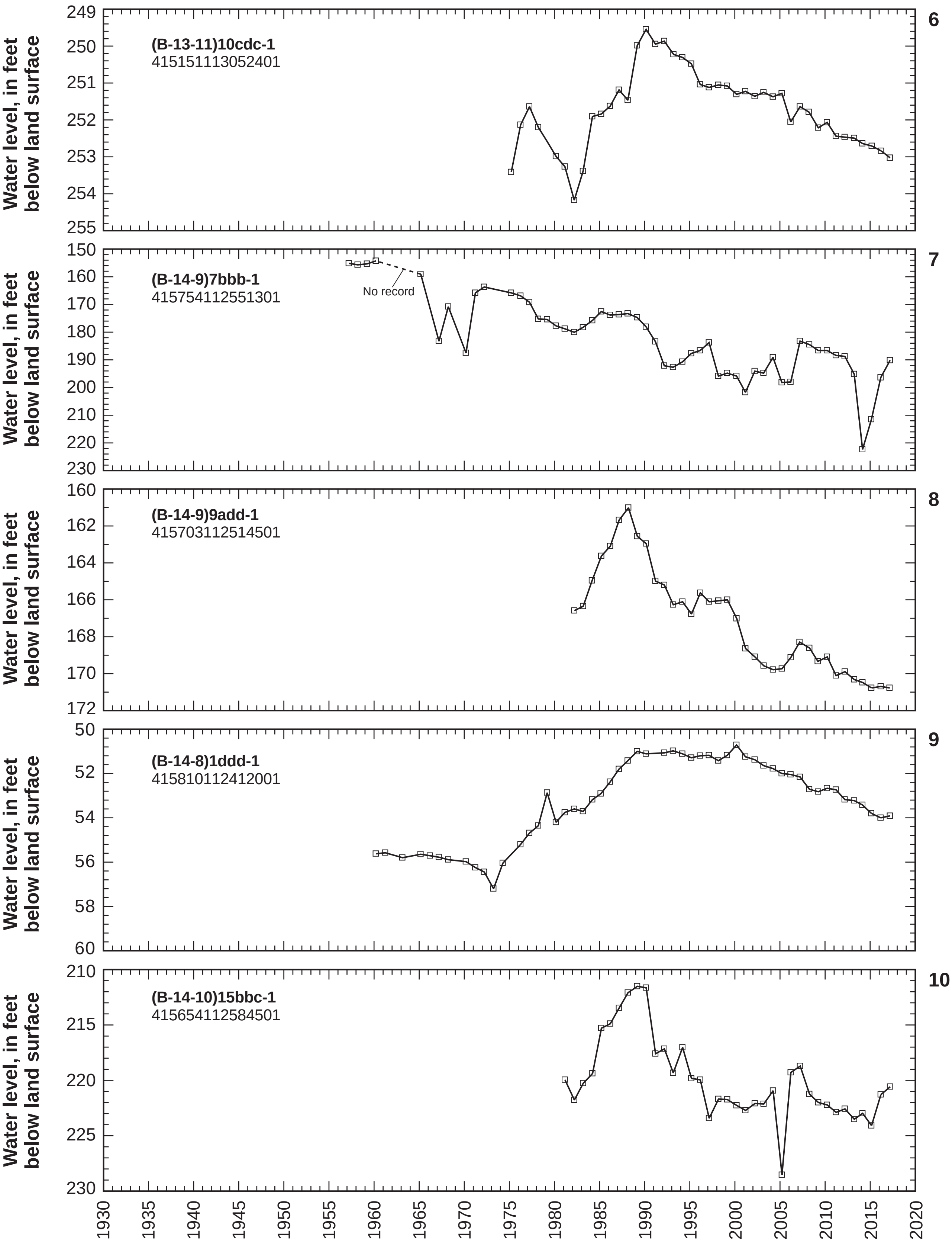


Figure 3. Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Oakley, Idaho, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.—Continued

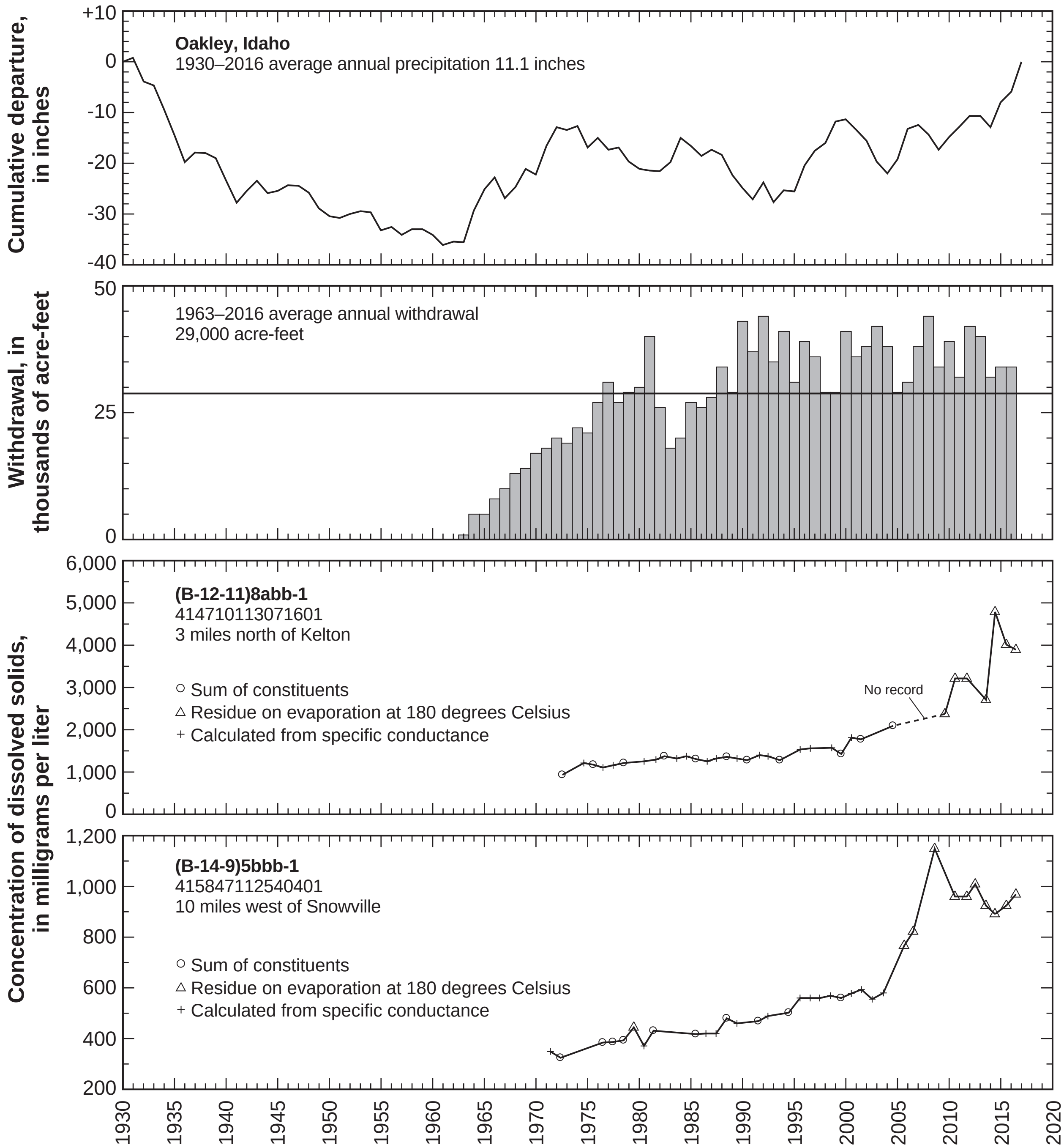


Figure 3. Relation of water level in selected wells in Curlew Valley to cumulative departure from average annual precipitation at Oakley, Idaho, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.—Continued

Cache Valley

By Michael D. Hess

Cache Valley covers about 450 square miles in Cache County where it is bounded on the east by the Bear River Range and on the southwest by the Wellsville Mountains (fig. 4). Groundwater occurs in unconsolidated basin-fill deposits in the valley, under both water-table and artesian conditions, and is used primarily for irrigation and public supply (table 2). Recharge to the groundwater system occurs principally along the margins of the valley, and groundwater moves toward the center of the valley and west toward Cache Junction.

Total estimated withdrawal of water from wells in Cache Valley in 2016 was about 30,000 acre-feet, which is 1,000 acre-feet less than in 2015 and 3,000 acre-feet less than the average annual withdrawal for 2006–2015 (tables 2 and 3). Withdrawal for irrigation was 13,600 acre-feet, largely from flowing wells. Irrigation withdrawals were 400 acre-feet less than in 2015. Withdrawal for public supply was 10,400 acre-feet, which is 800 acre-feet less than in 2015.

The location of wells in Cache Valley in which the water level was measured during March 2017 is shown in figure 4. The relation of the water level in selected observation 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.

Total discharge of the Logan River (combined flow from the Logan River above State Dam and Cache Highline Canal, near Logan) during 2016 was about 155,400 acre-feet, which is 31,400 acre-feet more than the 2015 total and 22,800 acre-feet less than the 1941–2016 average annual discharge. Precipitation at Logan, Utah State University, was about 25.6 inches in 2016. This is about 5.5 inches more than for 2015 and about 7.3 inches more than the average annual precipitation for 1930–2016.

Water levels throughout the valley generally rose from March 2016 to March 2017. Rises are probably the result of greater-than-average precipitation and less-than-average withdrawals. Water levels have fluctuated over the entire period of record, as far back as 1935 in many cases, depending on the amount and timing of precipitation, and recharge to the unconsolidated deposits from snowmelt runoff; however, long-term trends indicate declining water levels in most wells.

The concentration of dissolved solids in water samples collected during 1970 to 2015 from well (A-13-1)29bcd-1, located 1.5 miles west of Smithfield, is shown in figure 5. The concentration has ranged from 215 to 278 mg/L, with a median value of 258 mg/L. This well was not sampled in 2016.

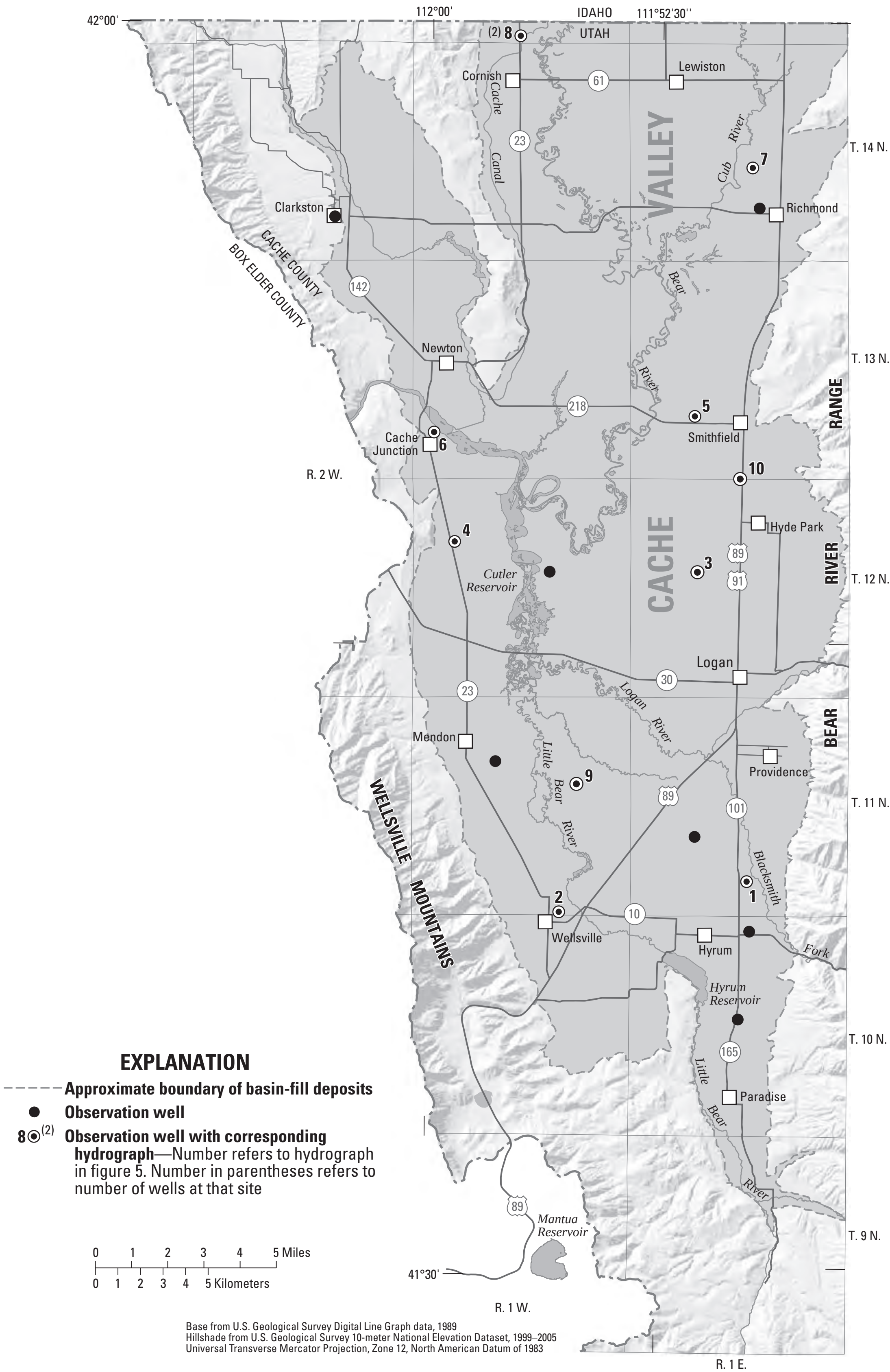


Figure 4. Location of wells in Cache Valley in which the water level was measured during March 2017.

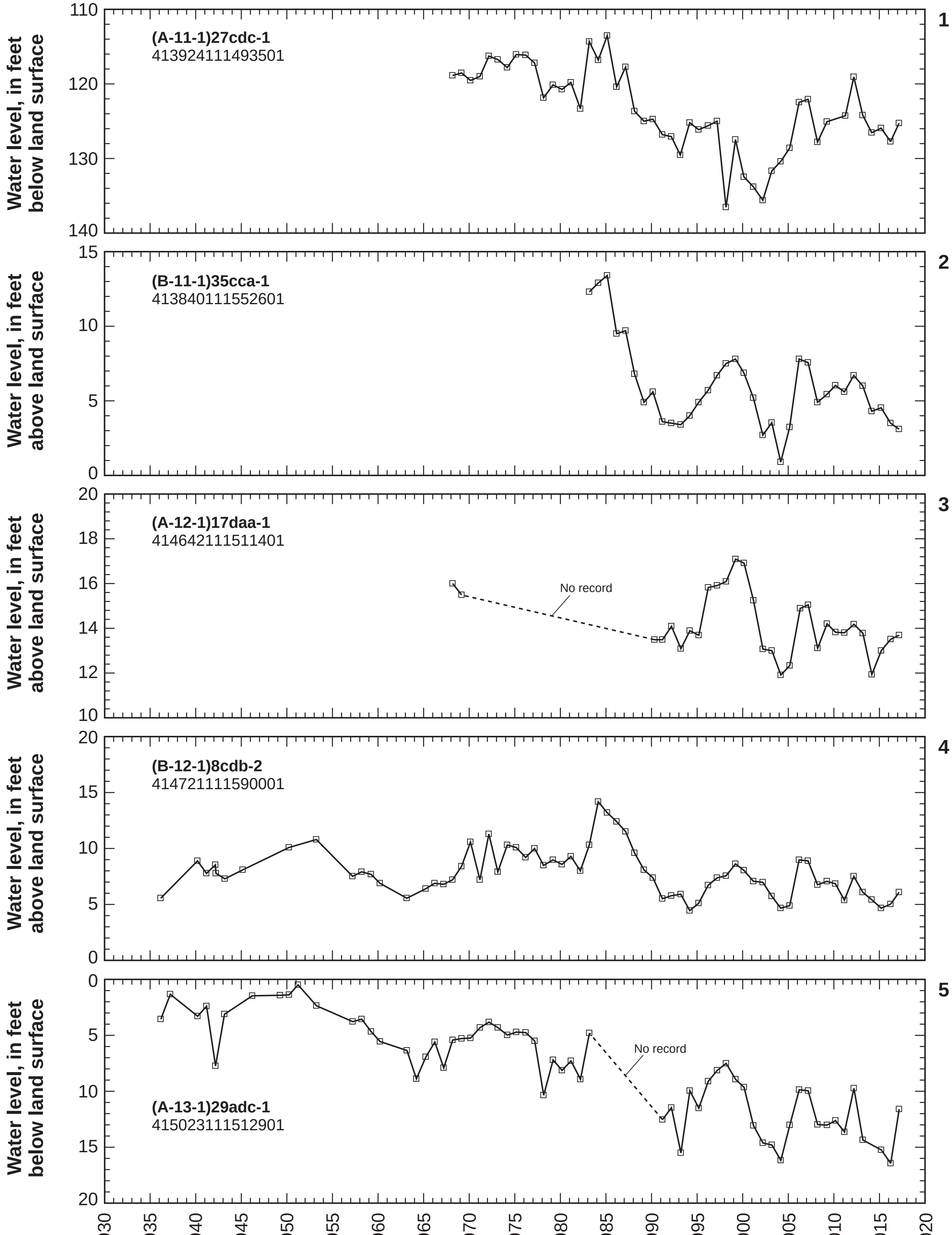


Figure 5. Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from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

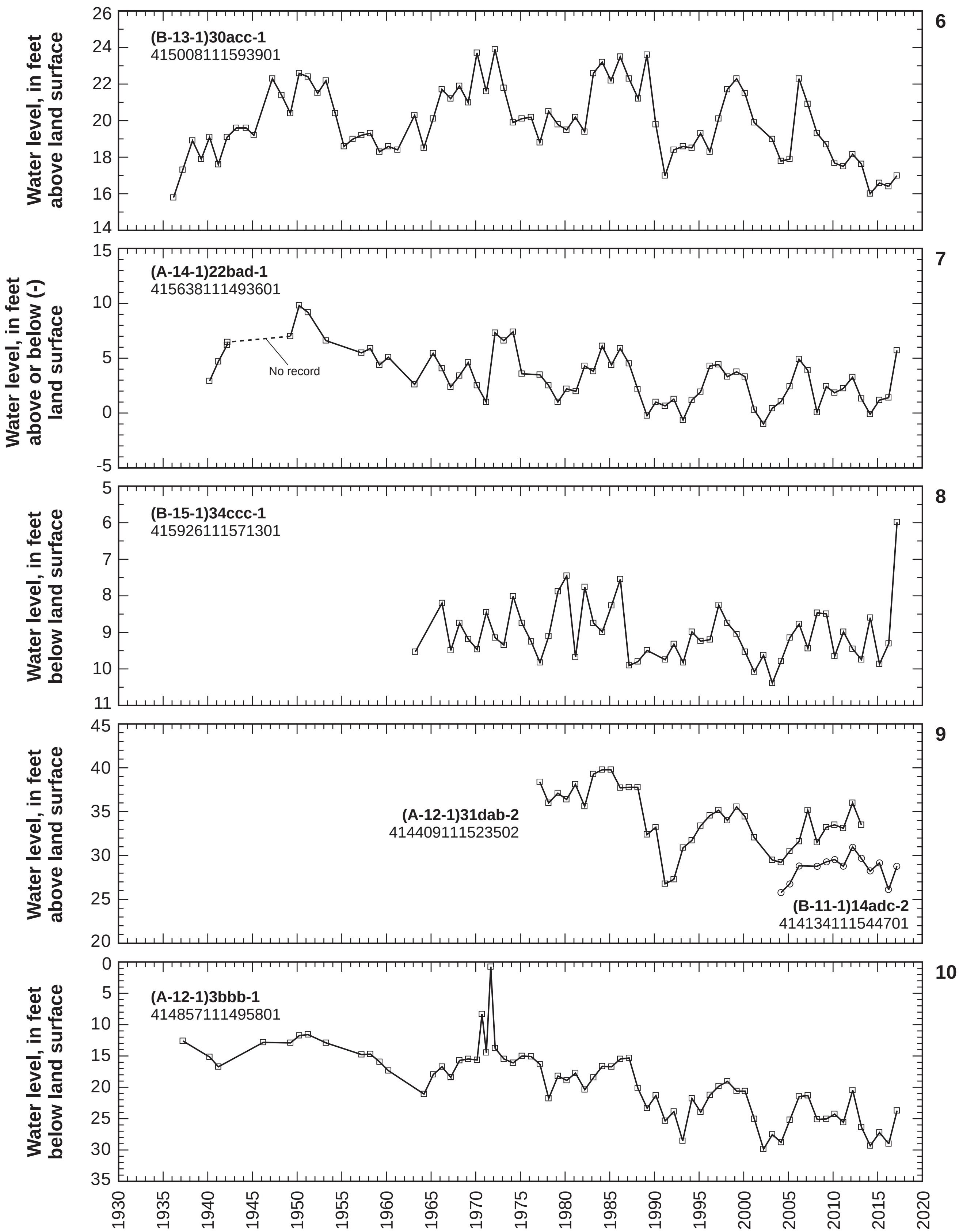


Figure 5. Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from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

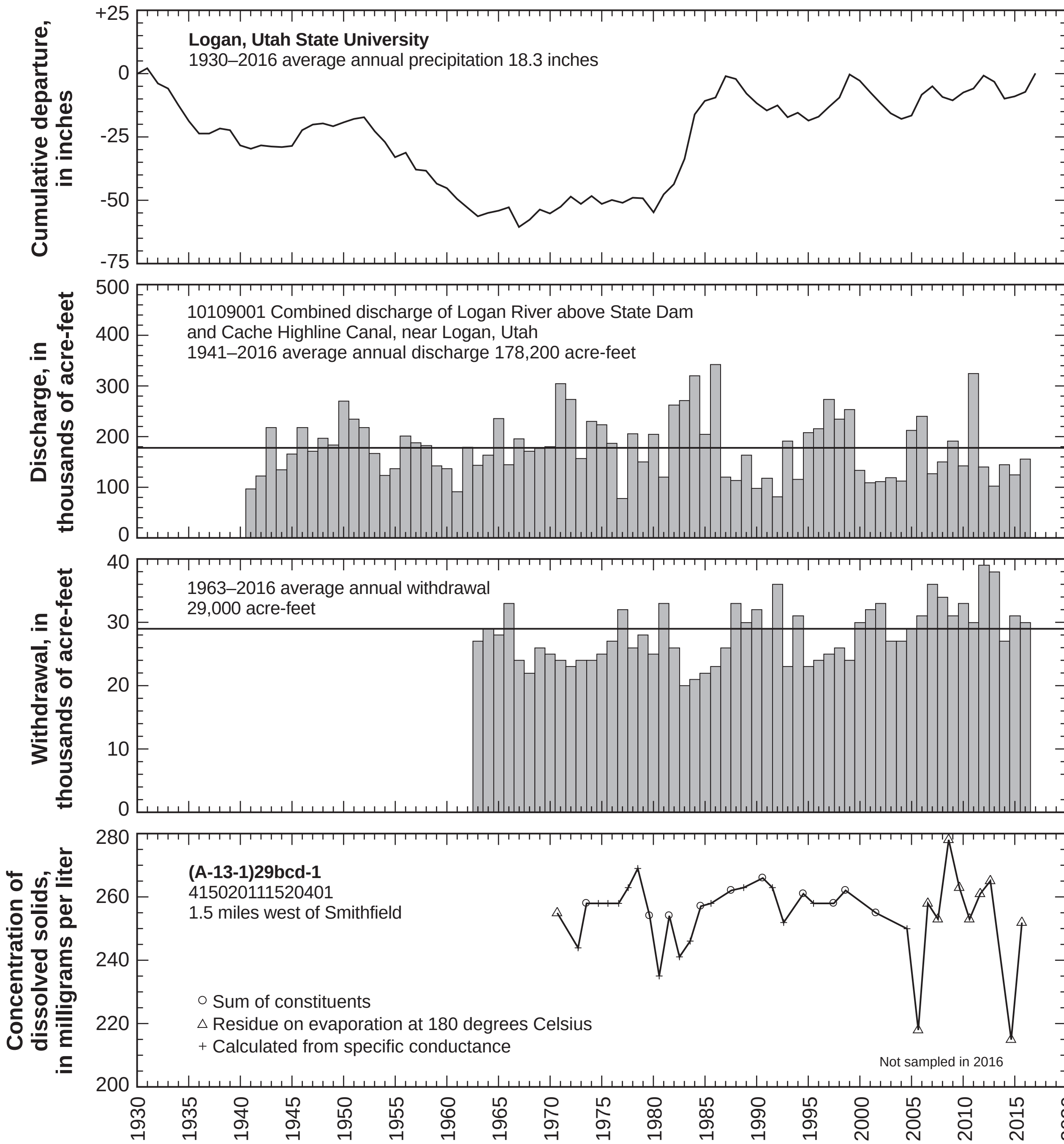


Figure 5. Relation of water level in selected wells in Cache Valley to total annual discharge of the Logan River near Logan, to cumulative departure from average annual precipitation at Logan, Utah State University, to annual withdrawal from wells, and to concentration of dissolved solids in water from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

East Shore Area

By Katherine K. Jones

The East Shore area is in north-central Utah between the Wasatch Range and Great Salt Lake within Davis, Weber, and Box Elder Counties (fig. 6). Groundwater occurs in unconsolidated basin-fill deposits under both water-table and artesian conditions, but most of the water withdrawn by wells is from the artesian aquifers, and is used primarily for public supply (table 2). Water enters the artesian aquifers along the contact between the Wasatch Range and the eastern edge of the basin-fill deposits, and generally moves westward toward Great Salt Lake.

Total estimated withdrawal of water from wells in the East Shore area in 2016 was about 37,000 acre-feet, which is 1,000 acre-feet more than was reported for 2015 and 8,000 acre-feet less than the average annual withdrawal for 2006–2015 (tables 2 and 3). Withdrawal for public supply was 29,600 acre-feet in 2016, about 2,000 acre-feet more than in 2015. Withdrawal for irrigation was about 2,800 acre-feet, which is 800 acre-feet less than was reported for 2015. Withdrawal for industrial use was about 3,000 acre-feet, which is 300 acre-feet less than in 2015.

The location of wells in the East Shore area in which the water level was measured during March 2017 is shown in figure 6. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Pineview Dam, 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. Precipitation at Pineview Dam in 2016 was about 34.5 inches, which is about 4.0 inches more than the average annual precipitation for 1949–2016 and about 4.6 inches more than in 2015.

Water levels declined from March 2016 to March 2017 in most of the wells measured in the East Shore area. Declines are probably due to continued large withdrawals for public-supply use. Water levels have generally declined since the mid-1980s in wells south of Kaysville and have generally declined since the mid-1950s in wells north of Kaysville.

The concentration of dissolved solids in water samples collected from well (B-4-2)27aba-1, located 2.3 miles south-southeast of Syracuse, from 1969 to 2016, is shown in figure 7. The median concentration during this period was 391 mg/L. From 1969 to 1993, dissolved-solids concentrations in water samples ranged from 287 to 633 mg/L. Dissolved-solid concentrations in water samples collected from 1995 to 2016 were much less variable, ranging from 362 to 399 mg/L. The dissolved-solids concentration in the water sample collected in June 2016 (382 mg/L) was similar to the median concentration.

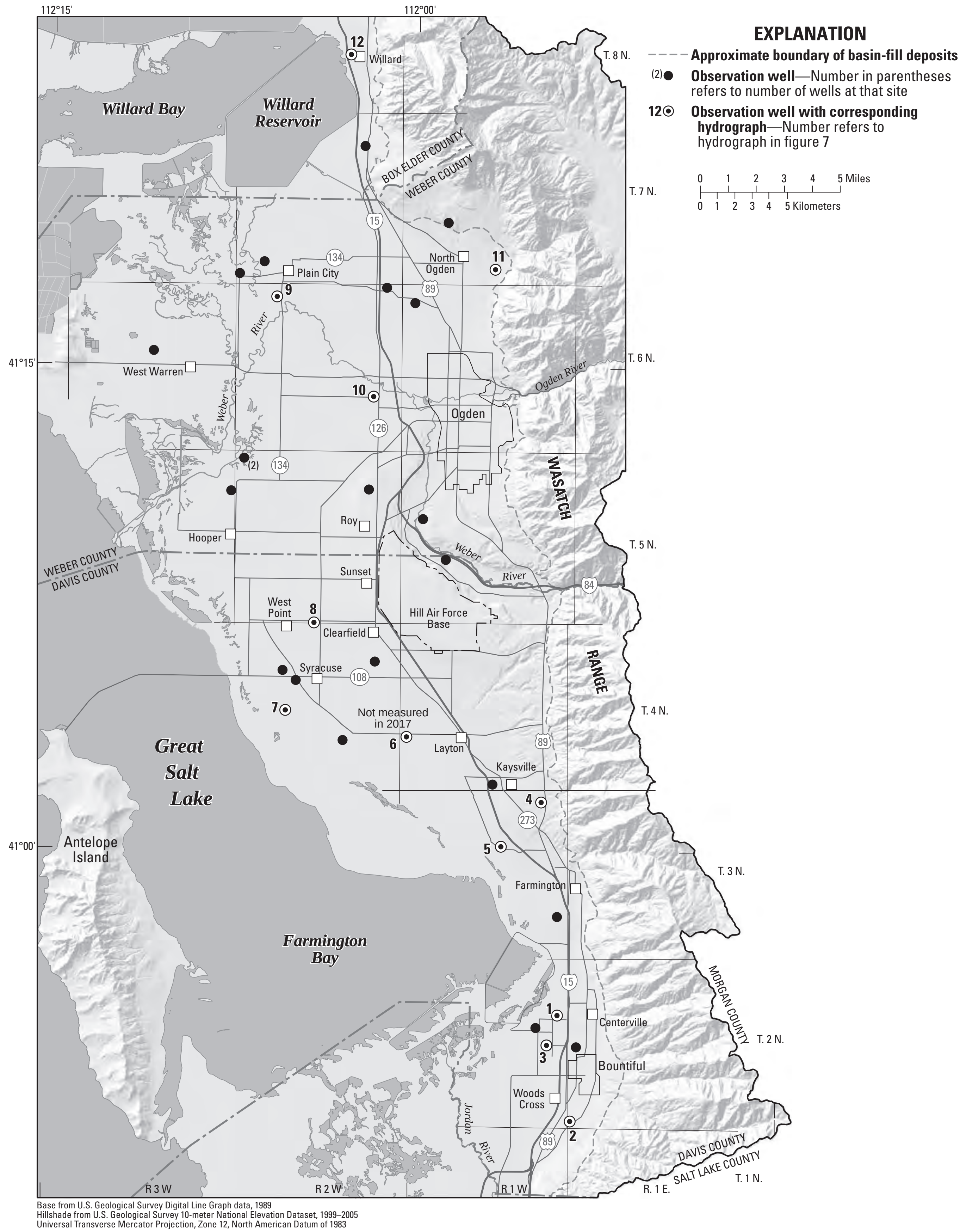


Figure 6. Location of wells in the East Shore area in which the water level was measured during March 2017.

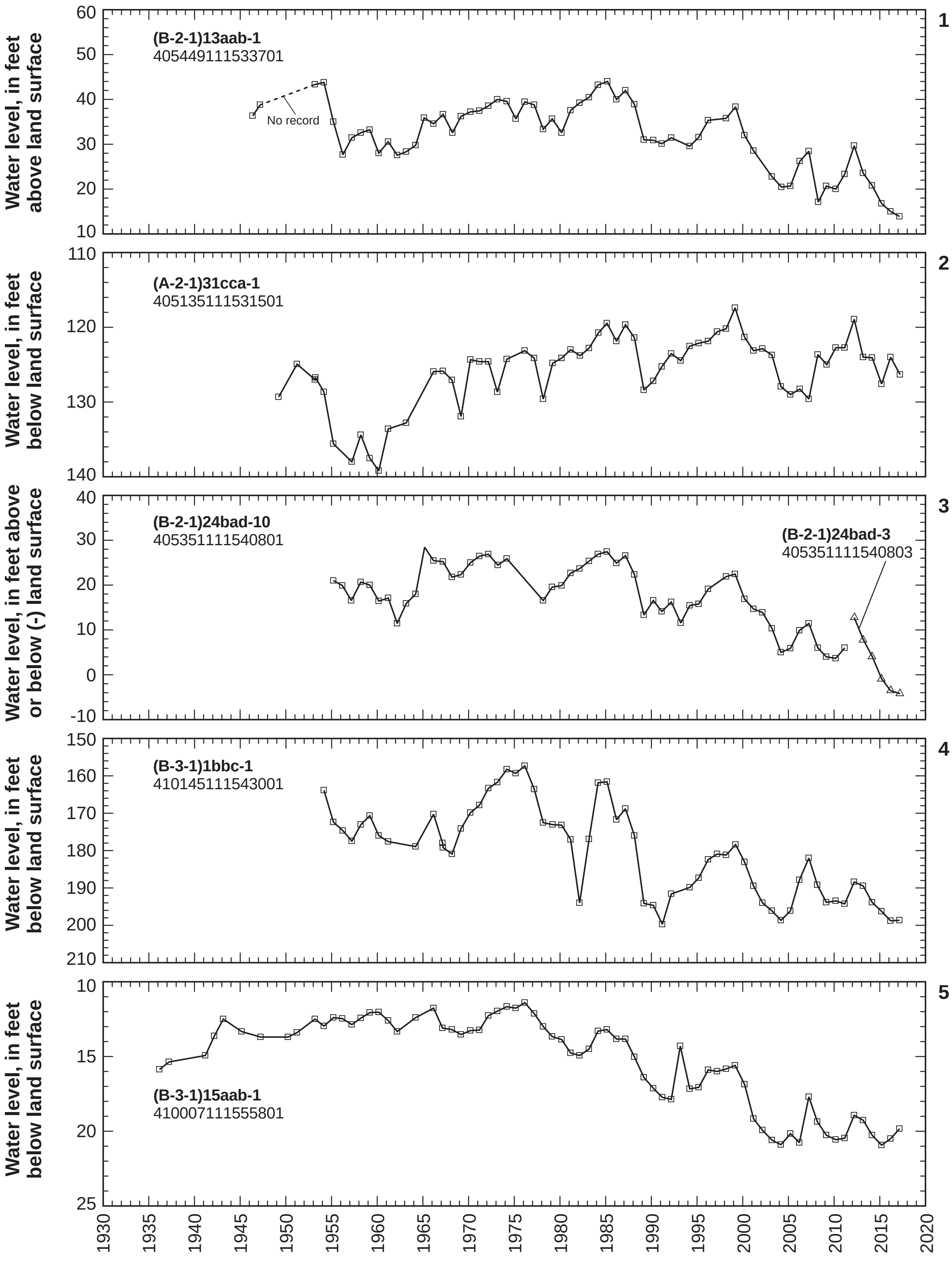


Figure 7. Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Pineview Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1.

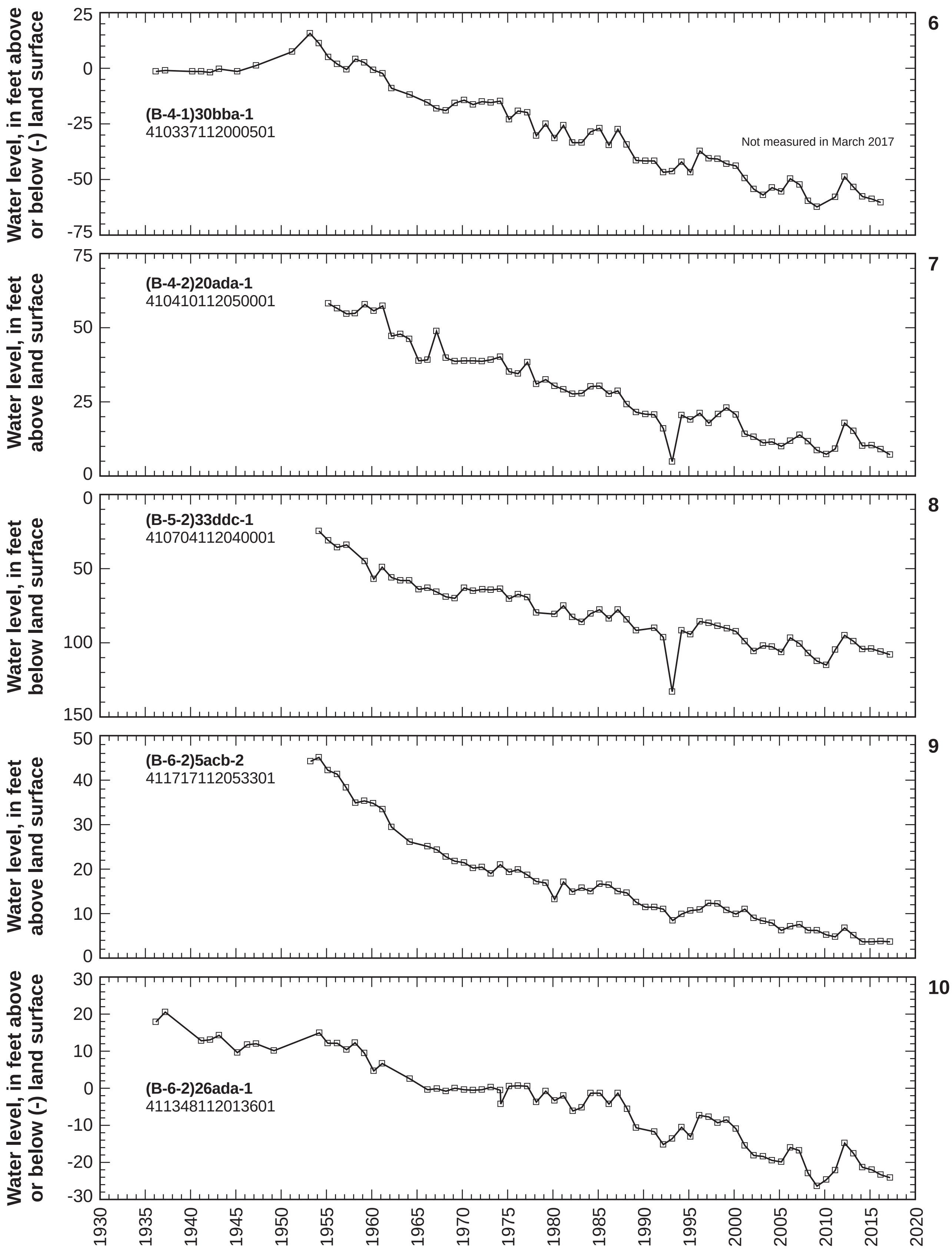


Figure 7. Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Pineview Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1.—Continued

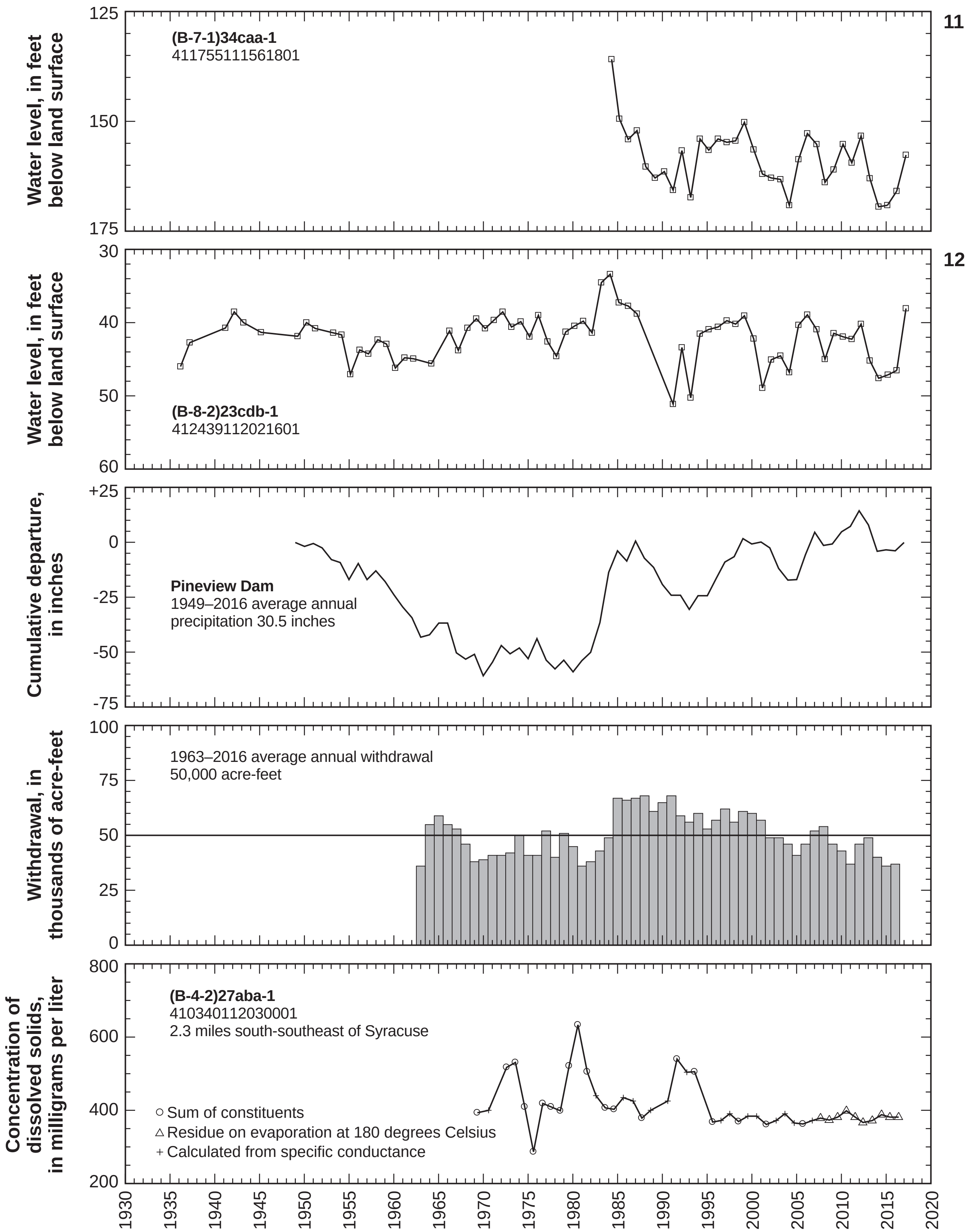


Figure 7. Relation of water level in selected wells in the East Shore area to cumulative departure from average annual precipitation at Pineview Dam, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (B-4-2)27aba-1.—Continued

Salt Lake Valley

By V. Noah Derrick

Salt Lake Valley covers about 400 square miles between the Wasatch Range and the Oquirrh and Traverse Mountains in Salt Lake County (fig. 8). Groundwater occurs in unconsolidated deposits in the valley under water-table and artesian conditions, and is used primarily for public supply and industrial purposes (table 2). Recharge to the aquifers occurs mainly along the area where the mountains border the valley. In the southwestern part of the valley, groundwater moves from the base of the Oquirrh Mountains eastward toward the Jordan River. In the northwestern part of the valley, the direction of movement is mostly toward Great Salt Lake. In the eastern half of the valley, groundwater moves westward from the base of the Wasatch Range toward the Jordan River. The Jordan River drains both surface water and groundwater from the valley.

Total estimated withdrawal of water from wells in Salt Lake Valley in 2016 was about 137,000 acre-feet, which is 5,000 acre-feet more than in 2015 and 5,000 acre-feet less than the average annual withdrawal for 2006–2015 (tables 2 and 3). Withdrawal for public supply was about 94,300 acre-feet, which is 8,100 acre-feet more than the total for 2015. Withdrawal for industrial use was about 42,400 acre-feet, which is 2,800 acre-feet less than the total for 2015. The increase in total withdrawals was due to increased withdrawals for public supply use.

The location of wells in Salt Lake Valley in which the water level was measured during February 2017 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 (International Airport) are shown in figure 9. Precipitation at Salt Lake City during 2016 was about 14.8 inches, about 1.3 inches less than in 2015 and about 0.4 inch less than the average annual precipitation for 1931–2016.

The relation of the water level in selected observation wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake 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 Brighton was about 39.4 inches in 2016, which is about 5.4 inches more than in 2015 and about 2.8 inches less than the average annual precipitation for 1931–2016.

Water level changes were mostly very small from February 2016 to February 2017 in most of the wells measured in 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. Levels have generally declined since 1987.

The concentrations of dissolved solids and dissolved chloride (from 1931–2015 and 1935–2015, respectively) in water samples collected from well (D-1-1)7abd-6, a flowing well at 800 South 500 East in Salt Lake City, are shown in figure 10. The concentration of dissolved solids has ranged from 554 to 879 mg/L with a median value of 711 mg/L. The concentration of dissolved solids has generally increased since about 1947. The dissolved-solids concentration from the water sample in June 2016 was 856 mg/L. The dissolved chloride concentration generally increased from 44 mg/L in February 1948 to 194 mg/L in July 2012, but has generally decreased since then, with a median value of 130 mg/L. The chloride concentration in the water sample from June 2016 was 168 mg/L.

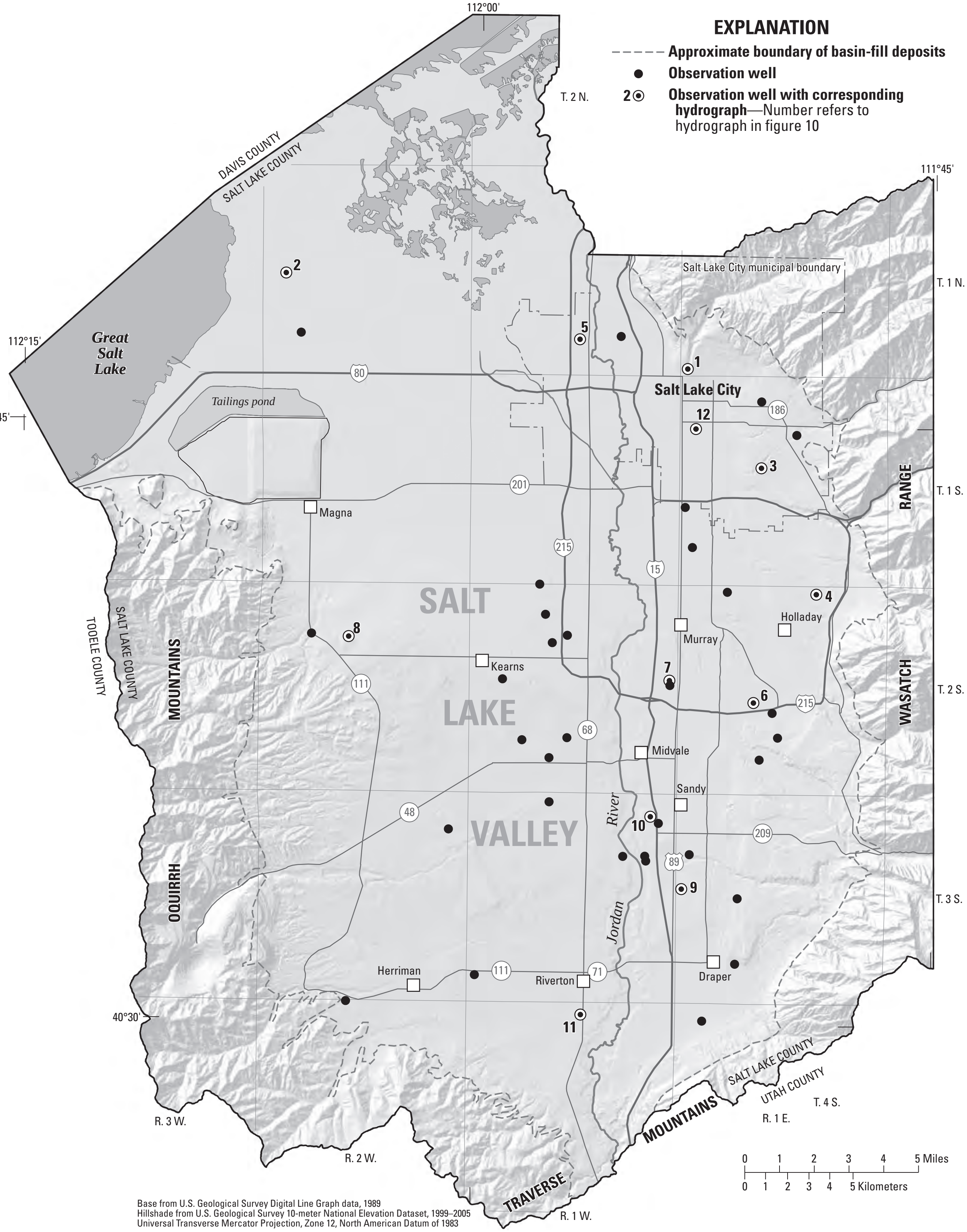


Figure 8. Location of wells in Salt Lake Valley in which the water level was measured during February 2017.

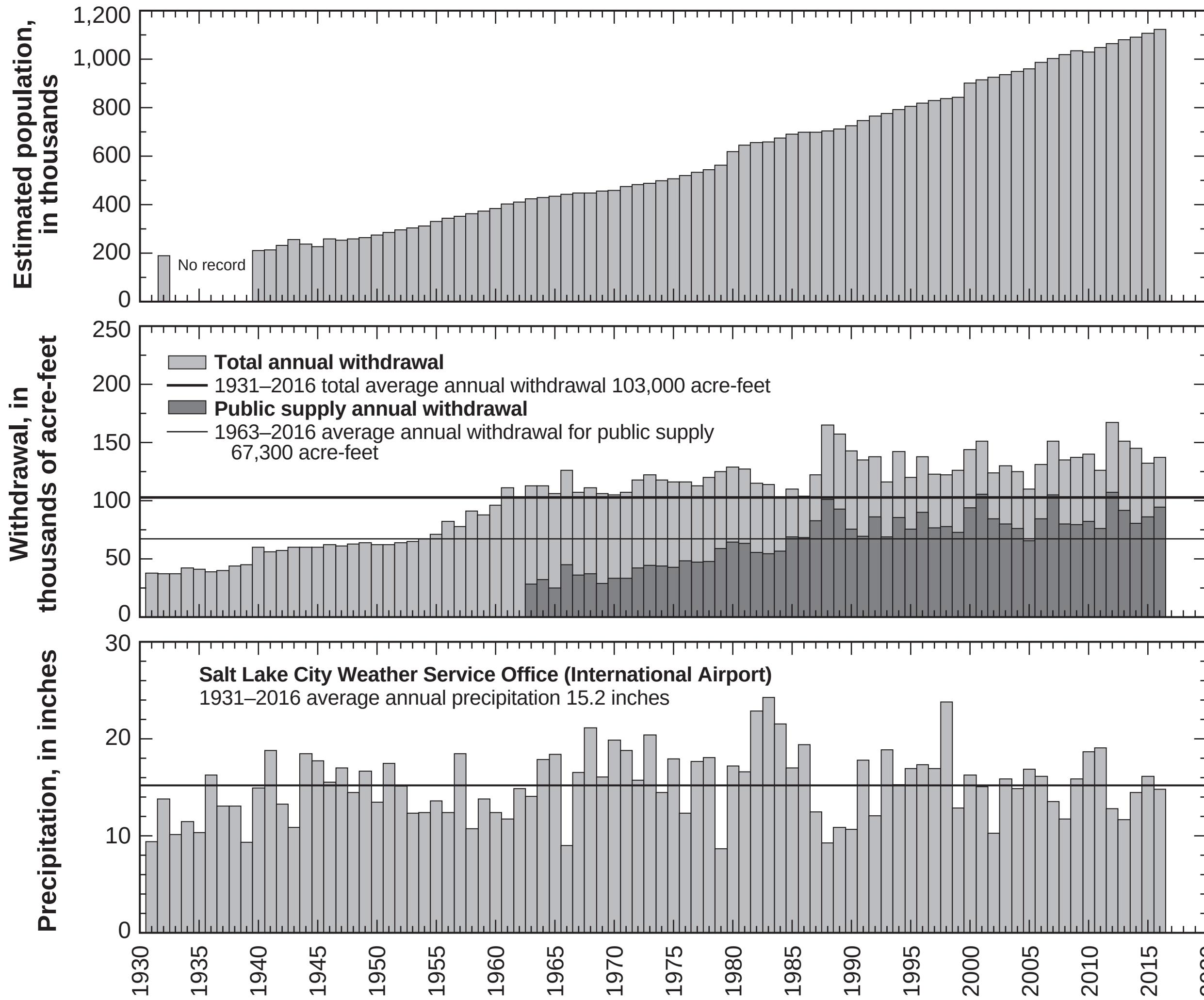


Figure 9. Estimated population of Salt Lake County, total annual withdrawal from wells, annual withdrawal for public supply, and average annual precipitation at Salt Lake City Weather Service Office (International Airport).

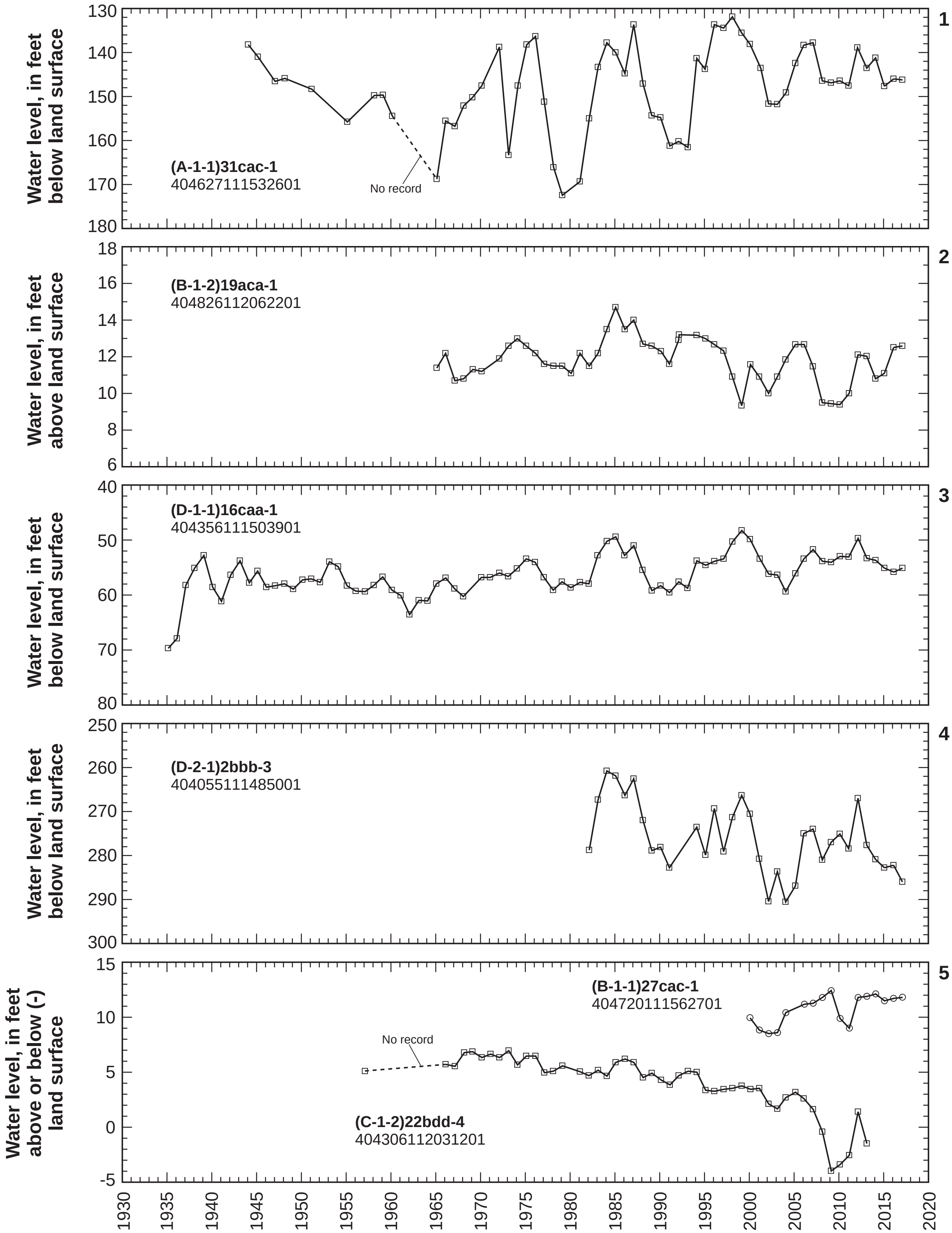


Figure 10. Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from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

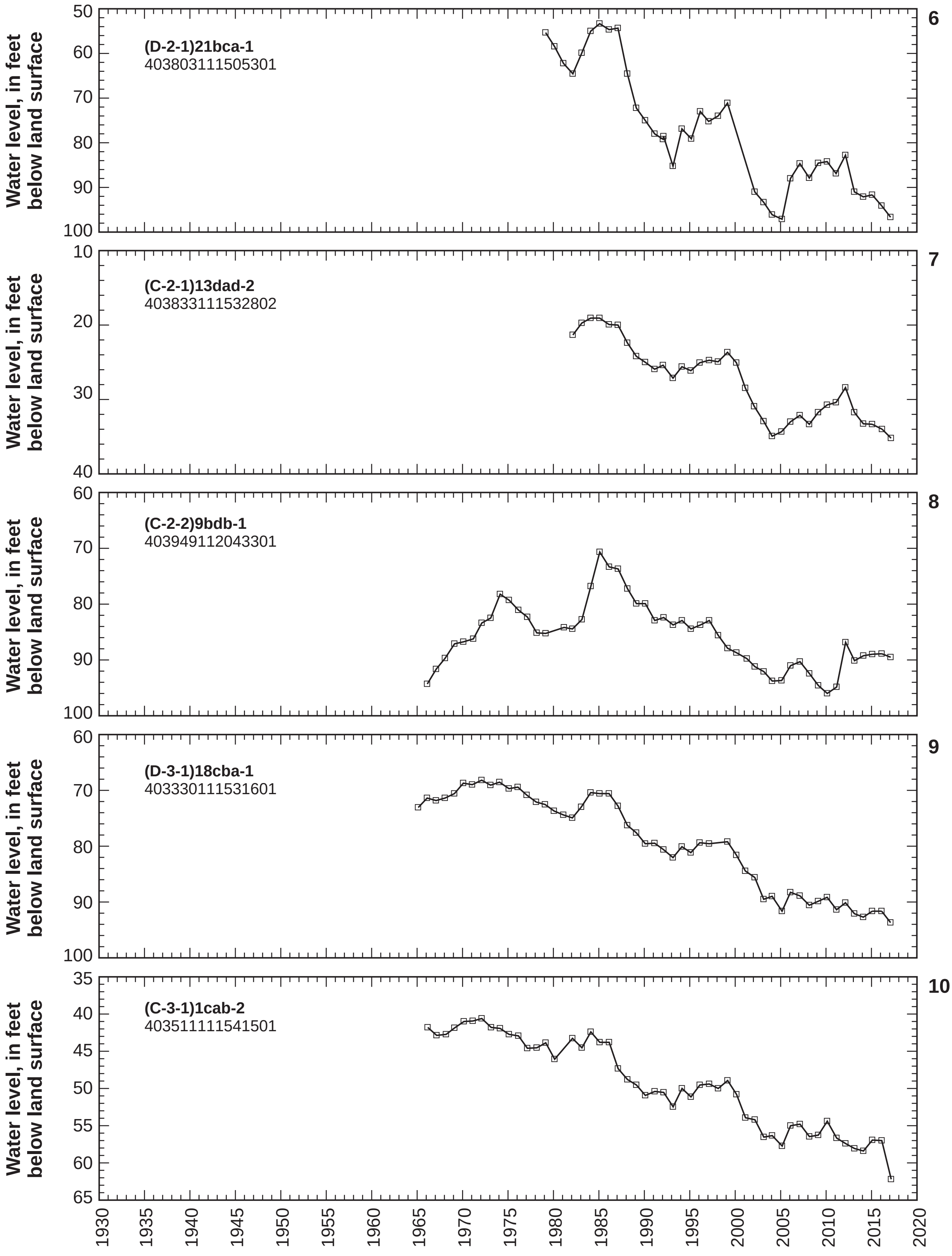


Figure 10. Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from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

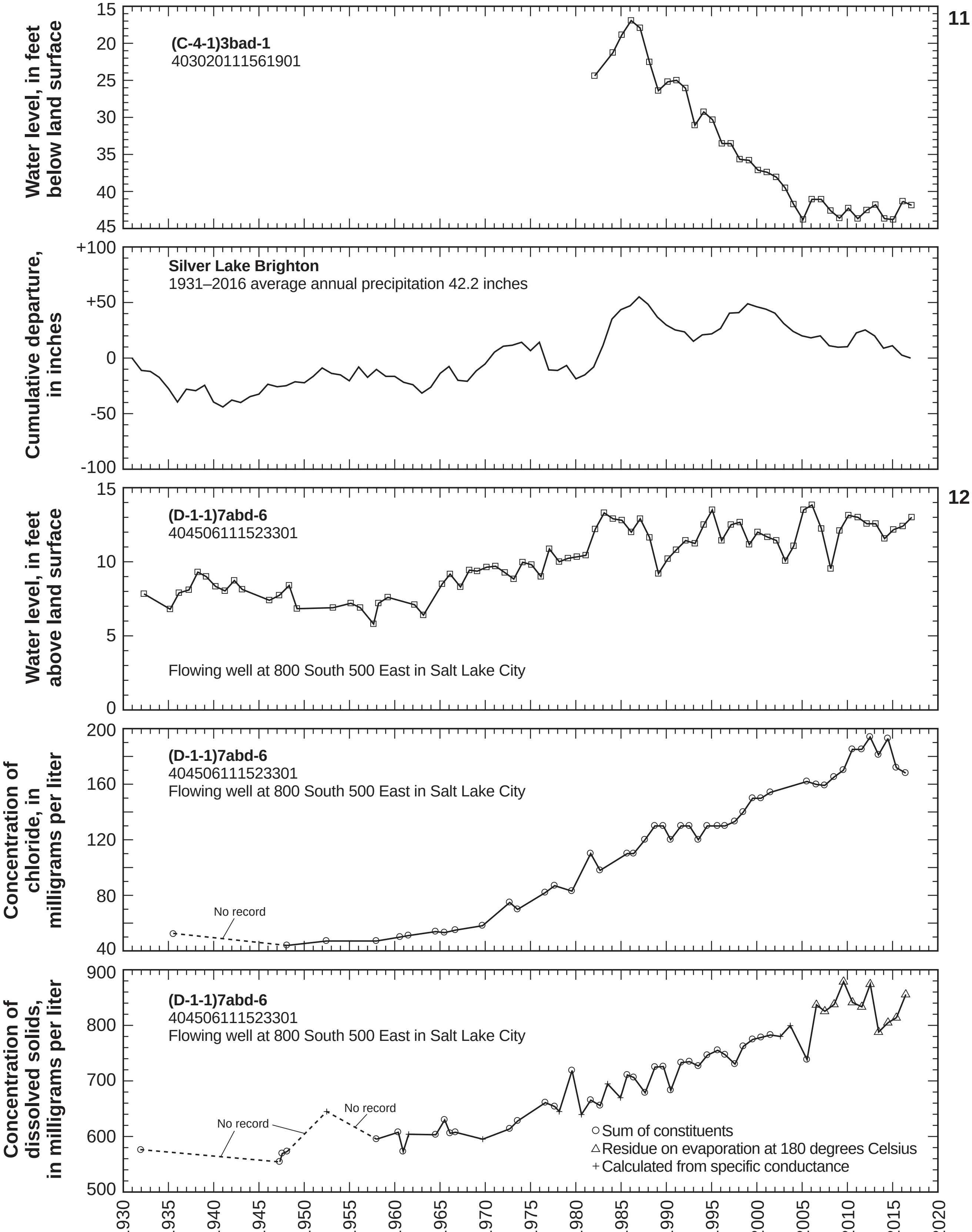


Figure 10. Relation of water level in selected wells completed in the principal aquifer in Salt Lake Valley to cumulative departure from average annual precipitation at Silver Lake Brighton, and relation of water level in well (D-1-1)7abd-6 to concentration of chloride and dissolved solids in water from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

Tooele Valley

By Paul Downhour

Tooele Valley lies between the Stansbury and Oquirrh Mountains and extends south from Great Salt Lake to South Mountain. The total area of the valley is about 250 square miles within Tooele County (fig. 11). Groundwater occurs in consolidated rock and unconsolidated basin-fill deposits in Tooele Valley under both water-table and artesian conditions, but most of the water withdrawn by wells is from artesian aquifers in the unconsolidated deposits, and is used primarily for irrigation and public supply (table 2).

Total estimated withdrawal of water from wells in Tooele Valley in 2016 was about 26,000 acre-feet, which is about 1,000 acre-feet more than the total for 2015 and 1,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3). Withdrawal for irrigation was about 11,800 acre-feet, which is 1,200 acre-feet less than the total for 2015. Withdrawal for public supply was about 12,700 acre-feet, which is 1,700 acre-feet more than in 2015. Withdrawal for industrial use was about 550 acre-feet, which is the same as in 2015.

The location of wells in Tooele Valley in which the water level was measured during March 2017 is shown in figure 11. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Tooele, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-2-4)33bdd-1 is shown in figure 12. Precipitation at Tooele during 2016 was about 16.2 inches, which is about 1.5 inches less than in 2015 and about 1.6 inches less than the average annual precipitation for 1936–2016.

Water levels declined from March 2016 to March 2017 in most of the wells measured in Tooele Valley. The largest decline, about 4.5 feet, occurred in a well about 3 miles northeast of Tooele. Water levels in most of the wells measured in Tooele Valley have declined since records began, many going back 60 years or more.

The concentration of dissolved solids in water samples collected from well (C-2-4)33bdd-1, located at Erda, from 1977 to 2015, is shown in figure 12. The concentration has ranged from 456 to 653 mg/L, with a median value of 586 mg/L. This well was not sampled in 2016.

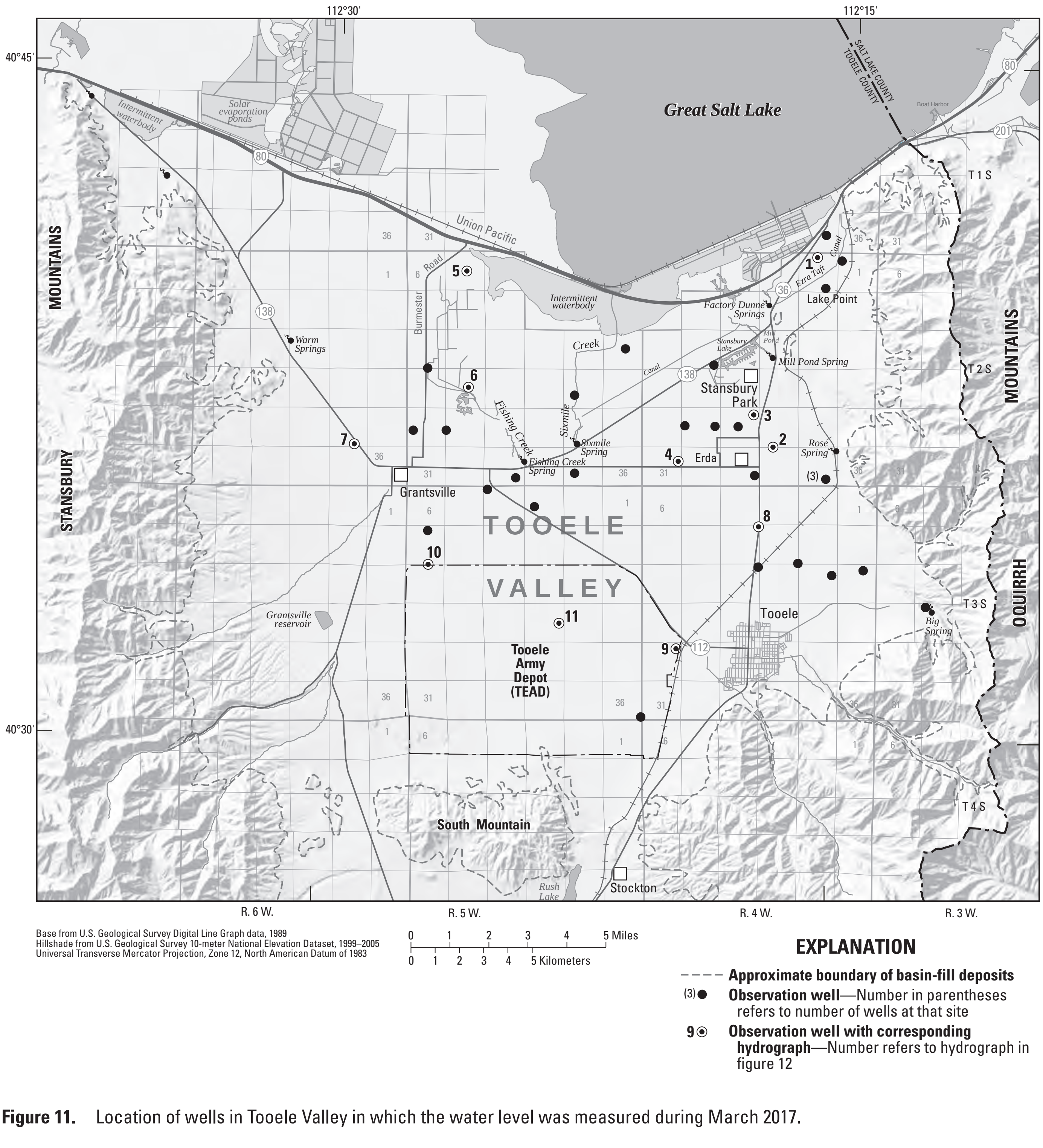


Figure 11. Location of wells in Tooele Valley in which the water level was measured during March 2017.

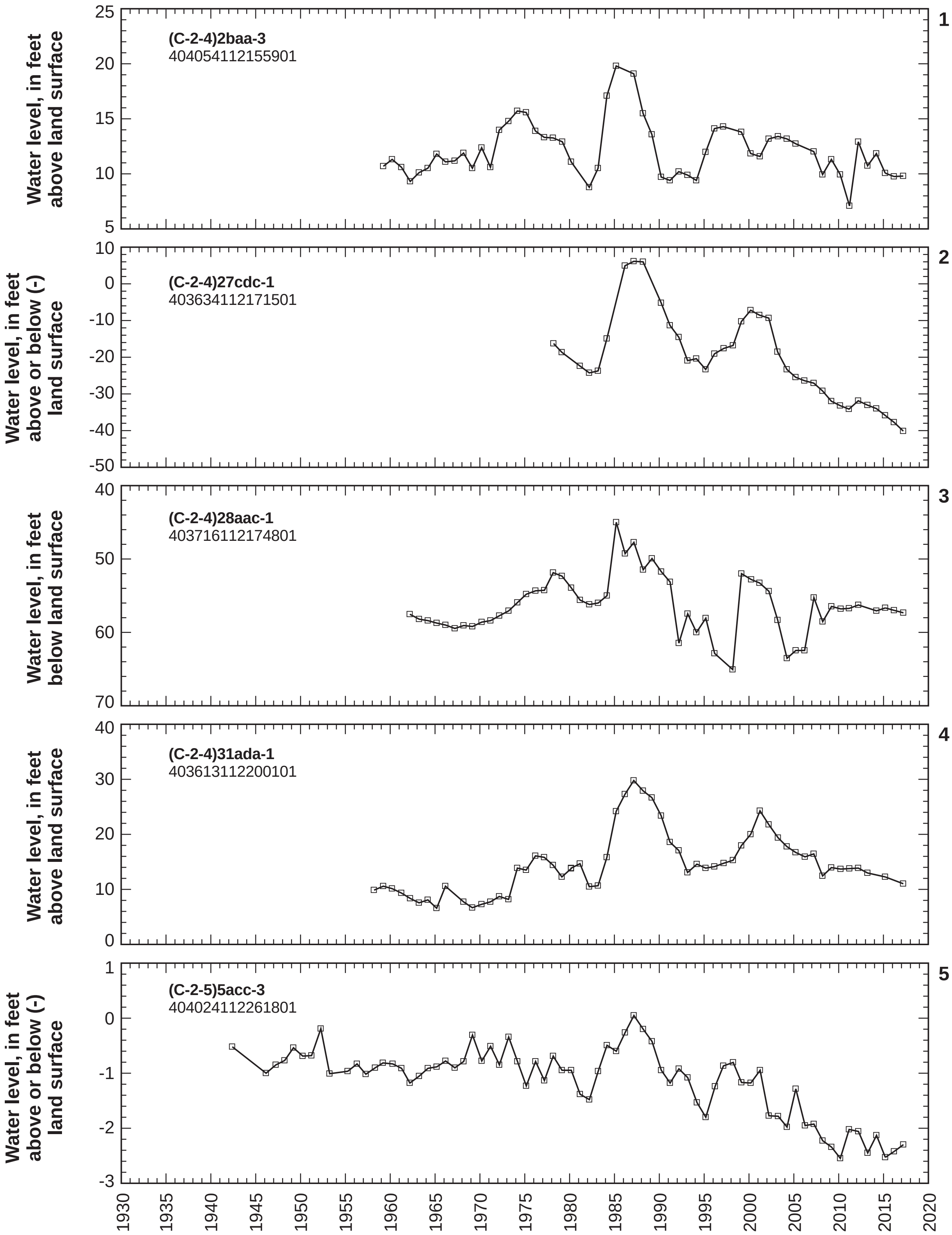


Figure 12. Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-2-4)33bdd-1.

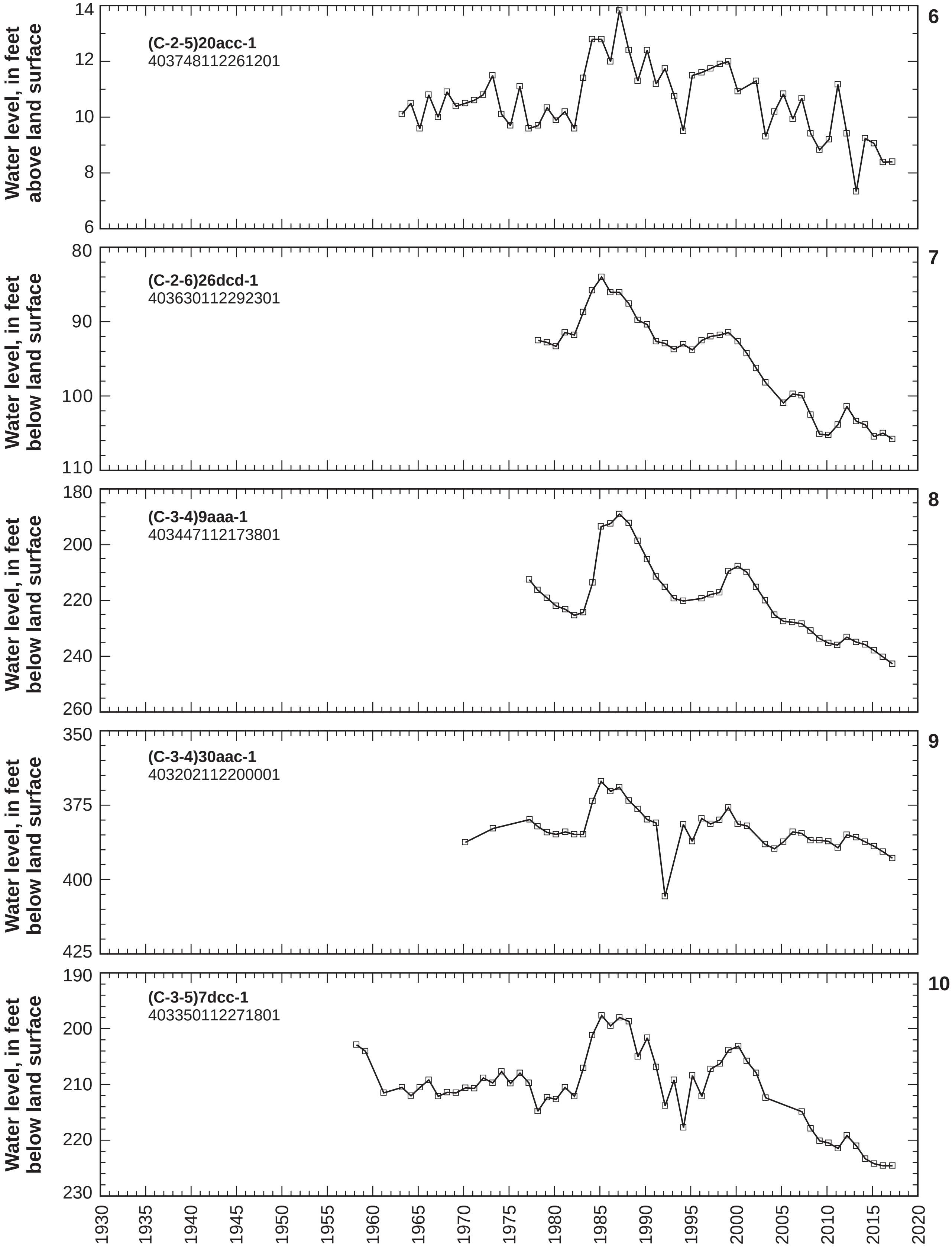


Figure 12. Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-2-4)33bdd-1.—Continued

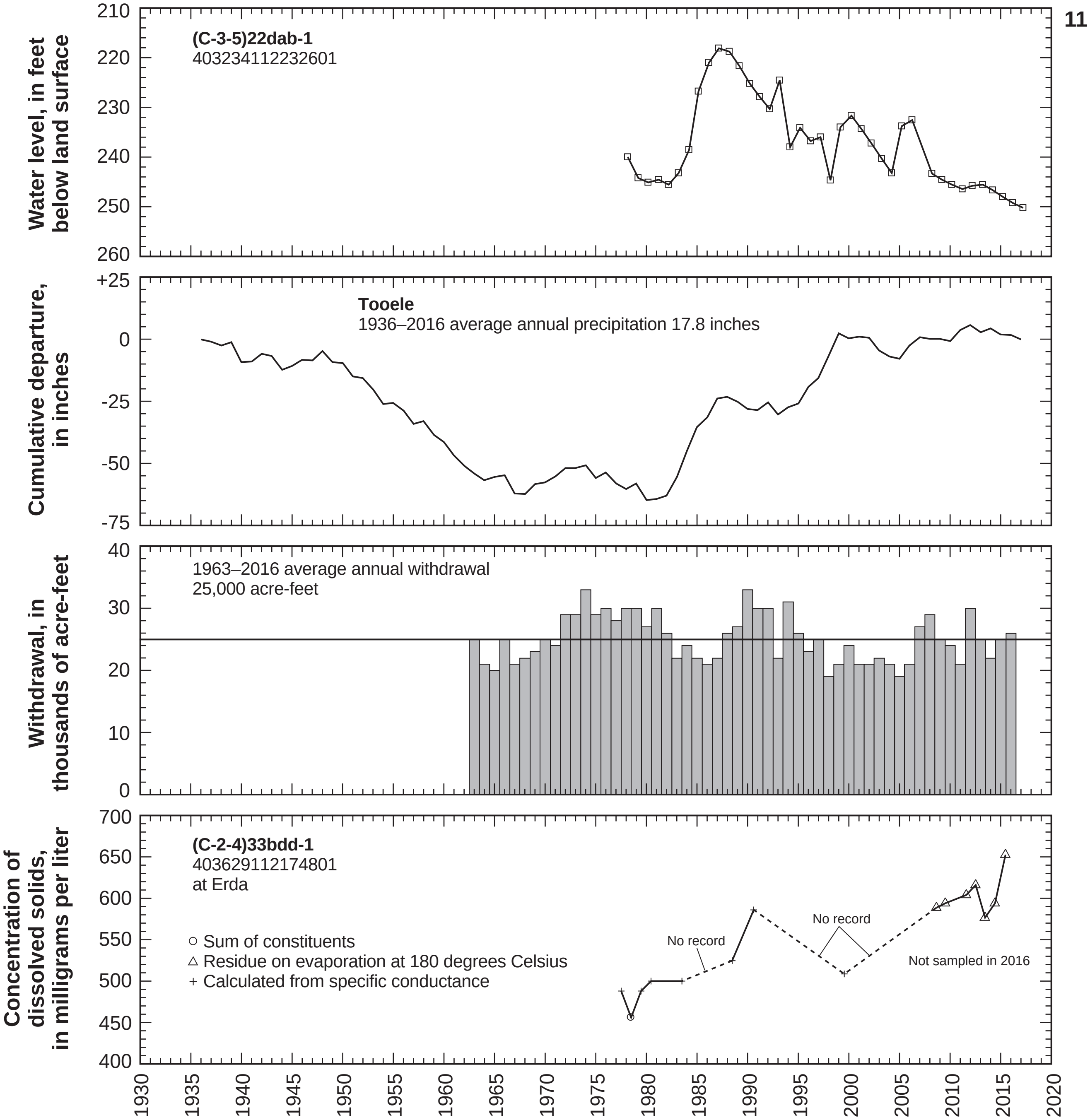


Figure 12. Relation of water level in selected wells in Tooele Valley to cumulative departure from average annual precipitation at Tooele, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-2-4)33bdd-1.—Continued

Utah and Goshen Valleys

By Lincoln Smith

Utah Valley is bounded by the Wasatch Range, West Mountain, and the northern extension of Long Ridge. The Valley is divided into two groundwater basins, northern and southern, which are separated by Provo Bay in northern Utah Valley (fig. 13). Northern Utah Valley is further divided by the Jordan River into two subbasins, northern Utah Valley-east and northern Utah Valley-west. Goshen Valley is bounded by West Mountain, Long Ridge, the Lake Mountains, and the East Tintic Mountains (fig. 13). Groundwater in Utah and Goshen Valleys occurs in unconsolidated basin-fill deposits under both water-table and artesian conditions, but most of the water is withdrawn from wells that discharge from artesian aquifers, and is used primarily for public supply and irrigation (table 2). The principal groundwater recharge area for the basin-fill deposits is in the eastern part of the valley, along the base of the Wasatch Range.

Total estimated withdrawal of water from wells in Utah and Goshen Valleys in 2016 was about 119,000 acre-feet, which is 17,000 acre-feet more than the value for 2015, and 11,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3). Withdrawal in northern Utah Valley (-east and -west) was about 65,600 acre-feet, which is 13,700 acre-feet more than the value for 2015. Total estimated withdrawal in northern Utah Valley-west was about 5,200 acre-feet, or about 8 percent of the total withdrawal in northern Utah Valley. Withdrawal in southern Utah Valley was 29,100 acre-feet, which is 800 acre-feet more than the value for 2015. Withdrawal in Goshen Valley was 24,100 acre-feet, which is 2,000 acre-feet more than the value for 2015. The overall increase in total withdrawals from all three valleys was mainly due to increased withdrawals for public supply use.

The location of wells in Utah and Goshen Valleys in which the water level was measured during March 2017 is shown in figure 13. Water levels declined from March 2016 to March 2017 in most of the wells measured in Utah and Goshen Valleys. Declines are probably due to continued large withdrawals for public supply and irrigation. Overall, water levels have declined since the mid- to late 1980s. There have been intervening periods (1983–86, 1993–98, 2005–07, 2009–11) when water levels generally rose. These periods correspond to greater-than-average precipitation.

The relation of the water level in selected observation wells to cumulative departure from average precipitation at Silver Lake Brighton and Spanish Fork Power House, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish Fork at Castilla, Utah, and to concentration of dissolved solids in water from three wells is shown in figure 14. Discharge of Spanish Fork at Castilla, Utah, in 2016 was about 124,500 acre-feet, which is 44,400 acre-feet less than the 1933–2016 annual average and 1,200 acre-feet less than in 2015.

Precipitation at Silver Lake Brighton in 2016 was about 39.4 inches, which is about 2.8 inches less than the long-term average (1931–2016) and about 5.4 inches more than in 2015. Precipitation at Spanish Fork Power House in 2016 was about 17.6 inches, which is about 1.6 inches less than the long-term average (1930–2016) and about 2.7 inches more than in 2015.

The concentration of dissolved solids in water samples collected from wells (C-9-1)28ccb-1, located 4 miles north of Elberta, (D-7-2)4cbb-2, located 2 miles west of Provo at the mouth of the Provo River, and (D-9-1)36bbc-1, located 1 mile north of Santaquin, is shown in figure 14. The concentration of dissolved solids in water from well (C-9-1)28ccb-1 has ranged from 498 to 1,970 mg/L with a median value of 796 mg/L. The concentration of dissolved solids in the June 2016 sample was 1,830 mg/L. The dissolved-solids concentration in water from well (D-7-2)4cbb-2 has ranged from 270 to 539 mg/L with a median value of 321 mg/L. This well was not sampled in 2016. The dissolved-solids concentration in water from well (D-9-1)36bbc-1 has ranged from 166 to 311 mg/L with a median value of 294 mg/L. The concentration of dissolved solids in the July 2016 sample was 291 mg/L.

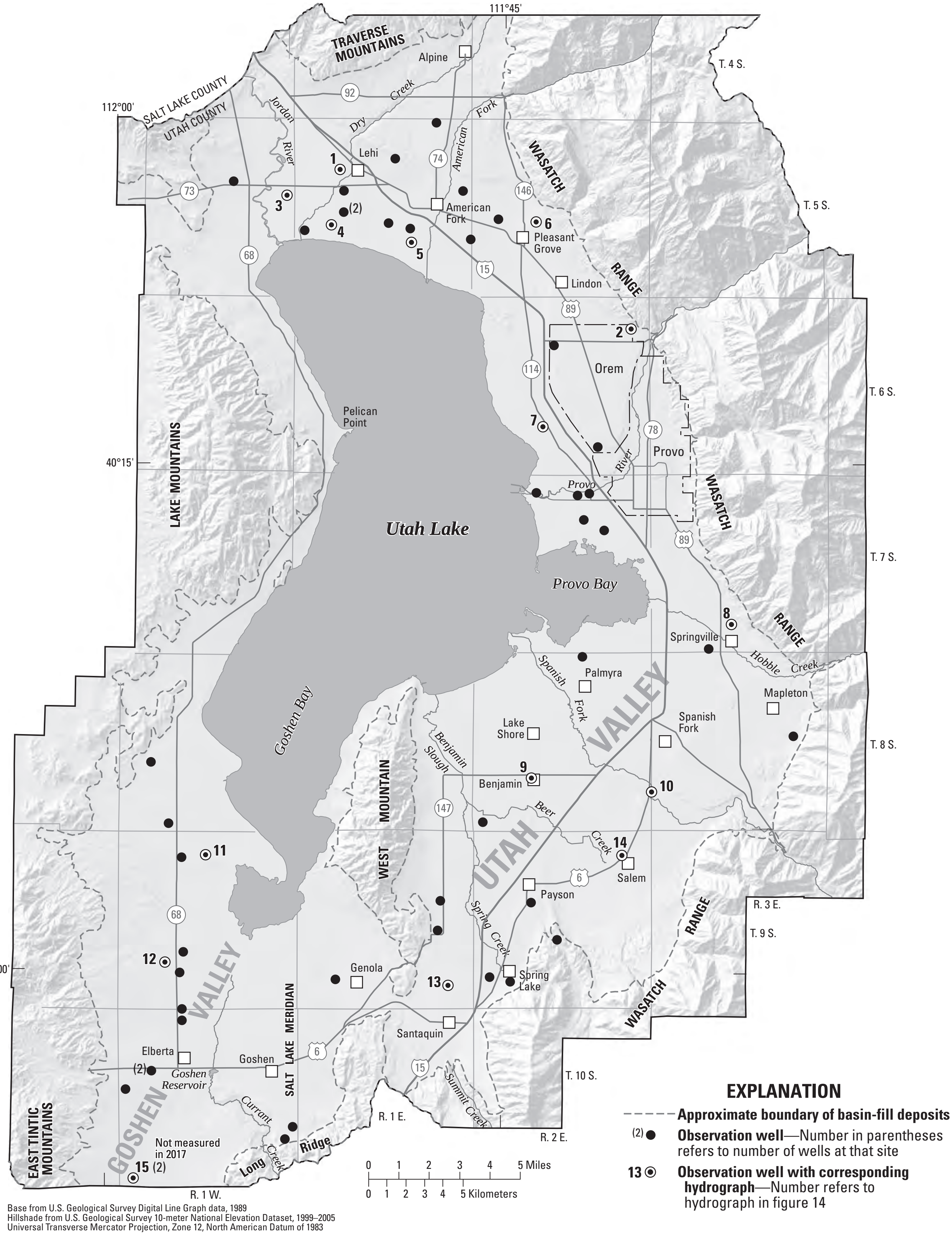


Figure 13. Location of wells in Utah and Goshen Valleys in which the water level was measured during March 2017.

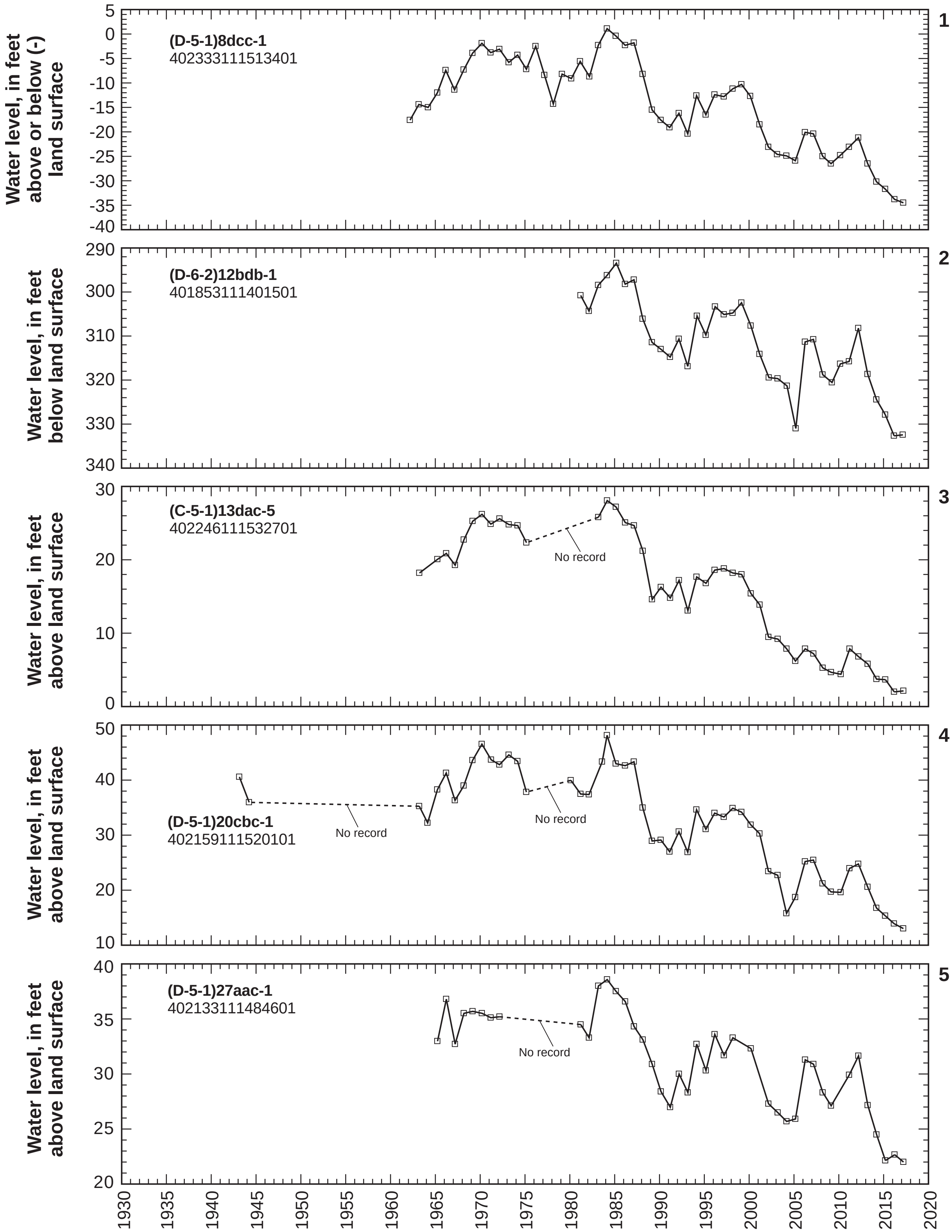


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake Brighton and Spanish Fork Power House, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish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

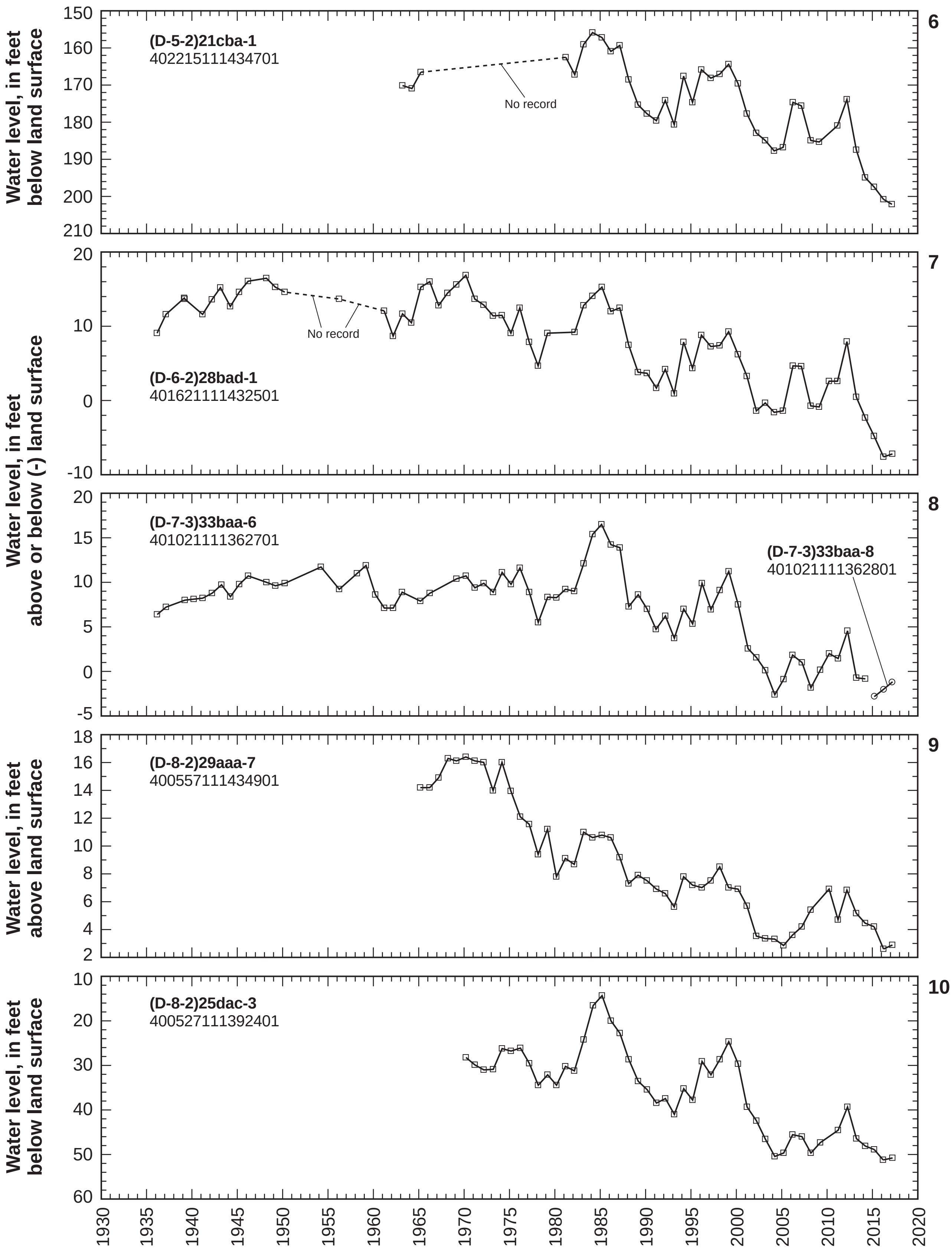


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake Brighton and Spanish Fork Power House, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish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

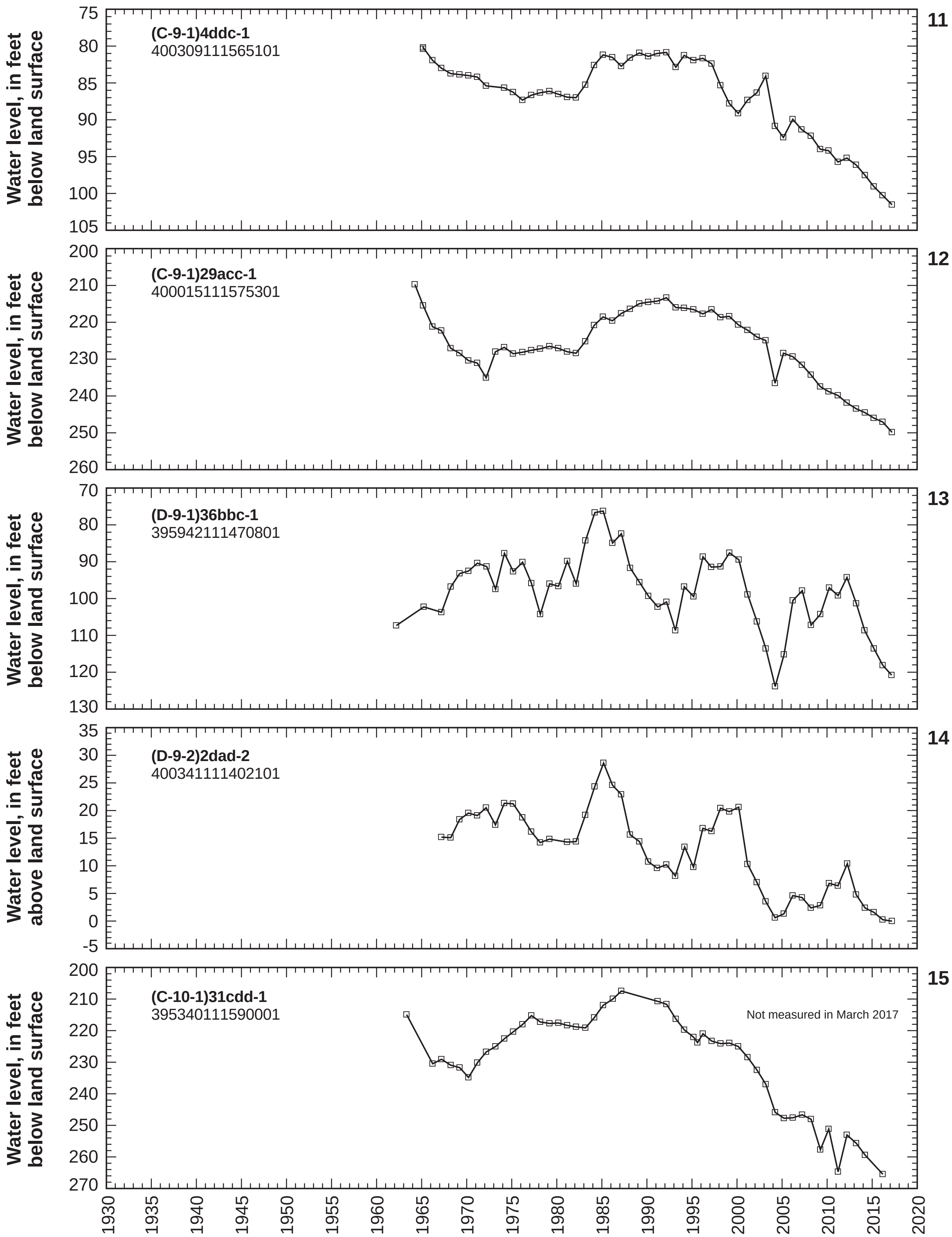


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake Brighton and Spanish Fork Power House, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish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

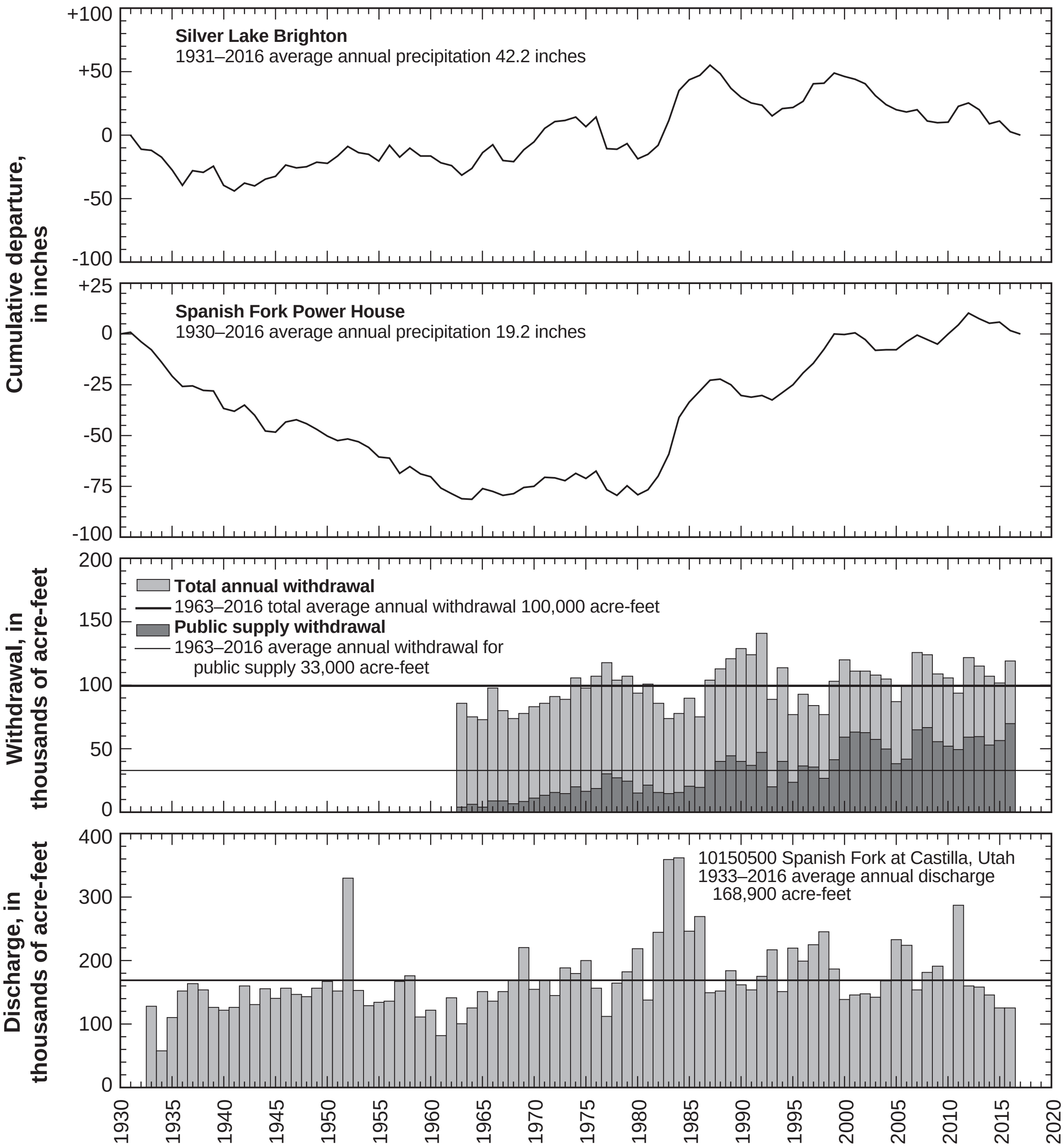


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake Brighton and Spanish Fork Power House, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish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

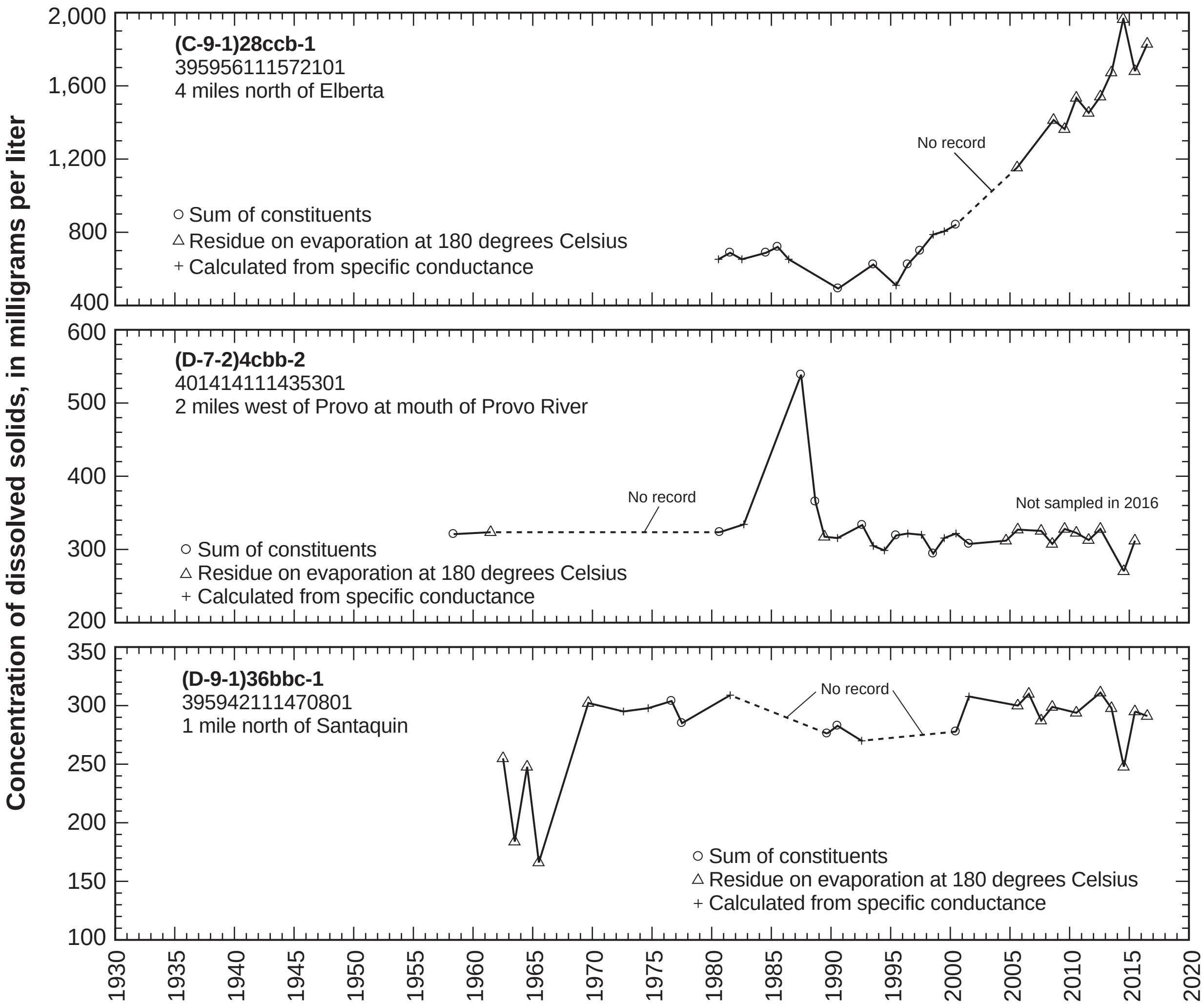


Figure 14. Relation of water level in selected wells in Utah and Goshen Valleys to cumulative departure from average annual precipitation at Silver Lake Brighton and Spanish Fork Power House, to total annual withdrawal from wells, to annual withdrawal for public supply, to annual discharge of Spanish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

Juab Valley

By Robert J. Eacret

Juab Valley, in central Utah, is about 30 miles long and about 4 miles wide. It is bounded on the east side by the Wasatch Range and the San Pitch Mountains and on the west side by the West Hills and Long Ridge (fig. 15). Groundwater drains from the valley in two directions—in northern Juab Valley it drains north via Currant Creek into Utah Lake, and in southern Juab Valley it drains south via Chicken Creek into the Sevier River. The northern and southern parts of Juab Valley are separated topographically and hydrologically by Levan Ridge, a gentle rise near the midpoint of the valley floor.

Groundwater in Juab Valley occurs in the unconsolidated basin-fill deposits under both water-table and artesian conditions, and is used primarily for irrigation (table 2). Artesian conditions are prevalent in the southern part of the valley. Most of the recharge to the groundwater reservoir occurs on the eastern side of the valley along the Wasatch Range and the San Pitch Mountains. Groundwater moves to discharge points at the northern and southern ends of the valley.

Total estimated withdrawal of water from wells in Juab Valley in 2016 was about 33,000 acre-feet, which is 2,000 acre-feet more than the amount reported for 2015 and 8,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3). The increase was mainly due to increased withdrawals for irrigation.

The location of wells in Juab Valley in which the water level was measured during March 2016 is shown in figure 15. The relation of the water level in selected observation 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 (C-14-1)26dbd-1, is shown in figure 16. Precipitation at Nephi during 2016 was about 10.8 inches, which is about 3.3 inches less than the average annual precipitation for 1935–2016, and about 0.7 inch less than in 2015.

Water levels declined in all of the wells measured in Juab Valley from March 2016 to March 2017 (fig. 16). Declines are probably the result of continued large withdrawals for irrigation (near record-high in 2016) and less-than-average precipitation. Water levels generally rose from 1978 to their highest level in 1985–87. This rise corresponds to a period of greater-than-average precipitation during 1978–86. Water levels generally declined from the late 1980s to 2017, although there was a substantial rise in some wells from 1993 to 1999.

The concentration of dissolved solids in water from well (C-14-1)26dbd-1, located 2 miles west of Levan, is shown in figure 16. This well replaces (C-12-1)24baa-1. The dissolved-solids concentration in the water sample collected in August 2016 was 854 mg/L.

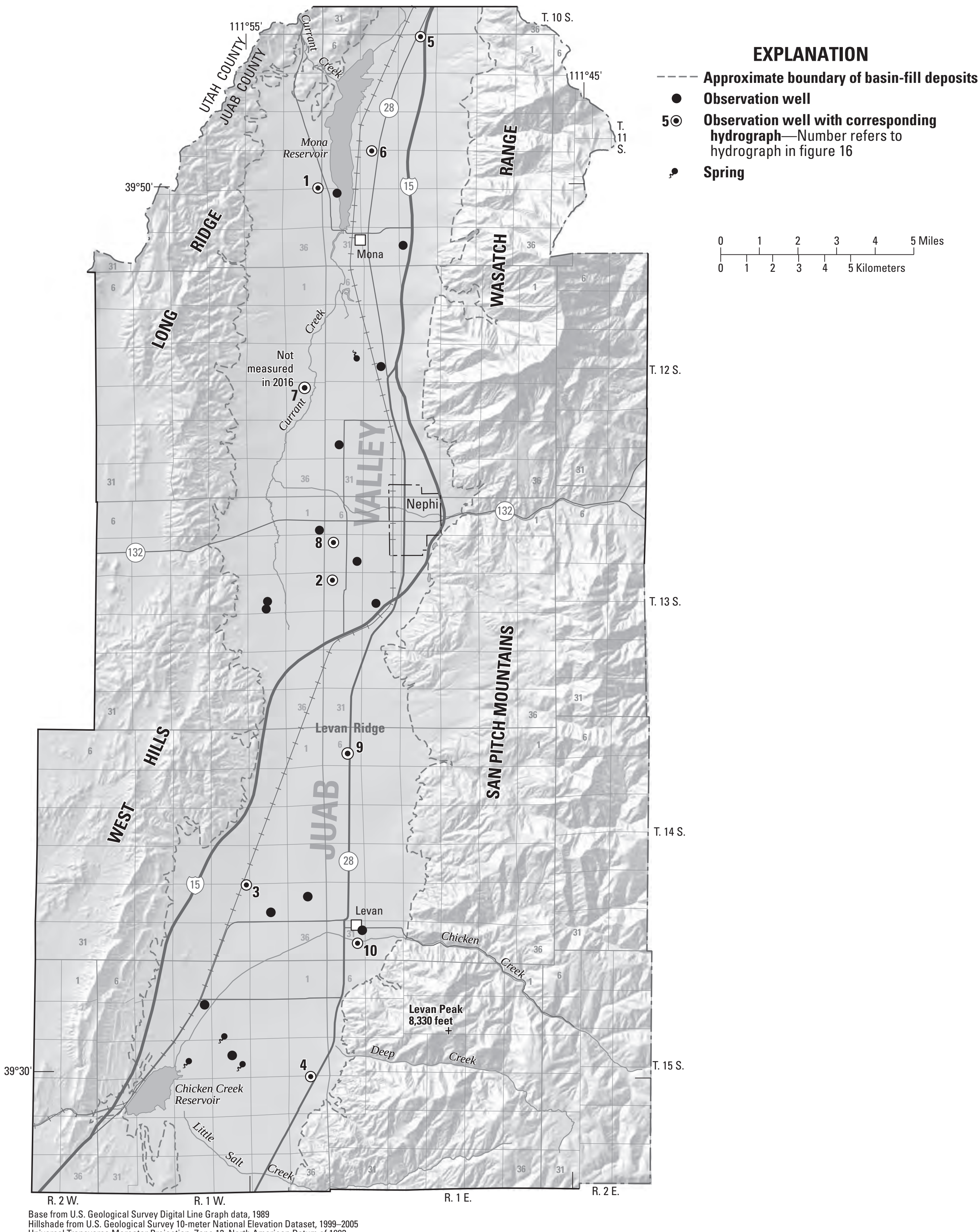


Figure 15. Location of wells in Juab Valley in which the water level was measured during March 2017.

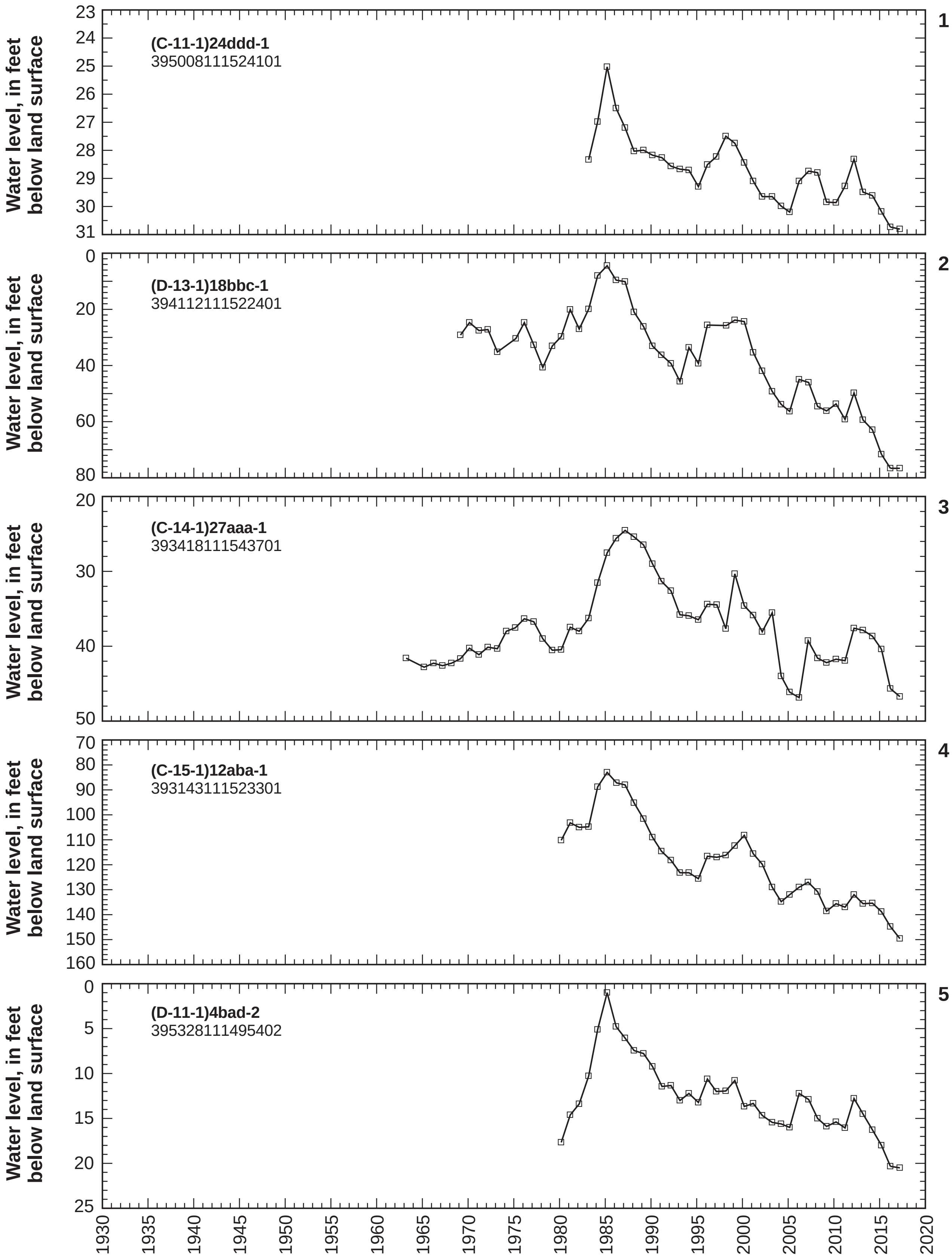


Figure 16. Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-14-1)26dbd-1.

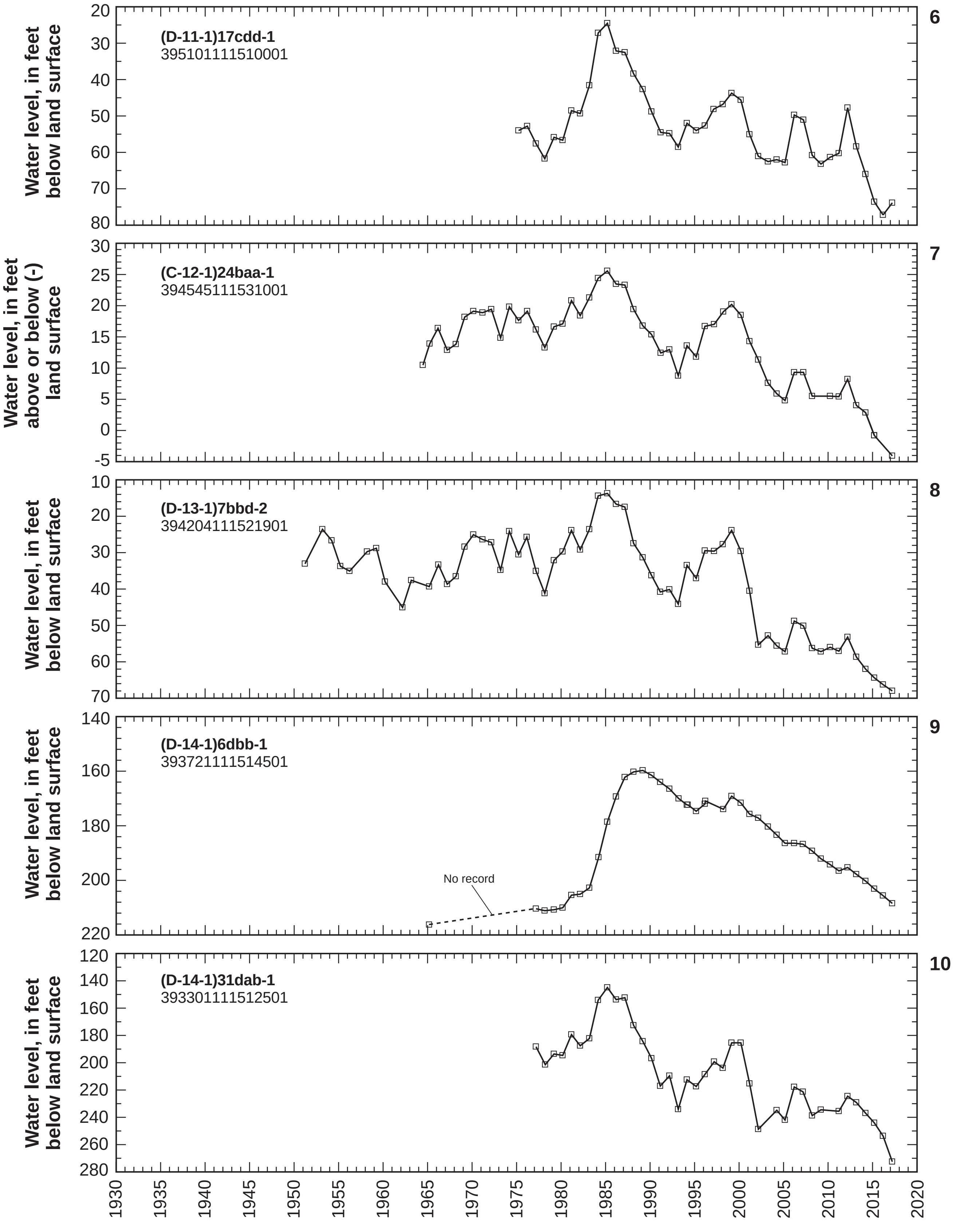


Figure 16. Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-14-1)26dbd-1.—Continued

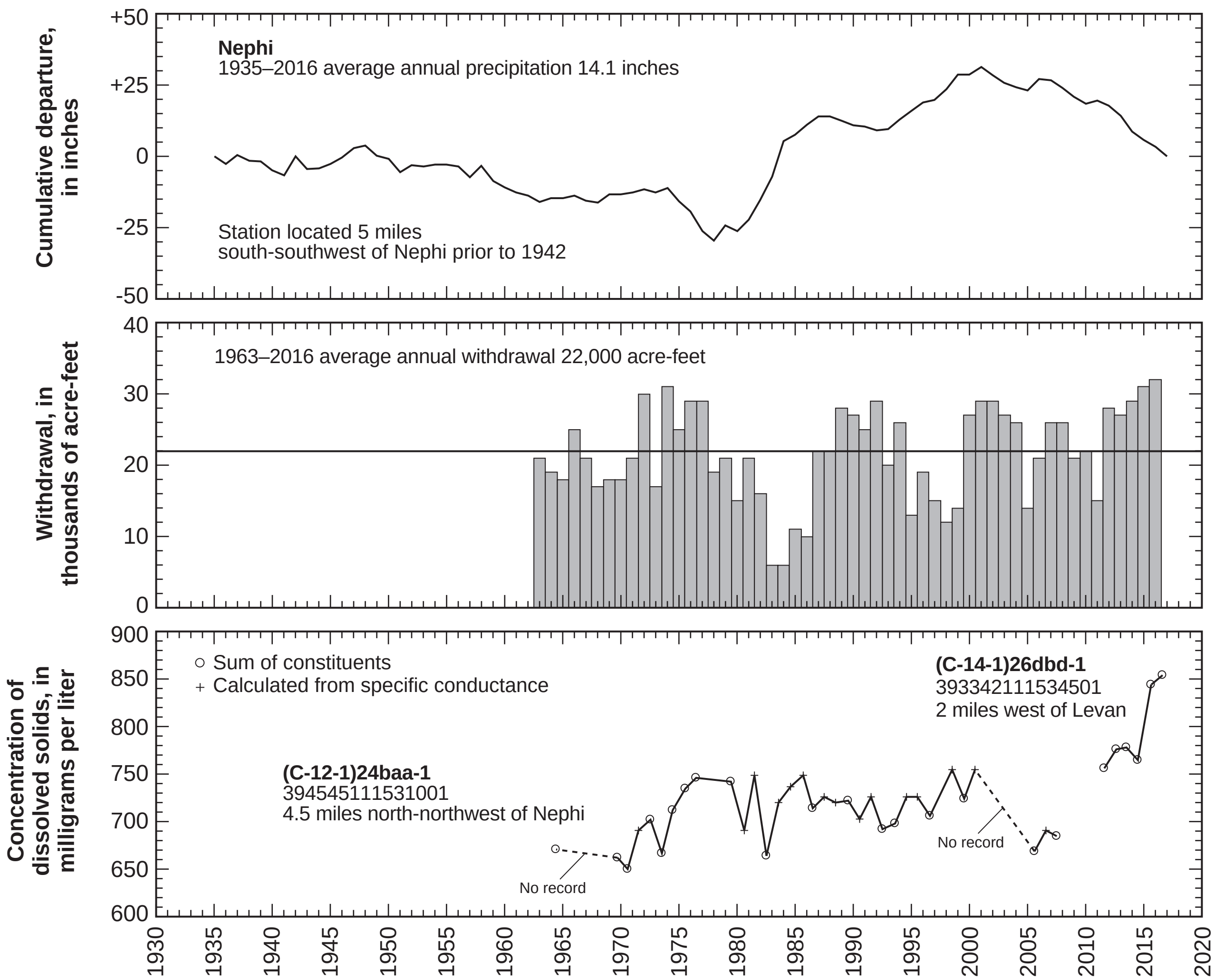


Figure 16. Relation of water level in selected wells in Juab Valley to cumulative departure from average annual precipitation at Nephi, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-14-1)26dbd-1.—Continued

Sevier Desert

By Travis L. Gibson

The part of the Sevier Desert described here covers about 2,000 square miles in northern Millard and southern Juab Counties (figs. 17 and 18). It principally includes the broad, gently sloping areas that radiate from the Canyon and Gilson Mountains to the east, the Drum Mountains to the west, and several non-continuous mountains to the north. Groundwater occurs in the Sevier Desert in unconsolidated basin-fill deposits under water-table and artesian conditions, and is used primarily for irrigation (table 2). Most of the groundwater is discharged from wells completed in either of two artesian aquifers—the shallow or deep artesian aquifer. The Sevier River enters the Sevier Desert from the east and is a source of recharge to the aquifers.

Total estimated withdrawal of water from wells in the Sevier Desert in 2016 was about 57,000 acre-feet, the largest annual withdrawal since records began in 1951. This is 2,000 acre-feet more than the total for 2015 and about 18,000 acre-feet more than the 2006–2015 average annual withdrawal (tables 2 and 3). The increase in withdrawals was mainly due to increased pumpage for industrial and public-supply use.

The location of wells in the Sevier Desert in which the water level was measured during March 2017 is shown in figures 17 and 18. The relation of the water level in selected observation wells 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)8cba-1 is shown in figure 19.

Discharge of the Sevier River near Juab in 2016 was 108,300 acre-feet, which is 11,500 acre-feet less than in 2015 and 69,900 acre-feet less than the long-term average (1935–2016). Precipitation at Oak City was about 14.2 inches in 2016, about 1.3 inches more than the 1930–2016 average annual precipitation and 3.9 inches more than in 2015.

Most water levels in the shallow artesian and deep artesian aquifers declined from March 2016 to March 2017 (fig. 19). In the shallow artesian aquifer, most water levels declined between 0 and 2 feet. In the deep artesian aquifer, most water levels declined between 1 and 6 feet. Declines are probably the result of continued large withdrawals for irrigation and less-than-average discharge of the Sevier River.

Periods when the water level in the shallow and deep aquifers generally rose (including 1980–89, 1995–99, 2006–07, and 2010–12) correspond to greater-than-average precipitation, less-than-average groundwater withdrawals, and greater-than-average discharge of the Sevier River, with apparent persistent recharge occurring to the deep aquifer in years following greater-than-average surface-water availability. Periods when the water level in the shallow and deep aquifers generally declined (including 1988–94, 2001–05, 2008–10, and 2013–17) correspond to less-than-average precipitation, greater-than-average groundwater withdrawals, and less-than-average discharge of the Sevier River. Overall, most water levels have generally declined since records began in the early 1960s.

The concentration of dissolved solids in water samples collected from well (C-15-4)8bcd-1, located 2.5 miles east of Lynndyl, from 1958 to 2016, is shown in figure 19. This well replaces (C-15-4)8cba-1. The dissolved-solids concentration in the water sample from August 2016 was 2,200 mg/L.

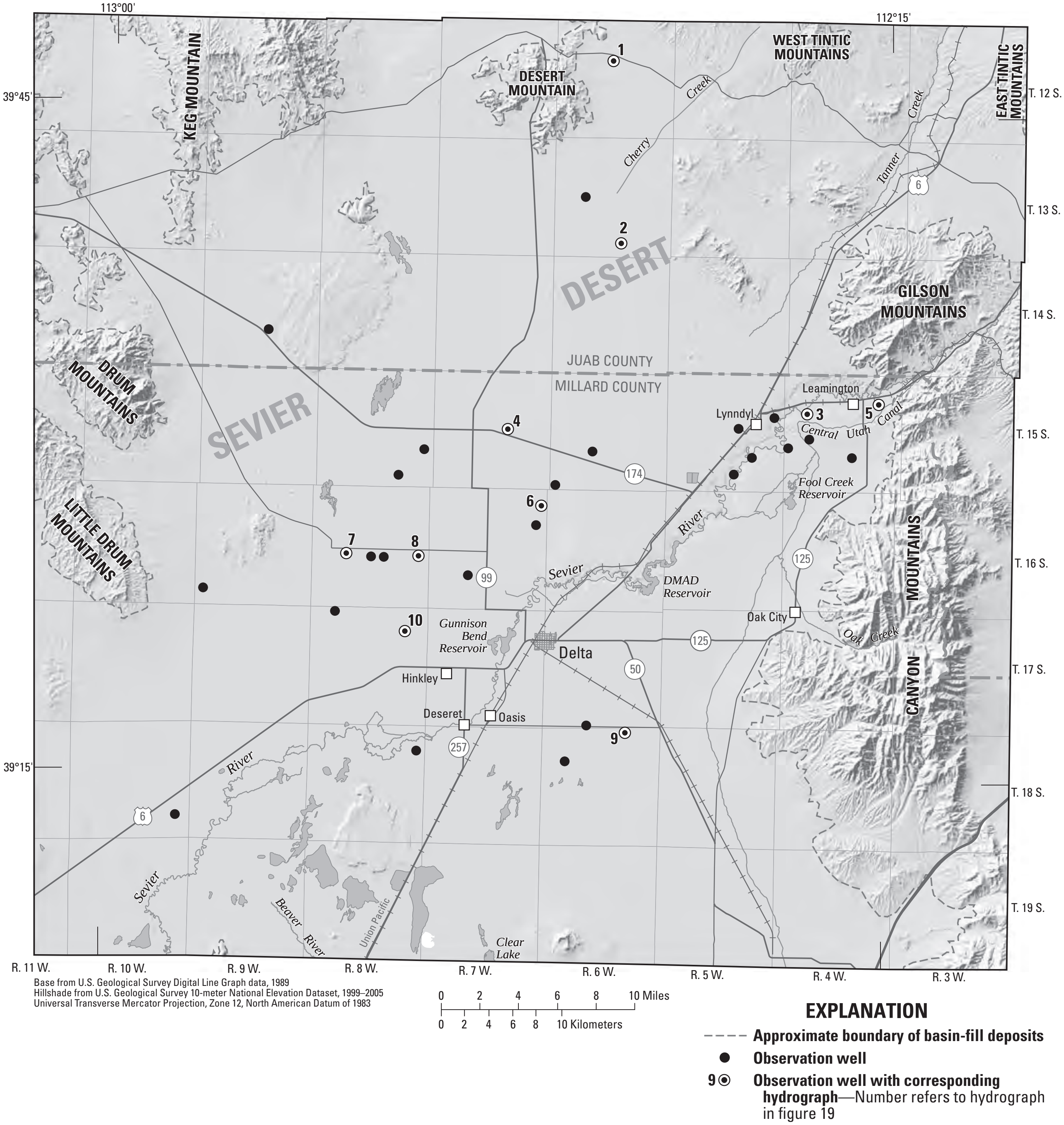


Figure 17. Location of wells in the shallow artesian aquifer in part of the Sevier Desert in which the water level was measured during March 2017.

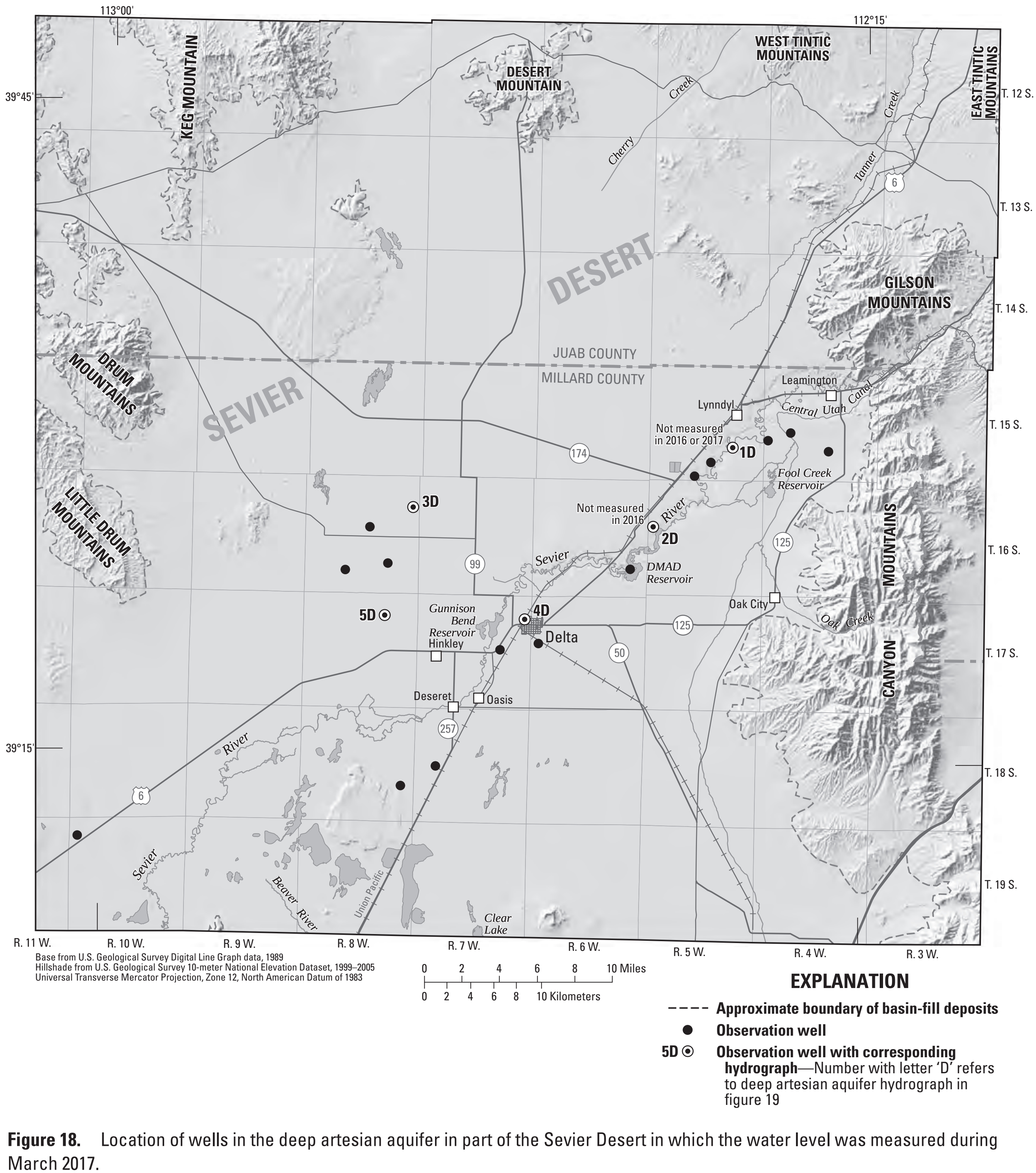


Figure 18. Location of wells in the deep artesian aquifer in part of the Sevier Desert in which the water level was measured during March 2017.

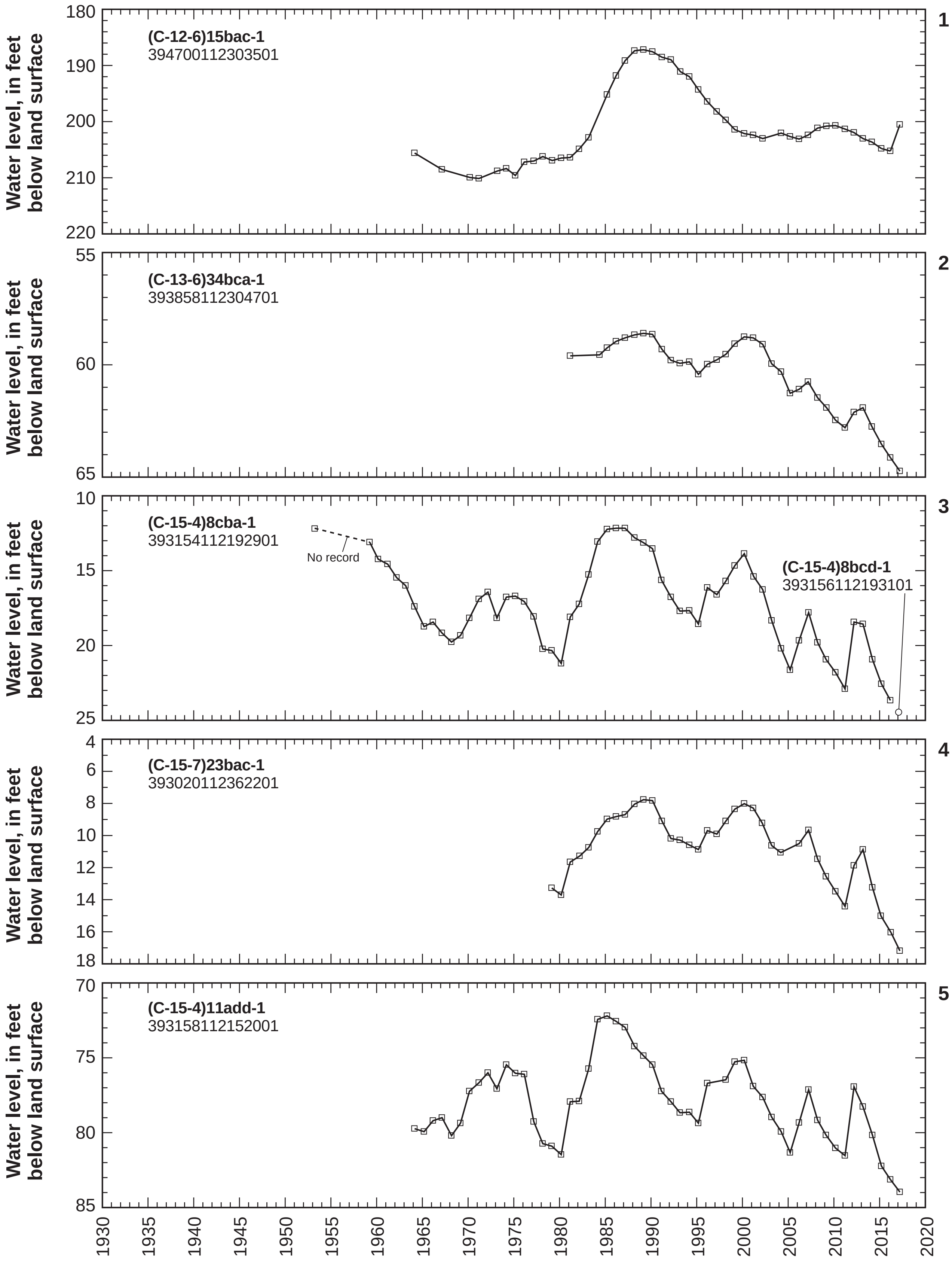


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)8bcd-1.

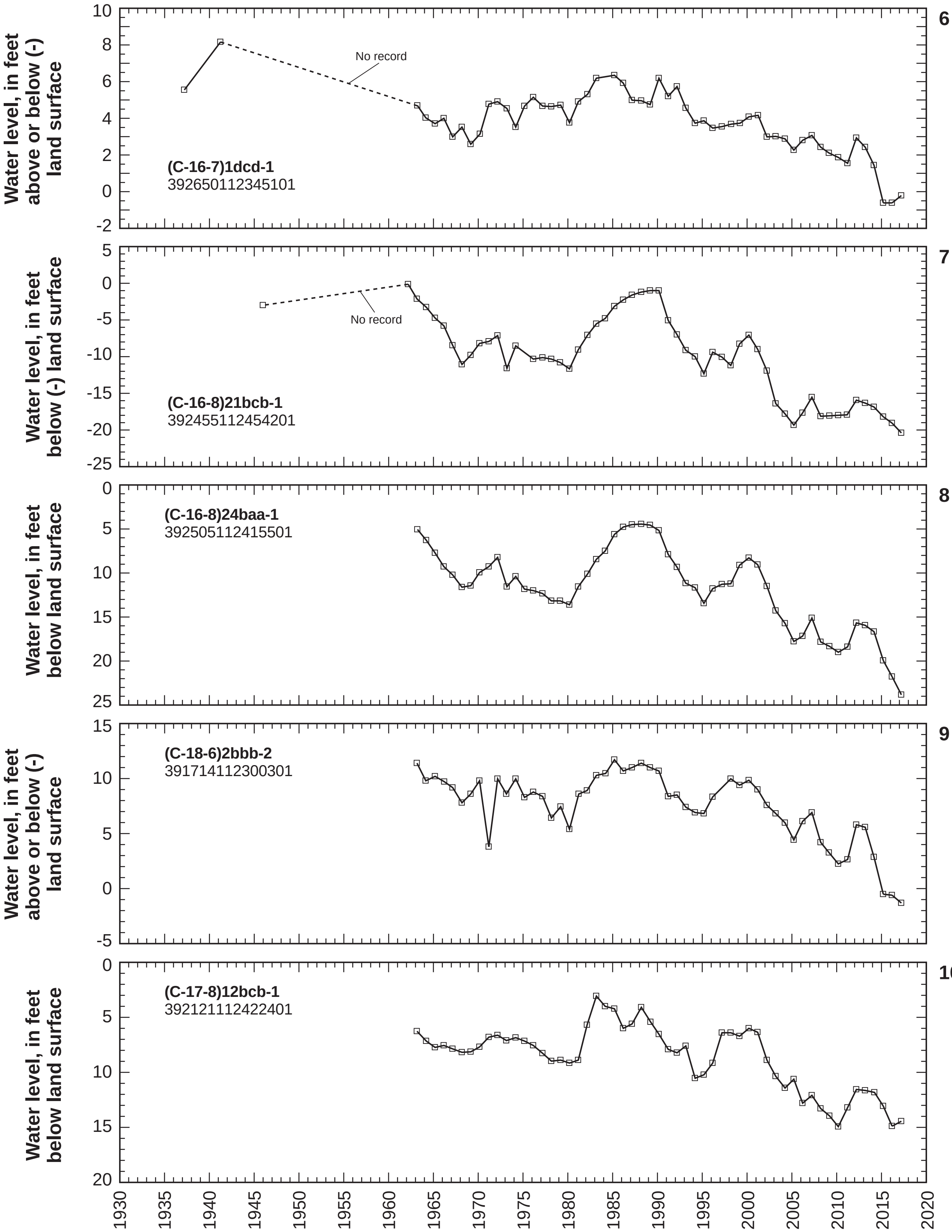


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)8bcd-1.—Continued

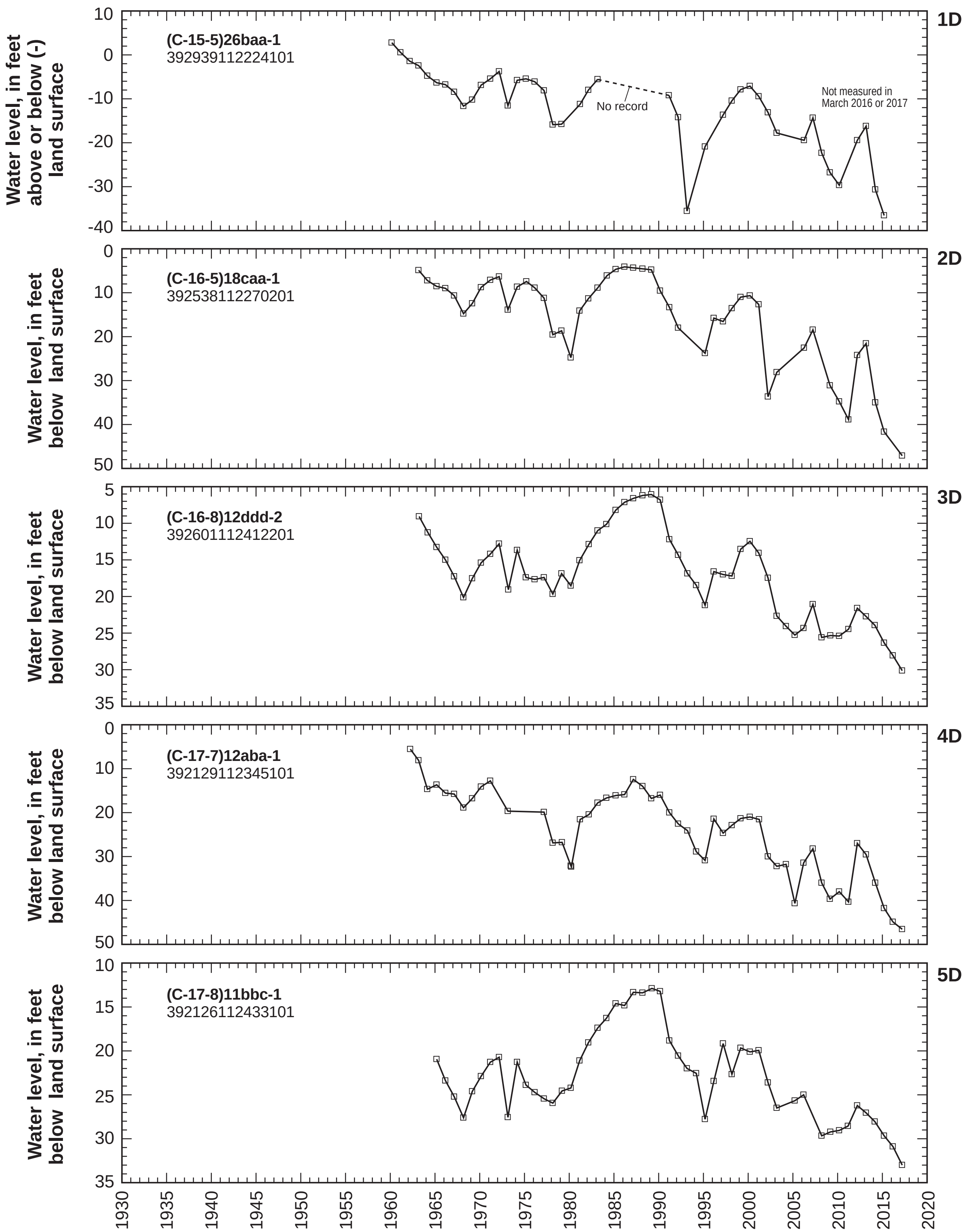


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)8bcd-1.—Continued

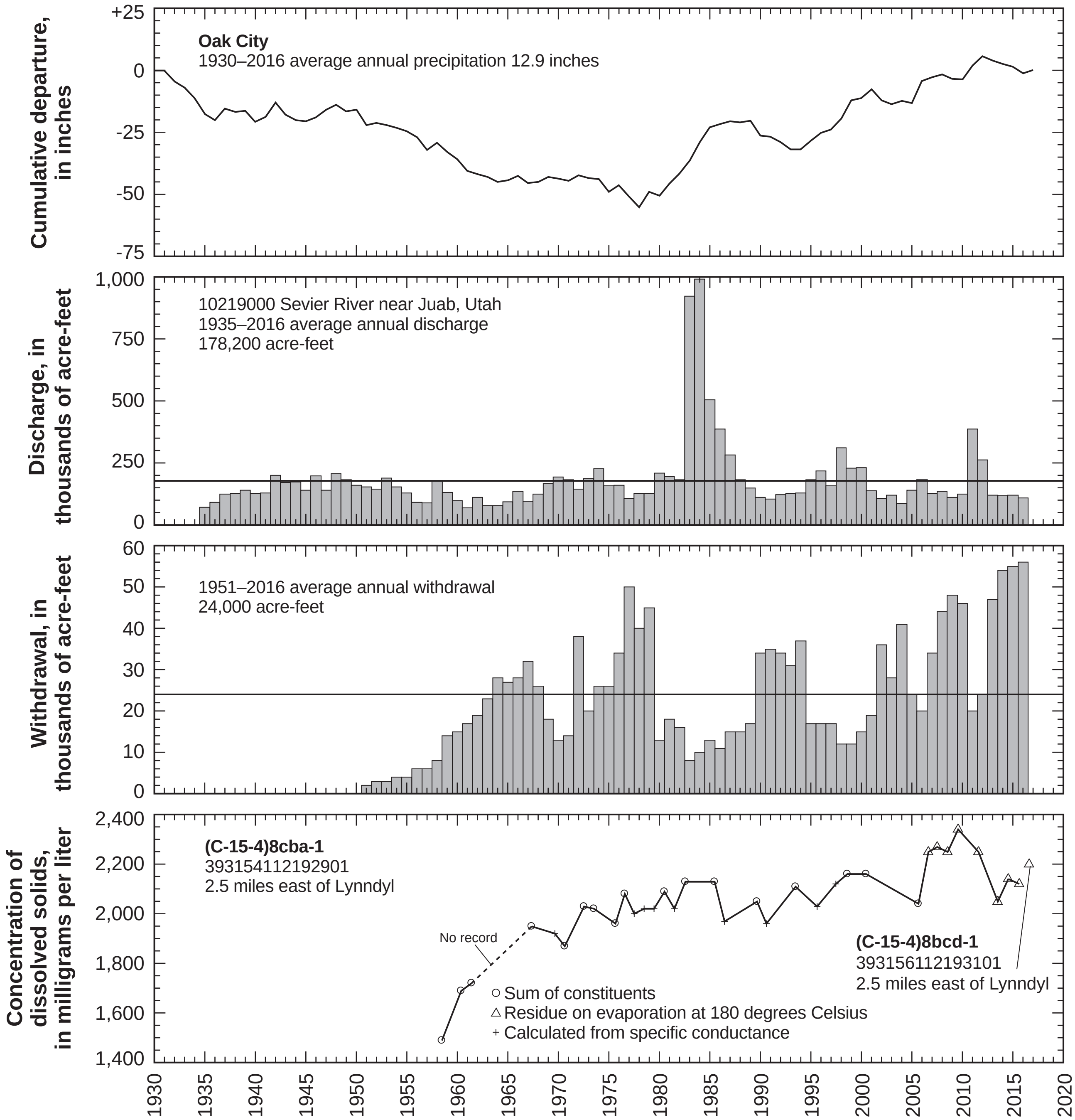


Figure 19. Relation of water level in selected wells in the Sevier Desert to annual discharge of the Sevier River near Juab, to cumulative departure from average annual precipitation at Oak City, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-15-4)8bcd-1.—Continued

Central Sevier Valley

By Bradley A. Slaugh

Central Sevier Valley, located in northern Piute, Sevier, and southern Sanpete Counties, in south-central Utah, is surrounded by the Sevier and Wasatch Plateaus to the east and the Tushar Mountains, Valley Mountains, and Pahvant Range to the south and west (fig. 20). Altitude ranges from 5,100 feet on the valley floor at the north end of the valley near Gunnison to more than 12,000 feet in the Tushar Mountains. Groundwater occurs in unconsolidated basin-fill deposits under both water-table and artesian conditions, and is used primarily for irrigation (table 2).

Total estimated withdrawal of water from wells in central Sevier Valley in 2016 was about 32,000 acre-feet, which is 2,000 acre-feet more than was reported for 2015 and 6,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3).

The location of 24 wells in central Sevier Valley in which the water level was measured during March 2017 is shown in figure 20. The relation of the water level in selected observation wells to annual discharge of the Sevier River at Hatch, Utah, to cumulative departure from average annual precipitation at Richfield Radio KVSC, 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.

Discharge of the Sevier River at Hatch, Utah, in 2016 was about 72,900 acre-feet, which is 25,600 acre-feet more than in 2015, and about 6,700 acre-feet less than the 1940–2016 average annual discharge. Precipitation at Richfield Radio KVSC was about 6.6 inches in 2016, which is about 1.5 inches less than the 1950–2016 average annual precipitation and 4.4 inches less than in 2015.

Water levels in central Sevier Valley generally declined in most areas from March 2016 to March 2017. Hydrographs for selected wells show that March water levels generally rose from about 1978 to 1985 and declined from 1985 to about 1993. Since 1993, water levels have fluctuated depending upon the amount and timing of precipitation and recharge to the basin-fill aquifer from snowmelt runoff.

The concentration of dissolved solids in water samples collected from well (C-23-2)15dcb-4, located 0.1 mile south of the Sevier River in Venice, Utah, from 1955 to 2016, is shown in figure 21. The concentration has ranged from 307 to 630 mg/L during this period. There were substantial increases and decreases in dissolved-solids concentration during the mid- to late 1960s and 1980s. Dissolved-solids concentrations in samples collected from 1990 through 2016 show little variability and are generally near the median value (410 mg/L) for all sample concentrations. The dissolved-solids concentration in the water sample from July 2016 was 386 mg/L.

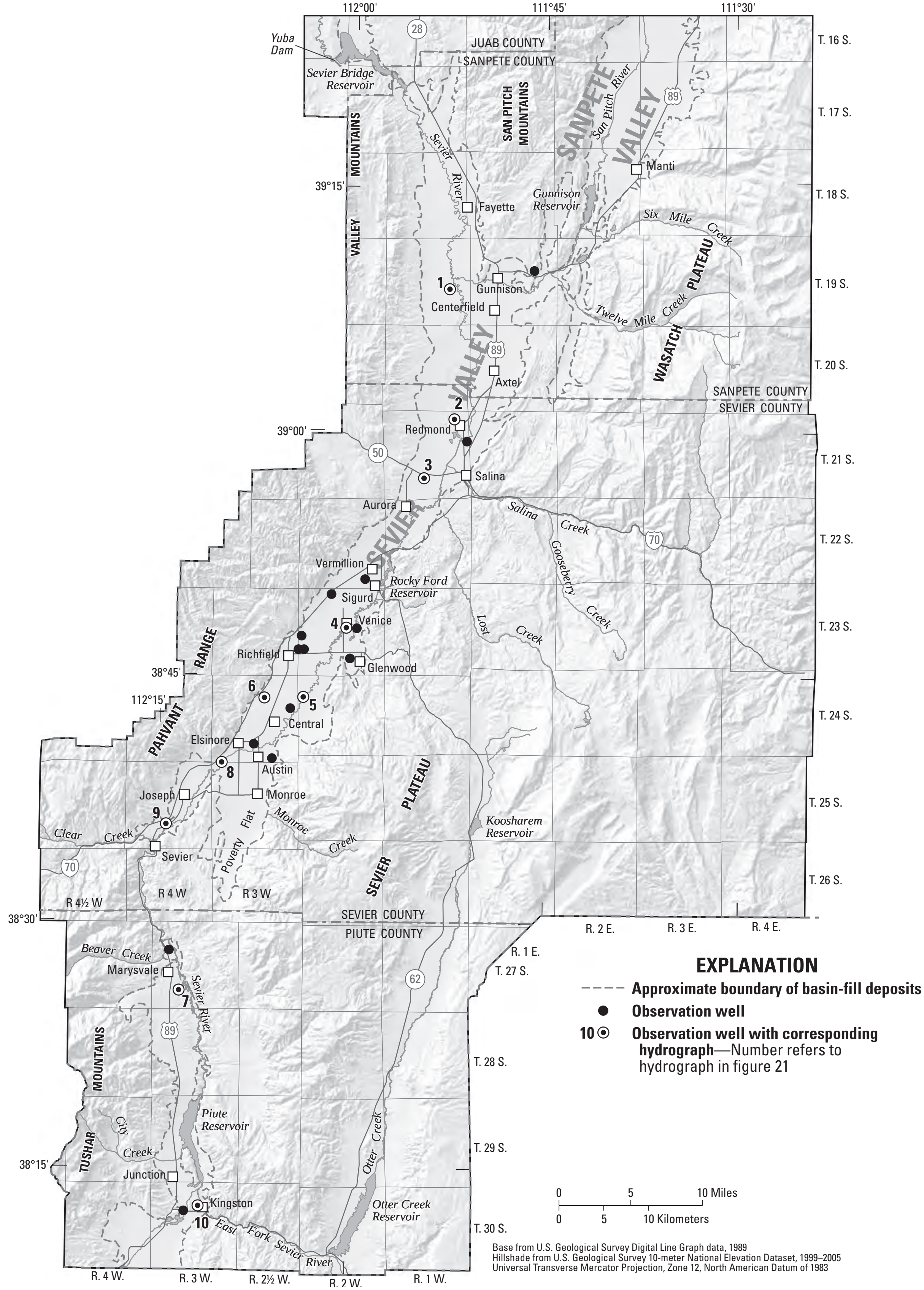


Figure 20. Location of wells in central Sevier Valley in which the water level was measured during March 2017.

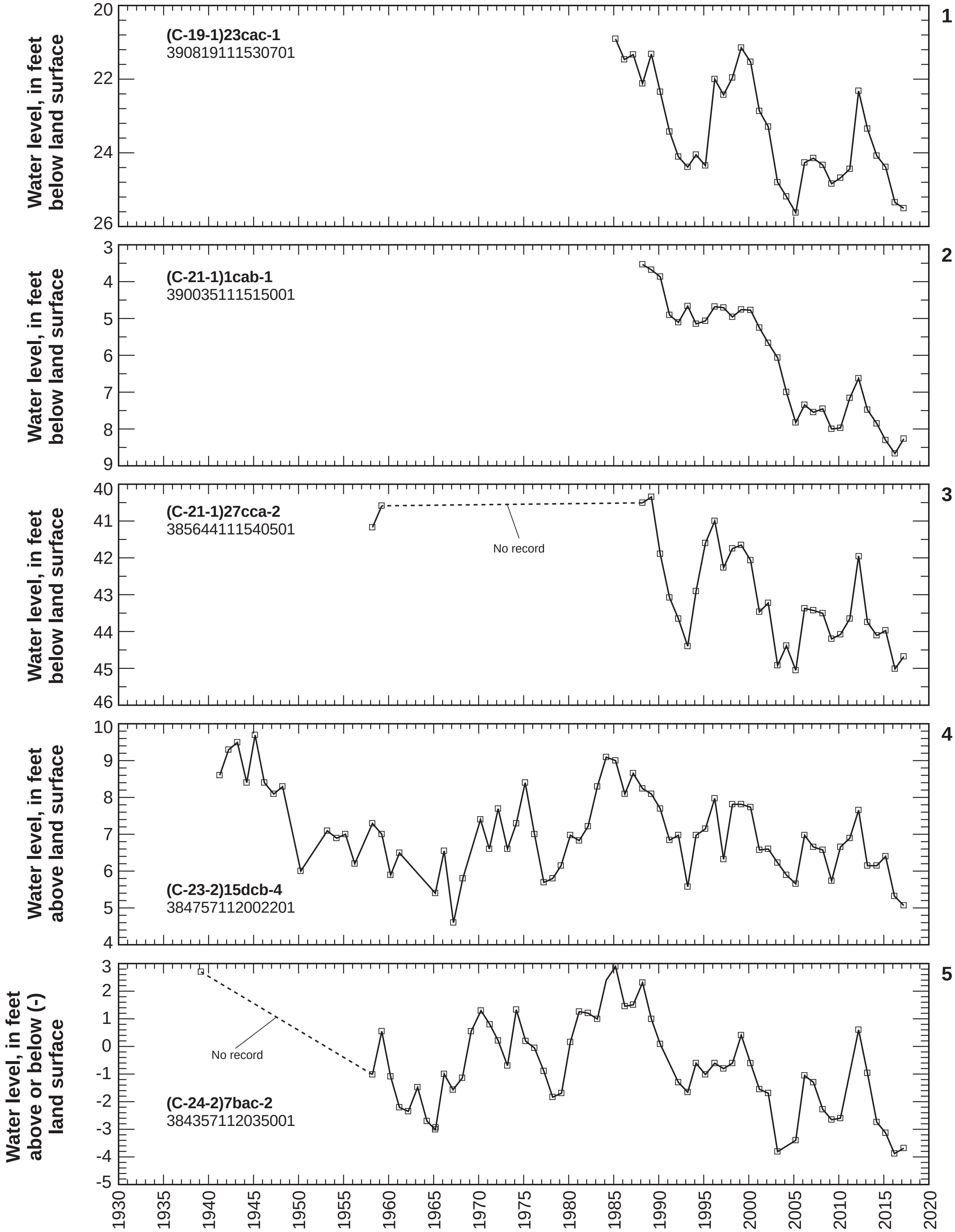


Figure 21. Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, Utah, to cumulative departure from average annual precipitation at Richfield Radio KVSC, to annual withdrawal from wells, and to concentration of dissolved solids in water from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

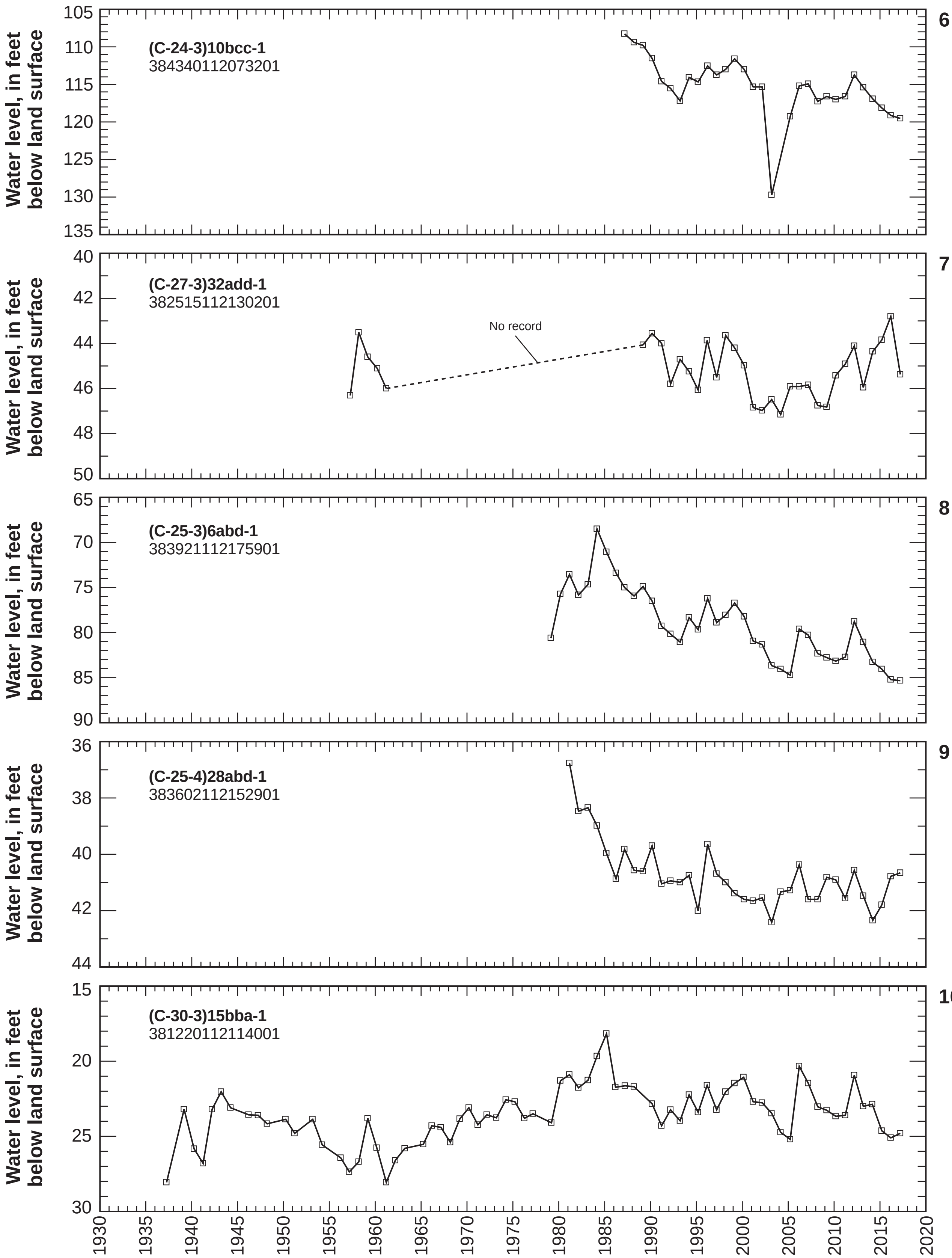


Figure 21. Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, Utah, to cumulative departure from average annual precipitation at Richfield Radio KVSC, to annual withdrawal from wells, and to concentration of dissolved solids in water from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

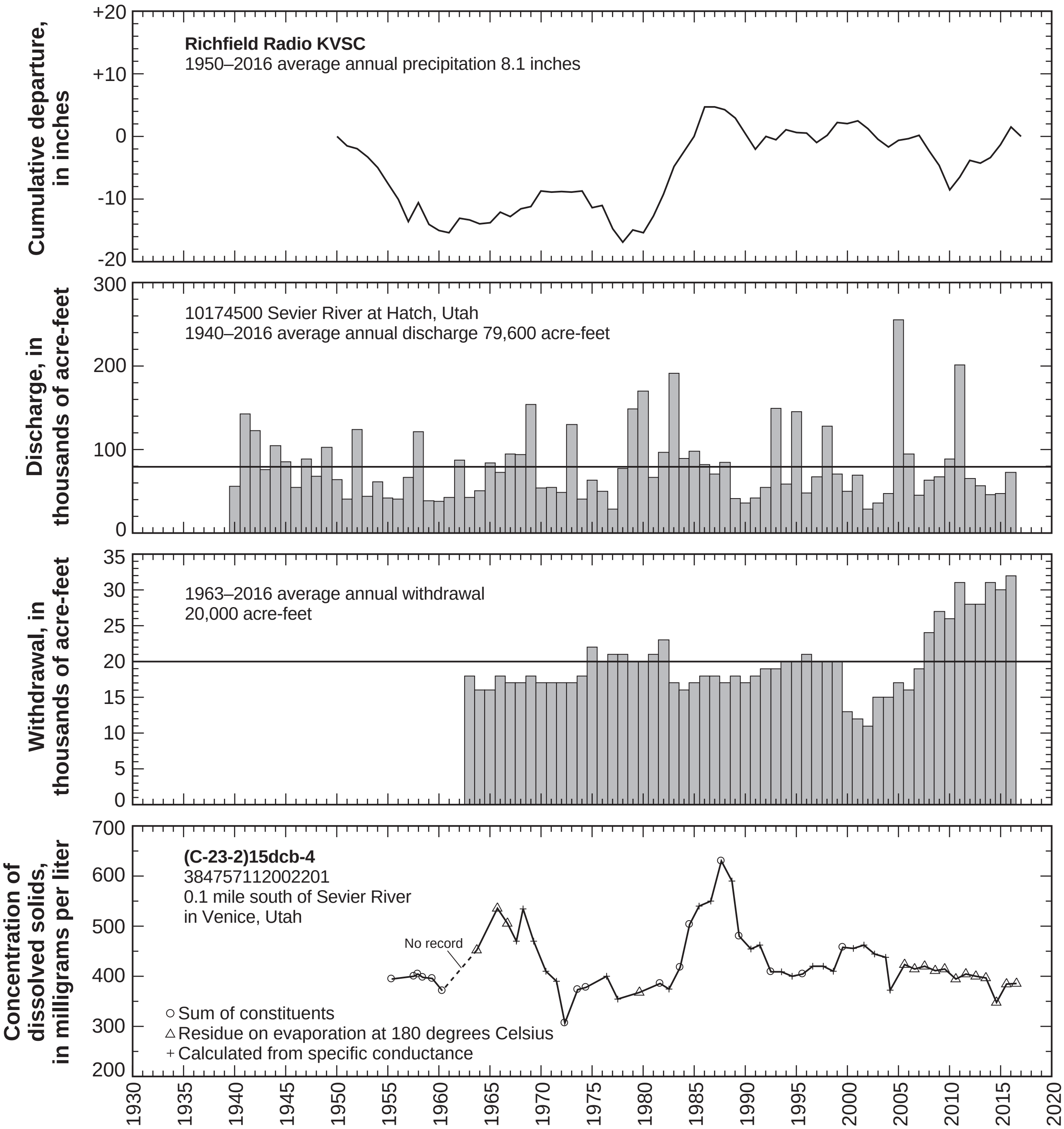


Figure 21. Relation of water level in selected wells in central Sevier Valley to annual discharge of the Sevier River at Hatch, Utah, to cumulative departure from average annual precipitation at Richfield Radio KVSC, to annual withdrawal from wells, and to concentration of dissolved solids in water from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

Pahvant Valley

By Nickolas R. Whittier

Pahvant Valley, in southeastern Millard County, extends from the vicinity of McCornick in the north to Kanosh in the south, and from the Pahvant Range and Canyon Mountains on the east and northeast to a low basalt ridge known as The Cinders on the west (fig. 22). The area of the valley is about 300 square miles. Groundwater drains west to the valley from the mountainous terrain to the east. Groundwater occurs in unconsolidated basin-fill deposits and basalt in the valley under both water-table and artesian conditions, and is used primarily for irrigation (table 2).

Total estimated withdrawal of water from wells in Pahvant Valley in 2016 was about 114,000 acre-feet, which is about 14,000 acre-feet less than was reported in 2015 and 11,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3). Withdrawal for irrigation in 2016 was about 113,000 acre-feet, which is 14,000 acre-feet less than was reported in 2015.

The location of wells in Pahvant Valley in which the water level was measured during March 2017 is shown in figure 22. The relation of the water level in selected observation 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. Precipitation at Fillmore during 2016 was about 16.2 inches, which is about 1.0 inch more than the average annual precipitation for 1930–2016 and about 4.2 inches more than in 2015.

Water levels generally declined from March 2016 to March 2017 in nearly all parts of Pahvant Valley for which data are available. Water-level declines of more than 6 feet occurred in several wells north of Flowell. These declines are probably the result of continued large localized 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 rose substantially from 1982 to 1985 as a result of greater-than-average precipitation and decreased withdrawals for irrigation. Water levels generally have declined steeply throughout the valley since the mid- to late 1980s.

The concentration of dissolved solids in water samples collected from wells (C-21-5)7cdd-2 and (C-21-5)7cdd-3, located in the Flowell area, from 1954 to 1958 and 1960 to 2016, respectively, and from well (C-23-6)8abd-1, located in the Kanosh area, from 1957 to 2016, is shown in figure 23. Wells (C-21-5)7cdd-2 and (C-21-5)7cdd-3 are located near each other and are finished in the same aquifer. The dissolved-solids concentrations in water samples from these wells were combined to give an extended temporal record for this constituent. Dissolved-solids concentrations in water samples from these wells have ranged from 707 to 1,080 mg/L. The concentration of dissolved solids in the water sample collected in June 2016 was 1,080 mg/L. The concentration of dissolved solids in water samples from well (C-23-6)8abd-1 has ranged from 2,350 to 5,990 mg/L. The concentration of dissolved solids in the water sample collected from this well in June 2016 was 5,860 mg/L. These increases are probably due to continued large withdrawals for irrigation.

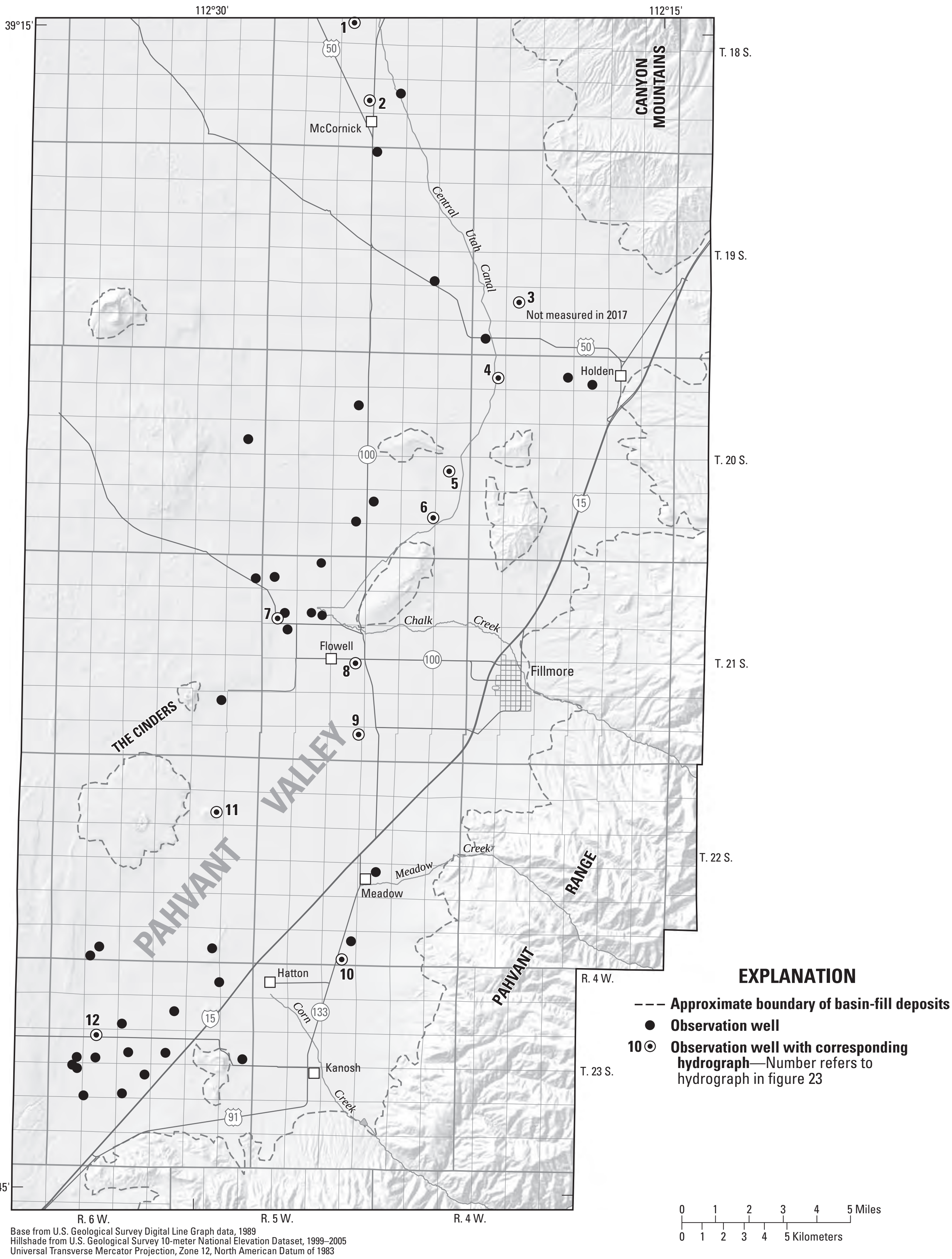


Figure 22. Location of wells in Pahvant Valley in which the water level was measured during March 2017.

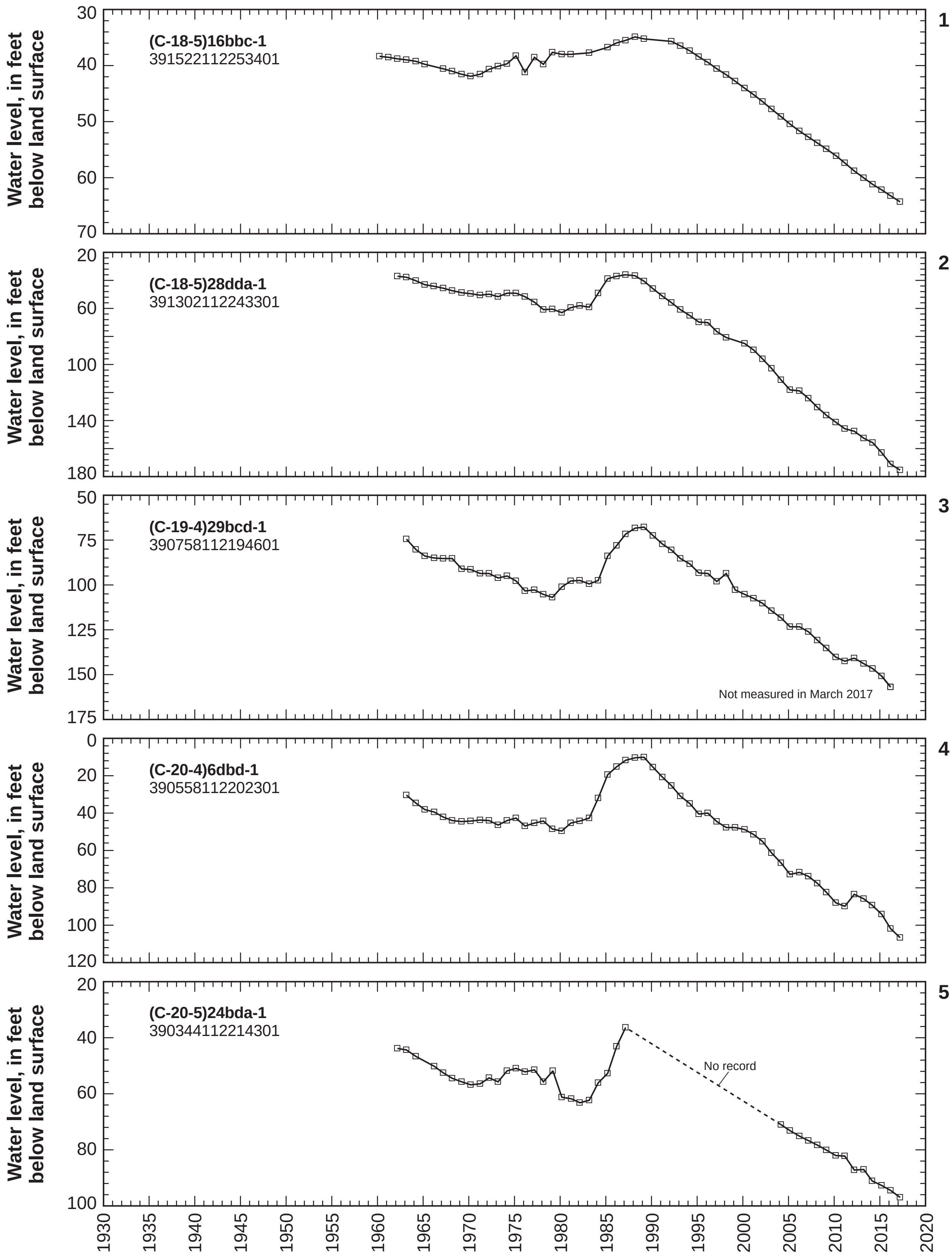


Figure 23. Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.

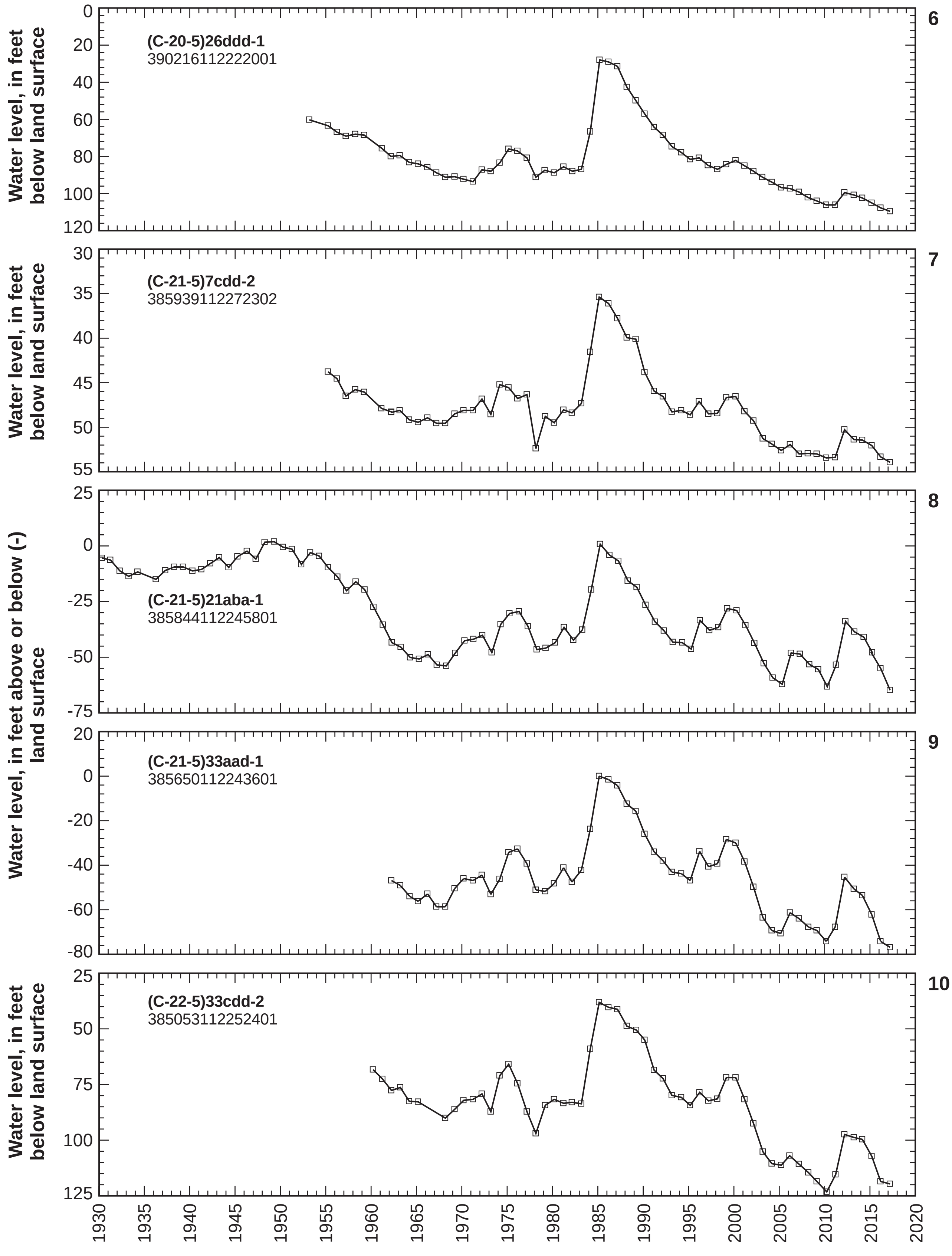


Figure 23. Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.—Continued

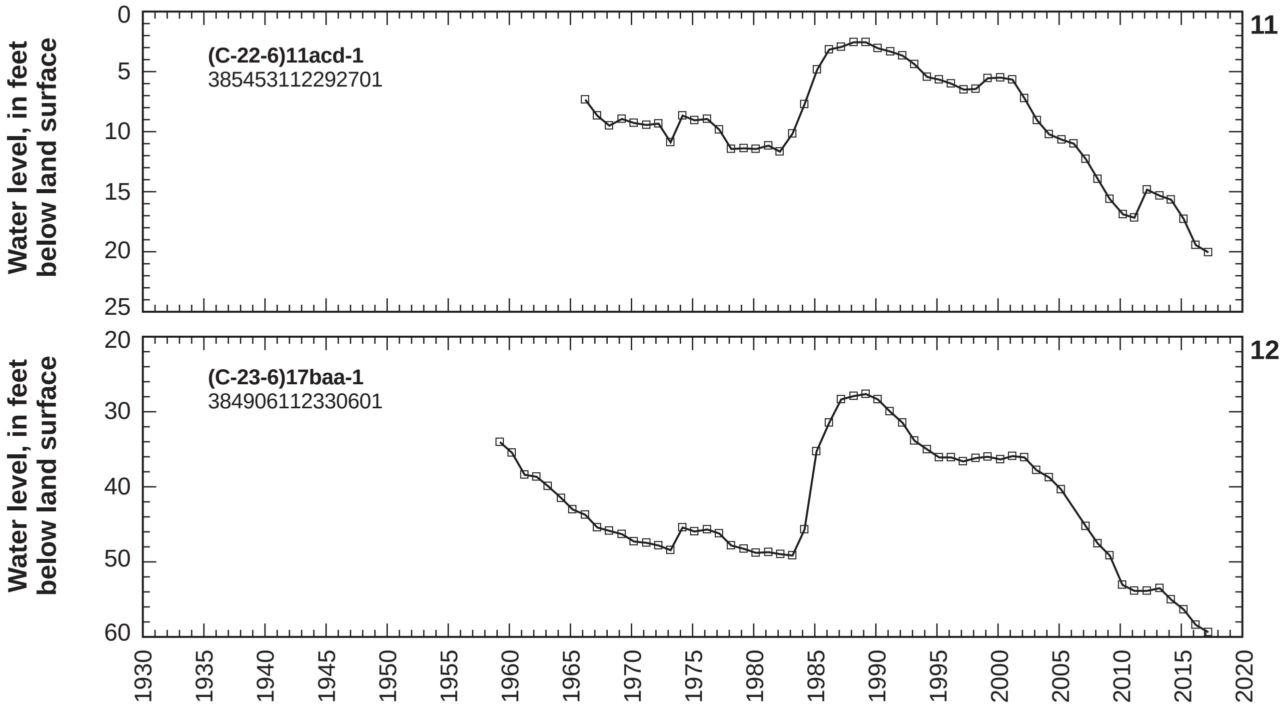


Figure 23. Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.—Continued

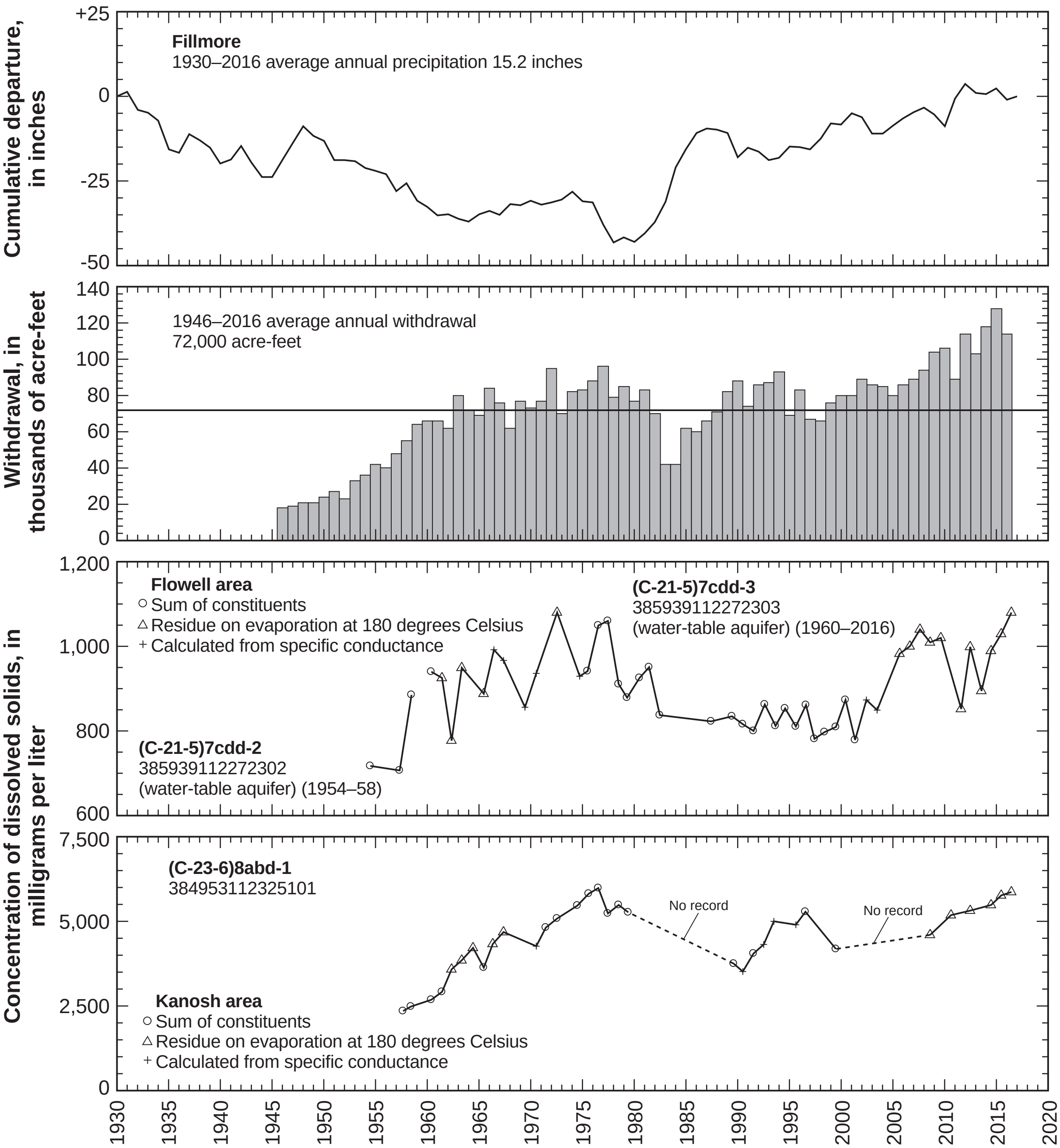


Figure 23. Relation of water level in selected wells in Pahvant Valley to cumulative departure from average annual precipitation at Fillmore, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells.—Continued

Cedar Valley, Iron County

By Andrew D. Freel

Cedar Valley is in eastern Iron County, southwestern Utah, and lies along the western edge of the Hurricane Cliffs. The valley covers about 220 square miles from the vicinity of Rush Lake in the north to the community of Kanarraville in the south and includes Cedar City on its eastern edge (fig. 24). Groundwater in Cedar Valley occurs in unconsolidated basin-fill deposits, mostly under water-table conditions, and is used primarily for irrigation (table 2). The principal source of recharge to the basin-fill aquifer is water from Coal Creek.

Total estimated withdrawal of water from wells in Cedar Valley in 2016 was about 39,000 acre-feet, which is 1,000 acre-feet less than in 2015 and the same as the average annual withdrawal for 2006–2015 (tables 2 and 3).

The location of wells in Cedar Valley in which the water level was measured during March 2017 is shown in figure 24. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, Utah, to annual withdrawal from wells, and to concentration of dissolved solids in water from selected wells is shown in figure 25.

Precipitation at Cedar City Federal Aviation Administration Airport in 2016 was about 10.8 inches, which is about 2.6 inches less than the total for 2015 and 0.1 inch less than the average annual precipitation for 1949–2016. Discharge of Coal Creek was about 23,700 acre-feet in 2016, which is 8,300 acre-feet more than in 2015, and 600 acre-feet less than the average annual discharge for 1936 and 1939–2016.

Groundwater levels declined from March 2016 to March 2017 in most parts of Cedar Valley. The largest decline, about 4.9 feet, was measured in a well near Kanarraville. Water-level declines are probably the result of continued large withdrawals for irrigation.

The concentration of dissolved solids in water samples collected from well (C-37-12)23abd-1, located about 2.0 miles northeast of Kanarraville, from 1991 to 2015, and well (C-35-11)31dbd-1, located about 4 miles northwest of Cedar City, from 1991 to 2016, is shown in figure 25. The dissolved-solids concentrations in water from both wells have generally increased, probably due to localized pumpage for irrigation.

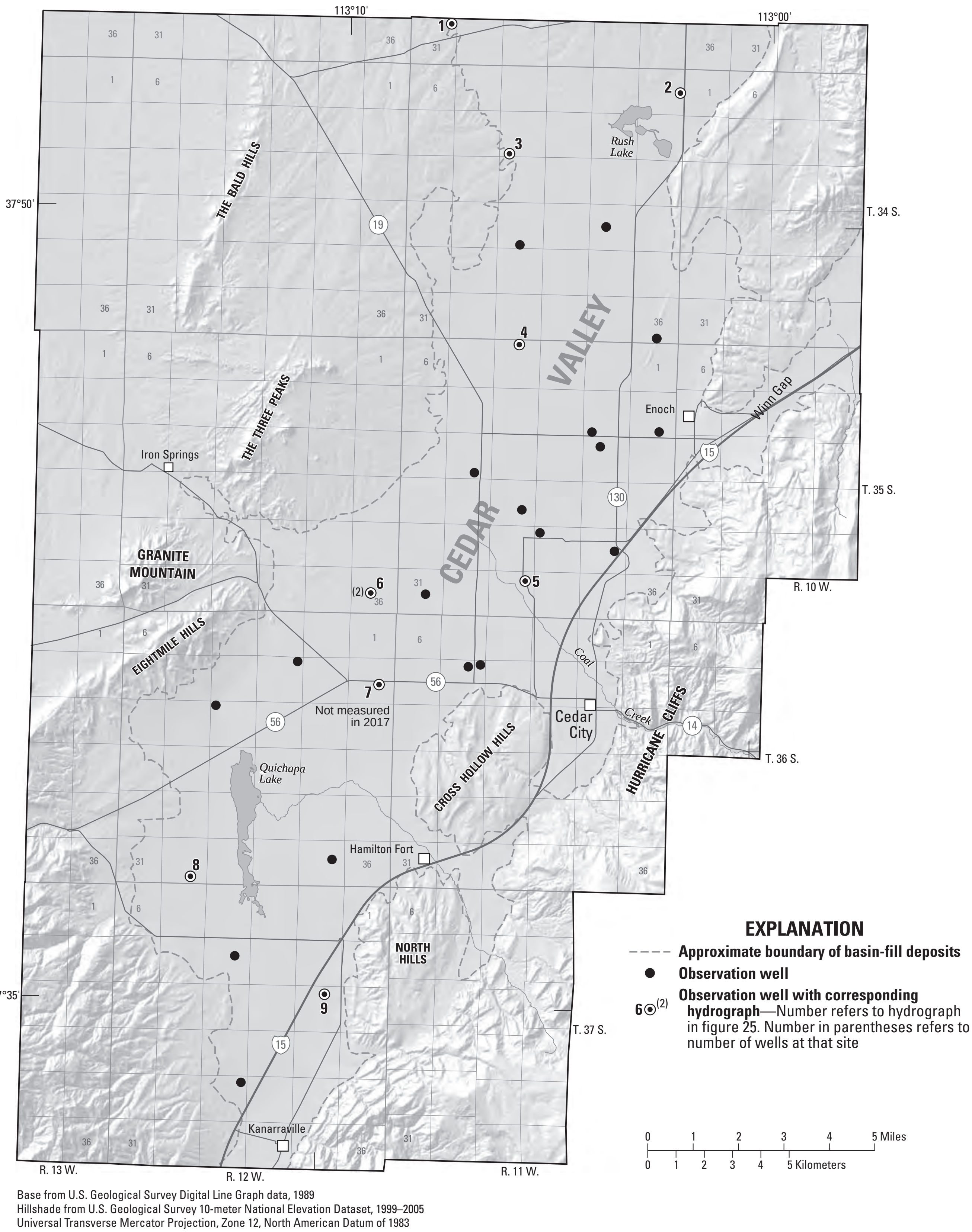


Figure 24. Location of wells in Cedar Valley, Iron County, in which the water level was measured during March 2017.

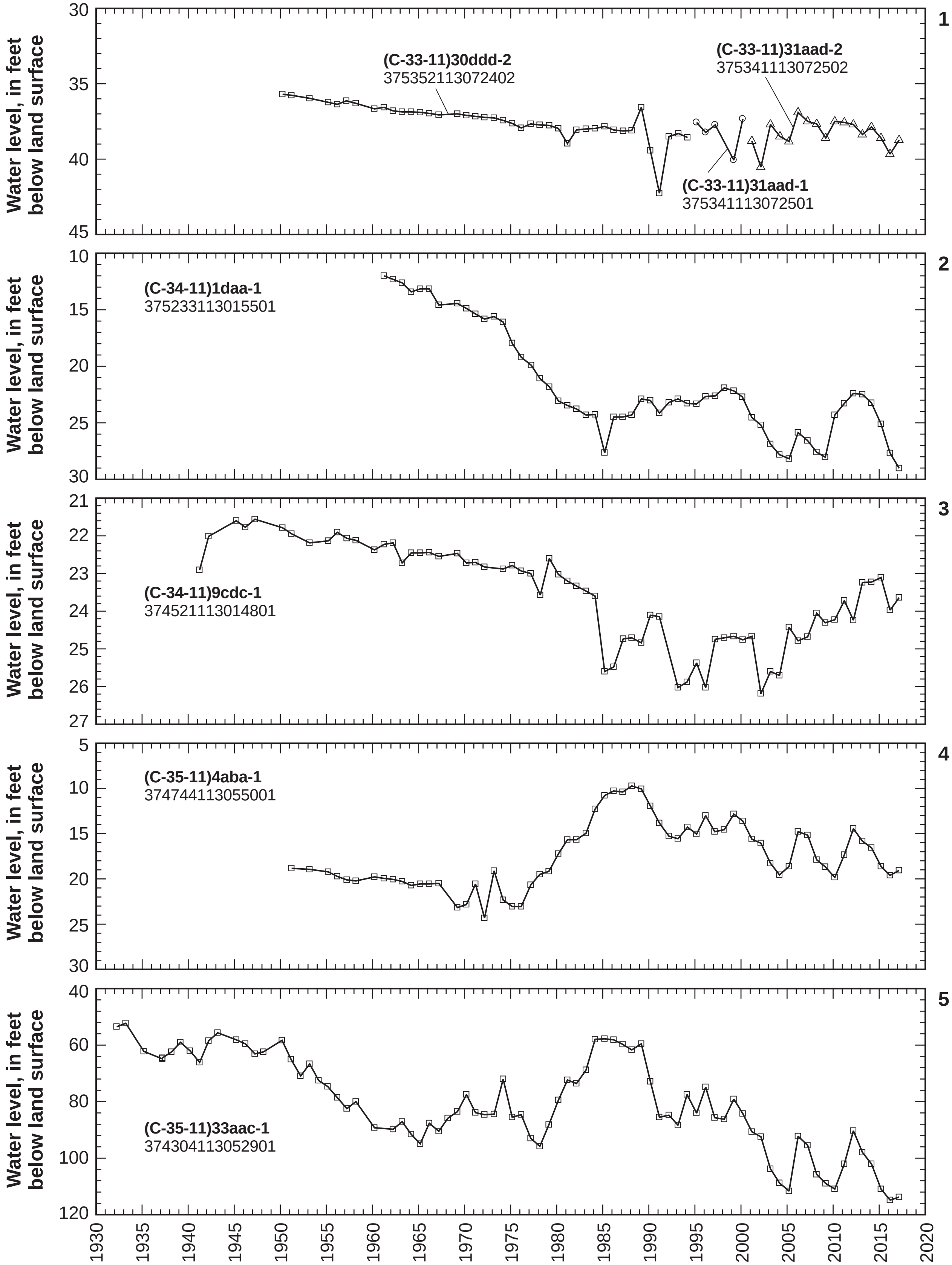


Figure 25. Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, Utah, to annual withdrawal from wells, and to concentration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

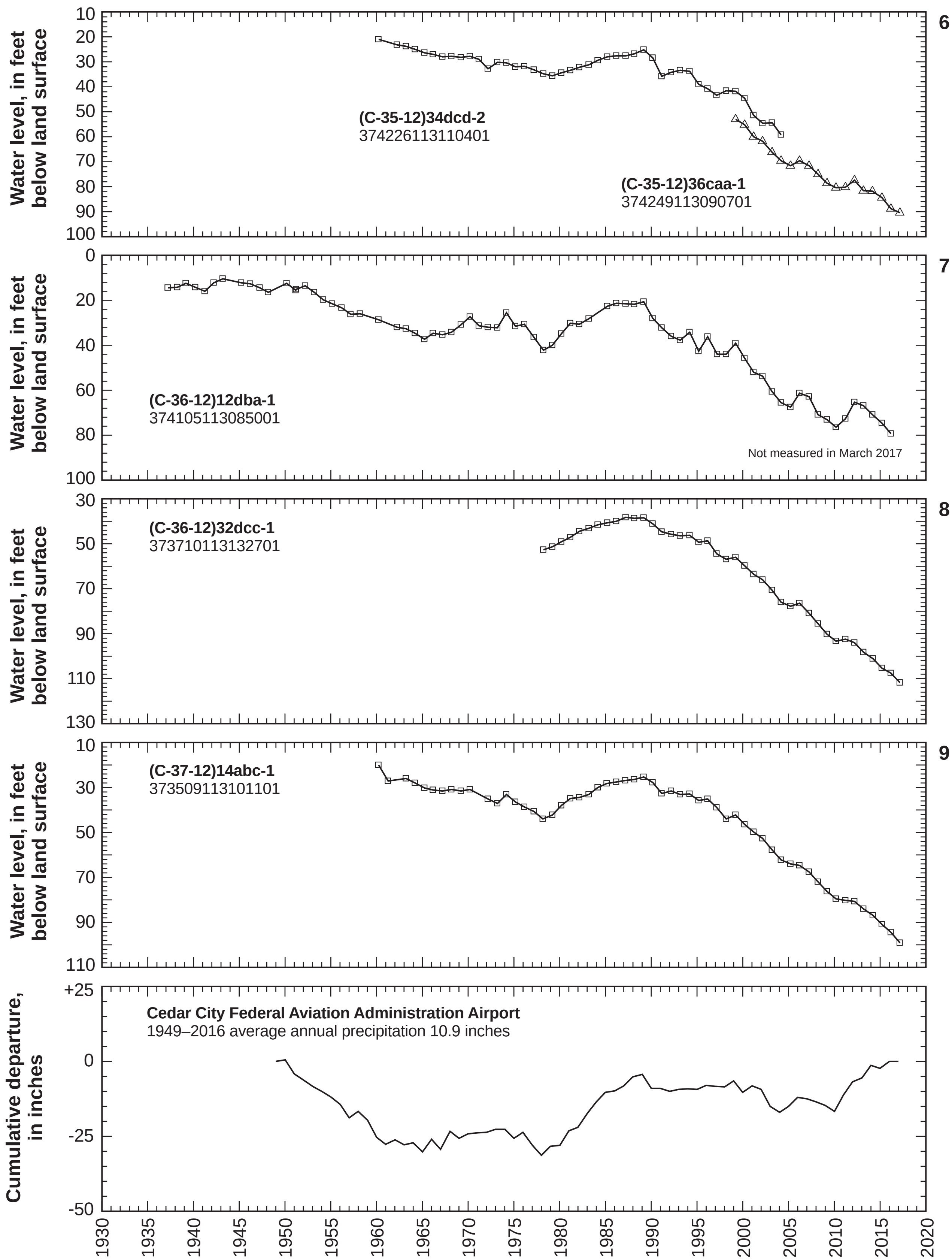


Figure 25. Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, Utah, to annual withdrawal from wells, and to concentration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

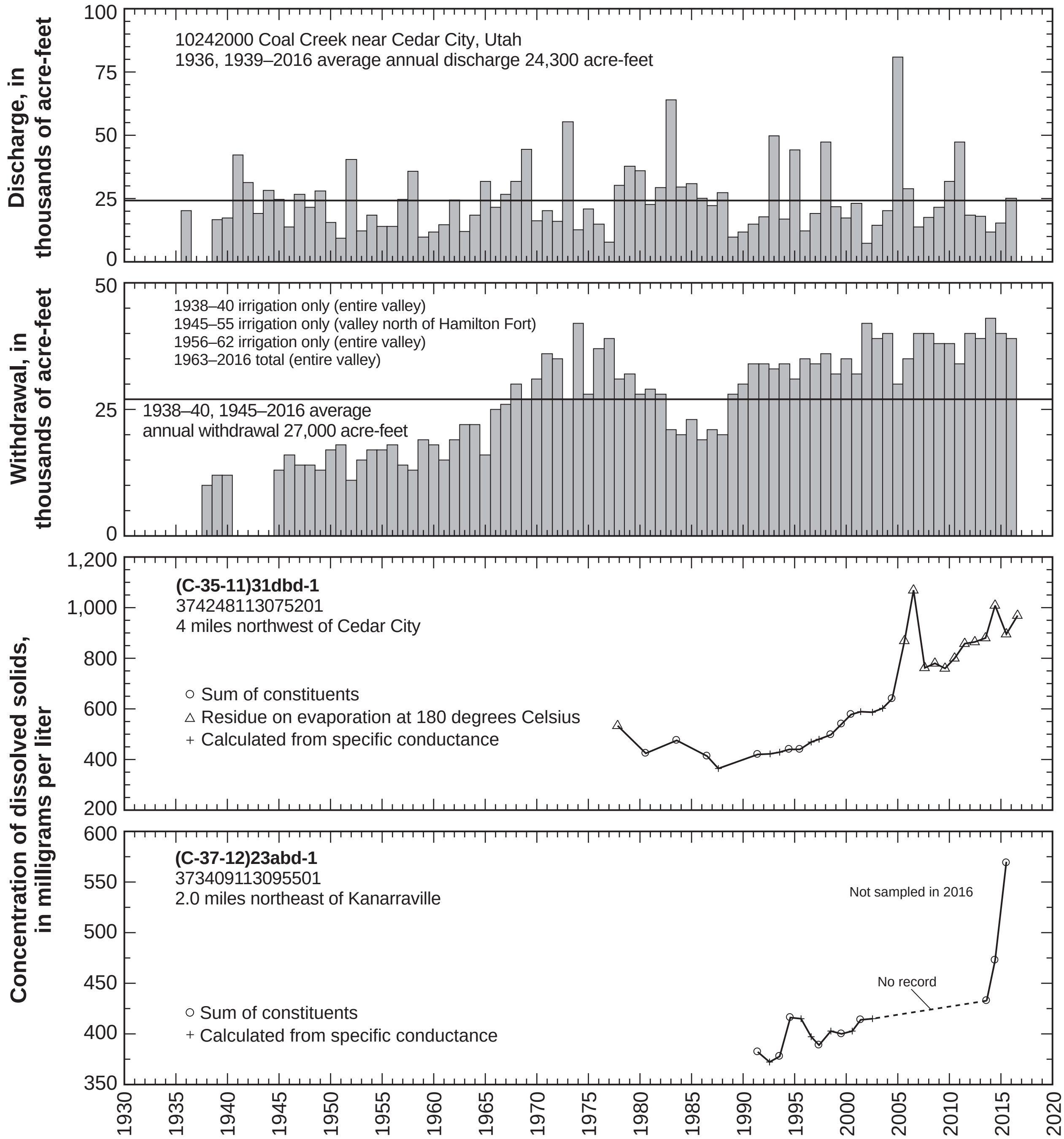


Figure 25. Relation of water level in selected wells in Cedar Valley, Iron County, to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual discharge of Coal Creek near Cedar City, Utah, to annual withdrawal from wells, and to concentration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

Parowan Valley

By Andrew D. Freel

Parowan Valley is in northern Iron County, southwestern Utah. The valley covers about 160 square miles west of the Hurricane Cliffs and east of Black Mountain, and includes the towns of Paragonah, Parowan, and Summit (fig. 26). Groundwater occurs in unconsolidated basin-fill deposits and consolidated rock under water-table conditions, and is used primarily for irrigation (table 2).

Total estimated withdrawal of water from wells in Parowan Valley in 2016 was about 37,000 acre-feet, which is about 3,000 acre-feet more than was reported for 2015 and is 2,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3). The increase is mainly due to increased withdrawals for irrigation.

The location of wells in Parowan Valley in which the water level was measured during March 2017 is shown in figure 26. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, 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. Precipitation at Cedar City Federal Aviation Administration Airport in 2016 was about 10.8 inches, which is about 2.6 inches less than the value for 2015 and 0.1 inch less than the average annual precipitation for 1949–2016.

Water levels declined from March 2016 to March 2017 in all parts of Parowan Valley for which data are available. The largest decline, about 2.8 feet, was measured in a well west of Parowan. Water levels in Parowan Valley generally have declined since 1950. For example, the water level in well (C-34-9)16cdd-2, located in the southwest part of the valley, has declined more than 65 feet since 1953. Declines in water levels are most likely the result of continued large local withdrawals for irrigation. Some rises occurred during 1973–74, 1983–85, 1996–99, 2006, and 2012, which correspond to periods of greater-than-average precipitation.

The concentration of dissolved solids in water samples collected from well (C-33-8)31ccc-1, located 2 miles west of Paragonah, from 1961 to 2016, is shown in figure 27. The water sample collected in July 2016 had a dissolved-solids concentration of 316 mg/L. With the exception of relatively high dissolved-solids concentrations in water samples collected in 1970, 1973, and 1974, concentrations have varied little.

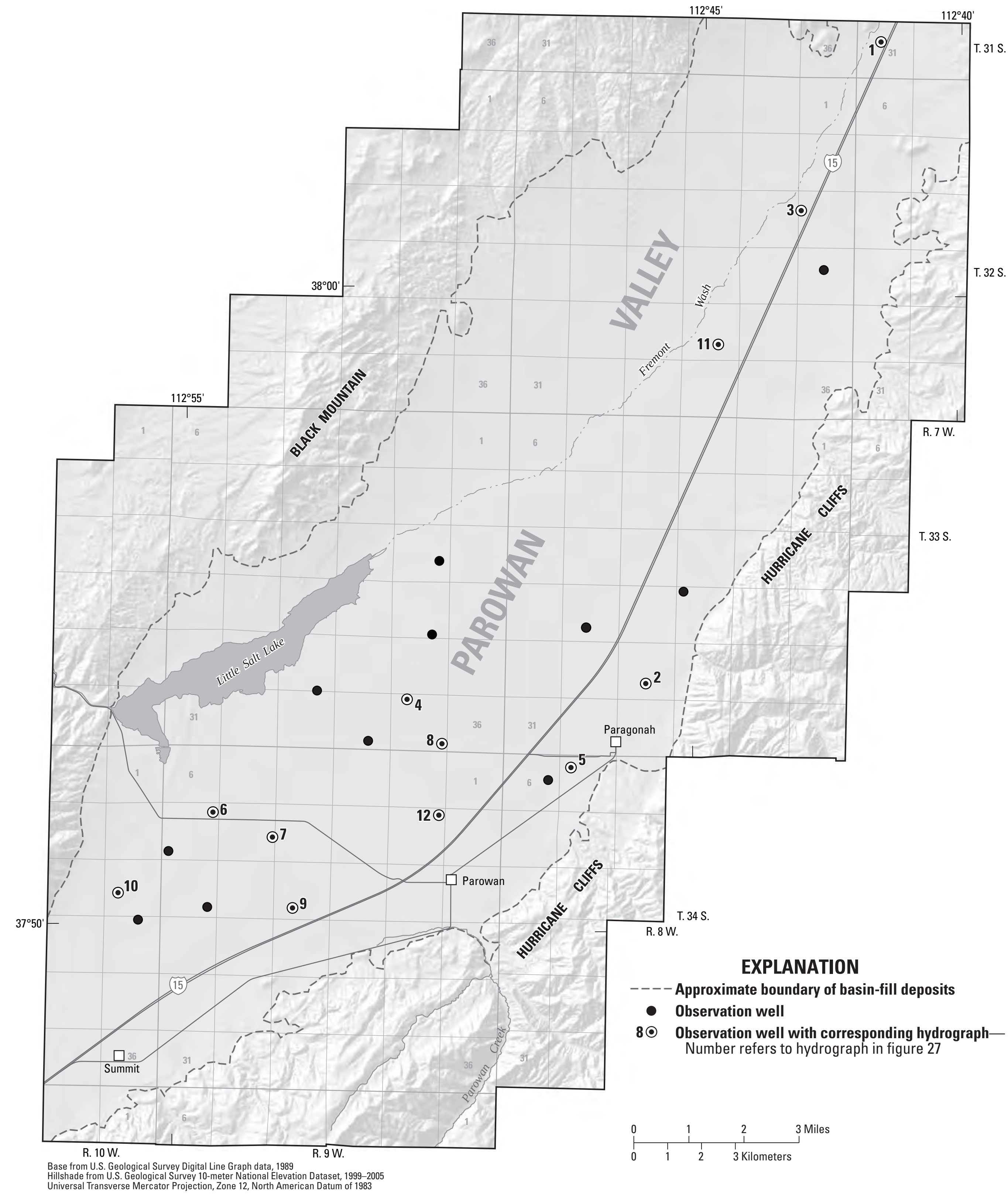


Figure 26. Location of wells in Parowan Valley in which the water level was measured during March 2017.

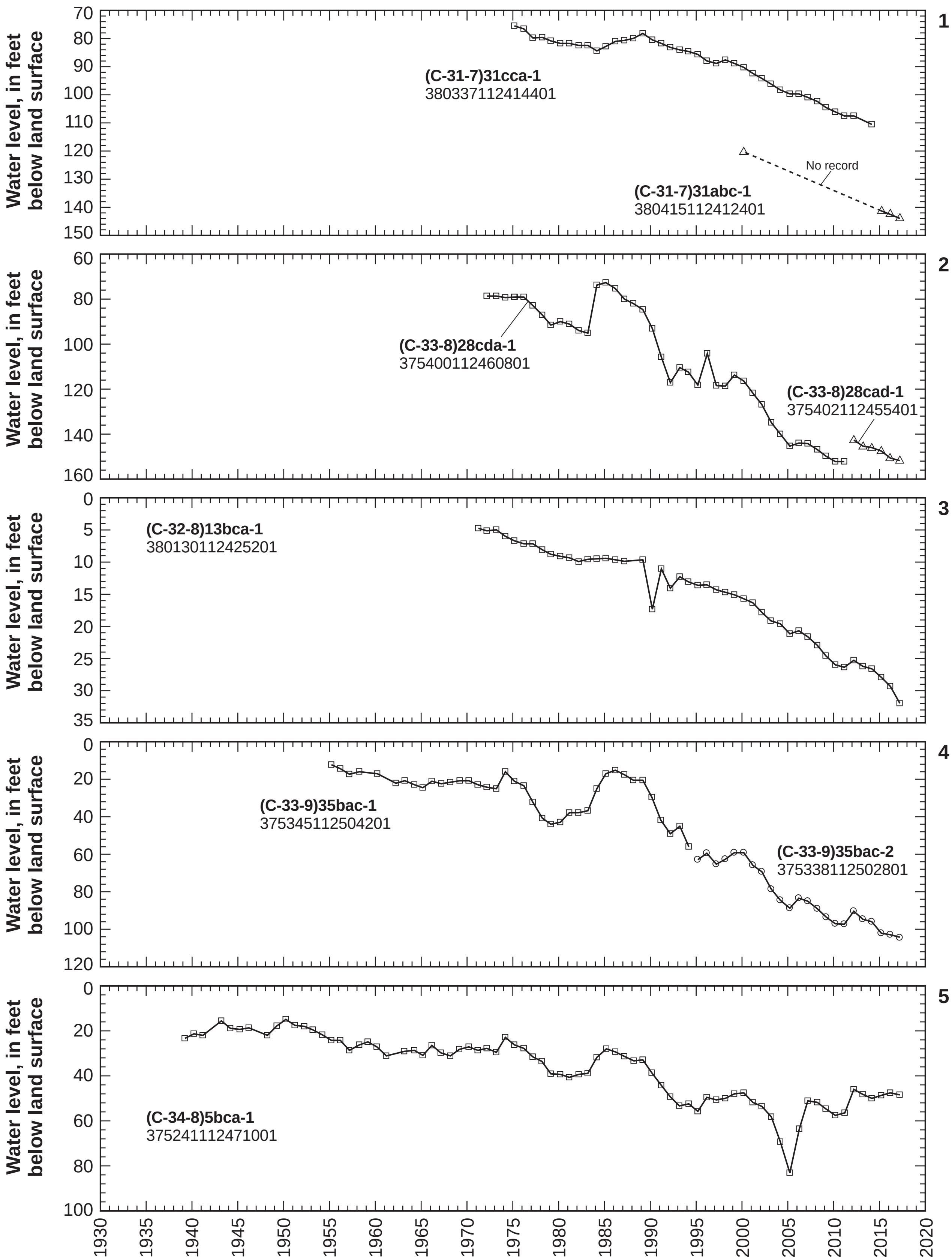


Figure 27. Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1.

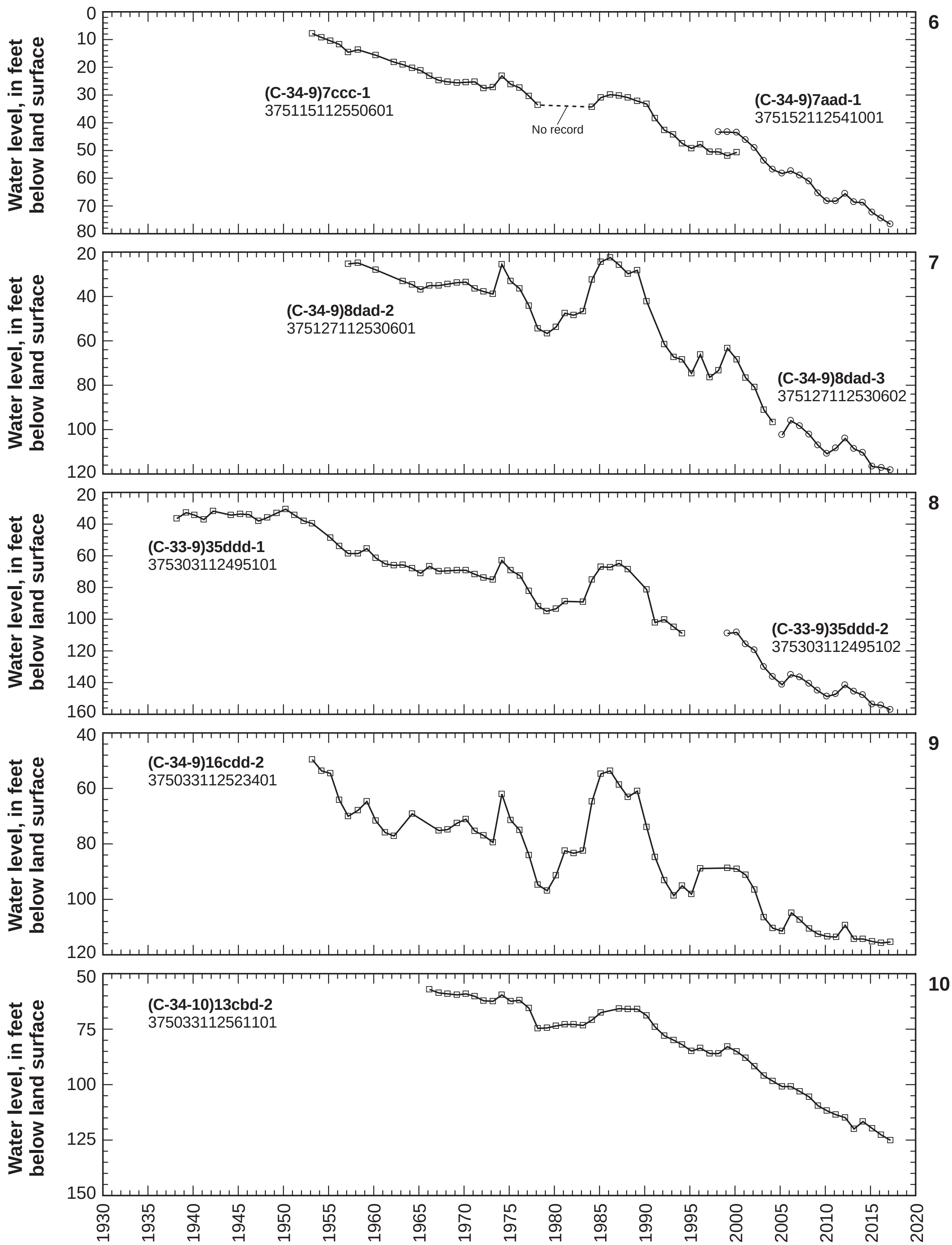


Figure 27. Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1.—Continued

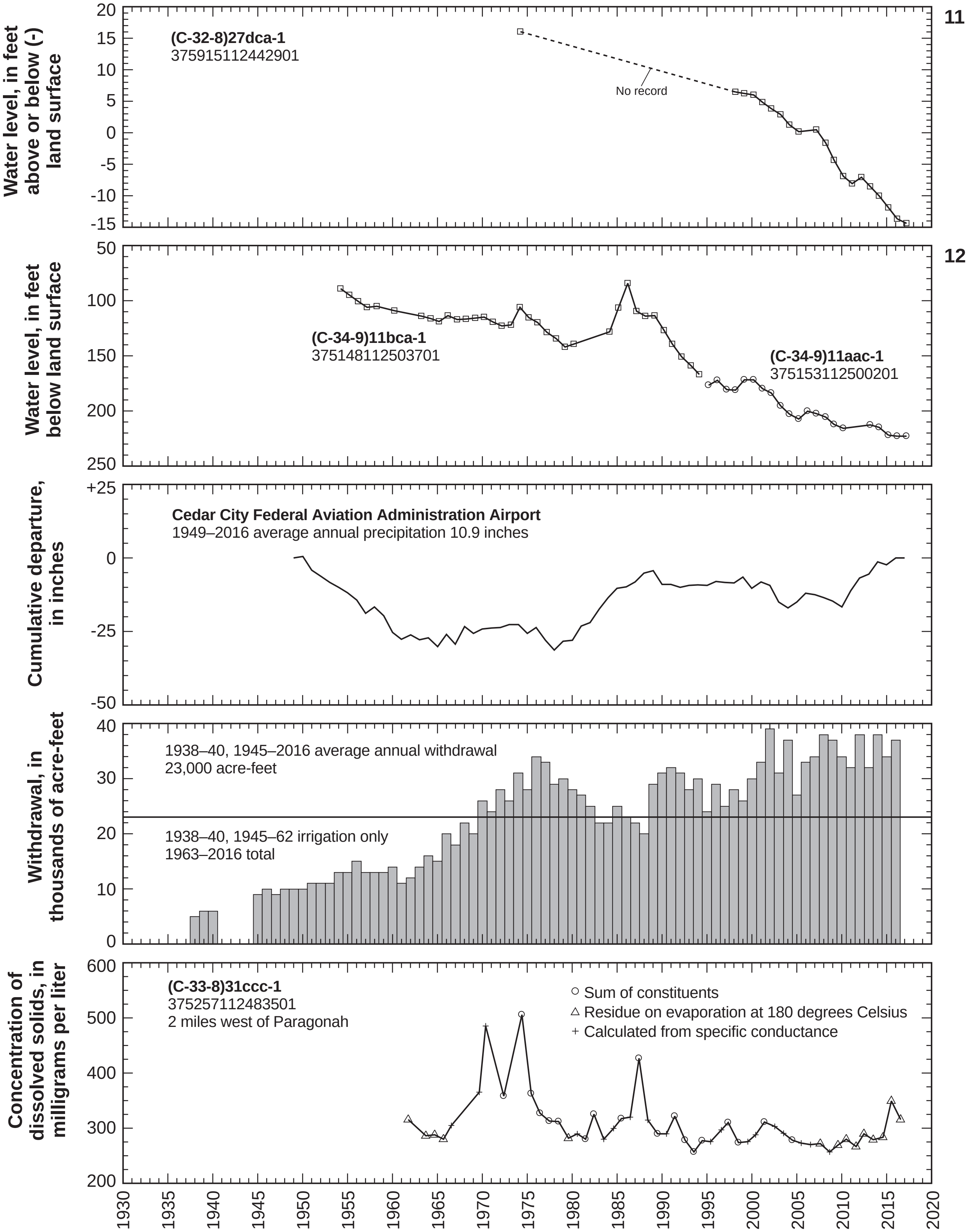


Figure 27. Relation of water level in selected wells in Parowan Valley to cumulative departure from average annual precipitation at Cedar City Federal Aviation Administration Airport, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-33-8)31ccc-1.—Continued

Escalante Valley

Milford Area

By Bradley A. Slaugh

The Milford area is in southwestern Utah and includes that part of Escalante Valley lying entirely within Beaver County west of the Mineral Mountains and east of the San Francisco Mountains, the southern part of Millard County, and a small area in the northern part of Iron County (fig. 28). Groundwater occurs in unconsolidated basin-fill deposits in the valley, and is used primarily for irrigation and industrial purposes (table 2).

Total estimated withdrawal of water from wells in the Milford area of Escalante Valley in 2016 was about 65,000 acre-feet, which is 3,000 acre-feet less than was reported for 2015 and 6,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3).

The location of wells in the Milford area in which the water level was measured during March 2017 is shown in figure 28. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Black Rock, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-29-10)5cdd-2 is shown in figure 29. Precipitation at Black Rock in 2016 was about 6.8 inches, about 1.4 inches less than in 2015 and about 2.1 inches less than the 1952–2016 average annual precipitation.

Water levels declined from March 2016 to March 2017 in most of the Milford area. The amount of water-level rise or decline depends largely on groundwater withdrawals, the amount and timing of precipitation, and recharge to the basin-fill aquifer from the Beaver River. Since the early 1950s, water levels generally have declined in the south-central Milford area in response to the long-term effects of groundwater withdrawals. Water-level rises during 1983–85 resulted from greater-than-average precipitation during 1982–85, greatly reduced withdrawals, and increased recharge to the basin-fill aquifer from record flow in the Beaver River during 1983–84.

The concentration of dissolved solids in water samples collected from well (C-29-10)5cdd-2, located 5 miles south of Milford, from 1969 to 2016, is shown in figure 29. The dissolved-solids concentration in the July 2016 sample was 403 mg/L.

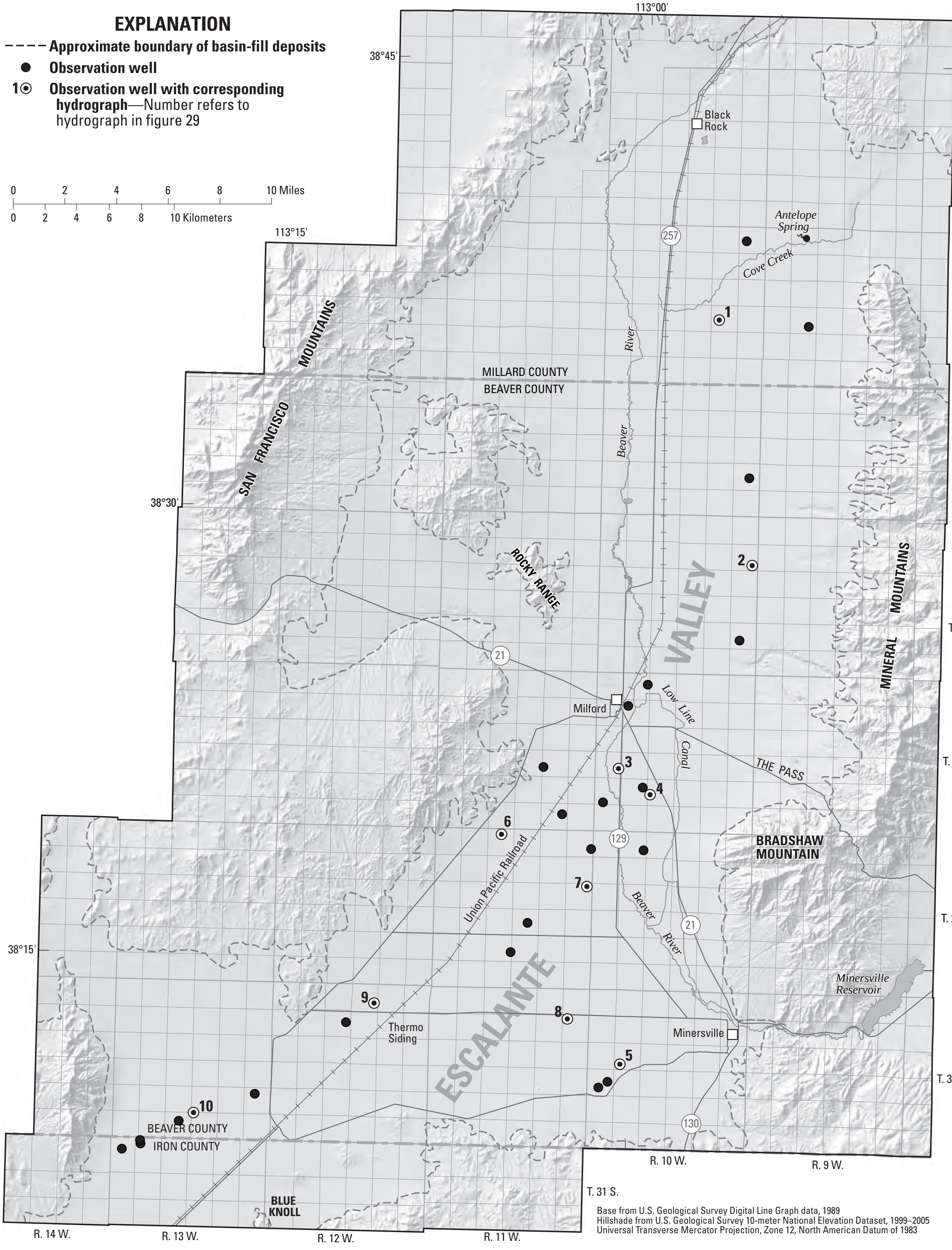


Figure 28. Location of wells in the Milford area in which the water level was measured during March 2017.

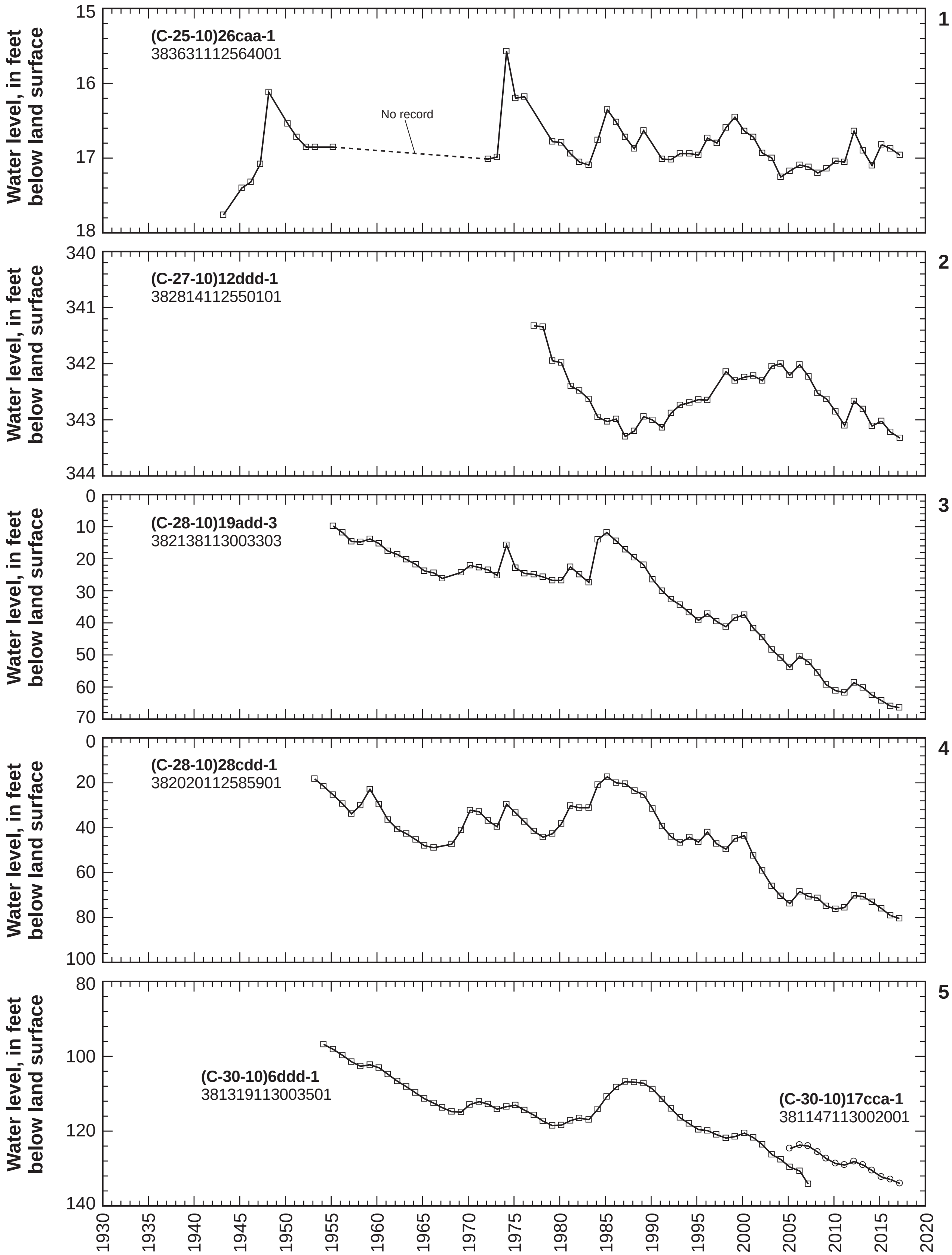


Figure 29. Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-29-10)5cdd-2.

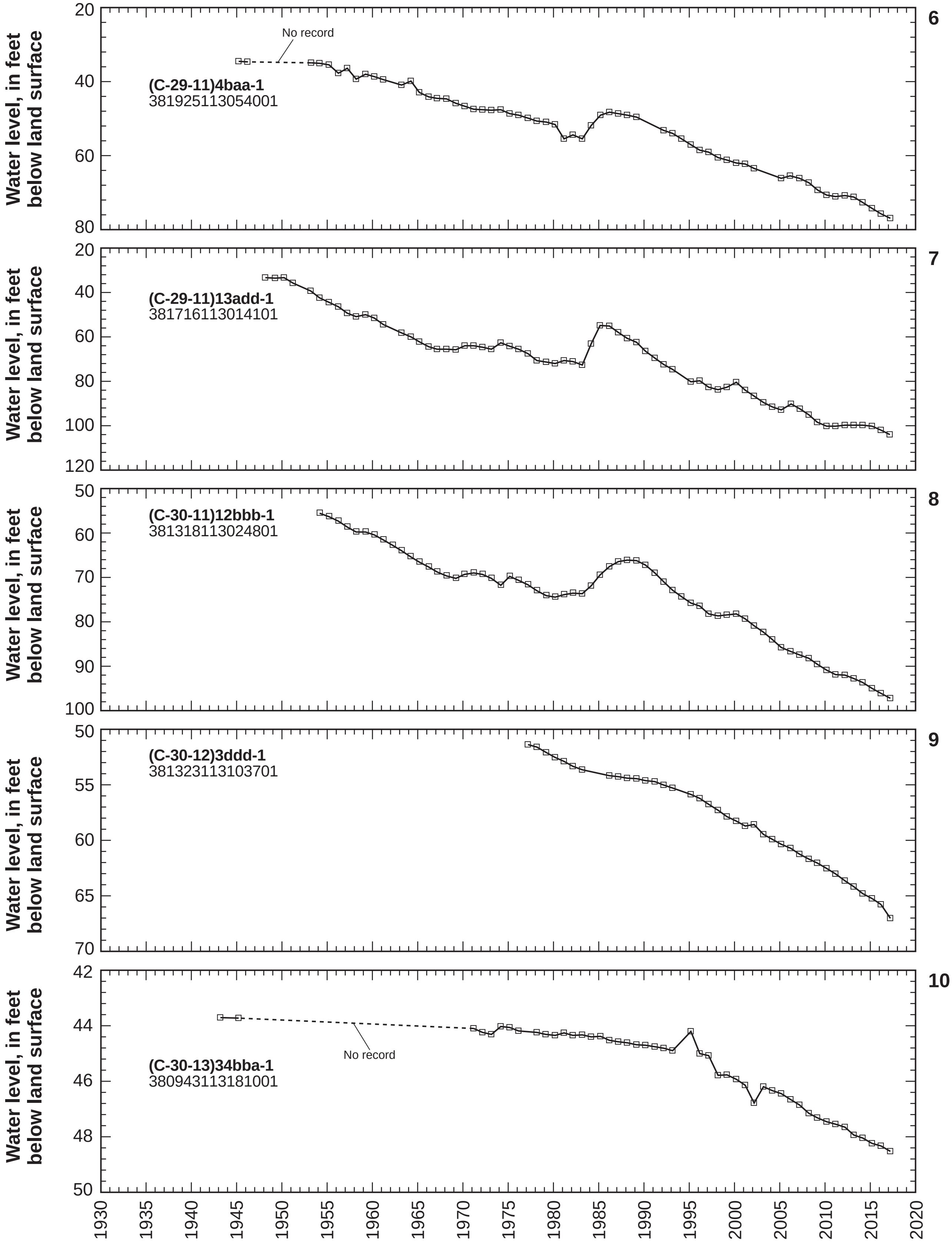


Figure 29. Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-29-10)5cdd-2.—Continued

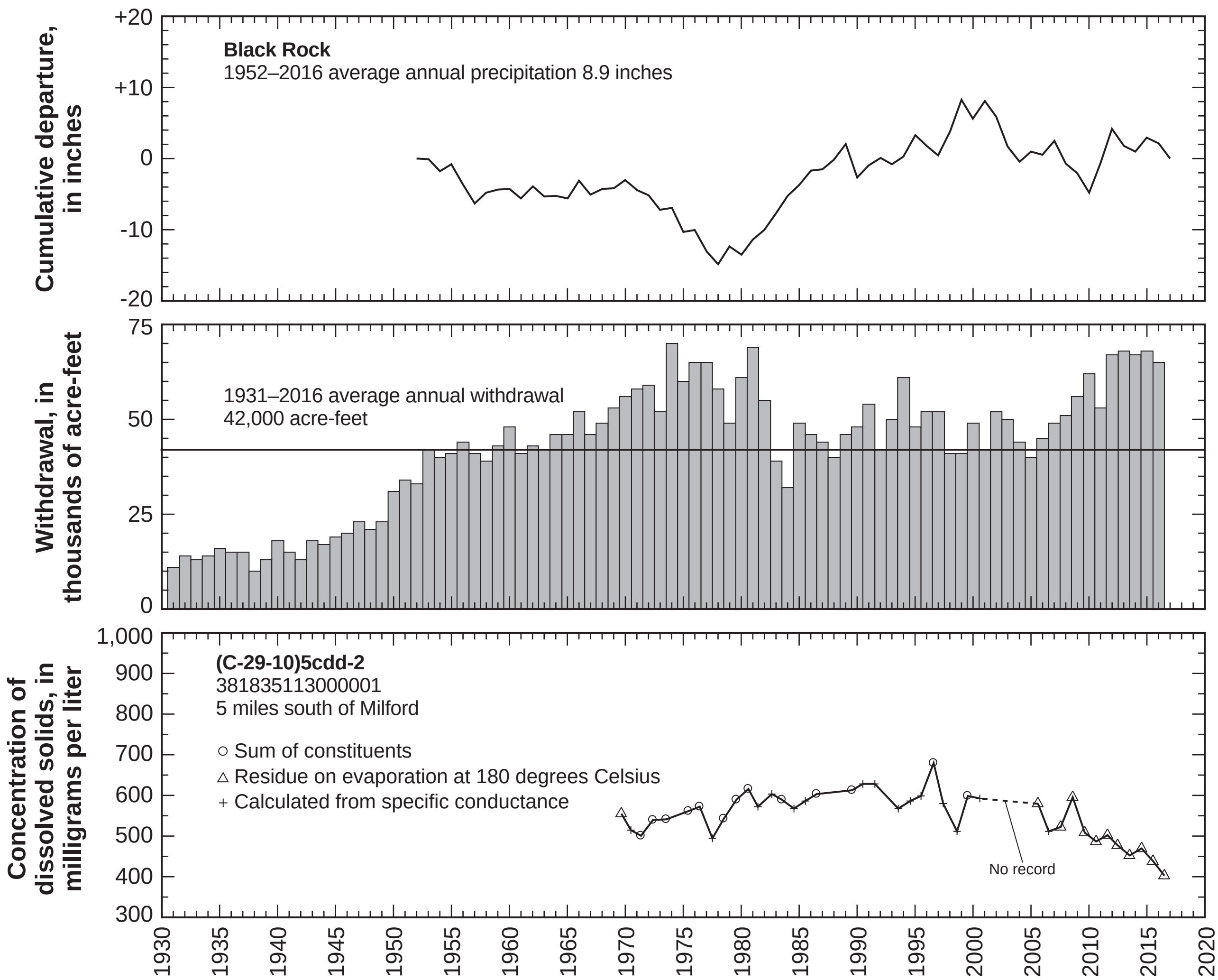


Figure 29. Relation of water level in selected wells in the Milford area to cumulative departure from average annual precipitation at Black Rock, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-29-10)5cdd-2.—Continued

Escalante Valley

Beryl-Enterprise Area

By Douglas V. LaBonte

The Beryl-Enterprise area covers about 800 square miles at the southern end of Escalante Valley, southeast of the Wah Wah Mountains in Iron County, and a small area in Washington County in the vicinity of the community of Enterprise (fig. 30). Groundwater occurs in unconsolidated basin-fill deposits in the valley, and is used primarily for irrigation (table 2).

Total estimated withdrawal of water from wells in the Beryl-Enterprise area in 2016 was about 95,000 acre-feet, which is 2,000 acre-feet more than in 2015 and 4,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3).

The location of wells in the Beryl-Enterprise area in which the water level was measured during March 2017 is shown in figure 30. The relation of the water level in selected observation wells to cumulative departure from average annual precipitation at Enterprise, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-3 is shown in figure 31. Precipitation at Enterprise in 2016 was about 16.2 inches, which is about 2.1 inches more than the average annual precipitation for 1955–2016 and about 2.3 inches more than in 2015.

Water levels declined from March 2016 to March 2017 in most of the wells measured in the Beryl-Enterprise area. Water levels throughout most of the area have declined steadily since 1950 and have shown little or no recovery, even during periods of greater-than-average precipitation. For example, water-level measurements in well (C-36-16)29daa-1, about 5 miles northeast of Enterprise, have shown a decline of nearly 147 feet from April 1945 to March 2017 (fig. 31). These declines are a result of continued large withdrawals for irrigation beginning around 1950.

The concentration of dissolved solids in water samples collected from well (C-34-16)28dcc-3, located 6 miles south-southeast of Beryl, is shown in figure 31. The concentration of dissolved solids in the water sample collected in June 2016 was 648 mg/L.

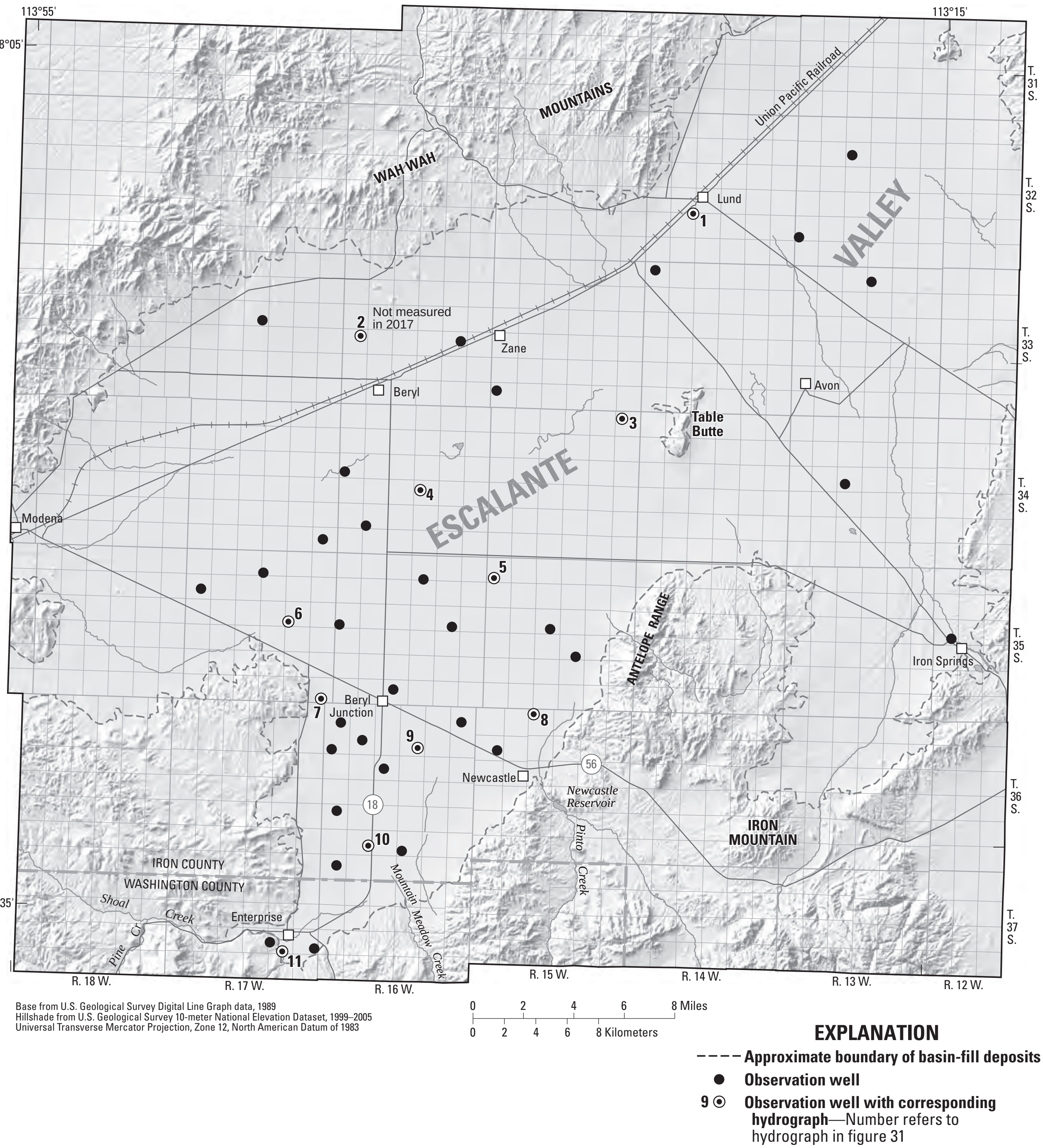


Figure 30. Location of wells in the Beryl-Enterprise area in which the water level was measured during March 2017.

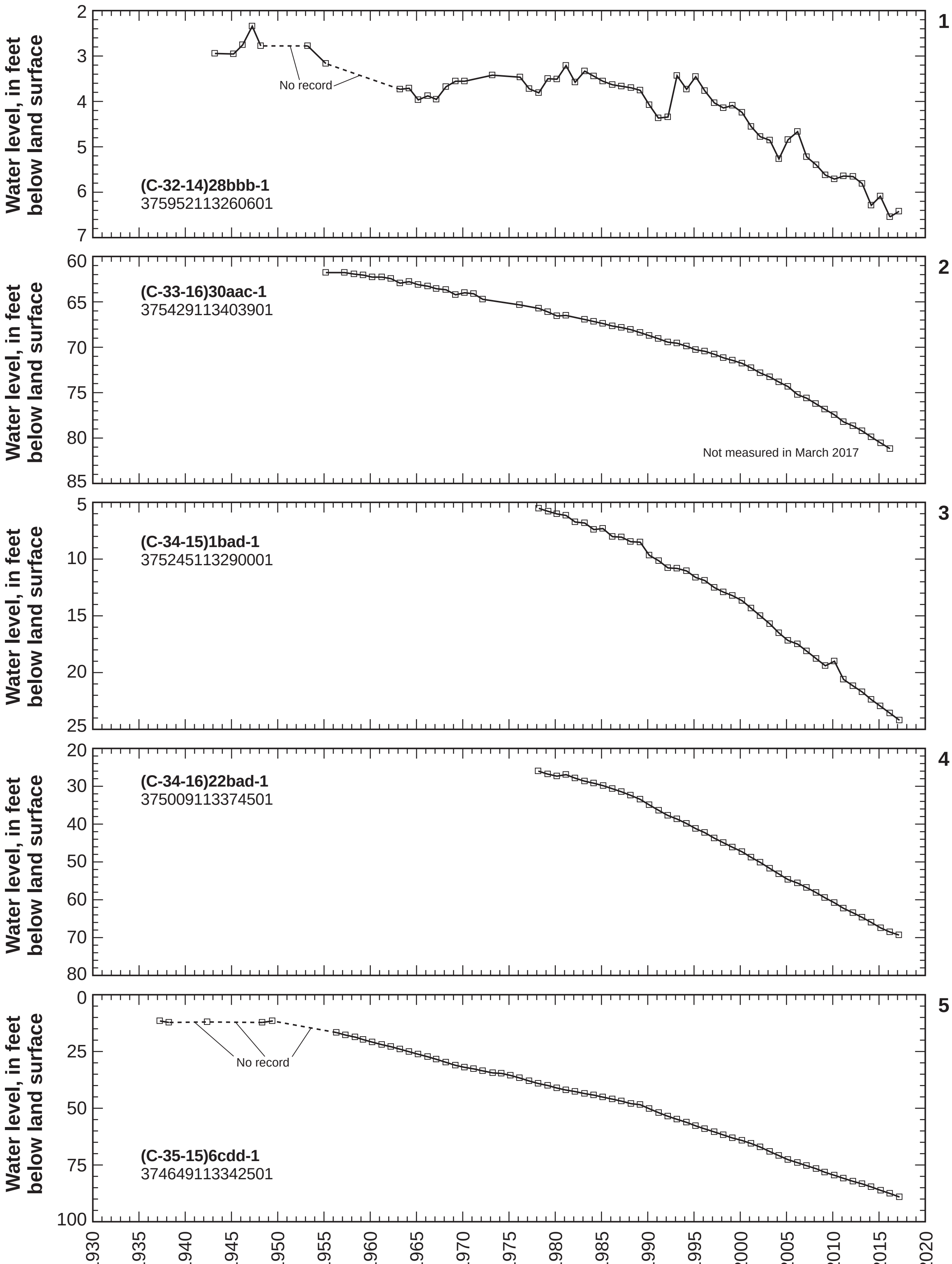


Figure 31. Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Enterprise, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-3.

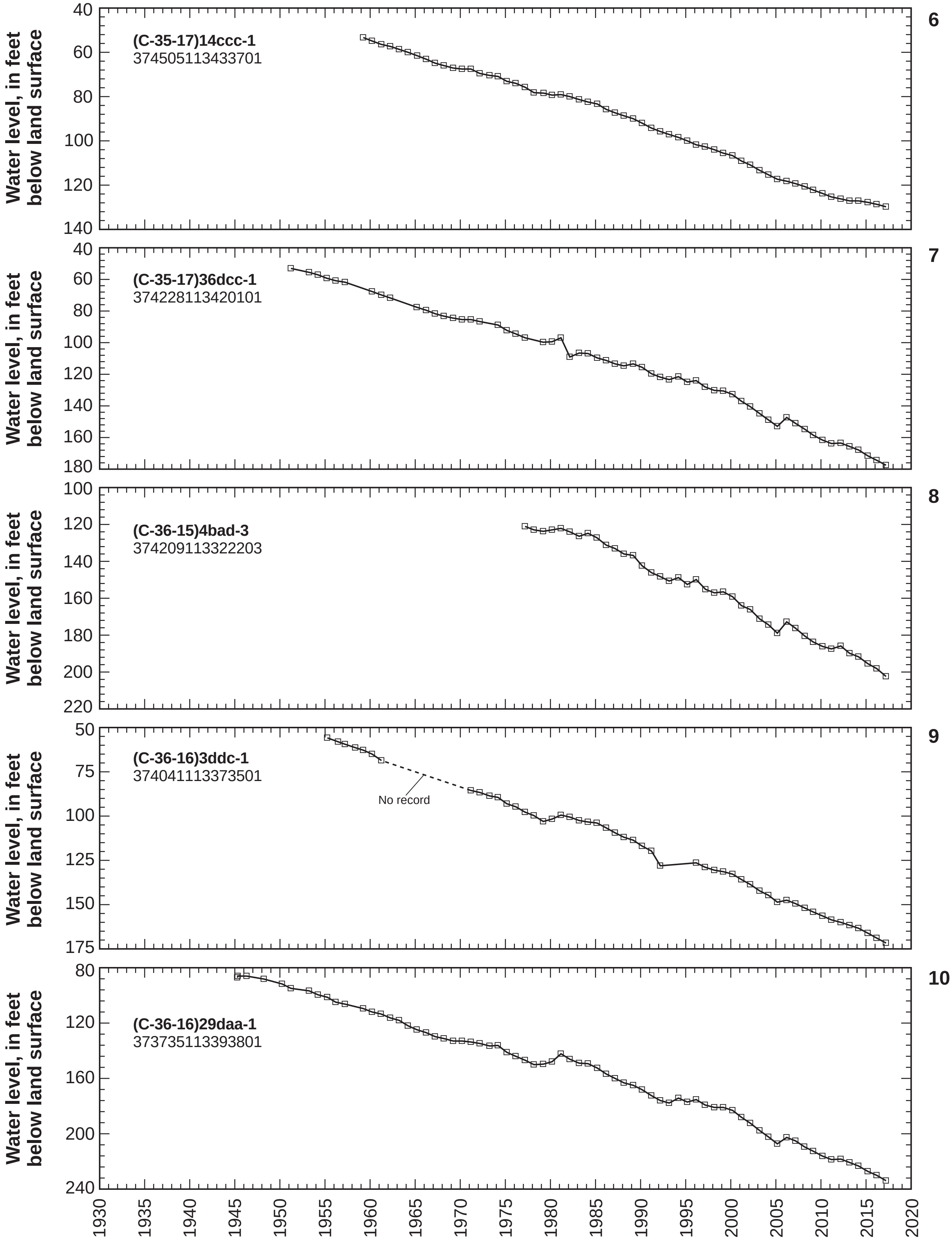


Figure 31. Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Enterprise, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-3.—Continued

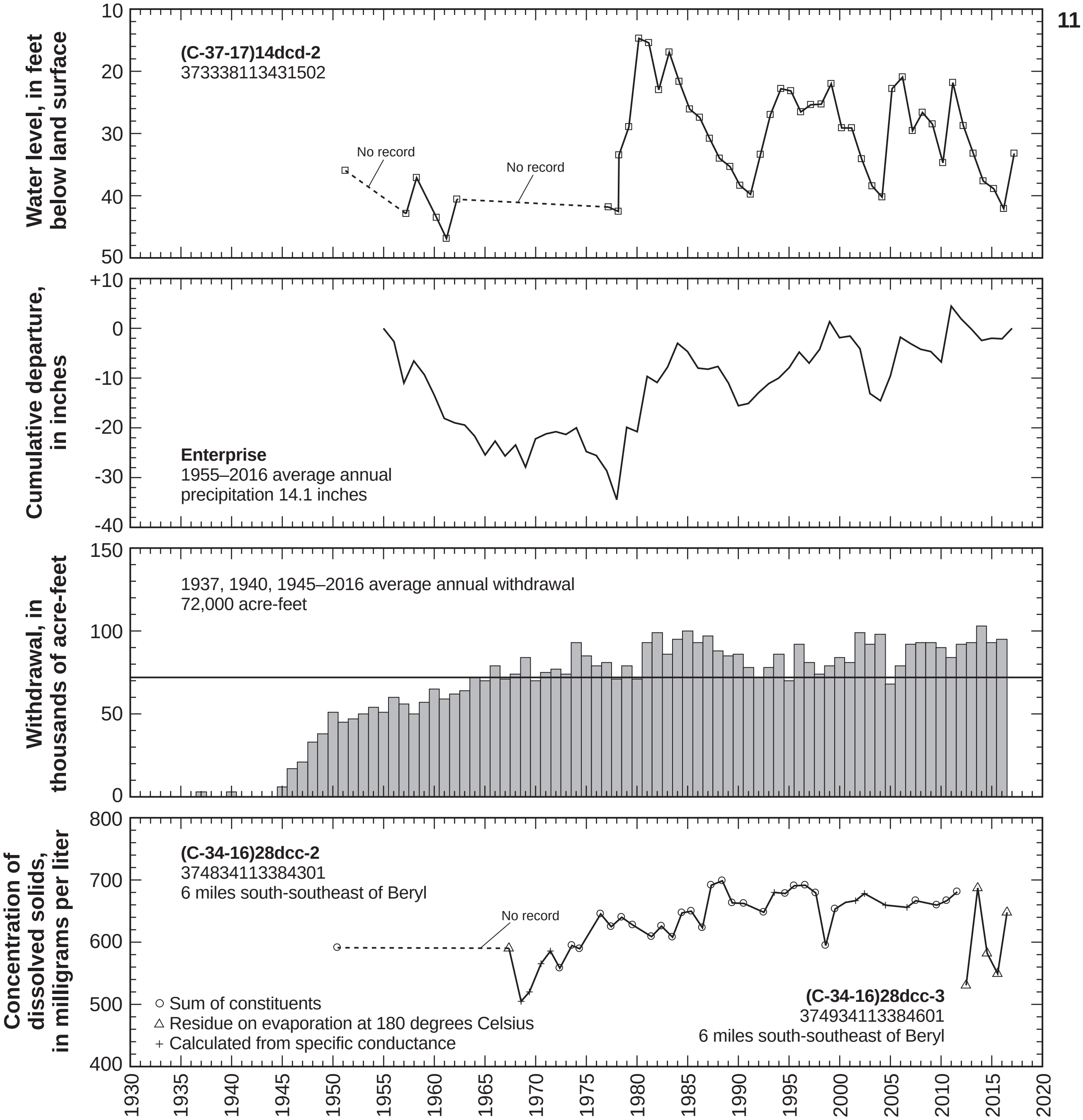


Figure 31. Relation of water level in selected wells in the Beryl-Enterprise area to cumulative departure from average annual precipitation at Enterprise, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-34-16)28dcc-3.—Continued

Central Virgin River Area

By Douglas V. LaBonte

The central Virgin River area extends north from the Arizona border in Washington County and includes the Santa Clara and Virgin River drainages. The region is bounded on the west by the Beaver Dam and Bull Valley Mountains, on the north by the northern flank of the Pine Valley Mountains, and on the east and southeast by the Hurricane Cliffs (fig. 32). Groundwater is withdrawn from valley-fill aquifers and used primarily for irrigation. Water is also withdrawn from consolidated rock and valley-fill aquifers for public supply use. Most of the wells are located near the Virgin and Santa Clara Rivers.

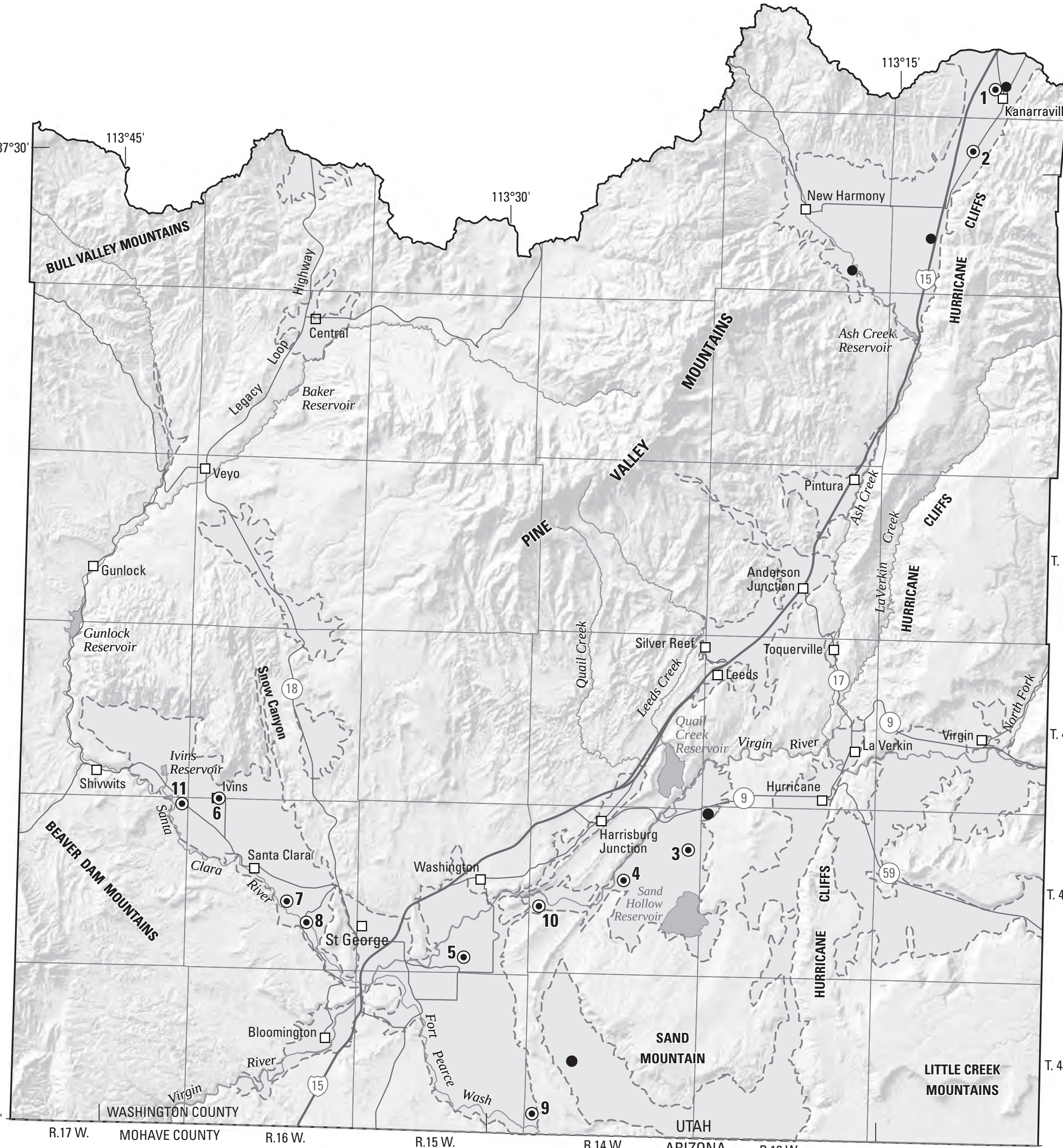
Total estimated withdrawal of water from wells in the central Virgin River area in 2016 was about 36,000 acre-feet, which is 2,000 acre-feet more than in 2015 and 5,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3). The increase was mainly due to increased withdrawals for irrigation.

The location of wells in the central Virgin River area in which the water level was measured during February 2017 is shown in figure 32. The relation of the water level in selected observation wells to annual discharge of the Virgin River at Virgin, Utah, to cumulative departure from average annual precipitation at La Verkin, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-17)8cbd-2 is shown in figure 33.

Discharge of the Virgin River at Virgin, Utah, in 2016 was about 113,900 acre-feet, which is 33,400 acre-feet more than the value for 2015 and about 17,800 acre-feet less than the long-term average for 1931–70 and 1979–2016. Precipitation at La Verkin in 2016 was about 14.3 inches, which is about 3.5 inches more than the average annual precipitation for 1951–2016 and 2.2 inches more than in 2015.

Water levels from February 2016 to February 2017 declined, or rose only slightly, in most of the central Virgin River area. The largest decline, about 8 feet, occurred in the southeast part of the area. Declines are probably the result of continued large withdrawals for irrigation and public supply use.

The concentration of dissolved solids in water samples collected from wells (C-41-17)8cbd-1 and (C-41-17)8cbd-2, located 1.5 miles south of Gunlock Reservoir is shown in figure 33. These wells are located near each other and are finished in the same aquifer. The dissolved-solids concentrations in water samples from both wells were combined on one graph to give an extended temporal record for this constituent. The concentration of dissolved solids in the water sample collected in June 2016 was 294 mg/L.



Base from U.S. Geological Survey Digital Line Graph data, 1989
Hillshade from U.S. Geological Survey 10-meter National Elevation Dataset, 1999–2005
Universal Transverse Mercator Projection, Zone 12, North American Datum of 1983

0 2 4 6 8 Miles
0 2 4 6 8 Kilometers

EXPLANATION

- - - - **Approximate boundary of valley-fill deposits**

● **Observation well**

9◉ **Observation well with corresponding hydrograph**—Number refers to hydrograph in figure 33

Figure 32. Location of wells in the central Virgin River area in which the water level was measured during February 2017.

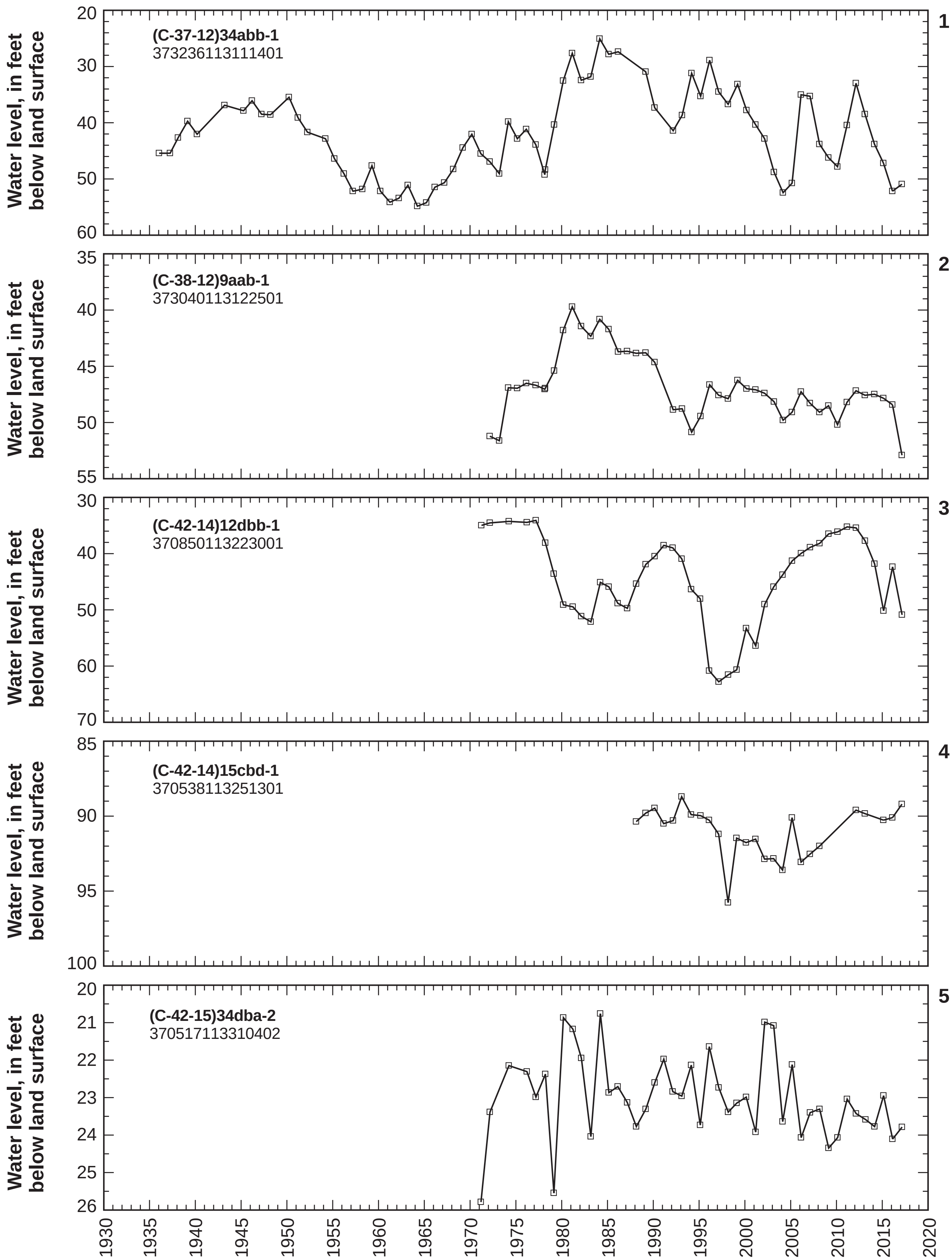


Figure 33. Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, Utah, to cumulative departure from average annual precipitation at La Verkin, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-17)8cbd-2.

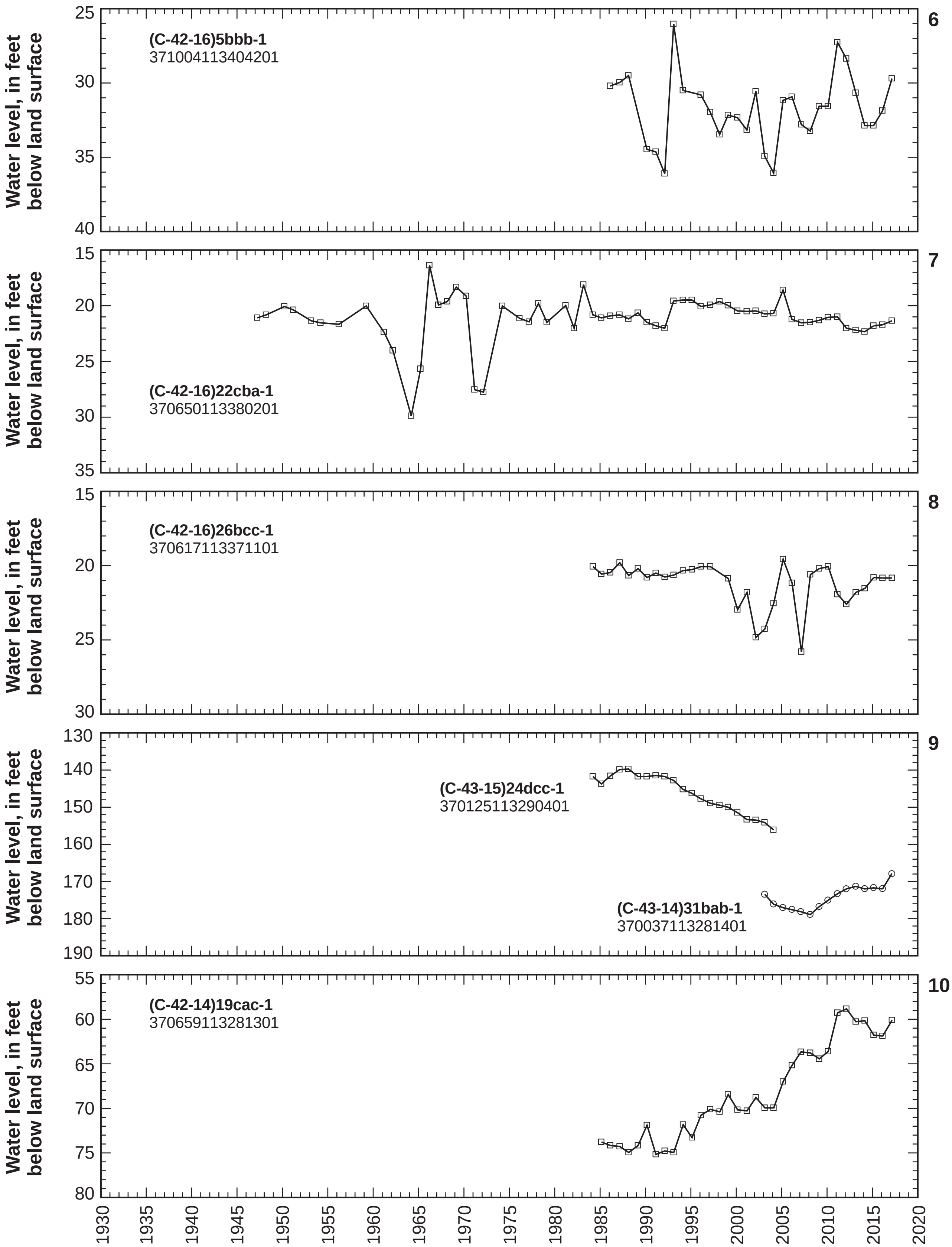


Figure 33. Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, Utah, to cumulative departure from average annual precipitation at La Verkin, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-17)8cbd-2.—Continued

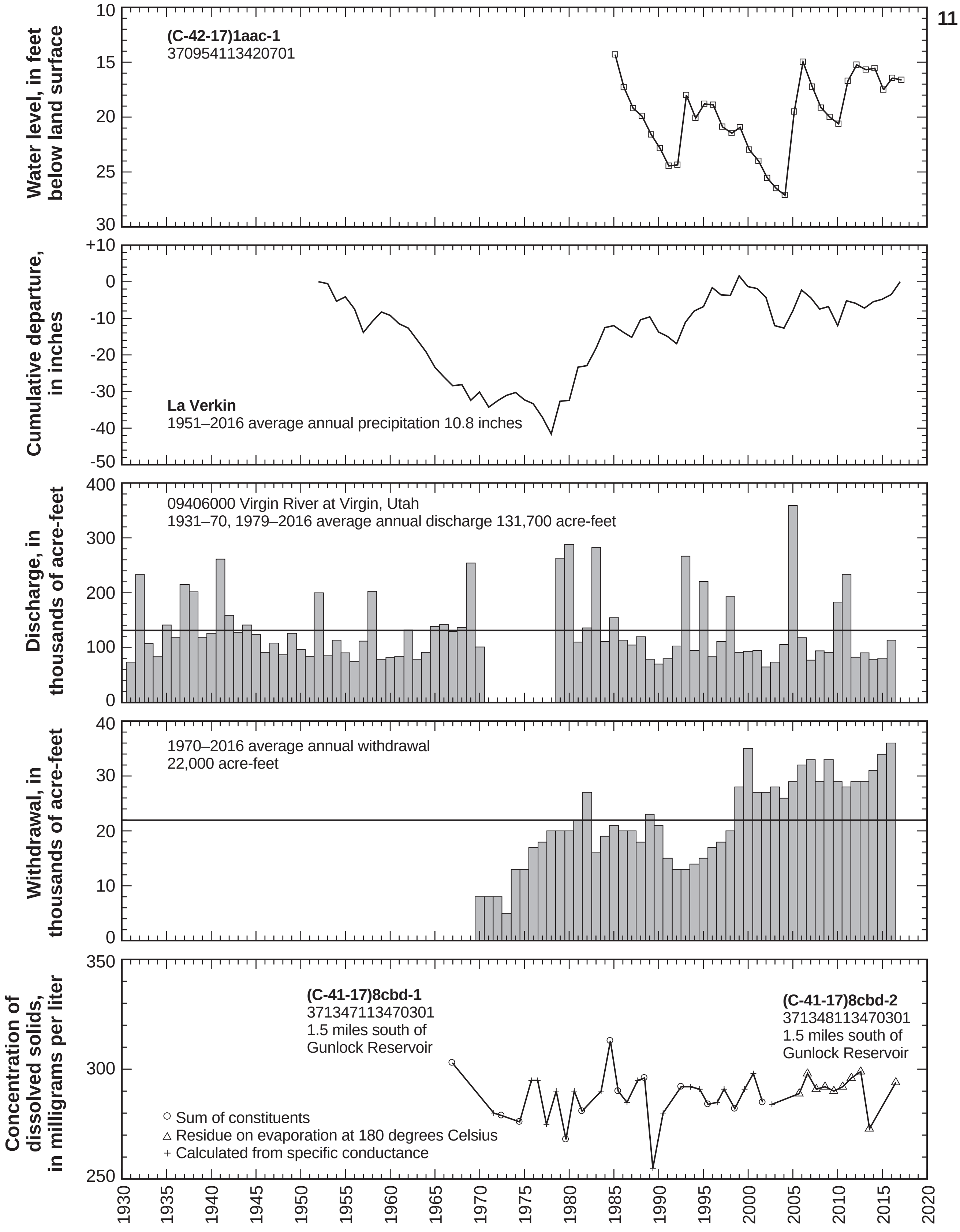


Figure 33. Relation of water level in selected wells in the central Virgin River area to annual discharge of the Virgin River at Virgin, Utah, to cumulative departure from average annual precipitation at La Verkin, to annual withdrawal from wells, and to concentration of dissolved solids in water from well (C-41-17)8cbd-2.—Continued

Other Areas

By Martel J. Fisher

Total estimated withdrawal of water from wells in other areas of Utah (table 4) in 2016 was about 145,000 acre-feet, which is about 1,000 acre-feet more than in 2015 and 3,000 acre-feet more than the average annual withdrawal for 2006–2015 (tables 2 and 3). The largest increases were due to increased withdrawals for irrigation. In most of the areas listed in table 4, withdrawals in 2016 were more than in 2015, except in Rush Valley, Sanpete Valley, Snake Valley, and Remainder of State, where irrigation use decreased.

The location of wells in Cedar Valley, Utah County, in which the water level was measured during March 2017, is shown in figure 34. The relation of the water level in selected observation wells in Cedar Valley to cumulative departure from average annual precipitation at Provo BYU is shown in figure 35.

Water levels in selected wells in Cedar Valley generally rose during the 1970s. Water levels rose sharply from the early to mid-1980s as a result of greater-than-average precipitation, and then declined during the mid- to late 1980s and early 1990s. Water levels in these wells have been relatively stable since 1995. Water levels declined in most of the wells from March 2016 to March 2017.

The location of wells in Sanpete Valley in which the water level was measured during March 2017 is shown in figure 36. The relation of the water level in selected observation wells in Sanpete Valley to cumulative departure from average annual precipitation at Manti is shown in figure 37.

Water levels in selected wells in Sanpete Valley rose from the late 1970s to the mid-1980s as a result of greater-than-average precipitation and have varied since the mid-1980s, but overall have declined. Water levels declined in all of the selected observation wells from March 2016 to March 2017.

The location of wells in Snake Valley in which the water level was measured during March 2017 is shown in figure 38. The relation of the water level in selected observation wells in Snake Valley to cumulative departure from average annual precipitation at Callao is shown in figure 39.

Water levels in all of the selected wells in Snake Valley declined from March 2016 to March 2017. Water levels rose sharply in the early to mid-1980s as a result of greater-than-average precipitation, but have generally declined since the mid-1980s.

The relation of the water level in selected wells in other areas of Utah (table 4) to cumulative departure from average annual precipitation at sites in or near those areas is shown in figure 40. Water levels rose or declined only slightly in most of the selected observation wells from March 2016 to March 2017.

Table 4. Estimated withdrawal of water from wells in other areas of Utah, 2016.

Number in figure 1	Area	Estimated withdrawal from wells (acre-feet)					
		2016					2015 total (rounded)
		Irrigation	Industrial [1]	Public supply [1]	Domestic and stock	Total (rounded)	
1	Grouse Creek Valley	2,000	0	0	40	2,000	2,000
2	Park Valley area	2,000	0	0	30	2,000	1,600
4	Lower Bear River area	4,100	530	8,300	200	13,100	11,500
8	Ogden Valley	0	0	11,700	630	12,300	11,500
13	Rush Valley	4,900	270	170	70	5,400	5,700
14	Skull Valley, Dugway area, and Old River Bed	2,400	4,700	780	20	7,900	7,700
15	Cedar Valley, Utah County	1,000	0	5,500	80	6,600	5,500
20	Sanpete Valley	6,200	710	730	1,100	8,700	9,900
25	Snake Valley	20,100	0	90	100	20,300	21,600
27	Beaver Valley	11,700	10	360	500	12,600	11,000
	Remainder of State	12,400	16,700	22,400	2,600	54,100	56,300
Total (rounded)		66,800	22,900	50,000	5,400	145,000	144,000

[1] Data provided by Utah Department of Natural Resources, Division of Water Rights.

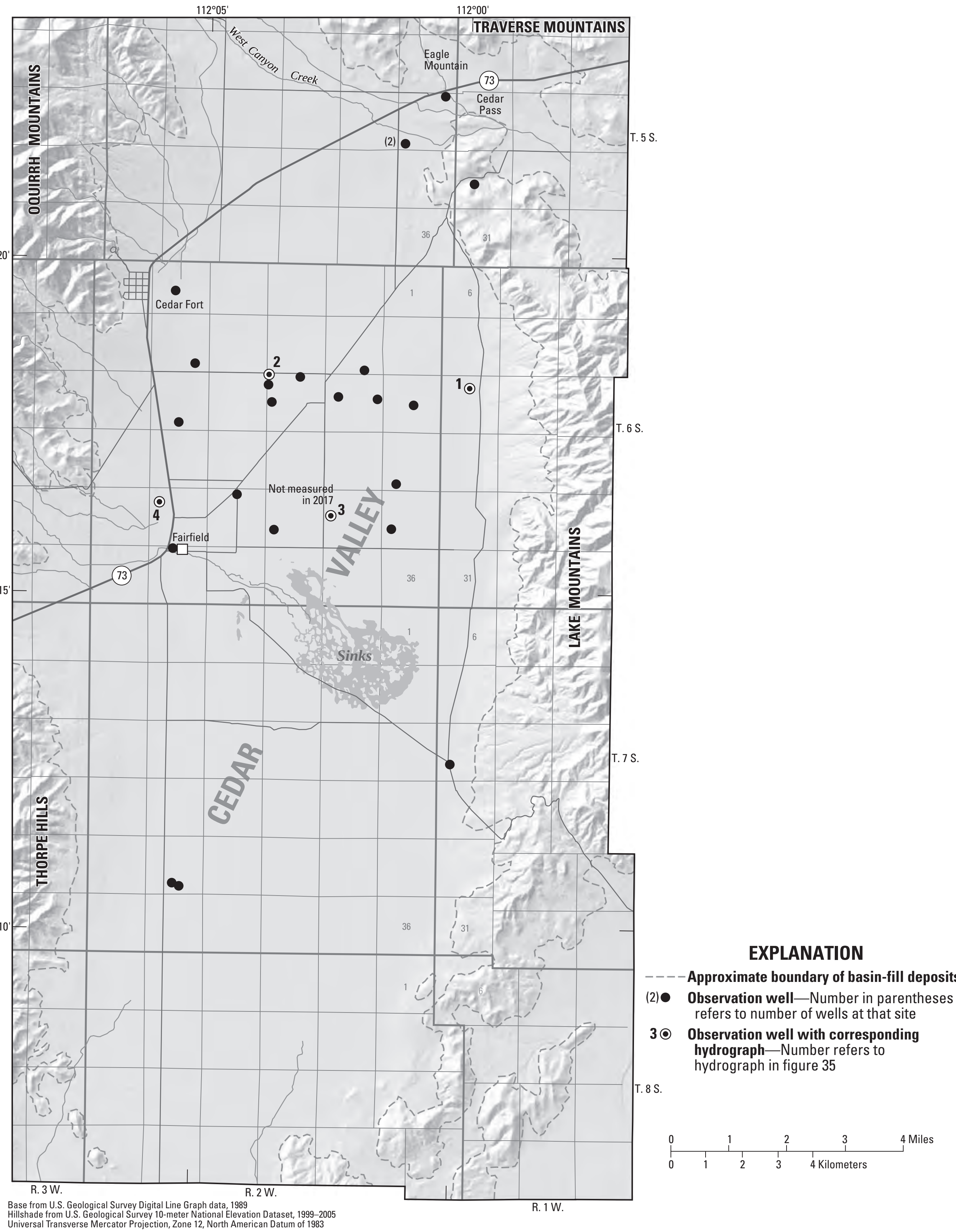


Figure 34. Location of wells in Cedar Valley, Utah County, in which the water level was measured during March 2017.

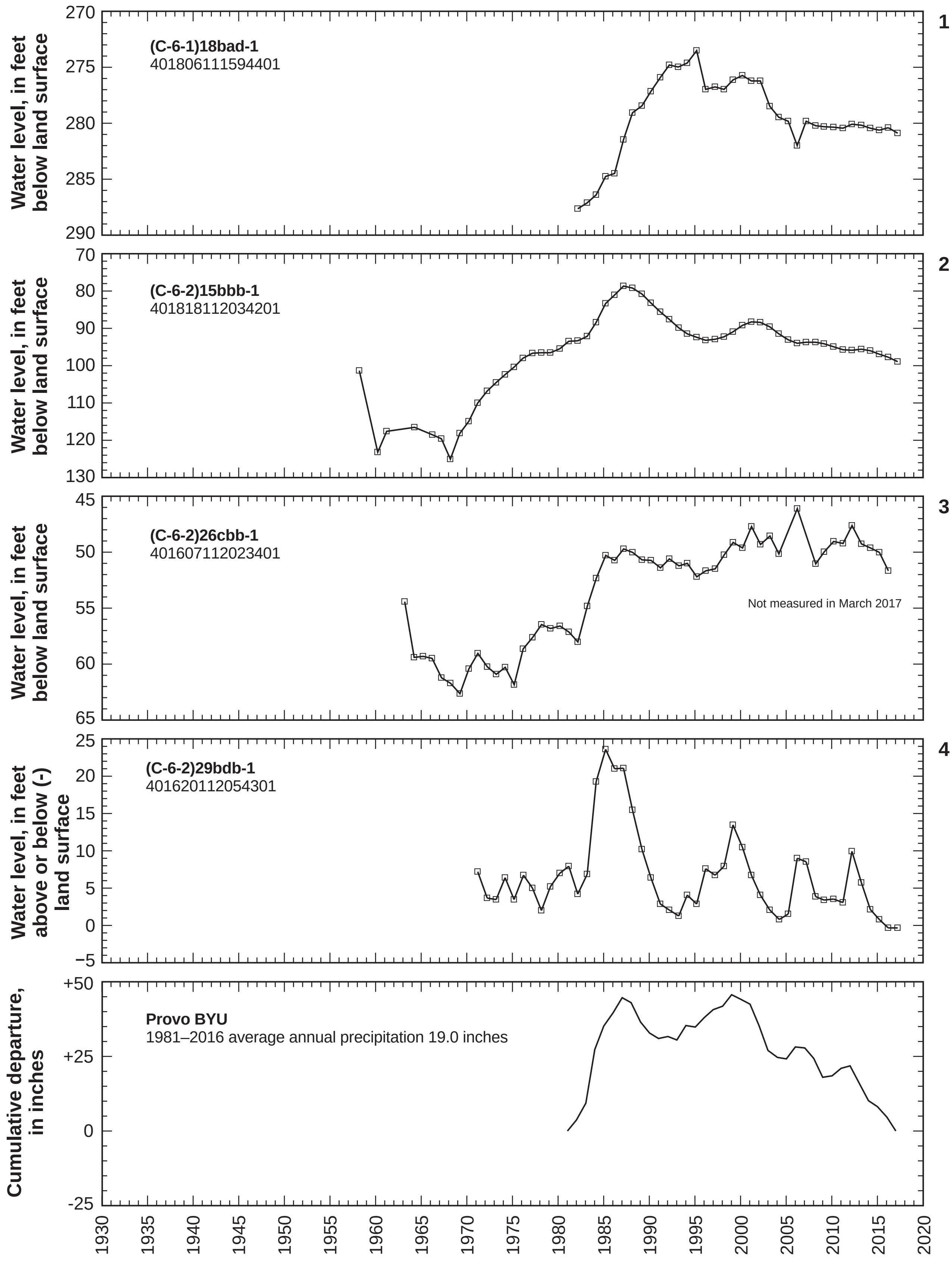


Figure 35. Relation of water level in selected wells in Cedar Valley, Utah County, to cumulative departure from average annual precipitation at Provo BYU.

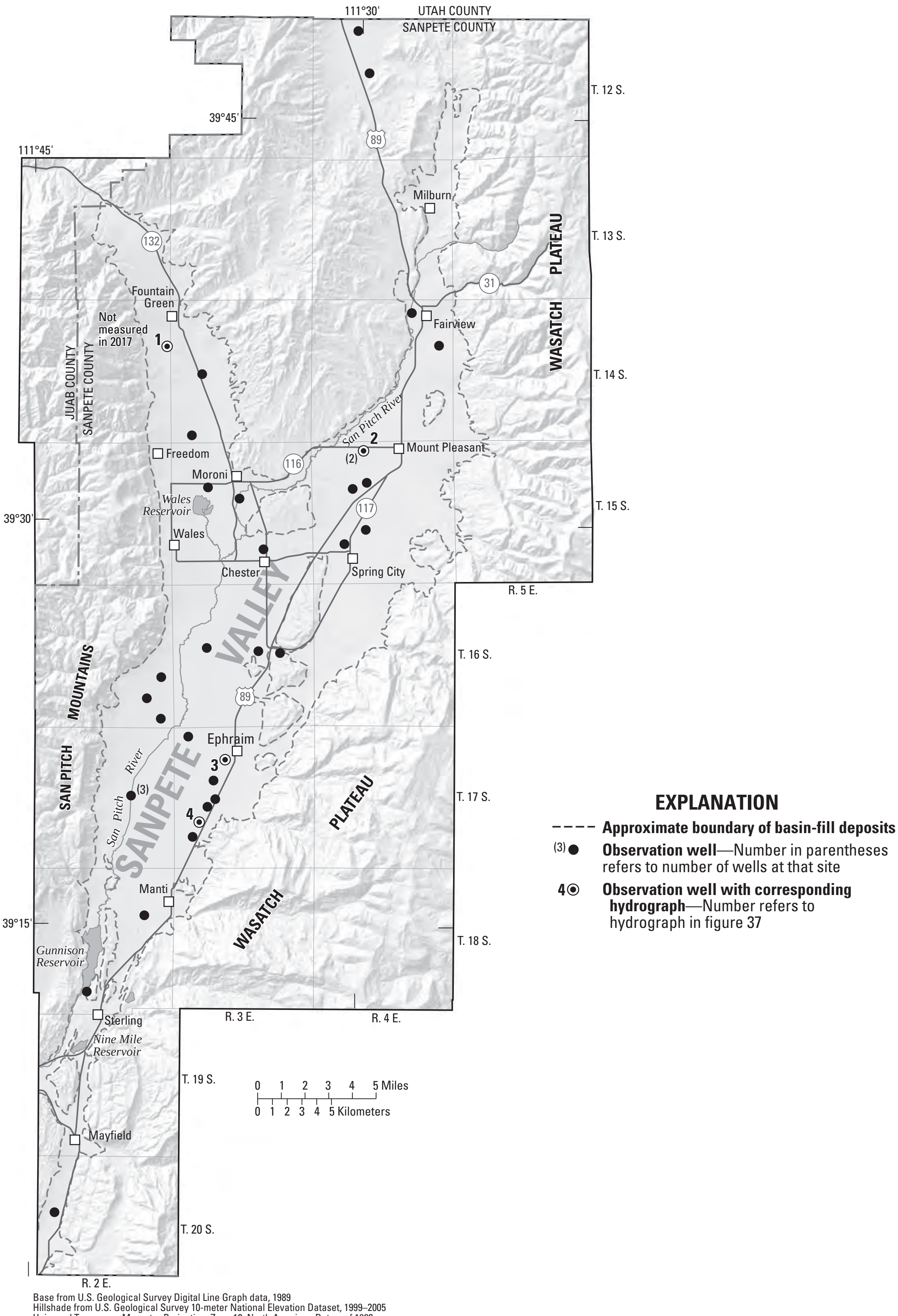


Figure 36. Location of wells in Sanpete Valley in which the water level was measured during March 2017.

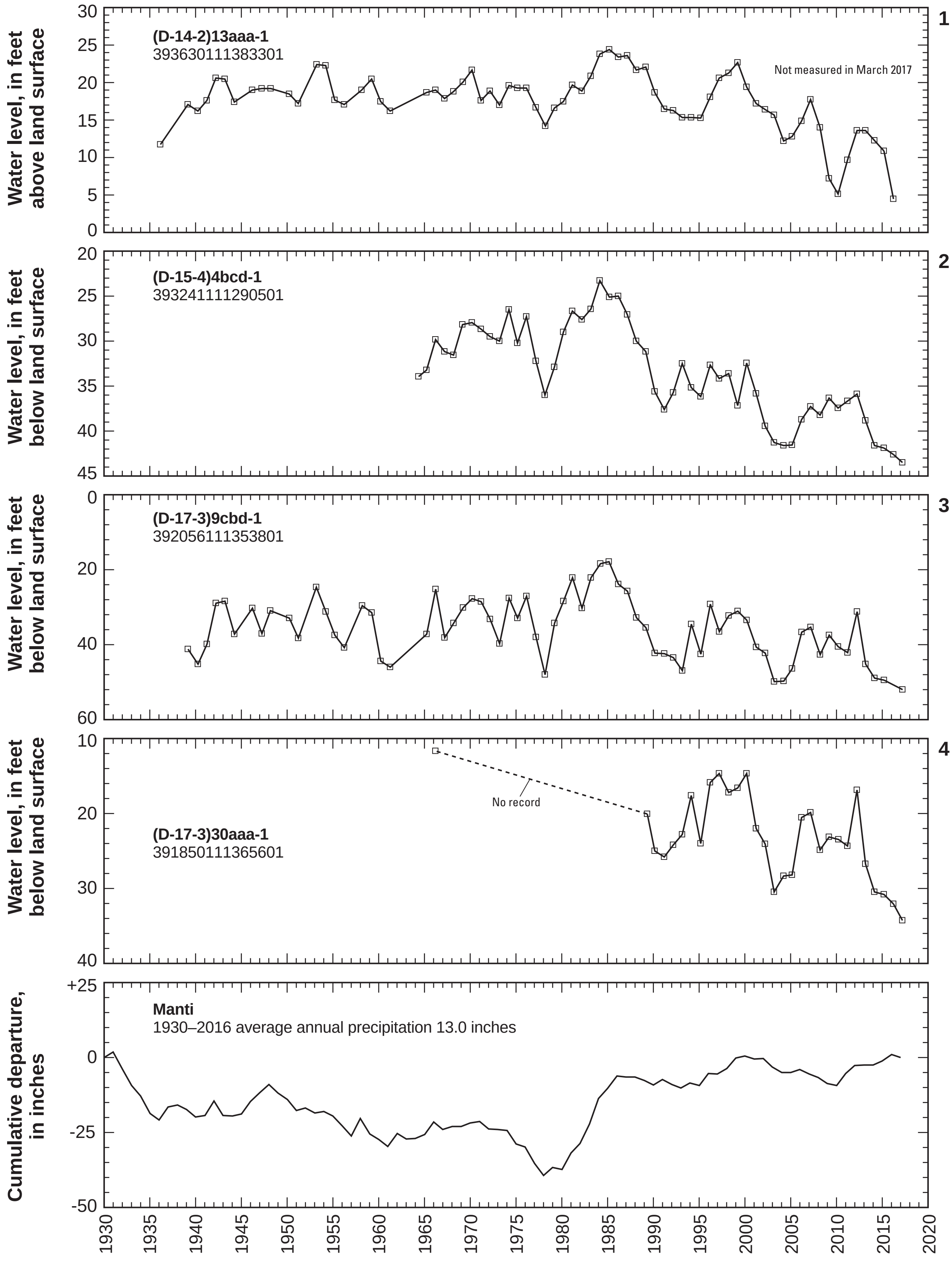
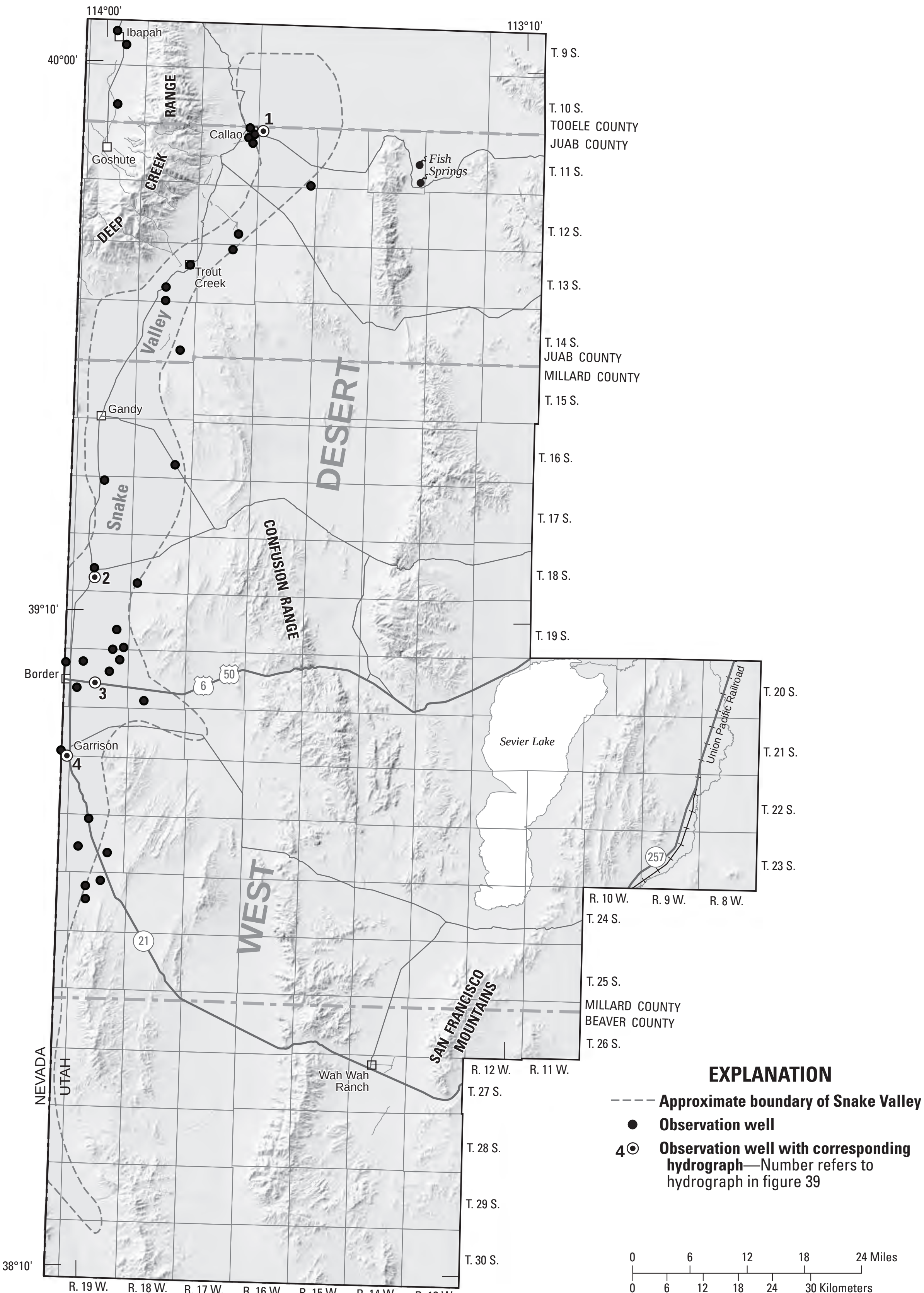


Figure 37. Relation of water level in selected wells in Sanpete Valley to cumulative departure from average annual precipitation at Manti.



Base from U.S. Geological Survey Digital Line Graph data, 1989
Hillshade from U.S. Geological Survey 10-meter National Elevation Dataset, 1999–2005
Universal Transverse Mercator Projection, Zone 12, North American Datum of 1983

Figure 38. Location of wells in Snake Valley in which the water level was measured during March 2017.

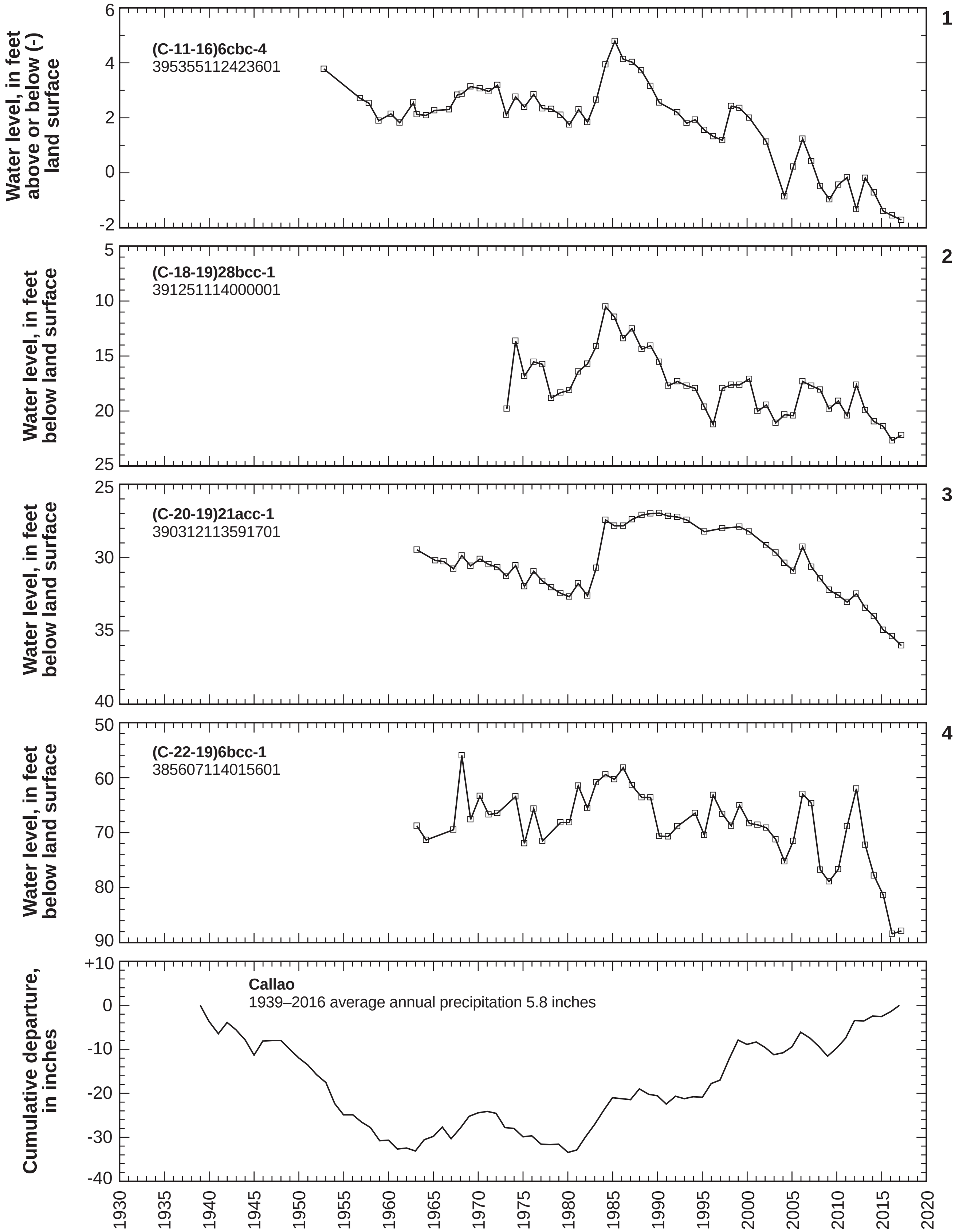


Figure 39. Relation of water level in selected wells in Snake Valley to cumulative departure from average annual precipitation at Callao.

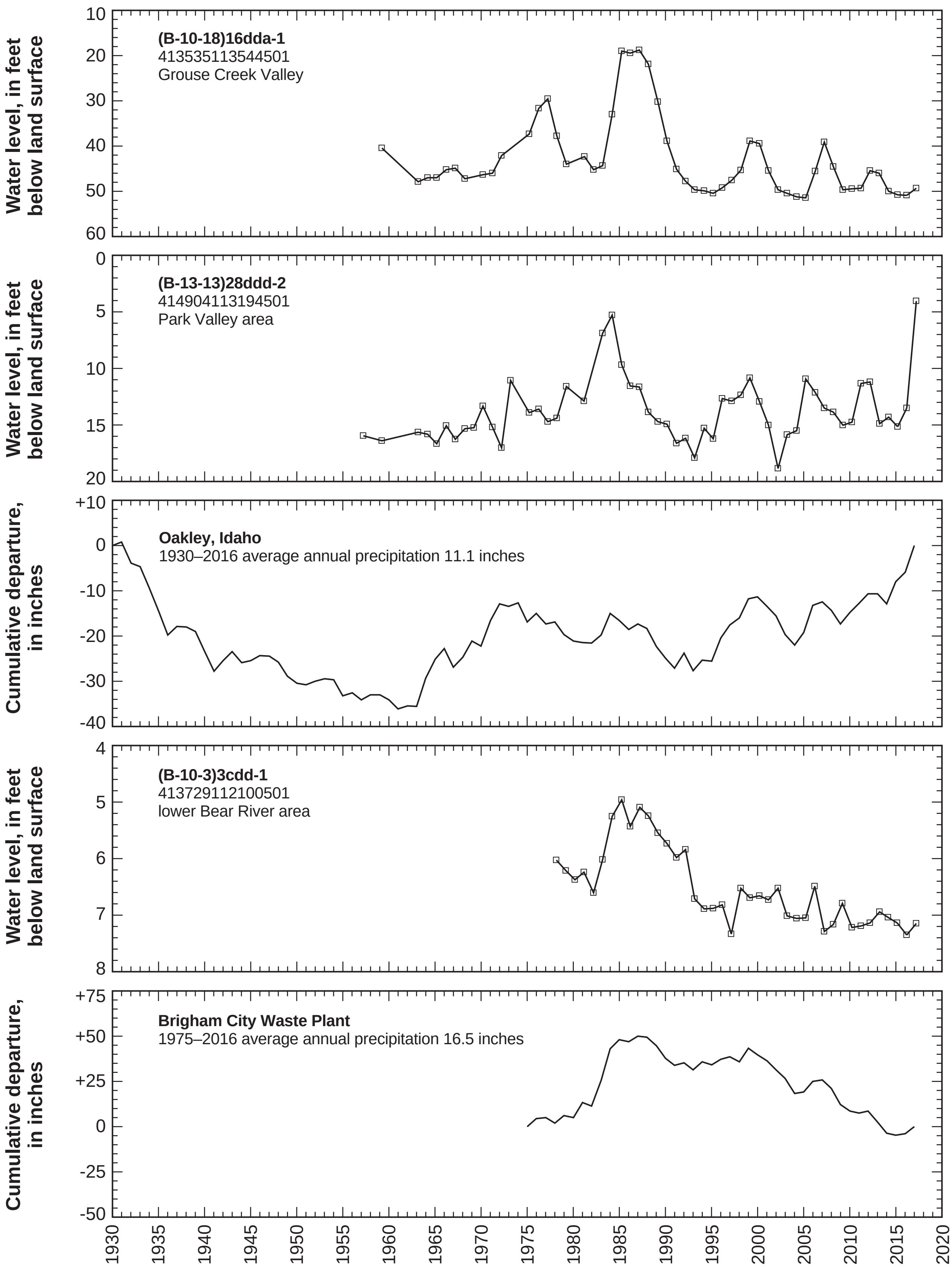


Figure 40. Relation of water level in selected wells in other areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.

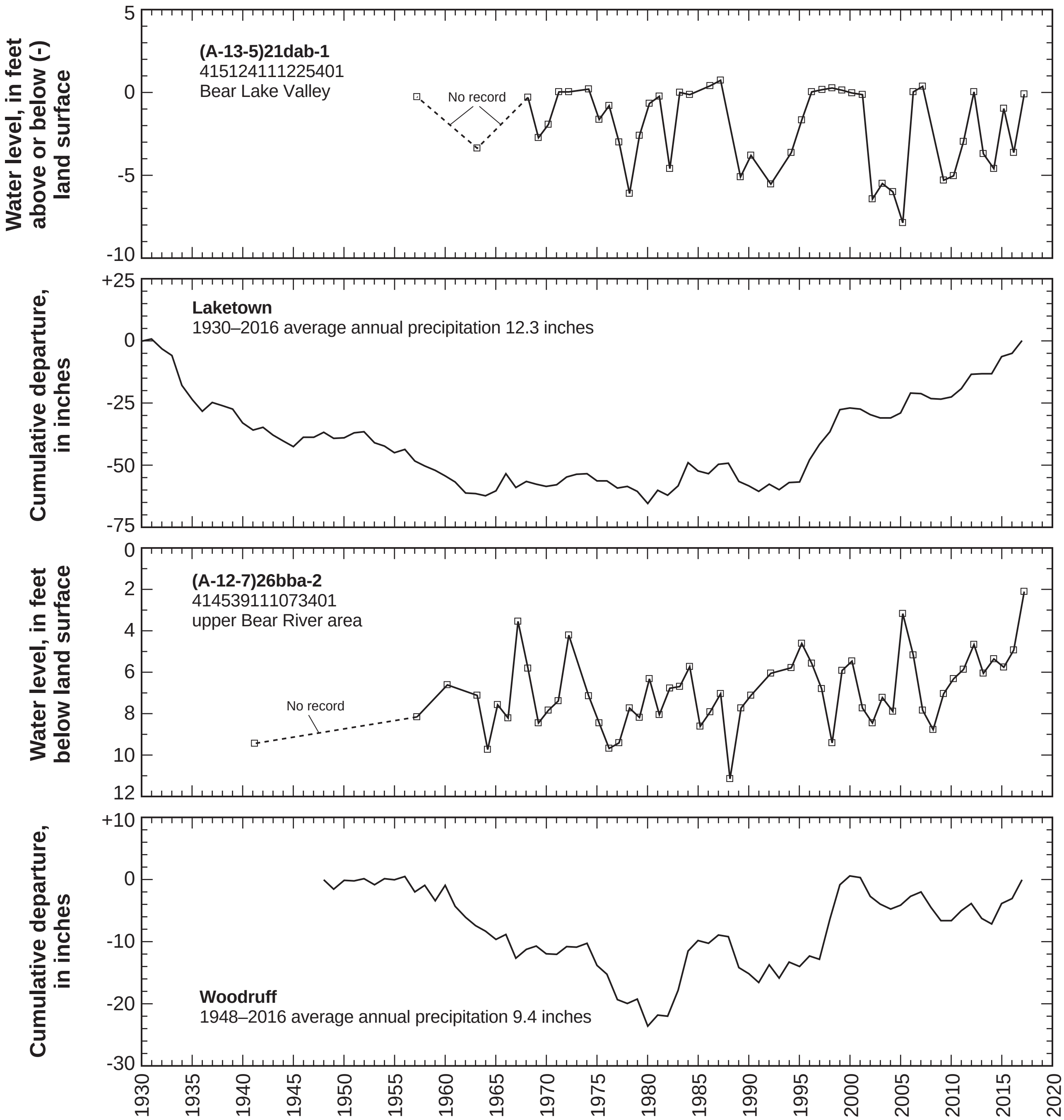


Figure 40. Relation of water level in selected wells in other areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.—Continued

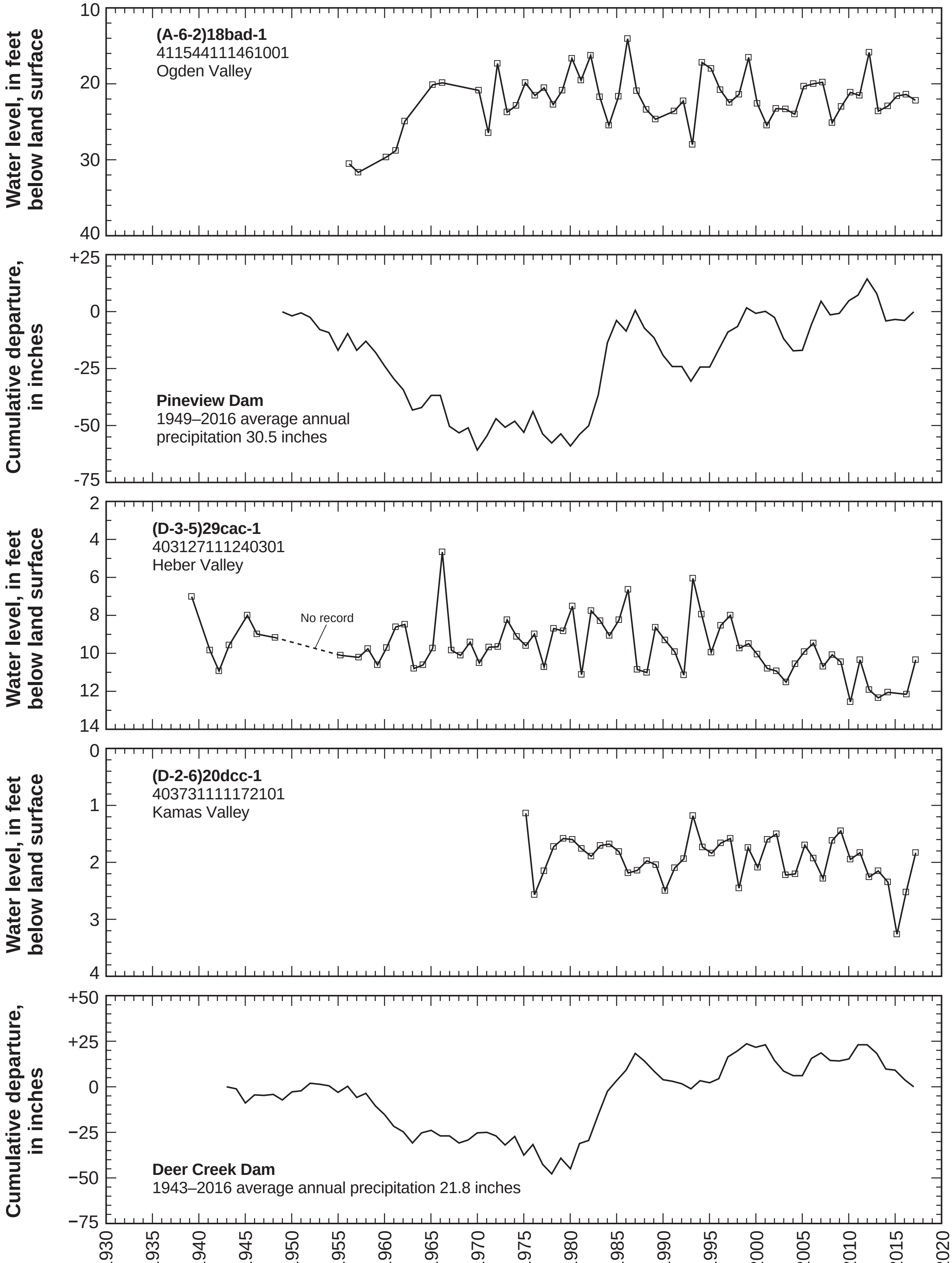


Figure 40. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.—Continued

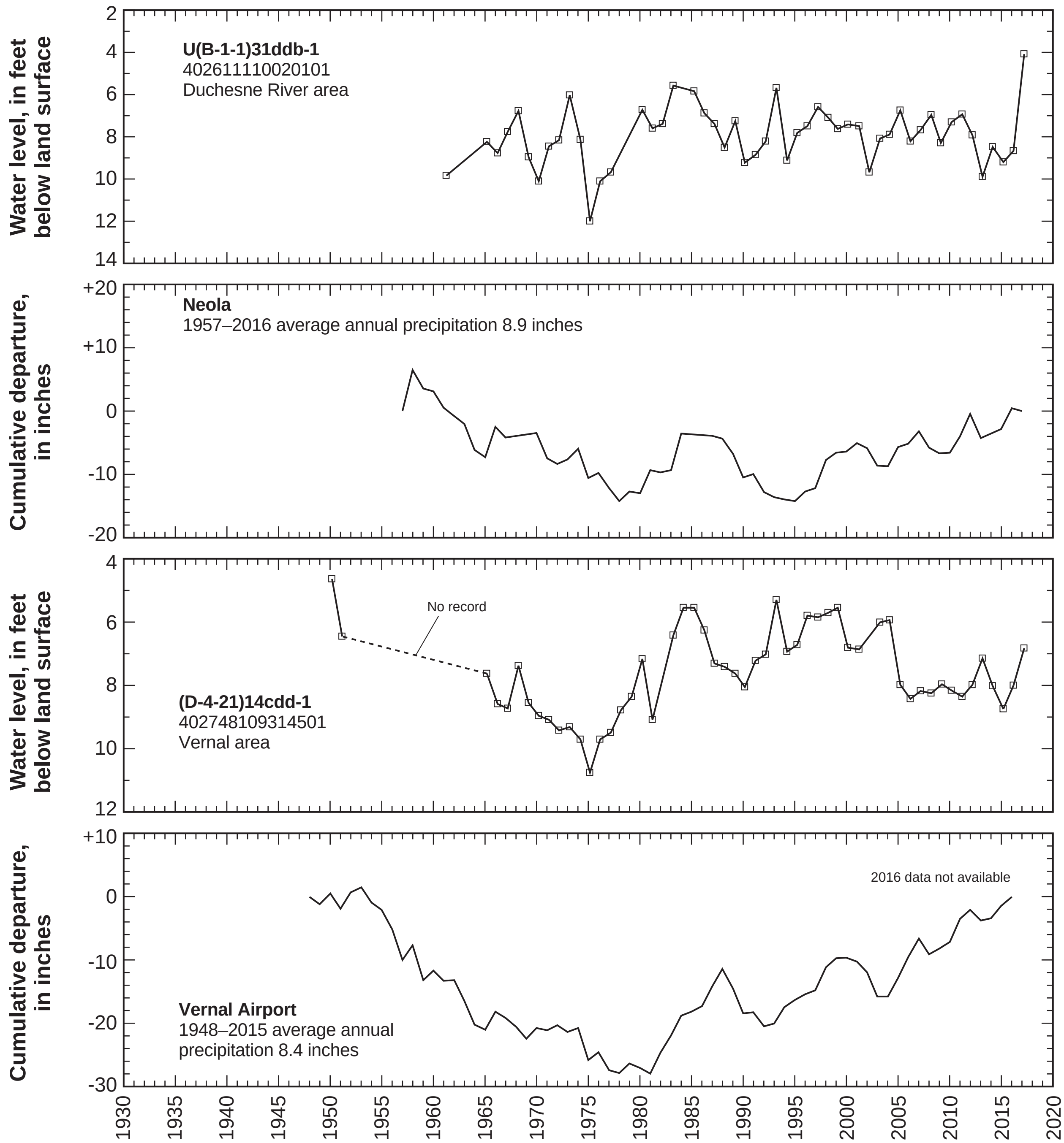


Figure 40. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.—Continued

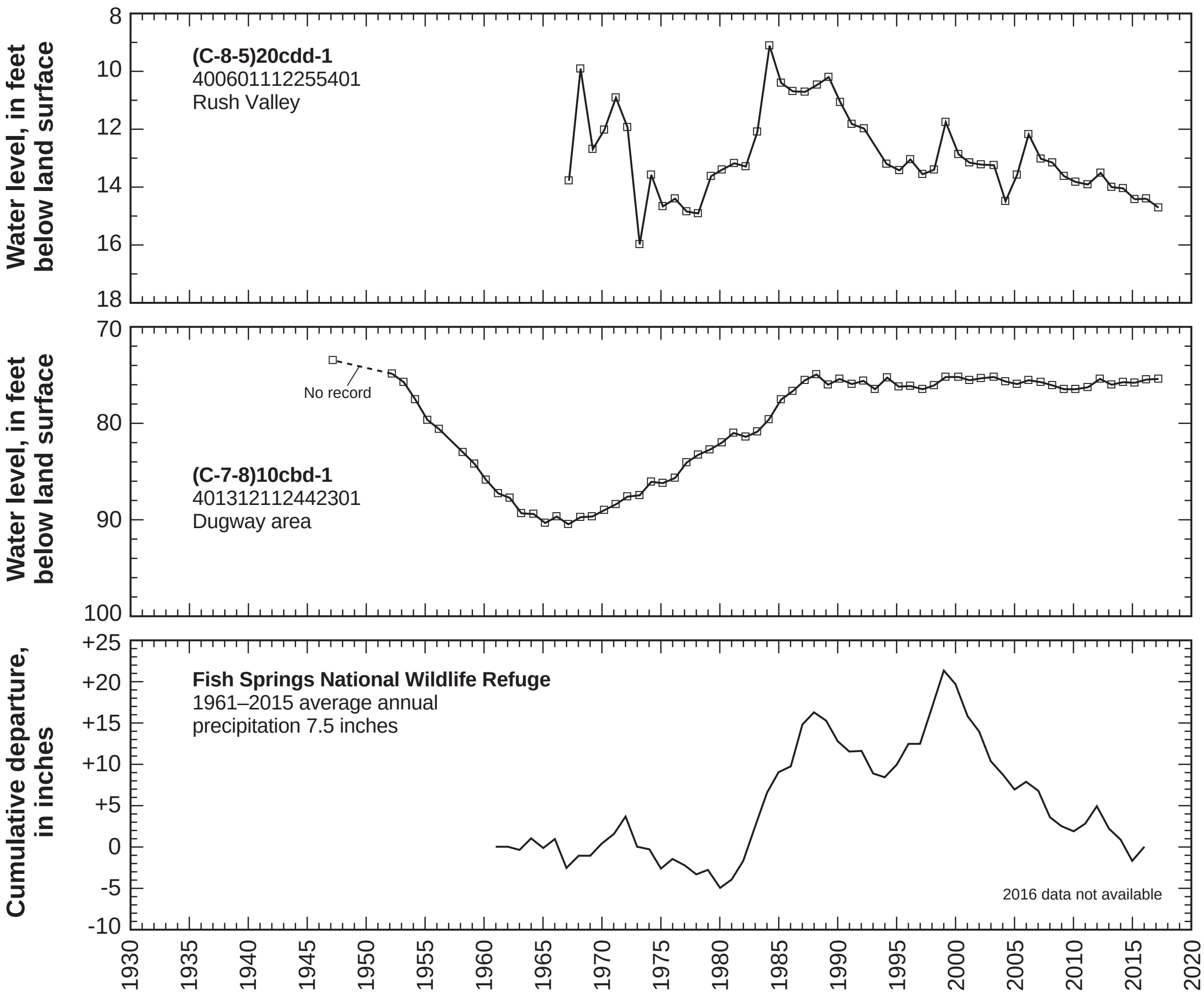


Figure 40. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.—Continued

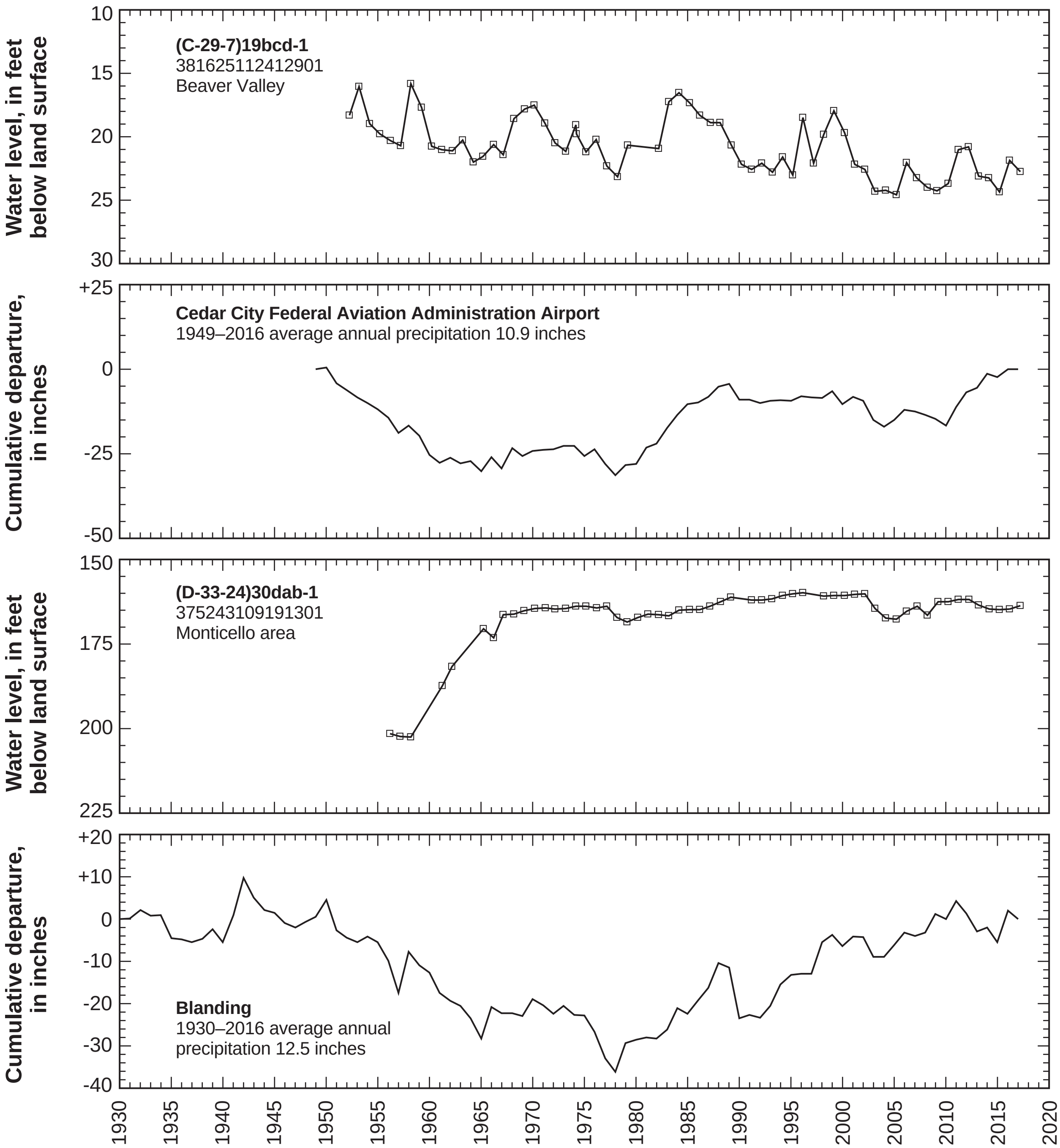


Figure 40. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.—Continued

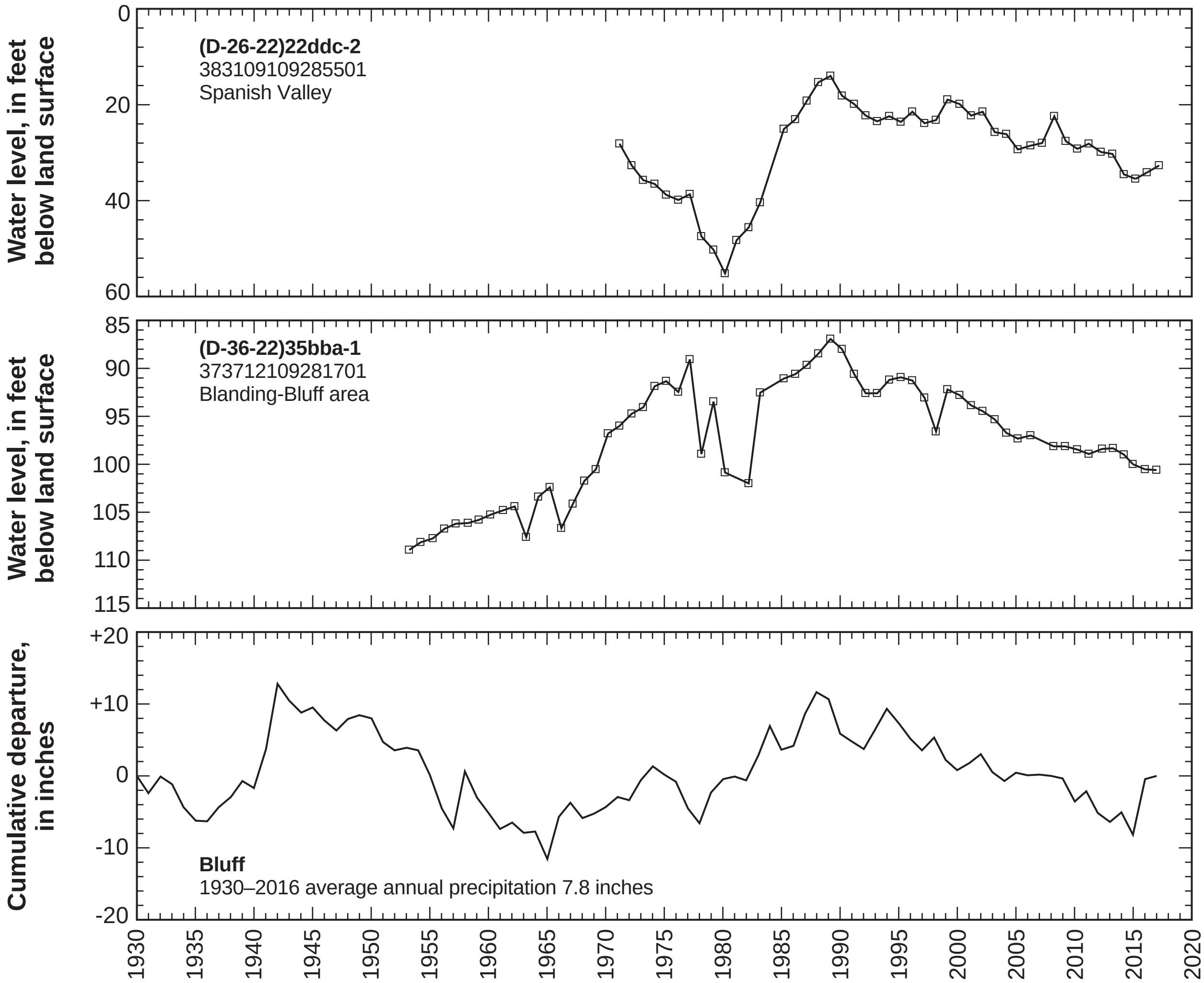


Figure 40. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.—Continued

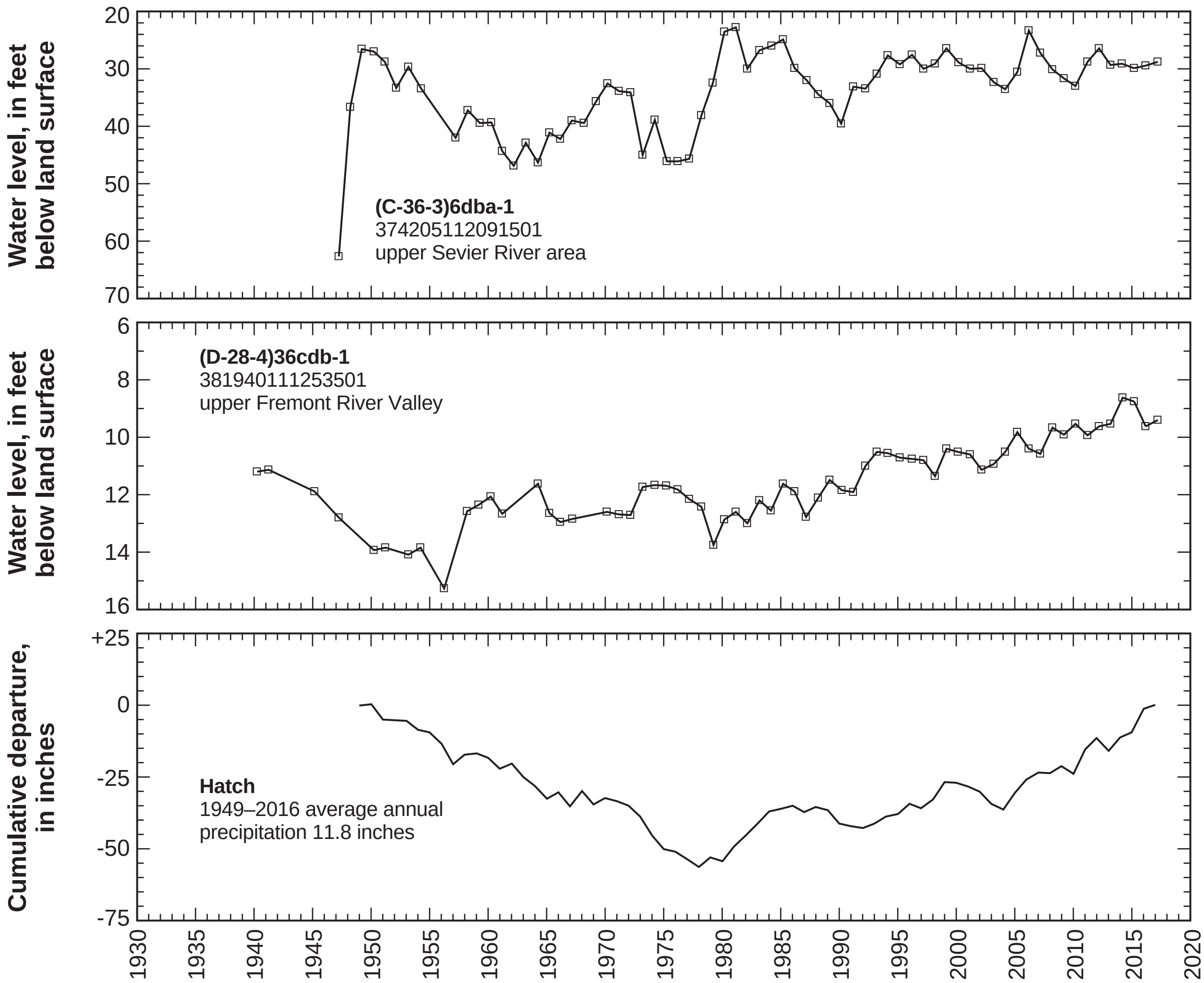


Figure 40. Relation of water level in wells in selected areas of Utah to cumulative departure from average annual precipitation at sites in or near those areas.—Continued

Quality of Water from Selected Wells in Utah, Summer of 2016

From June through September 2016, the U.S. Geological Survey (USGS) Utah Water Science Center, in cooperation with the Utah Department of Environmental Quality, Division of Water Quality, sampled water from 100 wells located in 22 counties (fig. 41). Samples were collected during this time period to limit seasonal variability in the data. The majority of the water samples were collected from irrigation wells. Field parameters that were measured at the time the water samples were collected included pH, specific conductance, and water temperature. Chemical constituents that were analyzed in the water samples included major ions, dissolved solids, nutrients (nitrate plus nitrite, and orthophosphate), and selected trace elements. The USGS National Water Quality Laboratory in Denver, Colorado, analyzed the water samples. Field parameter values and analytical results for major ions, dissolved solids, and nutrients are shown in table 5. Analytical results for trace elements are shown in table 6.

The water samples were collected using protocols in the USGS National Field Manual for the Collection of Water-Quality Data (U.S. Geological Survey, variously dated). Analytical methods used by the laboratory are described in Fishman and Friedman (1989). Water-quality data in this report are stored in the USGS National Water Information System (NWIS) database and are available online at http://waterdata.usgs.gov/ut/nwis/qw.

Water-quality field blanks were collected to determine if samples were being contaminated during equipment decontamination and/or sample collection and processing procedures. A field blank is an inorganic blank water sample that is prepared by the USGS National Water Quality Laboratory, carried in the field, and processed using the same methods and equipment as the environmental water samples. The field blank is subject to processing in the field, preservation, shipment, laboratory handling procedures, and analytical protocols. Fourteen field blank water samples were processed during the 2016 sampling period. Analytical results for all constituents in the field blanks were less than the laboratory reporting limits.

Replicate water samples also were collected at five wells. A replicate sample is collected concurrent with an environmental sample and is used to assess the repeatability of the laboratory analytical results. Analytical results for the replicate water samples were in good agreement with the results of the environmental samples and within 2 percent for all constituents.

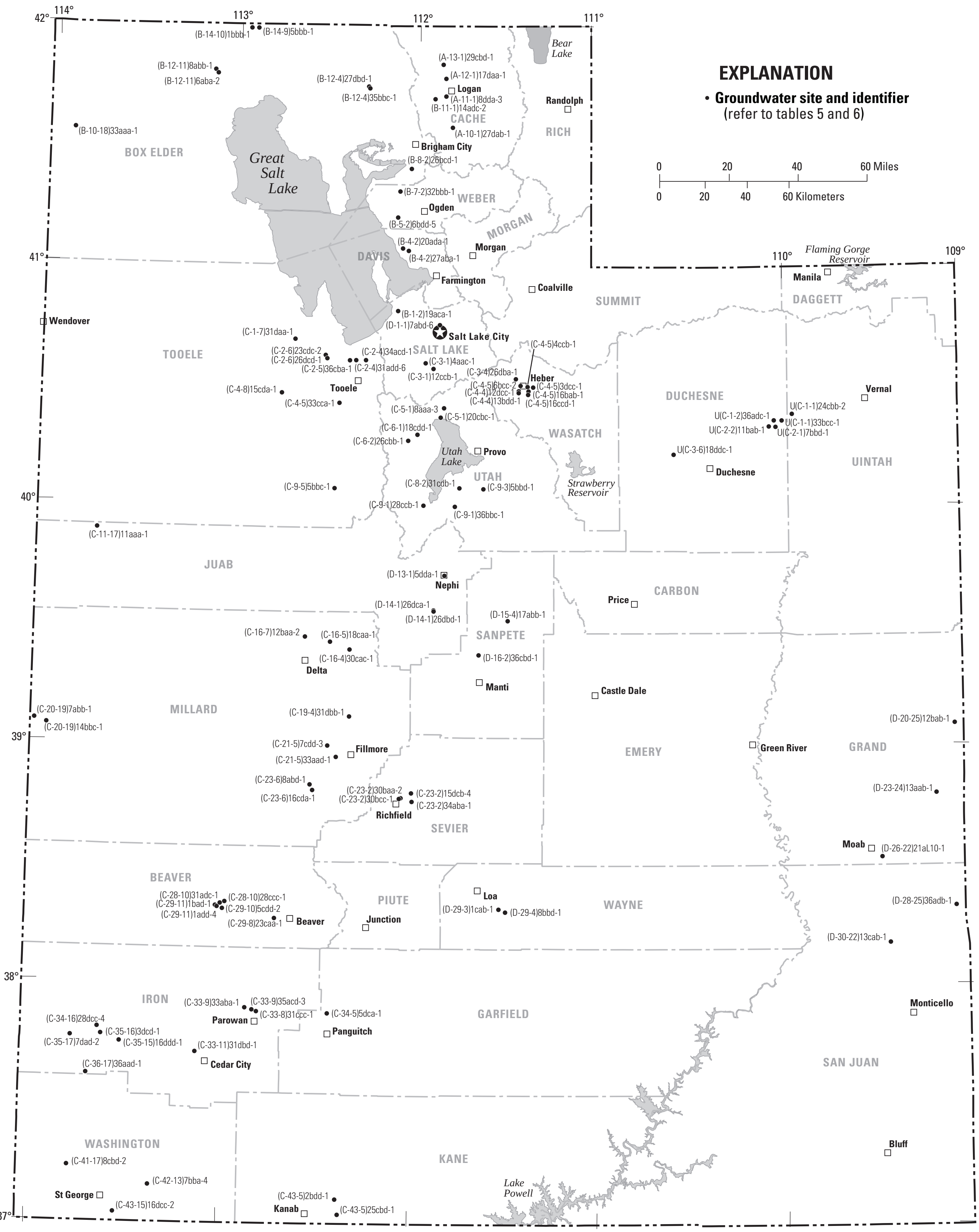


Figure 41. Location of groundwater sites sampled during the summer of 2016.

Table 5. Physical properties and concentrations of major ions and nutrients in water samples collected from selected wells in Utah, summer of 2016.

[Date of sample: YYYYMMDD, year, month, day; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter; ANC, acid neutralization capacity; <, less than; E, estimated; —, no data]

Local identifier (refer to figure 41)	Station number	Date (YYYYMMDD)	pH, field, in standard units	Specific conductance, field, in µS/cm at 25 °C	Water temperature, field, in °C	Hardness, water, in mg/L as $CaCO_3$	Calcium, dissolved, in mg/L	Magnesium, dissolved, in mg/L
Beaver County								
Beaver Valley								
(C-29-8)23caa-1	381618112432501	20160726	8.7	1,200	17.6	24	6.54	1.86
Escalante Valley, Milford area								
(C-28-10)28ccc-1	382019112591701	20160705	7.4	998	20.2	423	93.6	45.9
(C-28-10)31adc-1	381954113004401	20160705	7.6	511	19.9	209	55.6	17.0
(C-29-10)5cdd-2	381835113000001	20160705	7.9	641	17.1	262	70.2	21.0
(C-29-11)1add-4	381902113014502	20160705	8.3	356	26.5	78	17.9	8.03
(C-29-11)1bad-1	381920113021501	20160705	7.4	1,000	15.9	441	132	27.1
Box Elder County								
Curlew Valley								
(B-12-11)6aba-2	414808113080401	20160622	7.8	1,880	16.9	578	163	41.4
(B-12-11)8abb-1	414710113071601	20160622	7.3	5,930	13.8	2,470	712	167
(B-14-9)5bbb-1	415847112540401	20160622	7.5	1,490	17.4	556	161	37.4
(B-14-10)1bbb-1	415845112562201	20160622	7.6	570	15.8	229	64.5	16.5
East Shore area								
(B-8-2)26bcd-1	412405112022501	20160603	7.4	189	14.6	34	6.70	4.30
Grouse Creek Valley								
(B-10-18)33aaa-1	413300113543001	20160623	7.9	1,060	13.3	360	106	23.4
Lower Bear River area								
(B-12-4)27dbd-1	414454112173101	20160726	7.5	2,590	15.2	884	196	95.8
(B-12-4)35bbc-1	414406112163601	20160726	7.5	1,660	16.9	413	92.6	44.2
Cache County								
Cache Valley								
(A-10-1)27dab-1	413428111485701	20160711	7.3	508	12.2	256	64.0	23.4
(A-11-1)8dda-3	414216111511001	20160711	7.3	508	10.9	265	65.2	24.7
(A-12-1)17daa-1	414642111511401	20160711	7.4	524	20.3	253	61.4	24.1
(A-13-1)29cbd-1	415011111521401	20160711	7.8	453	13.4	209	43.9	24.2
(B-11-1)14adc-2	414134111544701	20160711	7.4	554	11.5	311	75.0	30.1
Davis County								
East Shore area								
(B-4-2)20ada-1	410410112050001	20160602	8.1	346	15.4	146	39.0	11.8
(B-4-2)27aba-1	410340112030001	20160602	8.1	610	14.6	48	12.3	4.22
Duchesne County								
Duchesne River area								
U(C-1-1)33bcc-1	402114110003301	20160727	7.7	1,450	13.1	583	155	47.4
U(C-1-2)36adc-1	402116110030801	20160726	7.4	338	12.3	172	45.8	13.9
U(C-2-1)7bbd-1	401940110023601	20160726	8.0	1,870	15.1	44	11.7	3.61
U(C-2-2)11bab-1	401946110044601	20160726	7.4	354	14.4	169	43.0	14.9
U(C-3-6)18ddc-1	401251110355801	20160725	6.7	2,270	12.8	1,160	274	116
Garfield County								
Central Sevier Valley								
(C-34-5)5dca-1	375241112261201	20160719	7.4	389	15.1	170	48.7	11.8
Grand County								
Spanish Valley								
(D-26-22)21aL10-1	383201109295301	20160817	7.3	1,310	16.0	636	164	54.9
Upper Colorado River area								
(D-20-25)12bab-1	390513109060601	20160825	7.4	577	16.3	271	34.0	45.1
(D-23-24)13aab-1	384750109122701	20160907	8.5	666	17.5	7	1.87	0.45

Potassium, dissolved, in mg/L	Sodium, dissolved, in mg/L	ANC, fixed end point, lab, in mg/L as $CaCO_3$	Bromide, dissolved, in mg/L	Chloride, dissolved, in mg/L	Fluoride, dissolved, in mg/L	Silica, dissolved, in mg/L	Sulfate, dissolved, in mg/L	Solids, dissolved, residue at 180 °C, in mg/L	Nitrate plus nitrite, dissolved, in mg/L as N	Orthophosphate, dissolved, in mg/L as P
7.16	286	333	0.11	35.3	4.97	58.4	222	814	0.12	0.134
4.11	43.6	103	0.37	130	0.39	32.4	210	651	2.24	0.014
4.07	26.4	112	0.16	55.3	0.47	37.8	52.9	317	1.51	0.020
3.94	29.6	168	0.16	52.9	0.38	30.2	77.3	403	1.91	0.033
2.43	49.6	118	0.05	13.9	0.76	27.8	39.8	219	0.13	0.029
6.66	28.8	85.1	0.24	155	0.37	44.4	173	771	2.59	0.027
7.55	142	140	0.34	467	0.21	21.1	47.6	1,110	0.82	0.014
16.4	258	110	1.19	1,610	0.10	22.5	28.7	3,900	0.98	0.012
14.4	59.8	124	0.29	370	0.16	57.6	23.2	969	2.10	0.030
6.94	28.3	154	0.07	76.0	0.26	59.3	24.6	381	0.31	0.030
3.66	26.5	74.8	0.02	6.50	0.08	14.5	10.4	121	0.61	0.133
8.49	53.4	226	0.22	126	0.29	50.6	68.8	597	0.61	0.046
4.39	196	170	0.86	619	0.21	24.7	163	1,760	5.26	0.016
4.14	190	199	0.37	365	0.23	23.4	68.1	932	2.35	0.016
0.64	9.76	236	0.01	12.6	0.14	18.2	8.06	287	2.95	0.033
1.51	7.39	244	0.01	10.1	0.11	9.73	24.7	311	0.33	0.009
6.57	18.8	240	0.02	10.1	0.23	26.7	11.1	301	2.20	0.018
1.52	27.5	224	0.02	8.72	0.10	11.1	11.1	267	0.10	0.012
1.97	7.12	219	0.02	8.73	0.25	10.8	74.8	348	0.41	0.014
2.93	18.9	167	0.02	14.6	0.15	22.3	0.14	200	<0.040	0.052
5.48	125	265	E0.062	42.4	0.34	32.1	0.13	382	<0.040	0.610
3.21	130	114	<0.020	0.85	1.22	8.41	694	1,170	<0.040	<0.004
3.96	3.98	135	<0.010	0.81	0.78	8.08	42.6	204	<0.040	<0.004
2.42	420	422	0.05	280	3.46	9.09	123	1,100	<0.040	<0.004
3.46	9.39	136	<0.010	0.93	0.55	10.2	49.3	210	<0.040	<0.004
1.45	163	320	0.39	85.0	0.11	41.2	845	1,920	<0.040	0.013
1.10	19.0	194	0.04	4.03	0.17	33.6	3.53	223	1.38	0.081
3.10	67.4	208	0.20	30.6	0.27	18.4	474	993	5.18	0.005
4.10	26.7	293	0.08	5.52	0.29	8.97	25.0	323	<0.040	<0.004
1.67	155	252	0.11	21.5	0.43	8.68	63.4	409	<0.040	0.005

Table 5. Physical properties and concentrations of major ions and nutrients in water samples collected from selected wells in Utah, summer of 2016.—Continued

[Date of sample: YYYYMMDD, year, month, day; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter; ANC, acid neutralization capacity; <, less than; E, estimated; —, no data]

Local identifier (refer to figure 41)	Station number	Date (YYYYMMDD)	pH, field, in standard units	Specific conductance, field, in µS/cm at 25 °C	Water temperature, field, in °C	Hardness, water, in mg/L as $CaCO_3$	Calcium, dissolved, in mg/L	Magnesium, dissolved, in mg/L
Iron County								
Cedar Valley								
(C-35-11)31dbd-1	374248113075201	20160822	7.6	1,190	14.0	719	142	88.7
Escalante Valley, Beryl-Enterprise area								
(C-34-16)28dcc-4	374934113384601	20160627	7.5	846	14.4	343	104	20.3
(C-35-15)16ddd-1	374503113313701	20160627	7.3	700	15.8	241	64.1	19.8
(C-35-16)3dcd-1	374648113373101	20160627	7.1	429	13.2	192	58.6	11.1
(C-35-17)7dad-2	374617113470601	20160627	7.4	477	16.2	174	55.6	8.40
(C-36-17)36aad-1	373656113415201	20160627	7.3	448	13.5	190	59.2	10.3
Parowan Valley								
(C-33-8)31ccc-1	375257112483501	20160726	7.2	512	14.5	234	48.8	27.3
(C-33-9)33aba-1	375344112521601	20160726	7.5	322	15.3	142	26.8	18.3
(C-33-9)35acd-3	375320112510003	20160726	7.5	448	14.1	221	46.1	25.7
Juab County								
Juab Valley								
(C-14-1)26dbd-1	393342111534501	20160811	7.6	1,230	14.4	539	111	63.6
(C-14-1)26dca-1	393335111534401	20160811	7.4	1,440	15.5	649	128	79.8
(D-13-1)5dda-1	394226111501601	20160811	7.3	1,810	12.1	581	159	44.7
Snake Valley								
(C-11-17)11aaa-1	395319113431201	20160810	7.2	1,270	15.3	428	126	27.4
Kane County								
Kanab area								
(C-43-5)2bdd-1	370608112230001	20160628	7.0	732	13.1	386	89.0	39.8
(C-43-5)25cbd-1	370220112221201	20160628	7.2	1,740	15.9	784	122	116
Millard County								
Pahvant Valley								
(C-19-4)31dbb-1	390700112203201	20160622	7.0	1,360	14.1	633	138	70.2
(C-21-5)7cdd-3	385939112272303	20160622	7.2	1,610	11.6	617	134	68.8
(C-21-5)33aad-1	385650112243601	20160622	7.0	726	13.5	319	85.1	25.9
(C-23-6)8abd-1	384953112325101	20160622	6.8	8,260	15.2	2,720	663	260
(C-23-6)16cda-1	384829112315901	20160622	6.7	6,360	17.8	1,710	470	130
Sevier Desert								
(C-16-4)30cac-1	392344112203801	20160811	7.5	823	13.3	331	82.0	30.7
(C-16-5)18caa-1	392538112270201	20160811	8.0	331	21.3	133	23.9	17.9
(C-16-7)12baa-2	392649112350802	20160810	8.1	491	14.7	134	23.4	18.3
Snake Valley								
(C-20-19)7abb-1	390430114013001	20160810	7.8	340	15.9	151	35.9	15.0
(C-20-19)14bbc-1	390416113573801	20160810	7.7	403	13.9	176	40.8	18.1
Salt Lake County								
Salt Lake Valley								
(B-1-2)19aca-1	404826112062201	20160613	8.2	2,280	17.0	51	8.06	7.54
(C-3-1)4aac-1	403533111570701	20160613	7.3	1,310	15.5	519	128	48.3
(C-3-1)12ccb-1	403408111543201	20160613	7.5	935	19.5	298	65.3	32.8
(D-1-1)7abd-6	404506111523301	20160613	7.2	1,350	14.4	605	146	58.4
San Juan County								
Upper Colorado River area								
(D-28-25)36adb-1	381941109064001	20160817	8.0	329	12.0	151	17.8	25.8
(D-30-22)13cab-1	381034109274501	20160823	8.0	390	13.0	221	24.5	38.8

Potassium, dissolved, in mg/L	Sodium, dissolved, in mg/L	ANC, fixed end point, lab, in mg/L as $CaCO_3$	Bromide, dissolved, in mg/L	Chloride, dissolved, in mg/L	Fluoride, dissolved, in mg/L	Silica, dissolved, in mg/L	Sulfate, dissolved, in mg/L	Solids, dissolved, residue at 180 °C, in mg/L	Nitrate plus nitrite, dissolved, in mg/L as N	Orthophosphate, dissolved, in mg/L as P
2.65	13.2	136	0.06	13.6	0.22	22.4	516	970	2.70	0.007
8.94	35.9	130	0.53	148	1.13	66.3	72.0	648	1.22	0.029
4.01	59.6	149	0.18	50.4	0.52	52.1	143	490	0.37	0.032
4.73	14.4	140	0.16	42.2	0.22	51.2	12.1	291	1.38	0.038
7.93	34.2	145	0.08	20.6	0.66	69.0	67.4	351	0.92	0.024
6.40	22.7	180	0.11	23.8	0.29	52.9	15.0	311	2.03	0.075
2.75	24.7	196	0.08	27.5	0.16	29.8	24.5	316	2.23	0.025
3.17	16.1	132	0.03	10.9	0.24	32.9	21.3	215	0.39	0.023
2.57	14.0	185	0.03	21.2	0.14	27.3	23.4	278	1.70	0.017
4.00	79.7	224	0.05	73.1	0.28	22.2	360	882	1.35	0.016
4.94	94.5	214	0.04	68.6	0.30	25.2	489	1,070	0.72	0.013
4.22	173	294	0.09	299	0.16	26.1	166	1,120	6.22	0.023
2.88	81.3	152	0.25	287	0.19	20.3	40.3	858	3.31	0.022
2.84	18.3	189	0.09	7.67	0.15	11.8	190	498	4.50	0.029
8.43	112	373	0.79	89.6	0.46	15.9	465	1,240	11.7	0.016
2.18	52.8	204	0.45	257	0.08	21.5	119	865	6.51	0.016
5.48	136	317	0.29	199	0.15	26.3	257	1,080	5.92	0.024
3.80	41.9	233	0.10	76.1	0.21	16.1	29.4	433	3.86	0.021
91.3	1,060	326	2.55	1,710	0.84	38.3	1,030	5,860	1.76	0.051
104	807	365	2.00	1,340	1.29	44.8	753	4,340	2.69	0.053
1.21	50.8	230	0.15	85.0	0.08	13.8	50.9	463	4.81	0.010
1.96	20.9	126	0.03	22.4	0.19	27.6	12.3	208	0.58	0.009
3.34	52.3	117	0.06	56.1	0.33	26.8	48.2	301	0.11	0.014
1.18	14.1	132	0.06	22.8	0.08	16.7	12.3	190	0.45	0.008
1.44	20.8	158	0.08	29.0	0.33	22.5	12.5	244	0.11	0.008
2.65	503	385	0.28	417	2.66	21.3	108	1,300	<0.040	0.177
3.78	91.3	217	0.15	161	0.10	26.7	206	852	3.37	0.025
8.52	85.0	184	0.10	123	0.22	32.8	109	577	0.26	0.018
3.03	62.9	289	0.09	168	0.15	18.7	152	856	4.58	0.041
3.88	17.3	171	<0.010	0.67	0.13	10.5	14.1	191	0.12	<0.004
3.24	4.78	207	0.05	5.99	0.24	8.81	8.32	221	0.39	<0.004

Table 5. Physical properties and concentrations of major ions and nutrients in water samples collected from selected wells in Utah, summer of 2016.—Continued

[Date of sample: YYYYMMDD, year, month, day; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter; ANC, acid neutralization capacity; <, less than; E, estimated; —, no data]

Local identifier (refer to figure 41)	Station number	Date (YYYYMMDD)	pH, field, in standard units	Specific conductance, field, in µS/cm at 25 °C	Water temperature, field, in °C	Hardness, water, in mg/L as $CaCO_3$	Calcium, dissolved, in mg/L	Magnesium, dissolved, in mg/L
Sanpete County								
Sanpete Valley								
(D-15-4)17abb-1	393113111294501	20160824	7.6	576	10.2	321	69.9	35.6
(D-16-2)36cbd-1	392238111390501	20160824	7.8	813	13.4	322	49.1	48.5
Sevier County								
Central Sevier Valley								
(C-23-2)15dcb-4	384757112002201	20160725	7.4	665	14.0	327	66.7	39.0
(C-23-2)30baa-2	384641112034601	20160725	7.2	933	—	437	74.8	60.8
(C-23-2)30bcc-1	384635112040801	20160725	7.3	805	20.0	410	84.1	48.5
(C-23-2)34aba-1	384550112000901	20160725	7.0	1,500	12.5	647	181	47.7
Tooele County								
Rush Valley								
(C-4-5)33cca-1	402526112252001	20160802	—	—	—	371	104	26.9
(C-9-5)5bbc-1	400401112262001	20160802	7.8	616	—	238	68.9	16.1
Skull Valley								
(C-1-7)31daa-1	404113112395801	20160824	7.5	8,830	17.4	576	110	73.5
(C-4-8)15cda-1	402757112440401	20160824	7.5	1,070	15.7	331	100	19.8
Tooele Valley								
(C-2-4)31add-6	403606112195401	20160610	7.1	1,980	15.9	597	151	53.2
(C-2-4)34acd-1	403609112164201	20160610	7.3	900	14.0	370	82.6	39.7
(C-2-5)36cba-1	403603112215801	20160830	7.3	1,950	19.6	346	86.5	31.5
(C-2-6)23cdc-2	403718112295602	20160610	7.3	1,540	17.5	441	106	42.6
(C-2-6)26dcd-1	403630112292301	20160610	7.5	634	16.7	250	62.0	23.2
Uintah County								
Duchesne River area								
U(C-1-1)24cbb-2	402252109571501	20160727	6.8	1,100	14.7	617	113	81.2
Utah County								
Cedar Valley								
(C-6-1)18cdd-1	401730111594501	20160803	7.4	742	—	289	70.6	27.4
(C-6-2)26cbb-1	401607112023401	20160803	7.5	837	—	384	63.8	54.6
Goshen Valley								
(C-9-1)28ccb-1	395956111572101	20160628	7.4	2,600	17.7	876	232	72.3
Northern Utah Valley								
(D-5-1)8aaa-3	402420111505701	20160627	7.8	409	14.0	177	42.4	17.3
(D-5-1)20cbc-1	402159111520101	20160627	7.8	383	11.5	189	45.1	18.4
Southern Utah Valley								
(D-8-2)31cdb-1	400422111454201	20160628	7.5	742	18.4	271	62.4	27.9
(D-9-1)36bbc-1	395942111470801	20160701	7.7	521	11.0	279	71.7	24.2
(D-9-3)5bbd-1	400407111375101	20160627	7.4	544	12.9	275	66.8	26.3

Potassium, dissolved, in mg/L	Sodium, dissolved, in mg/L	ANC, fixed end point, lab, in mg/L as $CaCO_3$	Bromide, dissolved, in mg/L	Chloride, dissolved, in mg/L	Fluoride, dissolved, in mg/L	Silica, dissolved, in mg/L	Sulfate, dissolved, in mg/L	Solids, dissolved, residue at 180 °C, in mg/L	Nitrate plus nitrite, dissolved, in mg/L as N	Orthophosphate, dissolved, in mg/L as P
1.28	9.33	163	0.02	6.87	0.09	9.65	14.3	283	3.03	0.005
1.24	54.7	271	0.15	75.4	0.26	20.1	54.8	462	0.65	0.005
3.26	21.1	270	0.07	26.4	0.37	35.5	51.5	386	1.05	0.040
2.63	37.1	436	0.07	14.4	0.20	14.6	33.8	491	2.54	<0.004
1.63	25.8	391	0.06	17.7	0.17	15.0	26.5	434	2.39	0.016
4.04	89.7	408	0.17	161	0.21	49.9	172	952	5.60	0.079
1.44	75.2	214	0.15	182	0.11	16.1	59.5	624	1.62	0.014
1.38	30.5	143	0.08	88.7	0.12	17.9	25.2	365	1.36	0.013
62.7	1,640	180	1.65	2,300	0.31	30.5	177	5,250	1.53	0.022
2.21	85.5	116	0.21	233	0.10	15.0	66.9	702	3.80	0.015
3.72	176	194	0.34	378	0.11	16.9	143	1,240	4.62	0.017
1.56	66.8	236	0.06	46.6	0.06	14.1	174	606	2.76	0.021
3.82	255	208	0.32	479	0.16	20.4	37.7	1,050	3.11	0.014
13.5	132	150	0.25	342	0.09	40.0	41.8	962	1.44	0.025
5.78	27.0	146	0.06	96.3	0.15	45.4	17.5	413	0.64	0.025
0.78	30.1	546	0.16	10.0	1.98	83.0	97.3	747	<0.040	0.028
3.49	40.5	202	0.09	72.0	0.56	22.4	66.2	428	1.11	0.007
3.76	23.5	213	0.16	136	0.34	60.1	30.0	490	0.17	0.030
21.1	162	102	0.88	600	0.20	67.5	132	1,830	28.3	0.024
2.20	16.6	129	0.05	39.8	0.23	21.2	18.5	227	0.75	0.015
1.21	10.8	145	0.02	9.22	0.20	12.9	39.6	228	1.86	0.010
13.2	54.3	230	0.07	78.3	0.38	64.6	42.5	458	<0.040	0.083
1.50	8.42	225	0.04	22.7	0.22	18.0	21.1	291	1.83	0.011
1.28	15.4	244	0.02	13.7	0.14	15.3	33.6	312	1.02	0.020

Table 5. Physical properties and concentrations of major ions and nutrients in water samples collected from selected wells in Utah, summer of 2016.—Continued

[Date of sample: YYYYMMDD, year, month, day; µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter; ANC, acid neutralization capacity; <, less than; E, estimated; —, no data]

Local identifier (refer to figure 41)	Station number	Date (YYYYMMDD)	pH, field, in standard units	Specific conductance, field, in µS/cm at 25 °C	Water temperature, field, in °C	Hardness, water, in mg/L as $CaCO_3$	Calcium, dissolved, in mg/L	Magnesium, dissolved, in mg/L
Wasatch County								
Heber Valley								
(D-3-4)26dba-1	403146111272701	20160831	7.0	907	14.1	443	134	26.6
(D-4-4)12dcc-1	402842111263101	20160830	6.8	794	11.6	366	103	26.6
(D-4-4)13bdd-1	402810111263601	20160830	7.5	475	21.2	240	57.8	23.3
(D-4-5)3dcc-1	402937111214901	20160830	6.8	530	11.1	257	84.6	11.2
(D-4-5)4ccb-1	402946111233901	20160830	6.7	470	13.9	241	77.4	11.6
(D-4-5)6bcc-2	403003111255801	20160831	7.1	404	11.9	206	63.7	11.4
(D-4-5)16bab-1	402840111232201	20160830	7.0	622	11.8	328	90.1	25.1
(D-4-5)16ccd-1	402750111232701	20160831	7.4	517	12.2	262	65.2	23.9
Washington County								
Central Virgin River area								
(C-41-17)8cbd-2	371348113470301	20160627	7.0	476	18.5	240	68.1	17.0
(C-42-13)7bba-4	370915113213801	20160628	7.3	1,760	23.3	900	224	82.7
(C-43-15)16dcc-2	370218113322101	20160627	7.2	3,250	20.8	2,080	583	151
Wayne County								
Upper Fremont River Valley								
(D-29-3)1cab-1	381902111321101	20160719	6.9	253	21.4	105	28.8	8.04
(D-29-4)8bbd-1	381820111300501	20160719	7.0	866	12.5	745	242	34.4
Weber County								
East Shore area								
(B-5-2)6bdd-5	411153112064605	20160603	7.9	2,150	23.9	260	75.4	17.5
(B-7-2)32bbb-1	411824112060601	20160602	7.8	2,420	18.6	344	71.7	40.0

Potassium, dissolved, in mg/L	Sodium, dissolved, in mg/L	ANC, fixed end point, lab, in mg/L as $CaCO_3$	Bromide, dissolved, in mg/L	Chloride, dissolved, in mg/L	Fluoride, dissolved, in mg/L	Silica, dissolved, in mg/L	Sulfate, dissolved, in mg/L	Solids, dissolved, residue at 180 °C, in mg/L	Nitrate plus nitrite, dissolved, in mg/L as N	Orthophosphate, dissolved, in mg/L as P
7.27	32.3	296	0.10	39.7	0.54	19.5	143	507	3.11	0.028
1.59	27.8	270	0.04	70.2	0.08	22.4	38.9	431	4.20	0.050
1.80	10.4	200	<0.010	22.9	0.32	12.0	17.6	264	0.34	0.012
3.16	8.12	180	0.03	45.9	0.08	36.0	9.15	336	4.83	0.073
2.80	6.10	176	0.03	26.2	0.08	39.5	14.3	286	4.61	0.095
1.83	7.17	168	0.02	13.3	0.08	24.4	23.5	248	2.22	0.053
1.65	14.8	283	0.04	21.1	0.18	29.0	21.4	359	2.66	0.039
1.20	14.0	202	0.03	30.4	0.14	13.0	26.4	286	1.46	0.015
2.35	15.2	198	0.07	14.0	0.32	19.2	39.5	294	0.44	0.016
9.88	82.0	165	0.15	104	0.19	13.7	706	1,400	0.49	0.006
11.2	99.6	134	0.47	79.4	0.36	18.3	1,710	3,190	2.86	0.010
1.71	4.39	106	0.02	2.12	0.15	28.8	5.29	132	0.21	0.112
9.06	39.1	190	0.06	32.6	0.40	32.2	550	1,110	0.11	0.027
10.2	318	97.0	0.38	596	0.34	19.9	3.71	1,230	<0.040	0.010
21.0	329	154	0.25	626	0.27	31.3	<0.20	1,370	<0.040	0.072

Table 6. Concentrations of trace elements in water samples collected from selected wells in Utah, summer of 2016.

[Date of sample: YYYYMMDD, year, month, day; µg/L, micrograms per liter; < , less than]

Local identifier (refer to figure 41)	Station number	Date (YYYYMMDD)	Arsenic, dissolved, in µg/L	Iron, dissolved, in µg/L	Manganese, dissolved, in µg/L	Molybdenum, dissolved, in µg/L	Selenium, dissolved, in µg/L	Uranium, dissolved, in µg/L
Beaver County								
Beaver Valley								
(C-29-8)23caa-1	381618112432501	20160726	1.8	9.5	7.60	53.0	<0.05	2.87
Escalante Valley, Milford area								
(C-28-10)28ccc-1	382019112591701	20160705	3.6	<4.0	<0.20	1.65	3.0	5.91
(C-28-10)31adc-1	381954113004401	20160705	6.5	4.1	0.95	1.82	0.75	7.29
(C-29-10)5cdd-2	381835113000001	20160705	6.4	<4.0	<0.20	1.84	0.70	15.1
(C-29-11)1add-4	381902113014502	20160705	23.7	15.0	6.47	3.76	0.24	4.75
(C-29-11)1bad-1	381920113021501	20160705	2.0	<4.0	8.92	1.02	1.9	4.1
Box Elder County								
Curlew Valley								
(B-12-11)6aba-2	414808113080401	20160622	1.7	9.9	<0.20	1.61	1.1	2.27
(B-12-11)8abb-1	414710113071601	20160622	1.7	19.7	<0.60	0.95	1.1	3.5
(B-14- 9)5bbb-1	415847112540401	20160622	2.1	5.8	<0.20	0.84	1.9	1.5
(B-14-10)1bbb-1	415845112562201	20160622	4.4	<4.0	<0.20	1.35	1.1	2.14
East Shore area								
(B-8-2)26bcd-1	412405112022501	20160603	0.66	11.9	2.21	0.59	0.36	0.13
Grouse Creek Valley								
(B-10-18)33aaa-1	413300113543001	20160623	6.5	29.8	0.32	4.23	3.1	7.87
Lower Bear River area								
(B-12-4)27dbd-1	414454112173101	20160726	0.91	<10.0	<0.40	0.74	22.3	1.87
(B-12-4)35bbc-1	414406112163601	20160726	0.92	5.4	1.25	0.79	6.8	1.51
Cache County								
Cache Valley								
(A-10-1)27dab-1	413428111485701	20160711	1.5	<4.0	<0.20	0.58	0.12	0.59
(A-11-1)8dda-3	414216111511001	20160711	0.10	8.4	1.12	0.49	0.98	1.2
(A-12-1)17daa-1	414642111511401	20160711	1.3	<4.0	<0.20	0.77	0.21	0.66
(A-13-1)29cbd-1	415011111521401	20160711	6.1	186	66.6	0.76	<0.05	0.28
(B-11-1)14adc-2	414134111544701	20160711	0.69	<4.0	0.33	1.15	1.8	0.72
Davis County								
East Shore area								
(B-4-2)20ada-1	410410112050001	20160602	1.0	69.2	54.1	1.99	<0.05	<0.014
(B-4-2)27aba-1	410340112030001	20160602	23.6	344	52.9	0.36	<0.05	<0.014
Duchesne County								
Duchesne River area								
U(C-1-1)33bcc-1	402114110003301	20160727	1.2	1,120	31.7	1.16	<0.05	0.32
U(C-1-2)36adc-1	402116110030801	20160726	0.52	560	25.2	0.49	<0.05	0.27
U(C-2-1)7bbd-1	401940110023601	20160726	1.5	721	10.0	17.0	<0.05	0.40
U(C-2-2)11bab-1	401946110044601	20160726	0.10	247	9.99	0.35	<0.05	0.12
U(C-3-6)18ddc-1	401251110355801	20160725	0.08	18.8	11.6	0.36	<0.05	0.35
Garfield County								
Central Sevier Valley								
(C-34-5)5dca-1	383201109295301	20160817	0.32	33.1	1.71	0.79	7.1	5.39
Grand County								
Spanish Valley								
(D-26-22)21aL10-1	383024109283801	20150617	0.23	49.5	3.09	0.65	2.9	2.27
Upper Colorado River area								
(D-20-25)12bab-1	390513109060601	20160825	3.2	1,470	40.0	1.13	<0.05	0.51
(D-23-24)13aab-1	384750109122701	20160907	3.4	12.0	1.55	2.29	<0.05	0.04

Table 6. Concentrations of trace elements in water samples collected from selected wells in Utah, summer of 2016.—Continued

[Date of sample: YYYYMMDD, year, month, day; µg/L, micrograms per liter; < , less than]

Local identifier (refer to figure 41)	Station number	Date (YYYYMMDD)	Arsenic, dissolved, in µg/L	Iron, dissolved, in µg/L	Manganese, dissolved, in µg/L	Molybdenum, dissolved, in µg/L	Selenium, dissolved, in µg/L	Uranium, dissolved, in µg/L
Iron County								
Cedar Valley								
(C-35-11)31dbd-1	374248113075201	20160822	0.78	6.7	0.34	0.44	1.4	3.36
Escalante Valley, Beryl-Enterprise area								
(C-34-16)28dcc-4	374934113384601	20160627	16.4	<4.0	<0.20	1.58	1.8	3.15
(C-35-15)16ddd-1	374503113313701	20160627	14.0	<4.0	0.43	3.25	0.34	2.33
(C-35-16)3dcd-1	374648113373101	20160627	2.8	<4.0	<0.20	0.41	0.74	1.9
(C-35-17)7dad-2	374617113470601	20160627	6.1	<4.0	<0.20	0.83	0.58	4.98
(C-36-17)36aad-1	373656113415201	20160627	4.0	<4.0	<0.20	0.95	0.47	3.24
Parowan Valley								
(C-33-8)31ccc-1	375257112483501	20160726	3.7	<5.0	<0.20	0.42	1.0	2.01
(C-33-9)33aba-1	375344112521601	20160726	5.9	<5.0	<0.20	0.58	0.35	1.92
(C-33-9)35acd-3	375320112510003	20160726	2.2	<5.0	<0.20	0.22	0.37	1.8
Juab County								
Juab Valley								
(C-14-1)26dbd-1	393342111534501	20160811	1.5	8.4	0.28	3.28	1.2	3.03
(C-14-1)26dca-1	393335111534401	20160811	1.4	10.0	0.37	3.80	0.39	2.91
(D-13-1)5dda-1	394226111501601	20160811	0.73	7.8	<0.20	0.52	2.6	2.2
Snake Valley								
(C-11-17)11aaa-1	395319113431201	20160810	0.43	<5.0	<0.20	0.37	0.62	21.3
Kane County								
Kanab area								
(C-43-5)2bdd-1	370608112230001	20160628	0.60	10.3	<0.20	0.16	2.4	3.43
(C-43-5)25cbd-1	370220112221201	20160628	1.3	<4.0	41.1	3.52	21.8	11.4
Millard County								
Pahvant Valley								
(C-19-4)31dbb-1	390700112203201	20160622	2.0	122	2.09	0.27	1.9	1.14
(C-21-5)7cdd-3	385939112272303	20160622	2.3	<4.0	<0.20	1.75	2.7	3.7
(C-21-5)33aad-1	385650112243601	20160622	0.75	<4.0	<0.20	0.26	0.52	0.61
(C-23-6)8abd-1	384953112325101	20160622	11.4	42.8	<1.00	2.98	13.5	11.5
(C-23-6)16cda-1	384829112315901	20160622	10.8	<16.0	<0.80	1.34	3.8	1.91
Sevier Desert								
(C-16-4)30cac-1	392344112203801	20160811	1.1	<5.0	<0.20	0.14	0.91	0.98
(C-16-5)18caa-1	392538112270201	20160811	3.0	<5.0	<0.20	0.47	0.27	1.27
(C-16-7)12baa-2	392649112350802	20160810	14.5	<5.0	5.48	1.34	0.15	2.68
Snake Valley								
(C-20-19)7abb-1	390430114013001	20160810	1.8	<5.0	<0.20	0.51	0.33	1.37
(C-20-19)14bbc-1	390416113573801	20160810	4.4	<5.0	<0.20	2.86	0.27	2.41
Salt Lake County								
Salt Lake Valley								
(B-1-2)19aca-1	404826112062201	20160613	1.8	82.7	14.1	14.1	0.11	0.02
(C-3-1)4aac-1	403533111570701	20160613	4.6	5.8	<0.20	0.70	2.6	3.22
(C-3-1)12ccb-1	403408111543201	20160613	4.1	<4.0	<0.20	1.53	1.1	4.68
(D-1-1)7abd-6	404506111523301	20160613	1.2	6.6	3.71	1.2	1.5	1.81
San Juan County								
Upper Colorado River area								
(D-28-25)36adb-1	381941109064001	20160817	9.3	<5.0	<0.20	9.42	17.1	62.1
(D-30-22)13cab-1	381034109274501	20160823	0.05	<5.0	<0.20	1.05	2.8	2.2

Table 6. Concentrations of trace elements in water samples collected from selected wells in Utah, summer of 2016.—Continued

[Date of sample: YYYYMMDD, year, month, day; µg/L, micrograms per liter; < , less than]

Local identifier (refer to figure 41)	Station number	Date (YYYYMMDD)	Arsenic, dissolved, in µg/L	Iron, dissolved, in µg/L	Manganese, dissolved, in µg/L	Molybdenum, dissolved, in µg/L	Selenium, dissolved, in µg/L	Uranium, dissolved, in µg/L
Sanpete County								
Sanpete Valley								
(D-15-4)17abb-1	393113111294501	20160824	0.25	207	7.28	0.17	0.46	1.09
(D-16-2)36cbd-1	392238111390501	20160824	5.9	131	28.0	1.57	0.79	1.01
Sevier County								
Central Sevier Valley								
(C-23-2)15dcb-4	384757112002201	20160725	3.8	13.1	<0.20	3.31	1.0	5.08
(C-23-2)30baa-2	384641112034601	20160725	2.0	20.6	1.83	0.41	0.44	2.36
(C-23-2)30bcc-1	384635112040801	20160725	1.9	<5.0	<0.20	0.37	0.22	2.2
(C-23-2)34aba-1	384550112000901	20160725	3.2	5.1	<0.20	0.50	0.55	24.2
Tooele County								
Rush Valley								
(C-5-5)15add-2	402310112231002	20150720	1.6	<4.0	<0.2	0.70	1.5	1.98
(C-9-5)5bbc-1	400401112262001	20150724	1.7	4.7	<0.2	0.45	0.59	1.18
Skull Valley								
(C-1-7)31daa-1	404113112395801	20160824	5.1	<25.0	<1.00	1.08	0.73	2.12
(C-4-8)15cda-1	402757112440401	20160824	0.39	5.7	<0.20	0.20	1.8	0.62
Tooele Valley								
(C-2-4)31add-6	403606112195401	20160610	1.4	15.5	<0.20	0.49	4.5	2.65
(C-2-4)34acd-1	403609112164201	20160610	1.9	4.1	<0.20	0.32	11.4	1.96
(C-2-5)36cba-1	403603112215801	20160830	1.6	11.7	0.39	0.72	1.3	2.02
(C-2-6)23cdc-2	403718112295602	20160610	1.0	5.5	<0.20	0.48	1.1	1.31
(C-2-6)26dcd-1	403630112292301	20160610	1.1	<4.0	<0.20	0.58	0.53	1.35
Uintah County								
Duchesne River area								
U(C-1-1)24cbb-2	402252109571501	20160727	6.0	726	1,010	1.58	0.07	3.61
Utah County								
Cedar Valley								
(C-6-1)18cdd-1	401730111594501	20160803	<0.05	<5.0	<0.20	<0.050	<0.05	<0.010
(C-6-2)26cbb-1	401607112023401	20160803	5.3	<5.0	29.4	2.72	0.42	4.55
Goshen Valley								
(C-9-1)28ccb-1	395956111572101	20160628	3.5	<8.0	<0.40	1.64	8.0	5.49
Northern Utah Valley								
(D-5-1)8aaa-3	402420111505701	20160627	2.3	<4.0	<0.20	1.67	2.4	2.0
(D-5-1)20cbc-1	402159111520101	20160627	1.0	<4.0	<0.20	1.91	1.5	2.65
Southern Utah Valley								
(D-8-2)31cdb-1	400422111454201	20160628	5.3	355	154	1.16	0.95	1.34
(D-9-1)36bbc-1	395942111470801	20160701	0.42	<4.0	<0.20	0.53	1.2	1.51
(D-9-3)5bbd-1	400407111375101	20160627	0.44	<4.0	<0.20	0.81	2.4	1.83
Wasatch County								
Heber Valley								
(D-3-4)26dba-1	403146111272701	20160831	12.8	6.6	<0.20	0.70	0.43	1.01
(D-4-4)12dcc-1	402842111263101	20160830	1.2	<5.0	<0.20	0.15	0.22	1.81
(D-4-4)13bdd-1	402810111263601	20160830	1.0	10.5	5.21	1.10	0.66	1.54
(D-4-5)3dcc-1	402937111214901	20160830	1.4	34.4	3.63	0.10	0.14	2.15
(D-4-5)4ccb-1	402946111233901	20160830	1.7	9.3	0.66	0.10	0.07	1.4
(D-4-5)6bcc-2	403003111255801	20160831	1.3	48.9	1.83	0.22	0.21	1.89
(D-4-5)16bab-1	402840111232201	20160830	2.0	<5.0	<0.20	0.46	0.36	2.02
(D-4-5)16ccd-1	402750111232701	20160831	1.2	7.0	0.85	1.35	0.92	1.83

Table 6. Concentrations of trace elements in water samples collected from selected wells in Utah, summer of 2016.—Continued

[Date of sample: YYYYMMDD, year, month, day; µg/L, micrograms per liter; < , less than]

Local identifier (refer to figure 41)	Station number	Date (YYYYMMDD)	Arsenic, dissolved, in µg/L	Iron, dissolved, in µg/L	Manganese, dissolved, in µg/L	Molybdenum, dissolved, in µg/L	Selenium, dissolved, in µg/L	Uranium, dissolved, in µg/L
Washington County								
Central Virgin River area								
(C-41-17)8cbd-2	371348113470301	20160627	27.7	<4.0	<0.20	5.46	0.77	1.42
(C-42-13)7bba-4	370915113213801	20160628	0.86	53.9	0.27	0.46	2.8	6.38
(C-43-15)16dcc-2	370218113322101	20160627	0.94	<8.0	<0.40	3.46	3.9	4.23
Wayne County								
Upper Fremont River Valley								
(D-29-3)1cab-1	381902111321101	20160719	5.0	<4.0	<0.20	0.41	0.24	1.25
(D-29-4)8bbd-1	381820111300501	20160719	3.1	35.6	5.79	1.49	2.3	7.7
Weber County								
East Shore area								
(B-5-2)6bdd-5	411153112064605	20160603	2.1	413	112	2.62	0.07	0.04
(B-7-2)32bbb-1	411824112060601	20160602	4.2	284	275	0.48	0.07	<0.014

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