UNITED STATES
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

WATER RESOURCES OF COLD SPRING VALLEY, A GROWING URBAN AREA NORTHWEST OF RENO, NEVADA

By A. S. Van Denburgh

With a section on STREAMFLOW
By Terry Katzer

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NEVADA DIVISION OF WATER RESOURCES

Carson City, Nevada

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UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS AND ABBREVIATIONS

Except for water-quality units of measure, only the "inch-pound" system is used in this report. Abbreviations and conversion factors from inch-pound to International System (SI) units are listed below.

Multiply	*By*	*To obtain*
Inches (in.)	25.40	Millimeters (mm)
Feet (ft)	0.3048	Meters (m)
Miles (mi)	1.609	Kilometers (km)
Feet per mile (ft/mi)	0.1894	Meters per kilometer (m/km)
Square feet (ft^2)	0.09290	Square meters (mi^2)
Square miles (mi^2)	2.590	Square kilometers (km^2)
Acres	0.4047	Square hectometers (hm^2)
Cubic feet per second (ft^3/s)	0.02832	Cubic meters per second (m^3/s)
Acre-feet (acre-ft)	0.001233	Cubic hectometers (hm^3)
Gallons (gal)	3.785	Liters (L)
Gallons per minute (gal/min)	0.06309	Liters per second (L/s)
Tons (short)	0.9072	Metric tons (t)

Water-quality units of measure used in this report are as follows:

For concentration, milligrams per liter (mg/L), which are equivalent to parts per million for dissolved-solids concentrations less than about 7,000 milligrams per liter.

For temperature, degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by using the formula °F=[(1.8)(°C)]+32.

For specific conductance, micromhos per centimeter at 25°C (micromhos).

ALTITUDE DATUM

The term "National Geodetic Vertical Datum of 1929" (abbreviation, NGVD of 1929) replaces the formerly used term "mean sea level" to describe the datum for altitude measurements. The NGVD of 1929 is derived from a general adjustment of the first-order leveling networks of both the United States and Canada. For convenience in this report, the datum also is referred to as "sea level."

WATER RESOURCES OF COLD SPRING VALLEY, A GROWING URBAN AREA NORTHWEST OF RENO, NEVADA

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ABSTRACT

Within 29-square-mile Cold Spring Valley, northwest of Reno, Nev., both ephemeral streamflow--mostly from the south--and ground water move toward the White Lake playa and adjacent areas, and are dissipated there by evapotranspiration. Unconsolidated valley-fill sedimentary deposits of Quaternary age are the principal water-bearing units; reported well yields are as great as 2,150 gallons per minute and specific capacities range from 0.2 to 12 gallons per minute per foot of drawdown. During 1975-79, ground-water levels declined slightly (1-4 feet) throughout most of the valley, which may have been due in large part to climatic change. No local net decline of alarming magnitude related to ground-water withdrawal had been detected as of 1979.

Cold Spring Valley apparently is hydrologically closed; little, if any, ground water is lost to neighboring basins. A small amount of underflow--perhaps on the order of 200 acre-feet per year--enters the valley from adjacent Long Valley.

The valley-wide population as of late 1979 was about 2,000 people. Domestic and public-supply withdrawals, fed entirely by ground water, totalled about 250 acre-feet per year, of which about 50 acre-feet per year was consumed by evapotranspiration and the remainder percolated back to the ground-water reservoir. Irrigation of pasture lands consumed an estimated 150 acre-feet per year of streamflow and 15 acre-feet per year of well water.

The estimated system yield for the basin, as much as 1,300 acre-feet per year, is based on the assumption that all natural ground-water discharge (500 acre-feet per year) and as much as two-thirds of the average stream inflow to White Lake can be captured. Recycling of water during use, owing to percolation, would permit a sustained withdrawal significantly greater than the system yield, but also would ultimately require water treatment to counter deterioration of quality associated with the recycling. As of 1979, ground water and streamflow were chemically suitable for domestic and agricultural use. Effective management of water resources in the basin under a system-yield concept would involve (1) the conjunctive use of both ground water and surface water, and (2) the proper siting of large-capacity water wells. The areal distribution of natural ground-water discharge suggests that the optimum proportions for pumpage north, south, and west of White Lake may be on the order of 40, 40, and 20 percent of the total pumpage, respectively.

Consideration of the hazard potential of flash flooding and associated debris flows would be advisable as a part of future planning and development in the valley.

INTRODUCTION

Cold Spring Valley is a small basin about 13 miles northwest of, and easily accessible to, downtown Reno (figure 1). Most of the 29-square-mile basin lies in Washoe County, Nev., but a small part (less than 0.2 square mile) extends into Sierra County, Calif.

Purpose and Scope of the Investigation

In 1967, the water resources of Cold Spring Valley were described in an 11-valley reconnaissance report by Rush and Glancy. Since then, the population of Cold Spring Valley has increased considerably, and the valley's closeness to the expanding Reno-Sparks metropolitan area enhances the potential for additional growth. Because no water is imported to Cold Spring Valley and the local ground-water supply probably is small (Rush and Glancy, 1967, tables 20 and 22), there has been concern regarding the possible adverse long-term effects of continued development. Therefore, a more detailed hydrologic reappraisal of the valley has been made in cooperation with the Nevada Division of Water Resources. The results are summarized in this report.

Principal objectives of this recent appraisal included: (1) Reevaluation of surface runoff and of recharge to, discharge from, and yield of the ground-water system; (2) definition of the ground-water flow system and evaluation of possible areas of interbasin flow; and (3) definition of water-resources development as of 1979 and its effect on the flow system.

Intensive field work began in October 1974 and was completed in December 1977. Activities included: Canvassing selected wells and making periodic water-level measurements on a network of observation wells; drilling small-diameter exploratory wells where additional data were needed; mapping areas of phreatophytes (plants that use ground water); determining the bathymetry (lake area and volume versus lake-surface altitude) of ephemeral White Lake; estimating surface-water runoff, using discharge and channel-geometry measurements at selected sites; and collecting water samples for chemical-quality evaluation.

Many of the general descriptions and discussions presented by Rush and Glancy (1967) with regard to their 11-valley study area as a whole are not included in this report. Instead, the principal intent is to expand on pertinent quantitative aspects of water resources in Cold Spring Valley, including instances where findings differ from the preliminary results reported by Rush and Glancy.

The estimates developed in this study are subject to errors inherent in the simplifying assumptions that are required to permit a quantitative evaluation of hydrologic conditions. Most estimates derived for the valley as a whole may be accurate within ±25 percent. Additional data would be required to derive similar estimates for specific parts of the basin without risking greatly increased errors.

FIGURE 1.—Map of Reno and vicinity, showing location of Cold Spring Valley.

Acknowledgments

Many people provided assistance or cooperation that greatly facilitated the field work during this study. Of particular help were Josephine Sweeney and her family of the Heinz Ranch, and John Arden and his employees of Cold Springs Development Corp. In addition, Edward C. Bingler, at the time a geologist with the Nevada Bureau of Mines and Geology, provided valuable advice regarding the geologic setting of central Cold Spring Valley. Also, the staff of the Washoe County Assessor was of considerable assistance in identifying specific property coinciding with information on older well logs. Finally, within the U.S. Geological Survey, vital field assistance was provided by Joseph P. Johns, Richard A. McCullough, Carrol L. Williams, and David B. Wood.

SETTING

Physiography, Drainage, and Cultural Features

Cold Spring Valley is a topographically closed basin that encompasses 29 square miles in the far-western part of the Basin and Range Physiographic Province. The basin is elongate in a north-south direction, with approximate dimensions of 12 by 3 miles (figure 2). Altitudes range from 7,940 feet on the flank of Peavine Peak in the south, and about 7,800 feet on Petersen Mountain in the north, to 5,035 feet at the low point of White Lake playa. The flat to moderately sloping valley floor takes up most of the area below 5,200 feet altitude and covers about 7½ square miles, of which almost 2 square miles is occupied by the playa.

The only perennial streams in Cold Spring Valley drain the slopes of Peavine Peak, in the far southern part of the basin. Stream channels elsewhere contain water only during periods of runoff from snowmelt and intense rainfall. White Lake is the ultimate destination of all streams in the valley, but the broad, flat lake bed remains dry except during and after periods of appreciable runoff.

In the Pleistocene Epoch more than 10,000 years ago, Cold Spring Valley was the site of a large water body known as Lake Laughton (Hubbs and Miller, 1948, page 42; the lake may have been named for the first white settler in the valley, who homesteaded what is now the Heinz Ranch; see page 6). The lake level attained a peak altitude of 5,130 feet and covered 7½ square miles to a maximum depth of about 100 feet. At its highest level, the lake apparently overflowed--briefly, at least--into adjacent Long Valley.[1] The

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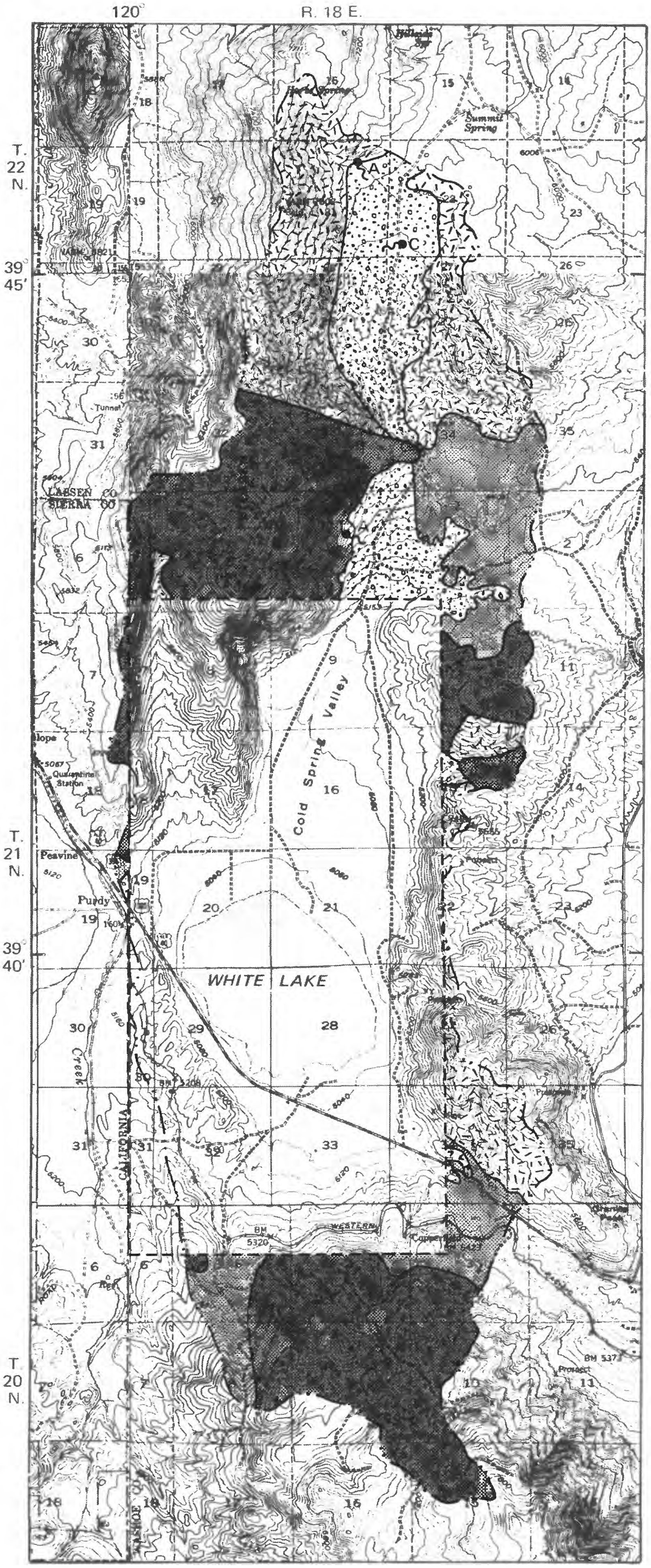
[1] The information listed here differs from that of Snyder and others (1964, Valley No. 17) but is considered more accurate.



EXPLANATION

QUATERNARY — Fan and sheetwash alluvial deposits

TERTIARY — Sedimentary rocks; Andesitic volcanic rocks

CRETACEOUS — Granitic intrusive rocks

JURASSIC(?) AND TRIASSIC — Metavolcanic and metasedimentary rocks

A — Spring, with location letter

Drainage divide

Boundary of area shown in figures 3, 4, 5, 14, and 16

Base from U.S. Geological Survey 1:62,500 Reno, 1950, Dogskin Mtn., 1957, Loyalton, 1955, and Chilcoot, 1950

0 1 2 MILES

0 1 2 3 KILOMETERS

Geology modified from E. C. Bingler (Bingler and Trexler, 1975) and Bonham (1969, pl. 1)

FIGURE 2.—Map showing area included in figures 3, 4, 5, 14, and 16, as well as geology and springs outside that area. More detailed descriptions of the geologic units are given in table 1. Present-day cultural features in vicinity of White Lake are considerably different from those shown on the 1950 topographic map used in this base.

probable point of overflow is at the Nevada-California State line near the present site of Bordertown Club (location 19DAB; see section titled "Location system for hydrologic sites"). The existence of ancient Lake Laughton is recorded by shorelines and other lacustrine features at several places in the valley.

Another feature of much more recent origin is the cut-and-fill roadbed constructed in 1881 for narrow-gauge rails of the Nevada-California-Oregon Railway (Myrick, 1962, page 345). The roadbed enters Cold Spring Valley from the northwest at the intersection of U.S. Highway 395 and the Nevada-California State line, meanders generally northeast along the northwestern margin of the valley floor (figure 4), and leaves the basin in sec. 2, T. 21 N., R. 18 E. This segment of rail line was abandoned in 1918, in favor of a shorter grade now used by the Western Pacific Railroad along the lower flanks of Peavine Peak (Myrick, 1962, page 331).

Homesteaders first settled in Cold Spring Valley in the mid-1800's, at what is now the Heinz Ranch (NW$\frac{1}{4}$ sec. 33). In fact, Josephine Sweeney, who presently (1979) operates the ranch, is a grandaughter of the Heinz who bought the property in 1885-90.

Appreciable population growth in the valley began in the early 1960's. By mid-1966, the valley-wide population may have been 130-140, centered mostly in the Border Town area (on the basis of aerial photographs taken in June 1966 and an estimated average of 3$\frac{1}{4}$ people per dwelling).

North of the playa, population growth began in late 1971, at the Reno Park Mobile Home Estates subdivision. Adjacent to and east of Reno Park, dwellings in the Cold Springs Valley Homes subdivision (Unit 1) became available in 1978. By November 1979, the two subdivisions had an estimated population of about 1,700 (approximately 380 mobile homes and 140 permanent dwellings, with an estimated 3$\frac{1}{4}$ people per dwelling).

The valley-wide population as of November 1979 was on the order of 2,000 people.

Geologic Units and Structural Features

Rocks and sedimentary deposits in Cold Spring Valley are divided into seven geologic units on the basis of rock type, age, and water-bearing properties (table 1, figures 2 and 3). These units are grouped in two main catagories: Valley-fill sedimentary deposits, which include the principal water-bearing units in the basin; and consolidated rocks, which form the mountain masses and underlie the valley fill. The lithologic character of valley-fill deposits penetrated by wells in the basin is indicated by representative drillers' logs in table 19.

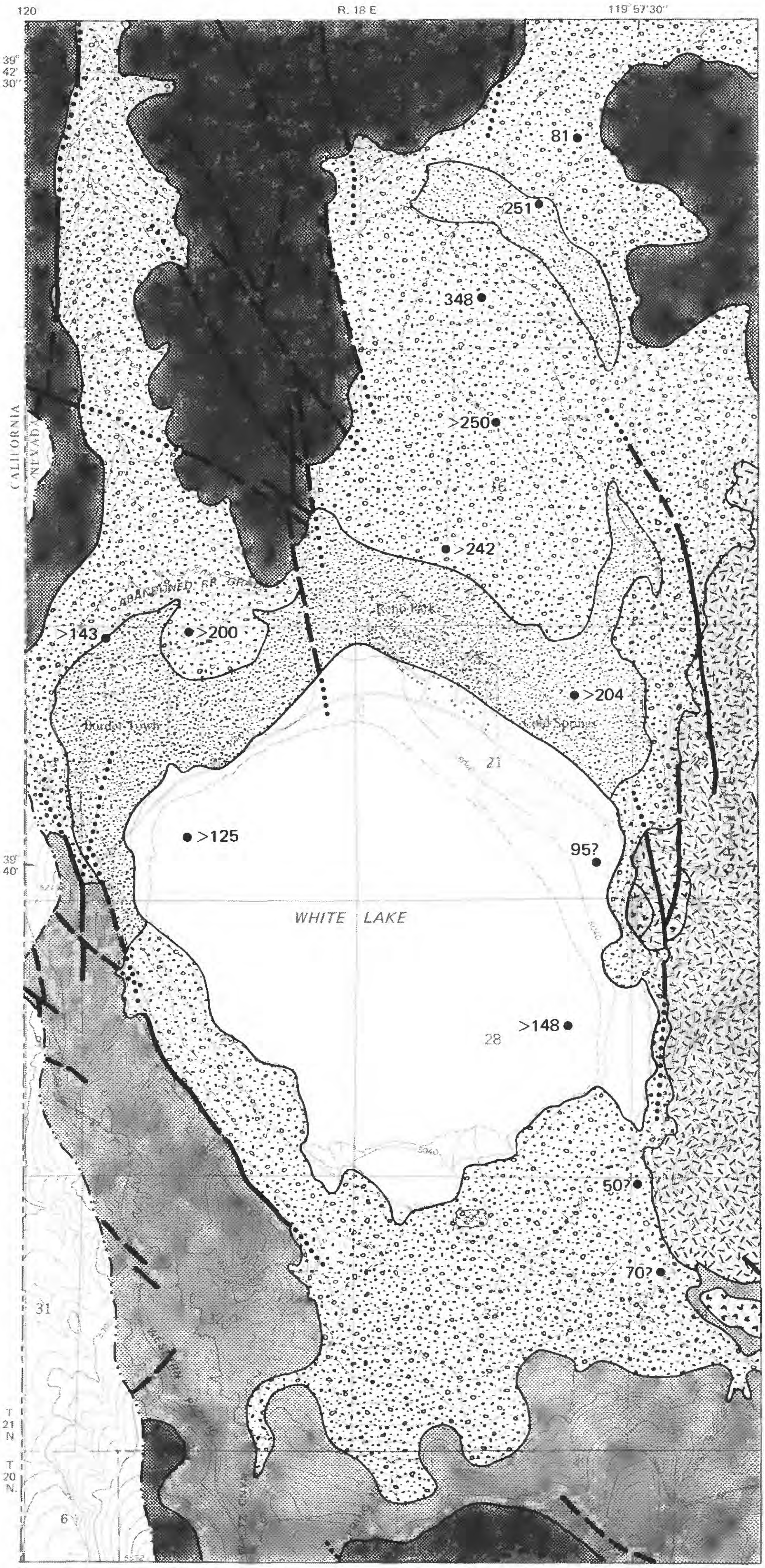
Many faults have been identified in the basin (figure 3). Most of them are within the consolidated-rock masses, but some cut the valley fill or form a boundary between valley fill and consolidated rocks. Additional faults, not yet discovered, may cut and "compartmentalize" the valley fill, as they do in neighboring Lemmon Valley (Harrill, 1973, figure 2).

TABLE 1.--*Geologic units and their water-bearing properties*[1]

Geologic age			Geologic unit	General characteristics and extent	Water-bearing properties
CENOZOIC	Quaternary	Valley fill	Playa and lake-floor deposits	Playa deposits: Clay and clayey silt of Holocene age, underlying White Lake. Lakefloor deposits: Clay, silt, sand and some gravel, of Pleistocene and Holocene age, adjacent to and underlying White Lake. Maximum thickness of combined unit exceeds 125 feet. Subsurface areal extent unknown.	Sand and coarser deposits are moderately to highly permeable and can yield moderate to large quantities of water to properly constructed wells (yields reported in table 18 range from about 10 to as much as 2,150 gallons per minute). Finer-grained deposits (silt and clay) have low permeability and can yield little water to wells.
			Beach and delta deposits	Beach deposits: Sand, mostly of Pleistocene age; arcuate beach bar in sec. 9, T. 21 N., R. 18 E. was deposited near highest known stage of Pleistocene lake. Delta deposits: Sand and gravel of Pleistocene age, which underlie at least 40 acres west of fault in and north of sec. 20, T. 21 N., R. 18 E. (figure 3). Maximum thickness of combined unit probably exceeds 125 feet. Subsurface areal extent unknown.	
			Fan, sheetwash, and flood-plain alluvial deposits	Largely unconsolidated deposits ranging from clay to boulders (sand and gravel most common at and near land surface); Pleistocene and Holocene in age. Maximum thickness probably exceeds 350 feet (in sec. 16, T. 21 N., R. 18 E., and perhaps elsewhere). Subsurface areal extent uncertain.	
	Tertiary	Consolidated rocks	Sedimentary rocks	Partly consolidated[2] to consolidated deposits composed of particles ranging from clay to boulders; may be of Pliocene age. Maximum thickness may exceed several hundred feet. Subsurface areal extent unknown.	Generally untested by wells except in and adjacent to sec. 29, T. 21 N., R. 18 E. Permeability low to at least moderate. Deposits yield small to large quantities of water to properly constructed wells.
			Andesitic volcanic rocks	In sec. 34, T. 21 N., R. 18 E.: Flows, and sedimentary rocks derived from them; correlated with Kate Peak Formation. In and adjacent to sec. 27, T. 21 N., R. 18 E.: Plugs and dikes.	Untested by wells except in NW¼ sec. 34, T. 21 N., R. 18 E. Permeability characteristically low except along fractures and faults. Metamorphic rocks feed springs N21 E18 4ACBD1 (Cold Spring), 4CDDD1, and N20 E18 4BCAB1.
MESOZOIC	Cretaceous		Granitic intrusive rocks	Mostly quartz monzonite and granodiorite.	
	Jurassic and Triassic?		Metavolcanic and metasedimentary rocks	Variety of metamorphosed volcanic rocks, as well as much smaller areas of metamorphosed sedimentary rock; considered a part of Peavine sequence (Bonham, 1969, p. 7-8). Rocks in northeast corner of sec. 17, T. 21 N., R. 18 E., and part of adjacent sec. 8, T. 21 N., R. 18 E., have been bleached by hydrothermal alteration.	

1 Geology modified from Bingler and Trexler (1975) and Bonham (1969).

2 The term "partly consolidated" denotes differing degrees of consolidation (lithification), both areally and at a single site.



EXPLANATION

QUATERNARY
- Playa and lake-floor deposits
- Beach and delta deposits
- Fan, sheetwash, and flood-plain alluvial deposits

TERTIARY
- Sedimentary rocks
- Andesitic volcanic rocks

CRETACEOUS
- Granitic intrusive rocks

JURASSIC(?) AND TRIASSIC
- Metavolcanic and metasedimentary rocks

Fault. Dashed where approximately located; dotted where buried

●348 Water well, with depth to "bedrock," in feet, on basis of driller's log. At some wells, "bedrock" may be Tertiary sedimentary rocks, rather than igneous or metamorphic rocks. Symbol ">" precedes total depth of deep well that apparently does not penetrate bedrock

Drainage divide

Quaternary geology modified from E.C. Bingler (Bingler and Trexler, 1975). Bedrock geology modified from R.L. Nielsen (unpublished Nev. Bur. Mines and Geology map, 1965).

Base from U.S. Geological Survey 1:24,000 Reno NW, 1967 (photorevised 1974)

0 0.5 1 MILE

0 0.5 1 KILOMETER

CONTOUR INTERVAL 20 FEET

DOTTED LINE REPRESENTS 10-FOOT CONTOUR

DATUM IS SEA LEVEL

FIGURE 3.—Geology of central Cold Spring Valley. More detailed descriptions of the geologic units are given in table 1.

Ground-Water Reservoirs

Extent and Boundaries

Sedimentary deposits, which partly fill the structural depression bounded by consolidated rocks, form the principal ground-water reservoir in Cold Spring Valley. The maximum depth of valley fill in the basin is unknown. The sediments reportedly are almost 350 feet deep at well 9CDAC1 (figure 3, table 19), and may be even deeper at places beneath and north of White Lake. Table 1 briefly describes the distribution of units that make up the valley-fill reservoir.

Within the reservoir, the principal hydraulic boundaries are lithologic changes and faults. The extent to which these boundaries affect ground-water flow is unknown in most places.

Most consolidated rocks in the basin probably are not capable of transmitting appreciable quantities of ground water except in relatively permeable zones associated with faulting and fracturing. Sedimentary rocks of Tertiary age (figures 2 and 3), which are arbitrarily assigned to the consolidated-rock group in table 1, apparently are porous and permeable in places, and therefore are capable of yielding at least moderate quantities of ground water.

Water-Bearing Properties

Qualitative water-bearing properties of the valley fill and consolidated rocks are described in table 1. The capacity of a ground-water reservoir to yield water can be characterized quantitatively, using estimates of transmissivity and specific yield.

Transmissivity is a measure of an aquifer's ability to transmit ground water. It depends on the permeability and thickness of the aquifer. Thomasson and others (1960, page 222) described a rough estimate that, in slightly modified form, relates aquifer transmissivity (in feet squared per day, abbreviated ft^2/d) to the specific capacity of a fully efficient well [specific capacity is the ratio of pumping yield, in gallons per minute, to water-level drawdown, in feet; abbreviated (gal/min)/ft]:

$$\text{transmissivity} \approx (270)(\text{specific capacity}).$$

Within the valley-fill deposits, specific capacities are available for only two deep, productive wells (9CDAC1 and 16CACD1, fig. 16 and table 18), which are 1.6 and 0.7 miles north of White Lake playa, respectively. The two specific capacities [12 and 3.2 (gal/min)/ft] suggest transmissivities on the order of 3,000 and 900 ft^2/d, respectively. Elsewhere on the valley floor, wells for which specific capacities are available characteristically tap water-bearing zones less than 100 feet below the water table. In the Border Town area northwest of the playa, reported yield and drawdown data for such wells indicate specific capacities that range from 0.2 to 3.5 and average 1.2 (gal/min)/ft, implying transmissivities in the range from 50 to 1,000 ft^2/d

(average, about 300 ft^2/d). This wide range may result from varying well efficiencies among the wells tested. Limited data for valley fill southwest of the playa (wells 29DCDA1 and 29DCDB1, table 18) suggest a specific capacity on the order of 1 (gal/min)/ft, which is comparable to a transmissivity of about 300 ft^2/d. No data are available for valley fill south of the playa.

Only one deep, productive well taps the Tertiary sedimentary deposits southwest of the playa. That well, 30DABB1 (figure 16, table 18), is in the Nevada part of adjacent Long Valley, several hundred feet west of the topographic divide between Long and Cold Spring Valleys. On the basis of a consulting report regarding the well, on file with the Nevada State Engineer, the transmissivity for screened intervals in the upper 520 feet of saturated material is 740 ft^2/d. Specific capacities of four much shallower wells, which range from 0.2 to 1.2 (gal/min)/ft, imply transmissivities on the order of 50 to 300 ft^2/d for the upper 100-150 feet of saturated Tertiary sediments.

Southeast of the playa, wells 34BBBB1 and 34BCAC1 apparently tap consolidated rocks (table 19). Data for those wells suggest transmissivities in excess of 1,000 ft^2/d for the upper 100-200 feet of saturated material.

The specific yield of a saturated deposit indicates the approximate amount of extractable ground water stored in the deposit. It is defined as the ratio of (1) the volume of water which the deposit will yield by complete gravity drainage, to (2) the volume of the deposit itself (Lohman and others, 1972, page 12). Specific yields for the upper 50 feet of saturated valley fill (based on static water levels as of about 1976) have been estimated for Cold Spring Valley by using the lithologic logs in table 19 and the specific yields for various lithologic categories listed in table 2. Figure 4 shows the estimated distribution of specific yields in the valley. The weighted average for the upper 50 feet of saturated valley fill is estimated to be 12 percent when including the playa area, and 15 percent when excluding it.

Occurrence and Movement of Ground Water

Most ground water in Cold Spring Valley is derived from the infiltration (recharge) of precipitation and runoff within the basin. Most of the deep infiltration occurs on the upper slopes of the valley fill. However, some also takes place in the mountains, where percolating water moves downward through the bedrock, then laterally to the valley fill. Some additional ground water is derived from subsurface inflow that originates outside the basin.

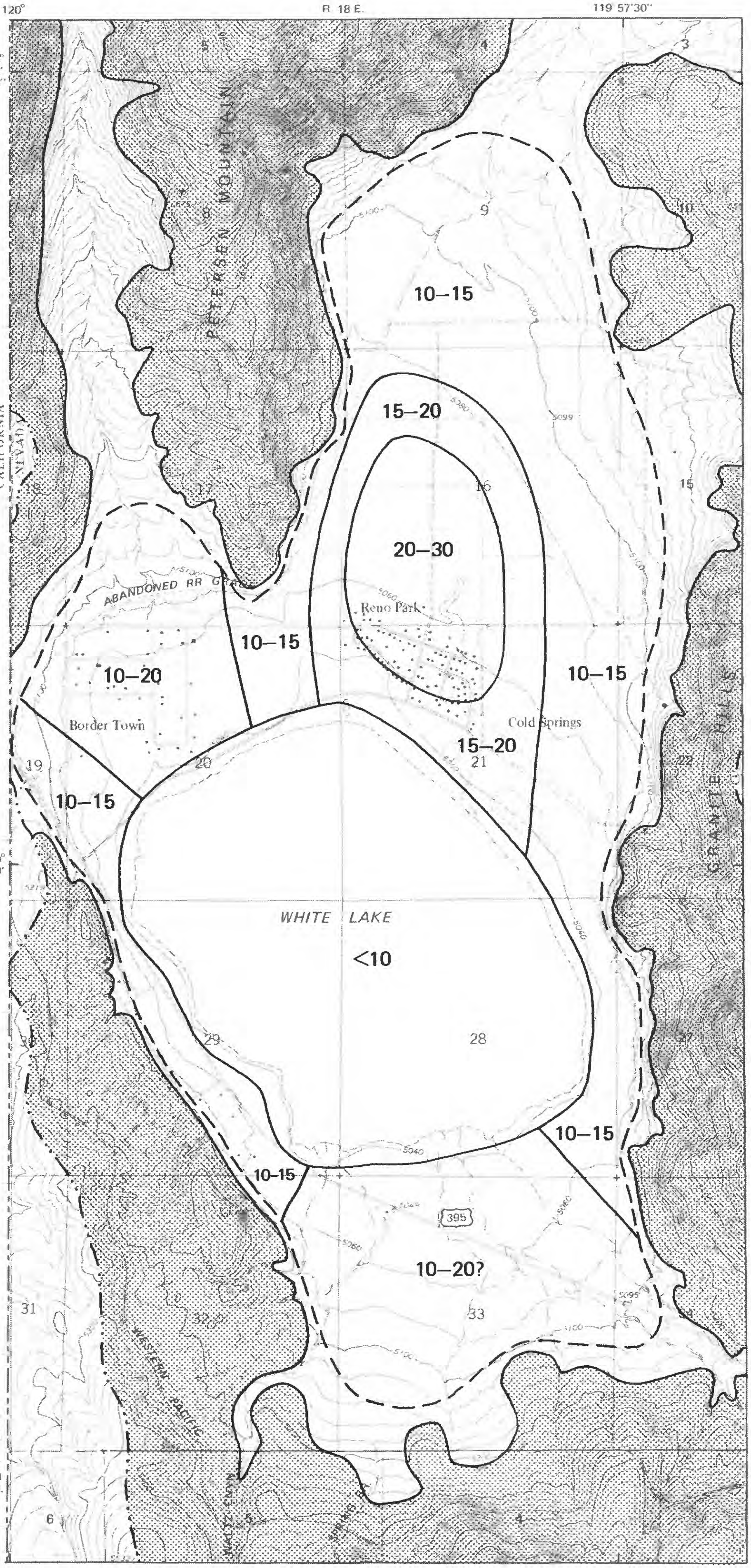
Ground water, like surface water, moves from areas of higher hydraulic head to areas of lower head. Unlike surface water, however, it generally moves slowly, at rates ranging from less than a foot to several hundred feet per year, depending on the permeability and effective porosity of the deposits and the hydraulic gradient.

In Cold Spring Valley, the ground water moves from recharge areas in and adjacent to the mountains to discharge areas on the valley floor, where it is dissipated at the land surface by evaporation and transpiration. Little, if any, ground water leaves the valley by subsurface leakage to adjacent basins.

TABLE 2.--*Specific yields of sedimentary materials*

Lithologic category	Assigned specific yield[1] (percent)
Sand, fine, medium, and coarse	30
Gravel; sand and gravel	25
Sand, gravel, and clay; gravel and clay; cemented gravel	15
Sand and clay; sandy clay; silt; silt and clay	10
Clay; silty clay	5+

[1] Based on data of Morris and Johnson (1966, pages 28-33) as listed by Harrill (1973, page 28).



EXPLANATION

Valley-fill deposits

Consolidated rocks

10–15 Estimated specific yield, in percent

Boundary of area used to estimate stored ground water in upper 50 feet of saturated valley fill

Drainage divide

Base from U.S. Geological Survey 1:24,000 Reno NW, 1967 (photorevised 1974)

0 0.5 1 MILE

0 0.5 1 KILOMETER

CONTOUR INTERVAL 20 FEET

DOTTED LINE REPRESENTS 10-FOOT CONTOUR

DATUM IS SEA LEVEL

FIGURE 4.—Estimated specific yields for upper 50 feet of saturated valley fill in central Cold Spring Valley. Saturated interval based on static water levels as of about 1976.

Figure 5 shows (1) water-level contours, which define the hydraulic gradient for ground water in the valley fill, and (2) directions of ground-water movement, which are generally perpendicular to the contours.

Ground water moves vertically as well as laterally. In and near areas of recharge or out-of-basin subsurface leakage along faults, the vertical movement is downward, whereas in areas of ground-water discharge by evapotranspiration, the movement is upward. The tendency toward vertical movement is indicated by the relationship between water levels in adjacent shallow and deep wells. (The actual quantity of ground water that moves upward or downward depends on the vertical permeability of finer-grained sedimentary deposits as well as the magnitude of vertical head difference.) Table 3 lists data for six well pairs, and figure 5 shows the directions of vertical ground-water movement implied by the data. Downward movement occurs in the area north of sec. 16 (site 9CDA), and upward movement occurs in the area of ground-water discharge (sites 20CDAB, 21DDBD, and 28ADCC); the directions of vertical movement for sites 16CACD and 21ADBB, at the margin of the discharge area, vary with time.

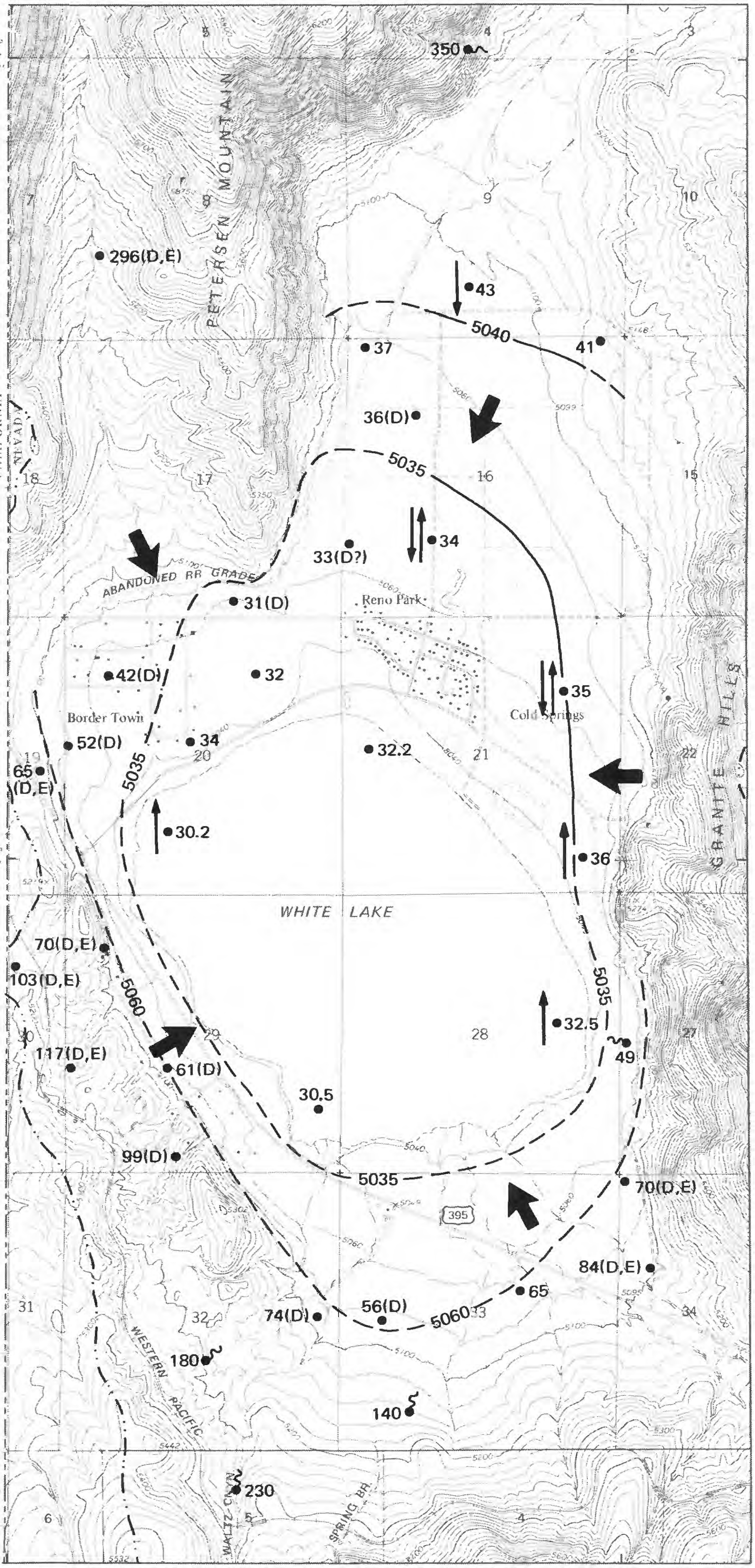
Depths to ground water differ from place to place in Cold Spring Valley. Currently (1979) they range from less than 10 feet in the vicinity of the playa to more than 50 feet in higher areas around the periphery of the valley floor (table 18).

Water-Level Fluctuations

Fluctuating ground-water levels can reflect seasonal and long-term changes in the quantity of stored ground water. Figure 6 shows the fluctuations for nine representative wells during 1974-79. The data indicate both seasonal and long-term trends.

Seasonal water-level variations are characterized in table 4. Generally, the amplitudes are most subdued away from areas of pumping north of the playa, (for example, well 9CDAA1 in figure 6) and greatest in pumped wells northwest and southwest of the playa (well 20BBDC1, figure 6). Levels normally are highest in the late winter or spring, in response to recharge and diminished pumping, and lowest in the summer, fall, or early winter, in response to evapotranspiration and heavier pumping.

Short-and long-term net changes in water level can result from climatic fluctuations and the activities of man. Table 5 lists annual net changes for observation wells in Cold Spring Valley. The common trend throughout most of the valley floor has been a slight decline--generally less than a foot per year--during the period from March 1975 to May 1979. This trend holds true for most measured wells, both within and away from areas of ground-water pumping. Only in and adjacent to sec. 33, south of Highway 395, did the dry winters of 1975-76 and 1976-77 have a pronounced effect on ground-water levels.



EXPLANATION

36● Well, with static water-surface altitude, in feet above 5,000 feet, March 1976. Altitudes estimated from earlier or later data are indicated by "E." Wells known or thought to be perforated more than 50 feet below water table are indicated by "D"

140 Spring, with altitude of land-surface orifice, in feet above 5,000 feet

—5035— — Water-level contour. Shows altitude of ground-water level. Dashed where approximately located. Contour interval 5 feet north of playa and 25 feet south and west of playa

Generalized direction of lateral ground-water movement

(up) (down) Direction of vertical component of ground-water movement. Double arrows indicate variable direction (upward and downward at different times)

— · · — · · — Drainage divide

Base from U.S. Geological Survey 1:24,000 Reno NW, 1967 (photorevised 1974)

0 0.5 1 MILE
0 0.5 1 KILOMETER

CONTOUR INTERVAL 20 FEET

DOTTED LINE REPRESENTS 10-FOOT CONTOUR

DATUM IS SEA LEVEL

FIGURE 5.—Altitude of ground-water level and generalized directions of ground-water movement in central Cold Spring Valley, March 1976. Altitudes are based on sea-level datum.

TABLE 3.--*Differences in water-surface altitude in adjacent shallow and deep wells, and implied directions of vertical ground-water movement*

Well pair	Approximate depth of perforations below water table (feet)	Approximate difference in water-surface altitude (in feet)[1], and direction of vertical component
9CDAD1	2 to 12	
9CDAC1	48 to 298	-0.1 (slight downward)
16CACD2	1 to 16	
16CACD1	24 to 216	-0.1 to +0.4 (variable)[2]
20CDAB1	0 to 10	
20CDAB2	116 to 118	+9 (pronounced upward)
21ADBB2	0 to 9	
21ADBB1	115 to 168	-0.3 to +0.4 (variable)
21DDBD1	0 to 8	
21DDBD2	84 to 86	+1.7 (upward)
28ADCC1	0 to 10	
28ADCC2	140 to 142	+12 to +4 (pronounced upward)

[1] Negative value indicates that water level in deep well is lower than water level in shallow well; positive value indicates the opposite.

[2] Prior to start of frequent pumping of 16CACD1 in July 1977.

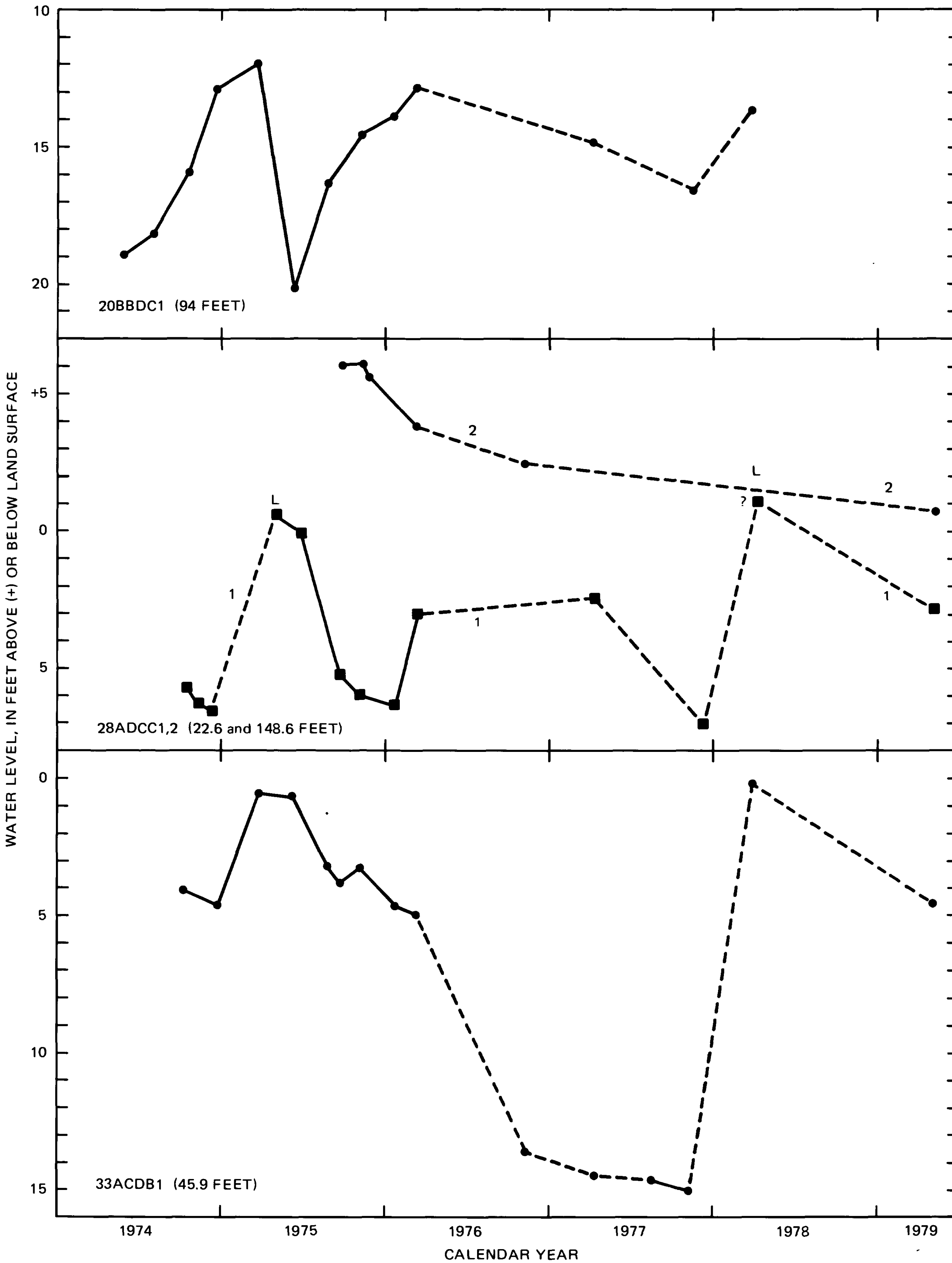


FIGURE 6.--Continued.

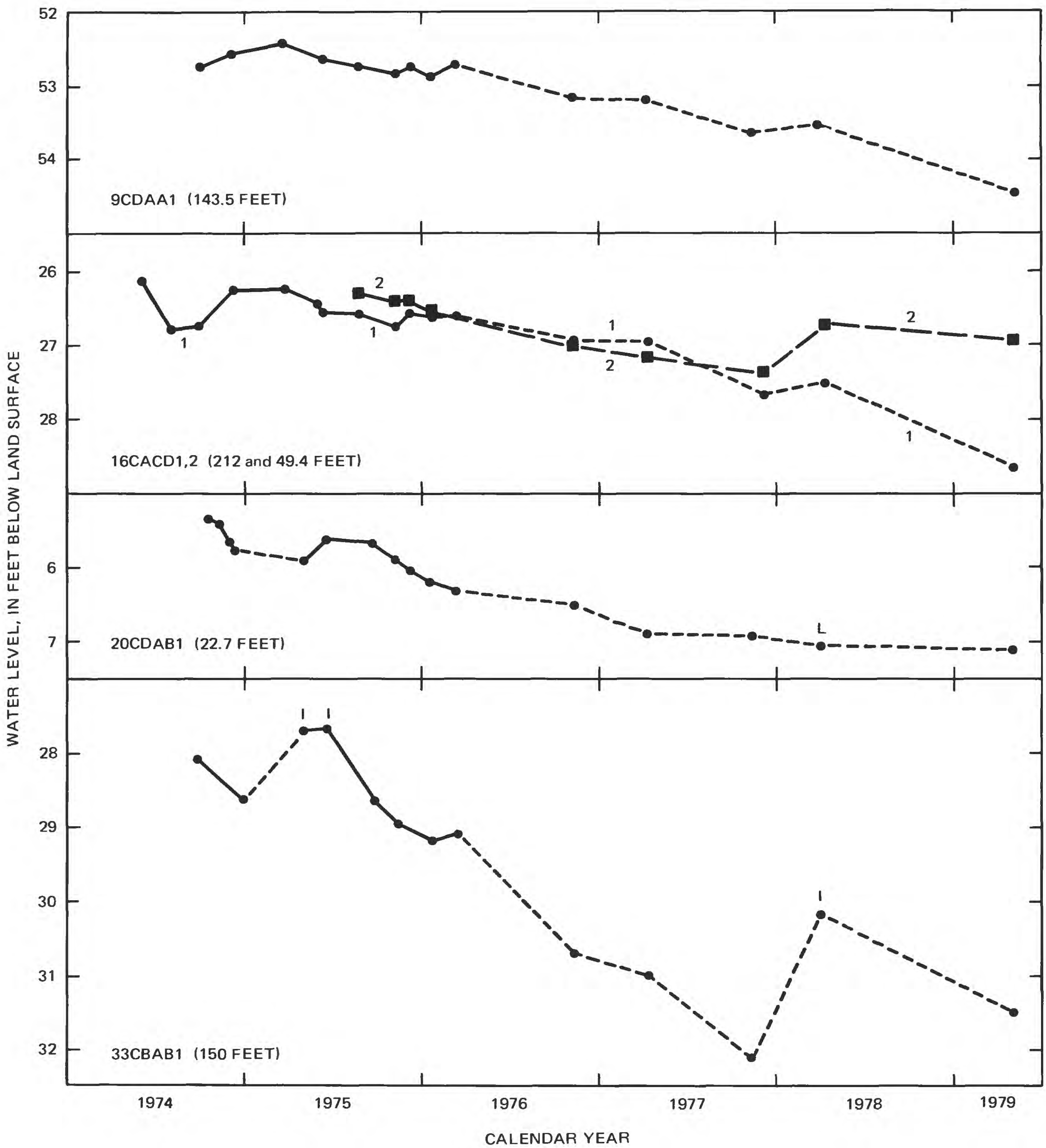


FIGURE 6.—Water-level fluctuations in selected wells, 1974-79. All wells unused except public-supply well 16CACD1 (pumping began in July 1977) and domestic well 20BBDC1. For shallow wells 20CDAB1 and 28ADCC1 (on bed of White Lake), "L" indicates lake water at well site when ground-water level was measured. For well 33CBAB1 (in middle of irrigated field), "I" indicates surface-water irrigation at time of measurement. Well depths are given in parentheses. Data points more than 3 months apart are connected by dashed line.

TABLE 4.--*Characteristic seasonal fluctuation of static water levels in observation wells*

Area (and number of wells evaluated)	Approximate timing of extremes: Highest level	Approximate timing of extremes: Lowest level	Approximate seasonal fluctuation (feet)[1]
	In areas where little or no ground water is pumped		
North of playa (10)	~ March	August-December	0.1 to 1
On playa (3)	~ Spring	~ Winter	<1 to >5
Southeast of playa (2)	~ May	~ January?	3 to 5
Irrigated area south of playa (2)	~ June	January?	1 to 4
	In or adjacent to areas of ground-water withdrawal		
Pumped wells (8)[2]	~ March	~ June-August	1 to 30
Unused wells (6)	March-May	September-October	0.8 to 3

[1] Excludes longer-term fluctuations.

[2] Water levels measured at least an hour after pump shut off.

TABLE 5.--*Annual and overall net changes in ground-water levels, March 1975-May 1979*

Well number	Maximum depth of perforations below water table[2]	Amount of well use[3]	Net water-level change, in feet[1]				
			March 1975-March 1976	March 1976-April 1977	April 1977-April 1978	April 1978-May 1979	March 1975-May 1979
9CDAA1	MD?	0	-0.3	-0.4	-0.3	-0.9	-2.0
9CDAC1	D	0	-0.3	-0.4	-0.3E	--	--
9CDAD1	S	0	-0.3	-0.4	-0.4	-0.8	-1.9
16AAAB1	S	0	-0.4E	-0.5	-0.3	-0.7	-1.9E
16BBBA1	S	0	--	-0.2	-0.2	-0.5	--
16BDAA1	D	0	-0.3	-0.3	-0.4	-0.9	-1.9
16BDBB1	MD	1	-0.3	-0.4	-0.4	-1.0	-2.0
16CACD1[a]	D	([b])	-0.3	-0.4	-0.6	-1.2	-2.4
16CACD2[a]	S	0	-0.2E	-0.6	+0.5	-0.2	-0.6E
16CBCC1[a]	S	0	-0.4	-0.5	+0.6	+0.1	-0.2
17DCCD1[a]	MS	0	-0.8	-0.5	--	--	--
20ABDD1[a]	S	0	-1.0E	-0.2	+0.3	-0.5	-1.5E
20BAAD1	MS	2	+5?	~0?	+0.5	--	--
20BBBB1	MS	2	--	--	--	0.0	--
20BBDC1	MS	2	-0.8	-2?	+1.2	--	--
20BCCC1	MS	2	-0.6	-0.8	+0.3	0.0	-1.1
20BDDD1	S	0	-1.7	-0.3	+0.9	-1.2	-2.4
20CDAB1	S	0	-0.3E	-0.6	-0.2	-0.1	-1.1E
20CDAB2	MD	0	-1.5E	+0.2?	+0.6	-0.5	-1.1E
21ADBB1[a]	D	0	-0.3	-0.4	-0.2	-0.6	-1.6
21ADBB2[a]	S	0	-0.4	-0.5	-0.1	-0.2	-1.2
21BCCD1[a]	S	0	-1.5?	-1?	--	--	--
21DDBD1	S	0	-0.2	-0.2	+1.0	-1.1	-0.5
21DDBD2	MS	0	-0.3	-0.4	+1.5	-2.5	-1.7
28ADCC1	S	0	--	←	+0.2	→	--
28ADCC2	MD	0	--	←	-3.1	→	--
29BBDC1	MS	2	-1?	-1?	+0.3	--	--
29CADB1	MD	2	-0.3?	~0?	+0.9	+0.6	+0.3
29CBCB1	D	0	--	--	+1.5	-0.3	--
29CDDC1	MS	2	-1.0	-1	+1.6	--	--
29DDAB1	S	0	0.0E	-0.2	-0.1	+0.6	+0.2E
30ADBA1	MD	0	--	--	0.0	-0.3	--
32DAAB1	D	0	-3?E	-3	+2.7	-1.1	-4E
33ACDB1	S	0	-4	-10	+14.3	-4.3	-4.0
33CBAB1	MD	0	-0.8E	-2	+0.8	-1.3	-3.3E

[1] Measurements were made during March 21-26, 1975; March 9-10, 1976; April 6-7, 1977; March 28-April 12, 1978; May 3, 1979. "E" indicates estimated net change, based on extrapolation for brief period of no record.

[2] Depth ranges: Shallow (S), deepest openings <50 feet below water table; moderately shallow (MS), 50-100 feet; moderately deep (MD), 100-150 feet; deep (D), >150 feet.

[3] Use categories: Unused, 0; light use, 1; moderate to heavy use, 2.

[a] Well is near Reno Park public-supply well 21BBDD1.

[b] Well unused until July 1977; used frequently thereafter.

There, the measured net decline during the period between March 1975 and April 1977 ranged from 3 feet in deep well 33CBAB1 to 14 feet in shallow well 33ACDB1 (figure 6), presumably because of diminished recharge (none of the wells in the area are used). During the following wetter year (April 1977-April 1978), water levels in that area recovered partly or completely.

During the overall period between late March 1975 and early May 1979, available data (table 5) indicate net water-level declines in all areas except sec. 29. The characteristic net declines were about 2 feet in the area north of the playa, 1-2 feet northwest of the playa, and 3-4 feet south of the playa. The generally moderate, almost valley-wide declines may be related in large part to climatic change--perhaps a slow response to the near-normal or below-normal amounts of precipitation in 1972-77, following the wet period during 1969-71.

Systematic long-term records of ground-water levels are not available in Cold Spring Valley. As a result, virtually the only clues to long-term fluctuation are provided by a comparison between (1) the reported static water levels at the time wells were drilled, or the single measurements at wells 16CBCC1 and 21BBDD1 in 1966, and (2) more recently measured water levels in the same wells. Table 6 lists such comparisons for 10 wells, and figure 7 shows the available data for well 21BBDD1 during 1966-71. The information in table 6 suggests a significant net rise in ground-water levels in many parts of the valley during the last three decades, presumably at least partly in response to climatic fluctuations. Long-term precipitation records for Reno (published data from the National Climatic Center, U.S. National Oceanic and Atmospheric Administration) indicate that dry conditions prevailed in the 1930's, the last half of the 1940's, and 1959-61, whereas the period 1962-75 was about average to significantly wetter than average.

Availability of Ground Water

Ground water is available throughout much of Cold Spring Valley. The availability in specific areas is indicated, in a general way, by well drillers' reports of the depth at which water was first detected during the drilling, by the reported well yields and drawdowns, and by the static water levels in completed wells (table 18, figure 16). Table 1 also discusses ground-water availability with regard to the several geologic units in the valley.

TABLE 6.--*Long-term net changes in ground-water level*

	Earlier measurement		Recent measurement		
Well	Date	Water level (feet)[1]	Date[2]	Water level (feet below land surface)	Net change (feet)[3]
9CDAA1	2- -48	65R	1-19-76	52.8	+12
16BDAA1	9- -64	40R	8-26-75	37.8	+2
16BDBB1	9- -62	42R	8-26-75	34.4	+8
16CBCC1	7-26-66	38.1	8-26-75	34.5	+4
20BACA1	10- -69	27R	11- 9-76	20.6	+6
20BABD1	2- -63	45R(?)	5- 3-79	26.4	+19?
20BBBC1	2- -63	32R	11-10-76	35.8	-4
20BBCC1	1- -63	25R	5- 3-79	30.6	-6
21BBDD1	7-26-66	5.8	3-30-71	5.4	0
29DCDB1	5- -61	35R	11- 9-76	24.4	+11

[1] Datum uncertain except at wells 16CBCC1 and 21BBDD1, where it is land surface. Measurements reported by well driller are indicated by "R".

[2] Where several measurements are available, the one that most closely corresponds with the earlier measurement in time of year is listed.

[3] In some instances, apparent change could be due at least in part to undocumented well deepening or water-level measurement by driller too soon after well-production test.

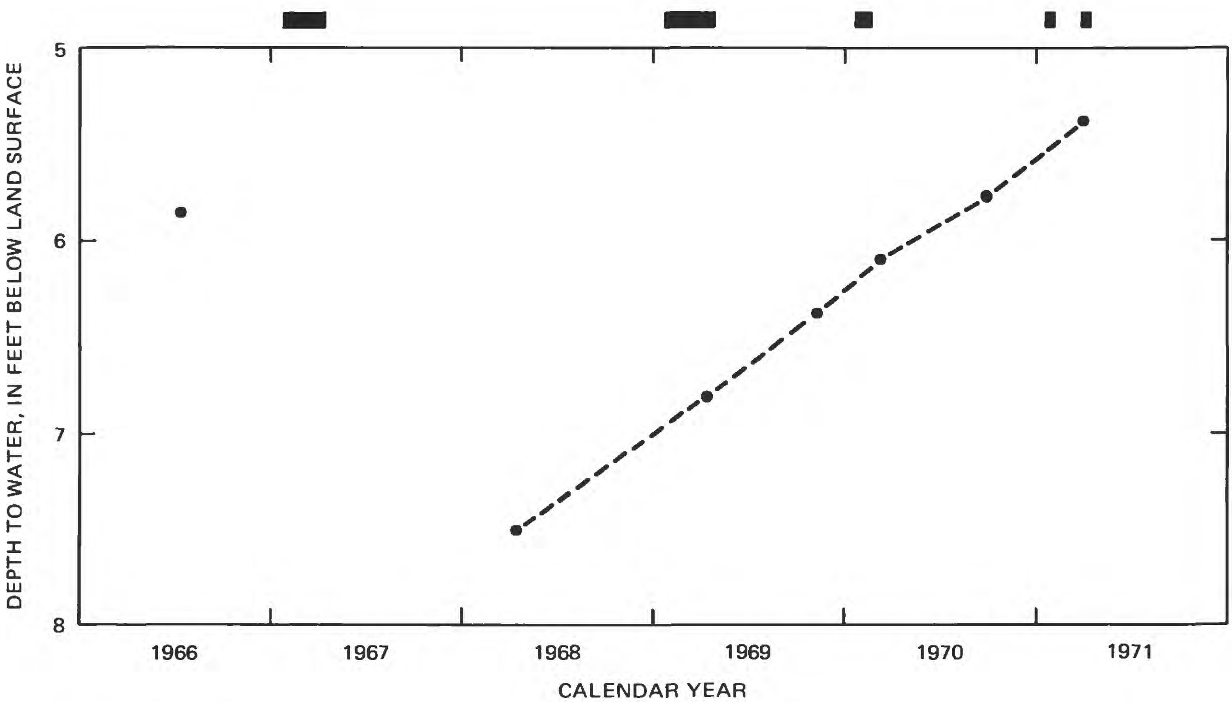


FIGURE 7.—Water-level fluctuations in unused well 21BBDD1, 1966–71. Bars above graph indicate periods of outflow from Peavine Reservoir, near Reno, as an index of possible inflow to White Lake. Well is 0.2 mile from lake and may be influenced by lake level.

NATURAL INFLOW TO THE VALLEY

Precipitation is the ultimate source of all surface water and ground water in Cold Spring Valley. No surface water enters the valley as stream inflow from adjacent basins, but a small amount of ground water apparently moves into the valley from adjacent Long Valley.

Surface Water

Streamflow

By Terry Katzer

General Conditions

Cold Spring Valley presents a contrast in surface-water hydrology. About 75 percent of the area that contributes to runoff is north of U.S. Highway 395 but generates only a small amount of runoff per unit of area, whereas the remaining 25 percent of the basin, south of Highway 395, generates much more runoff per unit area and produces most of the valley's total streamflow. The runoff is a result of high-intensity precipitation, commonly associated with thunderstorm activity, or rapid snowmelt. In late August 1975, there were three perennial streams, all in the far south part of the valley; in contrast, drainages in the north all were ephemeral. Several small springs issue along the mountain fronts in both areas. The northern mountains are sparsely covered with desert shrubs and grasses, whereas the southern mountains have a subalpine zone with moderately forested slopes. The southern area shows very little evidence of flash flooding, whereas past floods in some of the northern drainages have carried boulders as large as 3 feet in diameter well into the valley.

White Lake, an intermittant remnant of Pleistocene Lake Laughton (page 4), is the valley's terminal drainage sink (page 27). It occupies the playa depression north of U.S. Highway 395.

Available Records

Surface-water records are not available for Cold Spring Valley. However, the seasonal runoff pattern for this general area, and for perennial streams in particular, can be characterized by a comparison with the monthly flow distribution of Sagehen Creek near Truckee, Calif., as shown in figure 8.[2] Minimum flow occurs in late summer or early fall; winter rains occasionally

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[2] Figure 8 and tables 7 and 9 use the term "water year," which is defined as the 12-month period ending Sept. 30; thus, "water-year 1974" is the period from Oct. 1, 1973, to Sept. 30, 1974.

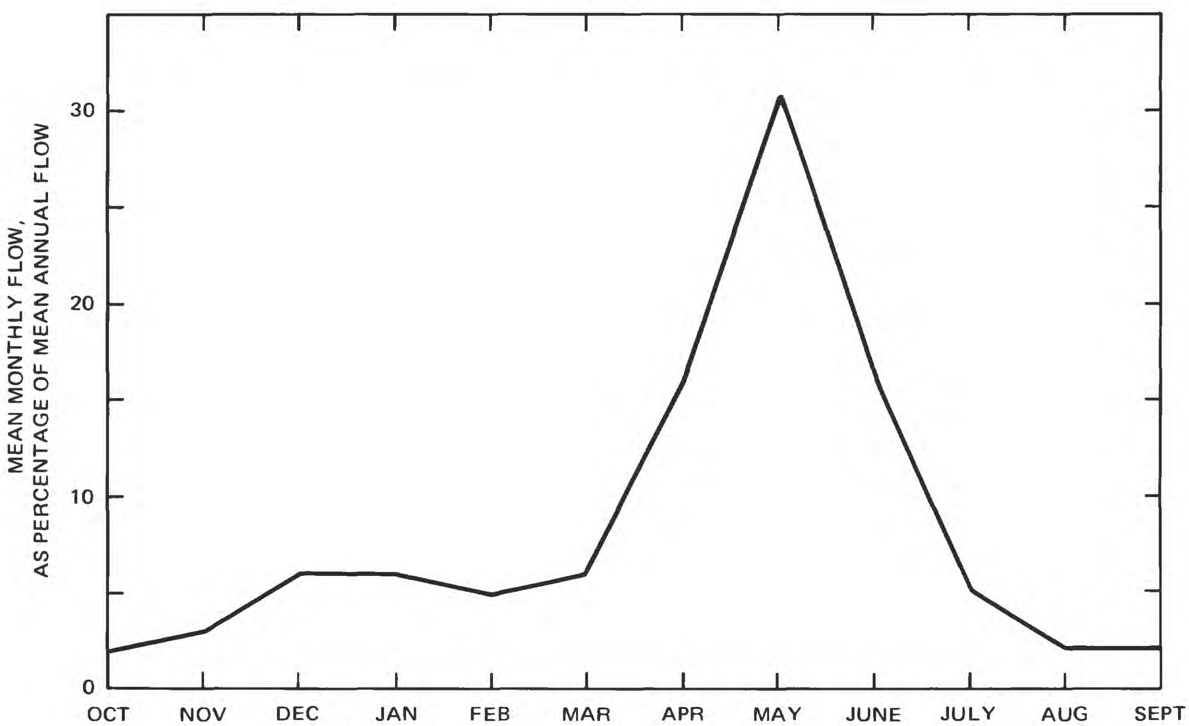


FIGURE 8.—Average seasonal distribution of flow in Sagehen Creek near Truckee, Calif., water years 1954-74 (from annual published records, U.S. Geological Survey).

cause flooding, generally in December and January; the spring runoff from snowmelt normally begins during or before April, reaching a maximum in late April or early May. After the peak, flows recede into the late summer. Runoff to the two principal streams in Cold Spring Valley--Spring Branch and Waltz Canyon creeks (figure 3)--characteristically peaks somewhat earlier than April, due to a lack of high-altitude snowpack; the two streams drain only about 200 acres above an altitude of 7,000 feet on the flanks of Peavine Peak (table 10).

The runoff to ephemeral streams in Cold Spring Valley can be characterized by the data for Peavine Creek near Reno (table 7, figure 1). Runoff generally occurs only during winter rainstorms and low-altitude snowmelt.

Measurements and estimates of streamflow in Cold Spring Valley, made on Aug. 26, 1975, are as follows:

Name	Location	Discharge (ft^3/s)
Unnamed creek	N20 E18 3AC	0.02
Spring Branch creek	N20 E18 5AD	[a] .06
Waltz Canyon creek	N20 E18 5BD	.02

[a] Measured flow; other values are estimated.

Mountain-Front Runoff

Most surface-water runoff occurs from the mountain block as a result of high-altitude snowmelt. Thunderstorms can produce surface-water flow anywhere in the valley; however, the resultant volume of water is probably minor compared to snowmelt volume except in the northern area, where the situation may be reversed. It is therefore assumed that almost all runoff is produced above the consolidated-rock/valley-fill contact, which is at an altitude that averages about 5,200 feet. Estimation of the mean annual flow crossing this contact is based on regional altitude-runoff relations, adjusted for local hydrologic factors, and channel-geometry measurements for the perennial and ephemeral streams (Moore, 1968). The estimated quantity is 1,100 acre-ft/yr. The southern part of the valley generates most of this amount, and Spring Branch creek presumably contributes the greatest portion.

Flash Flooding and Associated Debris Flows

Thunderstorms throughout the Great Basin and contiguous areas frequently produce flash flooding and associated debris flows, which in developed areas pose a serious threat to property and life. The potential for flash flooding

TABLE 7.--*Monthly and annual flow of Peavine Creek near Reno, in acre-feet, water years 1963-74*[1]

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total (rounded)
1963[a]	--	--	--	14	59	0	0	0	0	0	0	0	[a]73
1964	0	0	0	0	0	0	0	0	0	0	0	0	0
1965	0	0	46	55	10	0	0	0	0	0	0	0	111
1966	0	0	0	0	0	0	0	0	0	0	0	0	0
1967	0	0	0	32	8.5	60	.8	0	0	0	0	0	101
1968	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	0	0	0	33	22	63	25	0	0	0	0	0	143
1970	0	0	0	28	.4	0	0	0	0	0	0	0	28
1971	0	0	0	24	0	6.8	.9	0	0	0	0	0	32
1972	0	0	0	0	0	0	0	0	0	0	0	0	0
1973	0	0	.02	.08	7.4	4.4	0	0	0	0	0	0	12
1974[a]	0	0	0	7.3	0	1.6	0	0	0	0	0	0	9

[1] From published records, U.S. Geological Survey. Does not include contents of reservoir 100 feet upstream from gage [maximum capacity below lowest outlet, 90 acre-feet as of April 1967 (U.S. Soil Conservation Service, written commun., 1967)].

[a] No record prior to January 1963, or after September 1974.

and debris flows in any area depends primarily on: Storm intensity; drainage size; slope of landscape and channel; type and density of land cover; available supply of debris; and particle-size distribution of the debris.

Potential flash flooding and debris flows are most dangerous to development of sites on alluvial fans and at canyon mouths. The southern part of Cold Spring Valley, having moderate to heavy vegetal cover, shows less evidence of past flooding than the northern area and is therefore considered safer. Petersen Mountain and the Granite Hills, to the north, are very susceptible to flooding and debris flows. Figure 9 shows a boulder-strewn flood plain extending from Petersen Mountain into about the middle of the valley.

In addition to the flood plains, hillsides should also be considered as potential hazard areas. Previous Nevada investigations (Glancy, 1969; Glancy and Harmsen, 1975; Katzer and others, 1976), and other unpublished U.S. Geological Survey data (in files of the U.S. Geological Survey, Carson City, Nev.) indicate that even moderately flat slopes, with minor drainage areas, are subject to extensive overland sheetflow.

Present development in Cold Spring Valley is almost totally confined to the relatively flat valley floor and is therefore reasonably safe from flooding. It is natural to assume that with an increasing population the development will continue to expand accordingly, and that at some future date development will probably start to encroach on hillsides and mountain-drainage flood plains. Detailed site studies should be made prior to development of these potentially hazardous areas.

Railroad construction through Cold Spring Valley during the late 1800's and early 1900's (page 6) created potential flood hazards. The Nevada-California-Oregon Railway roadbed (now abandoned) traverses the western and northern parts of the valley, and the Western Pacific Railroad right-of-way tra erses the southern part. Where the roadbeds cross channels, flood water can be impounded in excess of the drain capacity of the small-diameter outlet culverts. During extreme floods, the roadbed may be overtopped and may fail, causing an increased flood surge having a great potential destructive force. Thus, areas immediately downstream from such crossings should be considered hazardous.

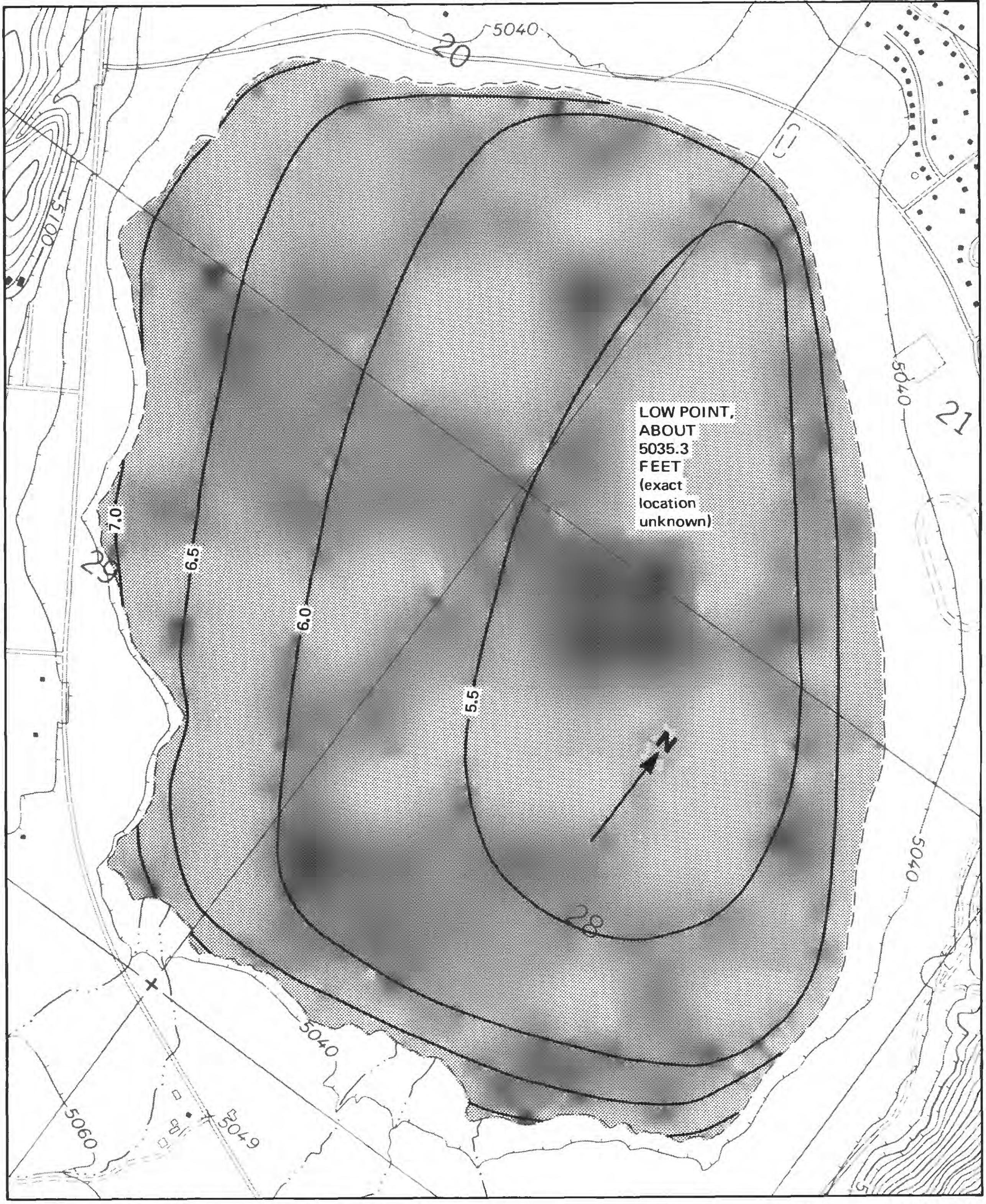
White Lake

By Terry Katzer and A. S. Van Denburgh

The lowest part of Cold Spring Valley is the site of an intermittent water body known as White Lake (figure 10). The normally dry lake bed (termed a "playa") is 1.75 square miles in area and has a low point at an altitude of 5,035.3 feet. The lake-bed bathymetry (topography) is shown in figure 11, and

FIGURE 9.--Boulder-strewn flood plain in north part of Cold Spring Valley. Photograph taken May 1979 in NW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 4, T. 21 N., R. 18 E. View facing northwest, with Petersen Mountain in background. Note shovel for scale.

FIGURE 10.--Oblique aerial photograph of White Lake playa and surrounding area, September 1974, looking east. Border Town in left foreground, with Reno Park farther east. Playa surface dry. Differences in color tone on playa represent shorelines associated with lake recession during previous spring (fig. 12).



Base from U.S. Geological Survey 1:24,000 Reno NW, 1967
(photorevised 1974)

0 1000 2000 FEET
0 200 400 METERS

EXPLANATION

——6.0—— Bathymetric contour. Shows lake-bottom altitude, in feet above 5,030 feet. Contour interval is 0.5 foot. Playa margin (dashed line) coincides approximately with 5,038-foot contour

FIGURE 11.—Bathymetry of White Lake, on the basis of survey of dry lakebed, September 1975. Altitudes are based on sea-level datum.

the relations among depth, area, and capacity are listed in table 8. The lake can contain as much as about 2,500 acre-feet of water (maximum depth, about 3 feet) without flooding adjacent low-lying areas.

During and after periods of intense rain or snowmelt runoff, White Lake contains water. Except for direct precipitation, the only flow that reaches the playa generally is from the south. In most years, a lake exists at least briefly, according to long-time residents of the area (Josephine Sweeney and David Evans, oral commun., 1976). Water has completely covered the playa on numerous occasions, and areas adjacent to the playa have been inundated at least once within the past several decades.

Available lake-level data are shown in figure 12.[3] Most of the information is for 1969-71 and 1974-75, when average to above-average precipitation and runoff occurred in western Nevada. In four of those five years, inflow was sufficient to cover virtually the entire playa at least briefly.

Stream inflow to the lake can be estimated from the information in figure 12 and table 8. Table 9 lists estimates of annual inflow for the five years of adequate lake-level record. Column 5 of table 9 refers to temporary lake-water recharge of the fine-grained bottom sediments, which is discussed on page 34.

The annual estimates for 1969-71 and 1974-75 have been used, along with data for Peavine Creek on the southeast flank of Peavine Peak (figure 1) and the Truckee River at Farad, Calif., to evaluate the long-term average value for annual stream inflow (table 9). The computations suggest an average inflow to White Lake on the order of 1,000 acre-ft/yr.

Prior to the start of irrigation in sections 32 and 33 (page 45), the inflow to White Lake presumably was somewhat greater than the present-day quantity. The average difference may have been on the order of 200 acre-ft/yr, which would make the natural (pre-irrigation) total about 1,200 acre-ft/yr.

A moderate discrepancy seems to exist between the estimated inflow to White Lake under natural conditions (1,200 acre-ft/yr) and the estimated mountain-front runoff (1,100 acre-ft/yr; page 25). Theoretically, if most runoff in the basin is generated at higher altitudes, and if some of that runoff is depleted downgradient from the mountain front by ground-water recharge, streamflow at the lake should be somewhat less than streamflow at the mountain front. The apparent discrepancy may be the result of (1) slight inaccuracies in the two estimated values, and (2) the occurrence of some runoff to the lake from areas on the valley floor during or after periods of heavy precipitation.

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[3] In addition to data shown in figure 12, an aerial photograph taken Nov. 21, 1956, indicates a lake with a surface area of about 800 acres, which would have been equivalent to a maximum depth and volume of 0.9 foot and 400 acre-feet, respectively, on the basis of bathymetric data for 1975. The lake was dry when photographed on July 10, 1946, and June 15, 1966.

TABLE 8.--*Area and capacity of White Lake*[1]

Lake-surface altitude (feet)	Maximum lake depth (feet)	Surface area (acres, rounded)	Capacity (acre-feet, rounded)
5,035.3	0.0	0	0
5,035.5	.2	290	30
5,036.0	.7	720	280
5,036.5	1.2	980	710
5,037.0	1.7	1,110	1,230
5,038.0	2.7	1,120	2,340
5,040.0	4.7	1,360	4,800±

[1] Based on lake-bed survey made in September 1975 and configuration of 5,040-foot topographic contour (figure 11); datum is sea level.

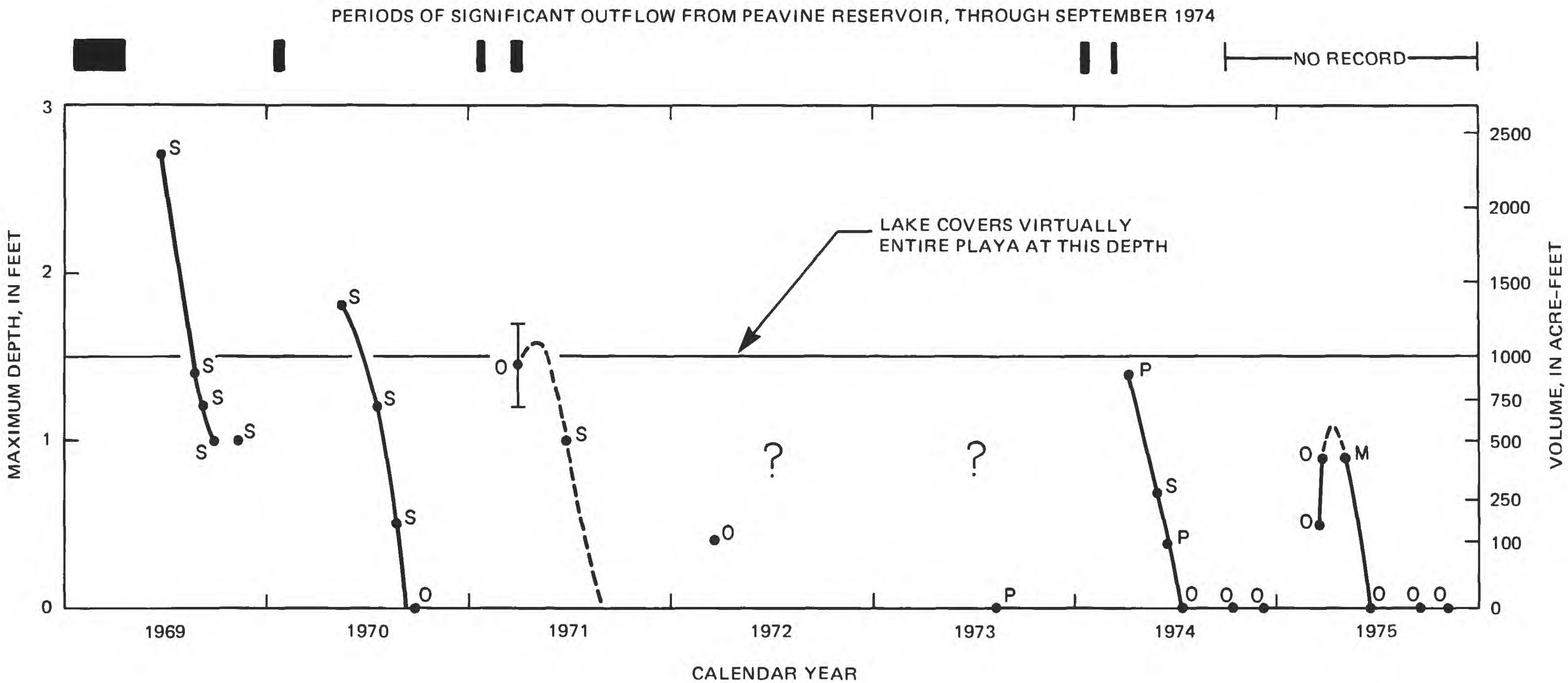


FIGURE 12.—Volume and depth of White Lake, compared with periods of significant outflow from Peavine Reservoir near Reno, 1969-75. Most lake levels were estimated by one of the following methods, using figure 11: O, ground-level observations of areal extent; P, aerial photographs; or S, distance measurements from shoreline to playa edge in the northeast quarter of sec. 29. One level was measured (M).

TABLE 9.--*Estimated annual stream inflow to White Lake, 1969-71 and 1974-75, and calculated long-term average inflow*

Water year	Estimated quantities (acre-feet): Maximum lake volume (fig. 12) (1)	Lake volume at start of inflow period (2)	Lake-surface precipitation during inflow period[1] (3)	Lake-surface evaporation during inflow period[2] (4)	Temporary recharge by lake water (see text) (5)	Stream inflow [(1)-(2)-(3)+(4)+(5)] (6)	Calculated long-term average inflow (acre-feet per year), based on comparsion between annual values for White Lake (column 6) and data for: Peavine Creek near Reno, Nev.[3]	Truckee River at Farad, Calif.[3]
1969	3,000	0	600	500	100	3,000	1,300	1,600
1970	1,600	400	300	100	0	1,000	800	800
1971	1,100	0	200	200	100	1,200	1,000	1,000
1974	1,200	0	200	100	100	1,200	1,200	900
1975	600	0	200	100	100	600	(*a*)	500

Mean of the calculated values for long-term average inflow -- 1,000

[1] Estimates are based on average of precipitation data for Reno, Nev., and Vinton, Calif. (published records of the National Climatic Center, U.S. National Oceanic and Atmospheric Administration), multiplied by an assumed average lake-surface area of about 800 acres. Periods of record used: 1969, January through April; 1970, January and February; 1971, January through March; 1974, January and February; and 1975, March.

[2] Estimates are based on an assumed lake-surface evaporation rate of 43 inches per year (Kohler and others, 1959, pl. 2), and a monthly distribution comparable to that measured at Camp Pardee, Calif. (published records of the National Climatic Center, U.S. National Oceanic and Atmospheric Administration). Periods are same as those listed in footnote 1. Total evaporation for each period is multiplied by an assumed average lake-surface area of about 800 acres.

[3] Calculation procedure: annual value for White Lake (column 6) is divided by the ratio of (*A*) annual streamflow quantity to (*B*) long-term average annual streamflow quantity. Data for Peavine Creek incorporate allowance for effect of 90-acre-foot reservoir above gage; long-term average is based on comparison of record for Peavine Creek (water years 1963-74) with data for Sagehen Creek near Truckee, Calif. (water years 1954-75).

[a] Data collection discontinued at end of water year 1974 (see table 7).

Ground Water

Recharge

Precipitation is the ultimate source of ground-water recharge in Cold Spring Valley. Even in the mountains and on alluvial slopes, however, most of the precipitation evaporates before infiltration, and some of the remainder adds to soil moisture. Thus, only a very small percentage actually recharges the ground-water reservoirs. On the valley floor, precipitation quantities are generally smaller than those at higher altitudes, and almost all the water that enters the ground is retained as soil moisture.

The potential natural recharge from precipitation is estimated by the general method described by Eakin and Maxey (1951, page 79-81). The method assumes that for any given altitude zone, a particular increment of total precipitation is available for recharge of the ground-water reservoir, and that that increment depends on the average amount of snow and rainfall within the zone. The term "potential recharge" is used because in many years some of the runoff generated south of White Lake reaches the lake and is dissipated by evaporation, rather than percolating to the ground-water reservoir.

Table 10 lists the estimates of precipitation and potential recharge for Cold Spring Valley. The recharge value of 1,000 acre-ft/yr is only 100 acre-ft/yr greater than the reconnaissance estimate made by Rush and Glancy (1967, page 22). The slight difference is due to three partly offsetting factors:

(1) The present calculations are based on more accurate topographic maps for determination of the basin boundary and area-altitude relations.

(2) An allowance is made for reduced rates of recharge on comparatively flat areas of the valley floor.

(3) Characteristic directions of movement for incoming winter storms suggest that the generally north-facing slopes of Peavine Peak, in the south part of the valley, are in a wetter precipitation-versus-altitude zone than are the generally east-facing slopes of Petersen Mountain in the north. The probability of this difference is substantiated by Frank H. Morine (National Weather Service, Reno, oral commun., 1977). Table 10 reflects the north-to-south difference.

At White Lake, inflow temporarily recharges the fine-grained lake-bottom sediments (the temporary recharge is subsequently dissipated by evapotranspiration soon after the lake has dried). The quantity of temporary recharge depends on (1) the associated water-table rise and (2) the capacity of sedimentary deposits above the water table to accept percolating lake water. The playa-wide average for the water-table rise is assumed to be about 3 feet in a normal year. The water-accepting capacity of the sediments is, for lack of specific data, assumed to be about half the normal specific yield of such deposits, or about 3 percent (the other 3 percent is assumed to have been already satisfied by existing soil moisture in the capillary fringe). On the basis of these assumptions, the estimated volume of temporary recharge may be on the order of 100 acre-ft/yr.

TABLE 10.--*Estimated average annual precipitation and potential ground-water recharge*

Altitude zone (feet)	Area (acres)	Estimated precipitation: Range (inches)	Estimated precipitation: Average Feet	Estimated precipitation: Average Acre-feet	Estimated potential recharge: Percentage of total precipitation	Estimated potential recharge: Acre-feet per year
		North of Highway 395				
7,000-7,800	420	15-20	1.5	630	15	90
6,000-7,000	2,800	12-15	1.1	3,100	7	220
5,035-6,000	[a] 8,000	8-12	.8	6,400	3	190
5,035-6,000	[b] 3,000	8-12	.7	2,100	minor	--
		South of Highway 395				
7,000-7,940	190	>20	1.8	340	25	80
6,000-7,000	1,000	15-20	1.5	1,500	15	220
5,040-6,000	[a] 3,000	12-15	1.1	3,300	7	230
5,040-6,000	[b] 200	12-15	1.0	200	minor	--
TOTAL (rounded)	18,600	--	1.0	18,000	6	1,000

[a] Areas of exposed bedrock and moderately to steeply sloping valley fill, where some recharge probably occurs.

[b] Comparatively flat areas of valley fill, where little recharge is thought to occur.

Subsurface Inflow

Intervalley ground-water flow requires two basic conditions: (1) A hydraulic gradient from one valley to another, and (2) rocks or sedimentary deposits that are capable of transmitting ground water. The floors of Lemmon Valley, to the east, and Red Rock Valley, to the north, are lower than that of Cold Spring Valley. Although the ground-water divides between the two adjacent basins and Cold Spring Valley may not everywhere coincide horizontally with the topographic divide, two facts--the relative altitudes of valley floors and the lack of evidence in Cold Spring Valley of appreciable inflow from the east or north-strongly suggest that virtually no inflow occurs from either valleys.

In contrast, a moderate amount of ground water may enter the valley from adjacent Long Valley on the west. Figure 13 shows water-level contours in the vicinity of the topographic divide between Long and Cold Spring Valleys, on the basis of the data in table 11. If ground water is moving between the two valleys, it is doing so largely or entirely through the faulted Tertiary sedimentary deposits that form the divide (figure 3, table 1). Thus, the smooth contouring in figure 13 may be oversimplified to the extent that it does not reflect accurately the hydraulic influence of the faulting.

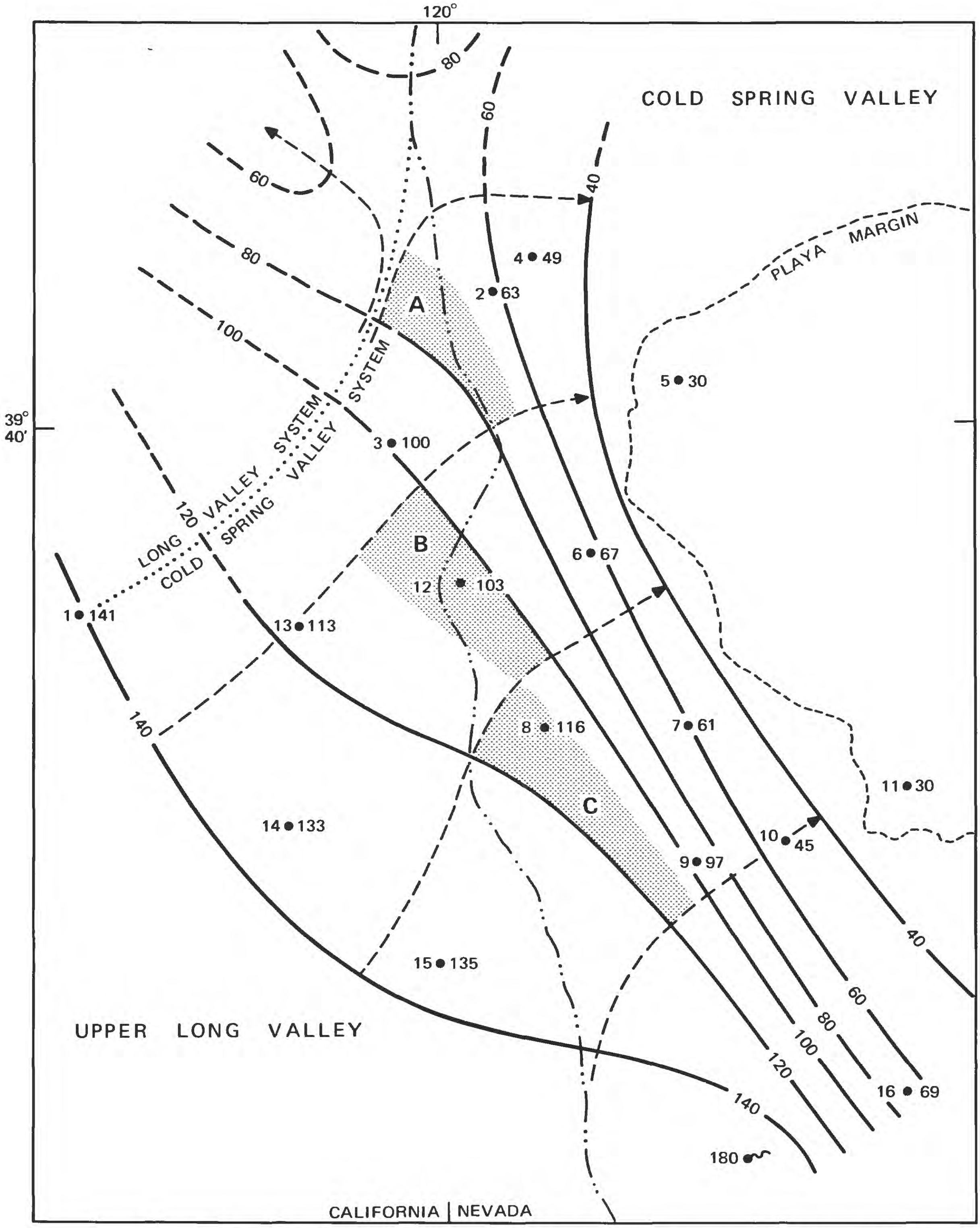
Assuming that the configuration of contours in figure 13 does approximate the actual system, the magnitude of interbasin flow can be estimated by using data in figure 13 and table 12 and the following formula (a form of Darcy's law):

$$Q = 0.00838TIW,$$

where Q is the quantity of flow, in acre-feet per year; T is the transmissivity, in feet squared per day, I is the hydraulic gradient, in feet per mile; W is the width of the flow section, in miles; and the factor 0.00838 converts cubic feet per day to acre-feet per year. The data, listed in table 12, indicate a ground-water flow into the valley on the order of 300-400 acre-ft/yr.

Other evidence, in contrast, suggests that the quantity is appreciably less than 300-400 acre-ft/yr. Under the near-natural conditions that still existed as of 1979 in the western part of Cold Spring Valley, almost all ground-water inflow from the west presumably is dissipated by evapotranspiration on and adjacent to the western part of White Lake playa (figure 14). Using calculations similar to those in table 13, the estimated amount of evapotranspiration involved is on the order of 100 acre-ft/yr.

The actual quantity of ground-water inflow from Long Valley may fall in between the two estimates (100 and 300-400 acre-ft/yr). Because the value based on evapotranspiration is considered the most accurate of the two, that value is favored in the arbitrary assignment of 200 (± 100) acre-ft/yr as the estimated inflow.



EXPLANATION

C — Segment for which intervalley ground-water flow is estimated (table 12)

—80— — — Water-level contour. Shows altitude of ground-water level, in feet above 5,000 feet. Dashed where approximately located or inferred. Contour interval 20 feet

— — — ▶ Flow line showing generalized direction of ground-water movement

. . . . Boundary between ground-water flow systems of Cold Spring and Long Valleys

15●135 Well. Number to left of symbol is well number in table 11. Number to right is water-surface altitude, in feet above 5,000 feet

180●〰 Spring, with water-surface altitude, in feet above 5,000 feet

—·· — Topographic divide between valleys

0 — 0.5 MILE

0 — 0.5 KILOMETER

FIGURE 13.—Altitude of ground-water level and generalized directions of intervalley ground-water movement in adjacent parts of Cold Spring and upper Long Valleys, late 1977. Altitudes are based on sea-level datum.

TABLE 11.--*Data on selected wells in Cold Spring and upper Long Valleys*

Well number, figure 13	Location[1]	Land-surface altitude (feet)[2]	Total well depth (feet)	Depth to water (feet below land surface)[3]	Water-surface altitude (feet)[3,4]
1	24ADAC1	5,145	45-50?	4	5,141
2	19DAAB1	5,110	203½	47 est.	5,063
3	19DCDB1	5,125	39	25	5,100
4	20BCCC1	5,080	121±	31	5,049
5	20CDAB1	5,037	23	7	5,030
6	29BBDC1	5,110	130	43	5,067
7	29CADB1	5,080	125	19	5,061
8	29CBCB1	5,150	186	34	5,116
9	29CDDC1	5,120	120±	23	5,097
10	29DCDB1	5,070	100	25	5,045
11	29DDAB1	5,036	22	6	5,030
12	30ADBA1	5,175	203	72	5,103
13	30BDAD1	5,125	19	12	5,113
14	30CDAC1	5,145	40+	12	5,133
15	31AACC1	5,220	180±	85	5,135
16	32DAAB1	5,090	250±	21	5,069

[1] All wells are in T. 21 N., R. 18 E., except well 1, which is in T. 21 N., R. 17 E.

[2] Estimated accuracy of land-surface altitudes: wells 6 and 9, ± 10 feet; wells 5 and 11, nearest foot; all others, ± about 5 feet. Datum is sea level.

[3] Water levels measured during August-December 1977, except for that of destroyed well 2, which is estimated on basis of earlier measurements.

[4] Although reported to nearest foot, water-surface altitudes are no more accurate than land-surface altitudes, most of which are reported to nearest 5 or 10 feet. Datum is sea level.

TABLE 12.--*Estimated ground-water flow from Long Valley to Cold Spring Valley, on the basis of Darcy's law*

Segment (figure 13)	Estimated average transmissivity, T (ft^2/day)[1]	Average gradient, I (ft/mi)	Average width, W (mi)	Ground-water flow, Q (acre-ft/yr)
A	680	80	0.45	200
B	140	60	.50	40
C	270	80	.65	120
TOTAL	--	--	1.6	360

[1] Estimates are based on specific capacities calculated from yield and drawdown data in table 18 and the following approximation: transmissivity = (270)(specific capacity).

NATURAL OUTFLOW FROM THE VALLEY

Evaporation and transpiration are the natural means of surface-water and ground-water dissipation in Cold Spring Valley. No surface water leaves the valley as stream outflow, because the basin is topographically closed, and no ground-water outflow is thought to occur.

Evaporation and Transpiration

In areas of shallow ground water, discharge (outflow) occurs by evaporation from the soil surface and by transpiration from plants called phreatophytes, whose roots tap the ground water. The principal natural phreatophytes in Cold Spring Valley are greasewood, rabbitbrush, sage, saltgrass, and wildrye. The distribution of phreatophytes and areas of soil-surface evaporation of ground water is shown in figure 14, and estimates of evapotranspiration are summarized in table 13. The rates used are based on work done in other areas by Lee (1912), White (1932), Young and Blaney (1942), Houston (1950), Veihmeyer and Brooks (1954), and Robinson (1965).

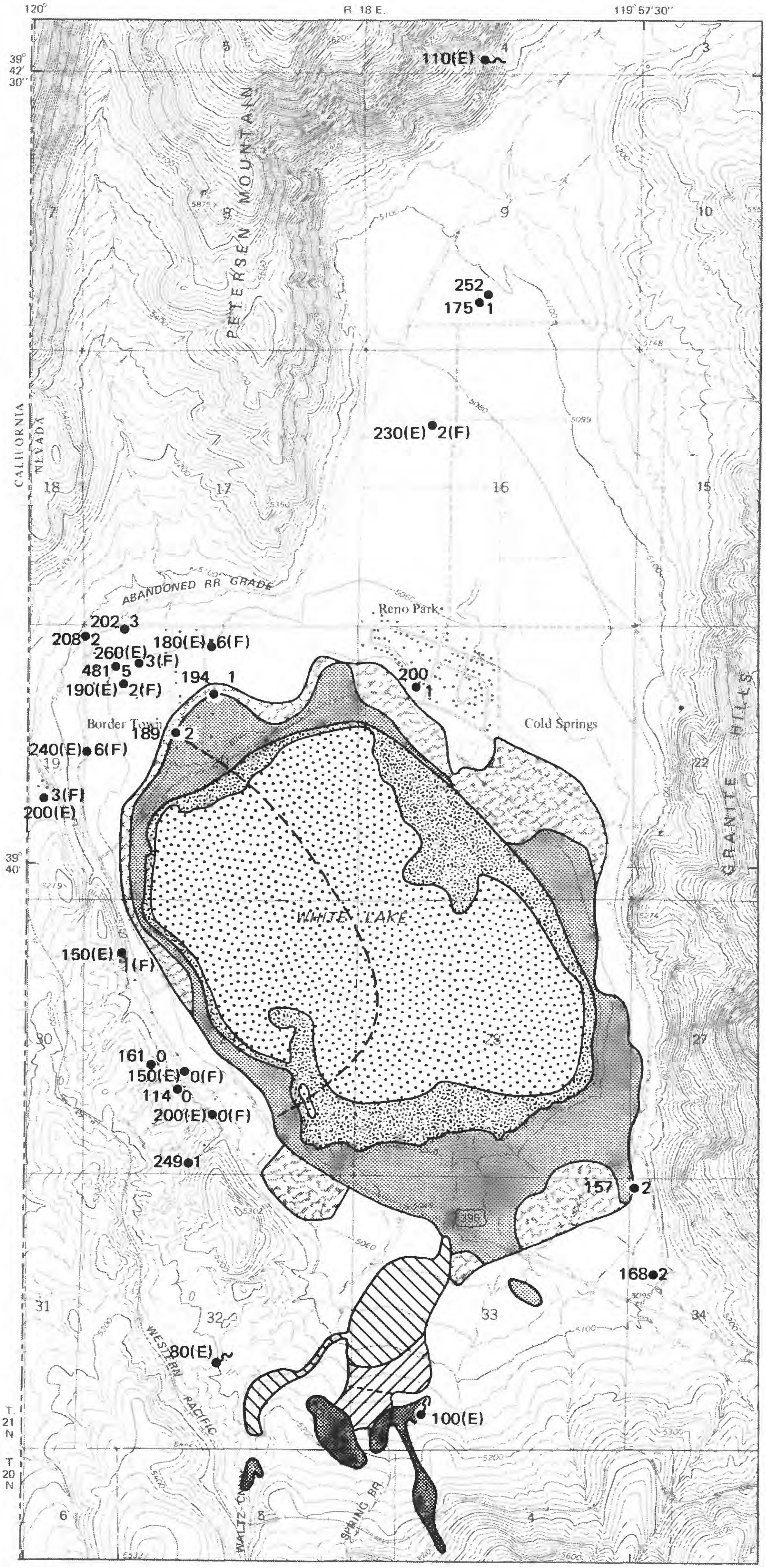
In NW$\frac{1}{4}$ sec. 33, the natural distribution of phreatophytes presumably has been changed somewhat by the activities of man. Other areas formerly occupied by phreatophytes also may have been altered by man. However, the total area involved is relatively small (perhaps only 30-60 acres), and the net effect of these changes on overall natural evapotranspiration in the valley is likewise small.

Surface-water inflow to White Lake is thought to average about 1,000 acre-ft/yr (page 30). Part of this inflow temporarily recharges the shallow, fine-grained sedimentary deposits beneath the lake and is dissipated by subsequent transpiration and playa-surface evaporation. The remaining inflow is lost even more quickly by lake-surface evaporation. Although the proportions of total surface-water inflow dissipated by lake-surface evaporation and playa-surface evapotranspiration are unknown, the two processes together remove the entire quantity.

The valley-wide total for natural evaporation plus transpiration in excess of lake-water loss, about 500 acre-ft/yr (table 13), far exceeds the 130 acre-ft/yr postulated by Rush and Glancy (1967, page 34). This is because a significant acreage of phreatophytes in Cold Spring Valley was overlooked during the rapid field reconnaissance of their 900-square-mile study area.

Springs

Cold Spring Valley is the namesake of a 15.0°C (59°F) flow of about 20 gal/min that emerges near the bedrock/valley-fill contact at 4ACBD1 (table 20). Data for several other, less prolific, springs also are listed in table 20. Several of the springs provide stock water (page 46) and one is used for domestic purposes (page 43). Additional springs and seeps emerge from the bedrock or from near the bedrock/valley-fill contact south of the valley floor, but they have not been cataloged. Part of the overall springflow is dissipated by evapotranspiration, and the remainder returns to the ground-water reservoir by percolation.



EXPLANATION

Phreatophytes in non-irrigated areas

Wildrye, greasewood, rabbitbrush, and large sage; individually or in combination. Includes several small areas of scattered saltgrass, with or without scattered rabbitbrush and (or) wildrye

Same phreatophytes as above, plus saltgrass

Saltgrass on discharging playa

Meadowgrass and scattered to dense saltgrass associated with springs and shallow ground water

Vegetation in irrigated areas

Dense to scattered meadowgrass

Dense meadowgrass and scattered saltgrass

—— Phreatophyte contact, approximately located

----- Approximate southern limit of irrigated meadowgrass cut once in most years

Other ground-water discharge

Bare playa

— — Approximate limits of evapotranspiration that may be fed by ground-water inflow from Long Valley

Ground-water quality

230(E) • 2(F) Well, with water-quality data. Number to left of symbol is dissolved-solids concentration, in milligrams per liter. Values estimated on basis of specific conductance are indicated by "(E)." Number to right of symbol is nitrate concentration, in milligrams per liter expressed as nitrogen (rounded). Field determinations are indicated by "(F)"

80(E) Spring, with estimated dissolved-solids concentration, in milligrams per liter

Base from U.S. Geological Survey 1:24,000 Reno NW, 1967 (photorevised 1974)

0 0.5 1 MILE

0 0.5 1 KILOMETER

CONTOUR INTERVAL 20 FEET

DOTTED LINE REPRESENTS 10-FOOT CONTOUR

DATUM IS SEA LEVEL

FIGURE 14.—Distribution of phreatophytes, irrigated area, and discharging playa, and data on ground-water quality in central Cold Spring Valley. Most water-quality data are for samples collected during 1970-76.

TABLE 13.--*Estimated average evapotranspiration of ground water under natural conditions*[1]

Type of water loss (see figure 14)	Depth to water (feet)	Area (acres)	Evapotranspiration	
			Feet per year	Acre-feet per year
Wildrye, greasewood, rabbitbrush, and large sage, individually or in combination; scattered to dense[2]	10-20	250	0.2	50
Same phreatophytes as above plus saltgrass; moderately dense to dense	1-10	460	.5	230
Meadowgrass and scattered to dense saltgrass associated with springs and shallow ground water	0-5	40	.8	30
Saltgrass on playa; moderately dense to dense	3-7	280	.5	140
Bare playa	3-7	840	.1	80
TOTAL (rounded)	--	1,900	--	500

[1] Does not include evapotranspiration associated with temporary lake-water recharge (page 34), irrigation, or well pumping.

[2] Also includes several small areas of scattered saltgrass, with and without scattered rabbitbrush and (or) wildrye.

Subsurface Outflow

Harrill (1973, page 38) suggested that some ground water may move from Cold Spring Valley to adjacent Lemmon Valley in or near sec. 35, T. 21 N., R. 18 E. His suggestion was based in part on the pronounced budget imbalance for ground water in Cold Spring Valley postulated by Rush and Glancy (1967, page 43), which the present report shows to be incorrect (page 48). Data obtained since the studies by Harrill, Rush, and Glancy indicate that Cold Spring Valley is hydrologically closed along the east side of its valley floor, as shown by the contours in figure 5. This all but eliminates the probability of significant eastward leakage.

As a possible explanation for their apparent budget imbalance, Rush and Glancy (1967, page 42) suggested that ground water might leak westward from Cold Spring Valley to adjacent Long Valley (presumably in or near sec. 19, T. 21 N, R. 18 E.). Again, subsequent data, shown in figure 13, refute this alternative by indicating that the subsurface flow apparently is from, rather than to, Long Valley.

In fact, the possibility of significant subsurface outflow in any direction is remote.

WATER-RESOURCES DEVELOPMENT

Water Rights

The first water right granted in Cold Spring Valley has a priority date of Sept. 3, 1914, for the appropriation of streamflow from Spring Branch creek, south of the playa. Table 14 lists the 16 rights that existed in the valley as of November 1979. Although the rights involve a total of almost 3,000 acre-ft/yr of surface water and ground water, only seven of those rights had as yet received a certificate of appropriation for beneficial use (table 14, footnote 2).

Domestic and Public Supplies

Residents of the Reno Park and Cold Springs subdivisions as of 1979 are supplied by wells 16CACD1 and 21BBDD1, with well 21ADBB1 in reserve for probable future use (table 18). In sec. 19, the Bordertown Club, plus a service station and private residence, are supplied by well 19DACA2. Domestic needs at the Heinz Ranch, in NW$\frac{1}{4}$ sec. 33, are met by the piped flow of spring 32DBCB1 (table 20). All other residents of the valley are supplied by individual domestic wells (representative data are listed in table 18).

As of November 1979, the rate of ground-water pumpage for the Reno Park/Cold Springs public supply was equivalent to an annual withdrawal of about 200 acre-feet (65,000,000 gallons), or approximately 340 gallons per day per dwelling (estimates are based on meter records of the Reno Park Mutual Co.). Elsewhere in the valley, pumpage for domestic use (about 105 dwellings) and public supply (Bordertown Club) probably was on the order of 45-50 acre-ft/yr (not including pasture irrigation). Thus, the overall rate of

TABLE 14.--*Existing water rights in Cold Spring Valley as of November 1979*[1]

Permit number	Date of priority	Source	Location	Acre-feet per year[2]	Use[3]	Current owner
3100	9- 3-14	Spring Branch creek	20N 18E 5AD	[a] 1,695	DI	Heinz Ranch
4762	12- 8-17	Cold Spring	21N 18E 4ACBD1	195	DI	David Evans
5026	4-26-18	Streib Spring	21N 18E 4CDDD1	72	DIS	Do.
20240	1-10-62	Heinz springs 2 and 3	20N 18E 4BC	14.48	DI	Heinz Ranch
20241	1-10-62	Waltz Canyon creek	20N 18E 5BD	22.8	DI	Do.
20242	1-10-62	Heinz spring 1	21N 18E 32DBCB1	8.0	DI	Do.
23171	6- 7-66	Well	21N 18E 9CDAC1	[b] 436.86	DQ	Silver Knolls Development Co
26556	2-17-72	Well	21N 18E 29DCDA1	18	DI	Jack L. Bacon
26956	1- 5-67	Well	21N 18E 21BBDD1			
26957	1- 5-67	Well	21N 18E 21ADBB1			
26958	1- 5-67	Well	21N 18E 16CACD1			
29459	1- 5-67	Well	21N 18E 29CBCB1	(c)	DQ	Cold Springs Development Corp.
29460	1- 5-67	Well	21N 18E 30ADBA1			
29461	1- 5-67	Well	21N 18E 29CB			
30753	10-15-76	Well	21N 18E 19DACA1			
30754	10-15-76	Well	21N 18E 19DACA2	4.64	CD	Joe E. and Natalie Gardner

[1] Information from records of the Nevada State Engineer and from Jack Cardinalli (Nev. Div. of Water Resources, oral commun., 1979).

[2] Totals for valley: Streams, 1,718 acre-feet per year; springs, 289 acre-feet per year; and wells, 960 acre-feet per year. Certificated rights include permit nos. 3100 through 20242, and 26556.

[3] Uses: C, commercial; D, domestic; I, irrigation; Q, quasimunicipal; S, stock.

[a] Restricted to a maximum of 3.738 cubic feet per second for the period March 1-Oct. 15.

[b] Water right specifies that the water is to be used in Lemmon Valley.

[c] Total withdrawal not to exceed 500 acre-feet per year. In Long Valley, Nev., permit No. 34587, for well 30DABB1, is included within this limitation, whereas No. 34588, for an as yet undrilled well at 21N 18E 30DD, allows an additional 200 acre-feet per year of pumpage. Both Nos. 34587 and 34588 authorize production for domestic and quasimunicipal use in Cold Spring and Long Valleys, Nev.

ground-water withdrawal for domestic and public supplies was approximately 250 acre-ft/yr as of late 1979.

On the basis of assumptions similar to those made by Harrill (1973, page 63) for neighboring Lemmon Valley, the amount of ground water actually consumed in Cold Spring Valley by evapotranspiration associated with domestic and public-supply use may have been about 20 percent of the total pumpage, or 50 acre-ft/yr. The remaining 200 acre-ft/yr returned to the ground-water system as percolation from septic-tank/drain-field systems and garden watering. Assuming a valley-wide population of 2,000, the estimated net consumption of ground water (50 acre-ft/yr) is equivalent to a per-capita rate of about 0.025 acre-ft/yr (22 gallons per day).

Irrigation

The only irrigated areas of significant size in Cold Spring Valley as of 1979 are south of Highway 395 in SE$\frac{1}{4}$ sec. 32 and W$\frac{1}{2}$ sec. 33 (figure 14). The areas total about 115 acres, of which approximately 100 acres is productive enough to support one cutting of meadowgrass plus subsequent grazing in most years. Irrigation water is provided by streams. The dominant stream is Spring Branch creek, which drains 1.7 square miles on the flank of Peavine Peak south of the railroad right-of-way. The runoff of Spring Branch creek is augmented as much as possible later in the irrigation season by impounded flow from Waltz Canyon creek, a stream that drains the smaller, lower altitude basin west of Spring Branch. The small impoundment (capacity, about 6 acre-feet) is formed by an earth-fill dam in SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 32.

Estimated consumption of surface water by evapotranspiration in the irrigated areas during an average year is as follows:

		Evapotranspiration	
Vegetation; harvest practices	Area (acres)	Feet per year	Acre-feet per year, rounded
Dense to moderately dense meadowgrass and scattered saltgrass; one cutting ---------------------	78	1.5	120
Dense to scattered meadowgrass; one cutting ----------------------	20	1.0	20
Moderately dense to scattered meadowgrass; uncut --------------	17	.5	10
Total	115	--	150

These estimates differ from the reconnaissance values of Rush and Glancy (1967, page 38, 41) in several respects: (1) The present estimate of 115 irrigated acres is a slight refinement of their 100-acre value; (2) Rush and Glancy incorrectly stated that well water was used to supplement the surface-water supply (neither well 32DAAB1 nor well 33CBAB1 has been used for irrigation); and (3) rates of evapotranspiration estimated in this report (average, about $1\frac{1}{4}$ feet per year) are slightly greater than those of Rush and Glancy (average, 1 foot per year).

In the Border Town area as of 1979, several pastures totaling about 12 acres are irrigated with well water. Similar pasture lands in SE$\frac{1}{4}$ sec. 29 total approximately 5 acres. Pumpage for irrigation of these areas may amount to about 25 acre-ft/yr, of which the quantity consumed by evapotranspiration may be on the order of 15 acre-ft/yr.

Ground-water consumption by garden watering in the valley is included as a part of domestic and public-supply use.

In all irrigated areas, part of the irrigation water percolates downward to the ground-water reservoir. Where the irrigation system is fed by diverted streamflow, some of the percolation replaces the natural stream-channel recharge that would have occurred in the absence of diversions, and the remainder augments that recharge. The hydrograph for well 33CBAB1 (figure 6) shows the effect of artificial recharge during periods of irrigation. In areas irrigated by pumped ground water, the percolation represents a partial recycling of the total pumpage (page 47).

Livestock Watering

Streams, springs, and wells provide stock water in Cold Spring Valley. South of Highway 395, cattle of the Heinz Ranch (about 50 head as of late 1976) rely on springflow and streamflow. In the area east of Reno Park, cattle and a few horses (total, about 100 as of 1979) use water from public-supply wells 16CACD1 and 21BBDD1. Cattle that graze on U.S. Bureau of Land Management acreage north of sections 9 and 20 rely mostly on springs. In the north part of T. 21 N., R. 18 E., about 150 head graze in the valley part of the time for approximately 5 months during the year (David Evans, oral commun., 1976). Principal water supplies are Cold Spring (4ACBD1, table 20; piped to a trough 0.25 mile southeast of the spring) and Streib Spring (4CDDD1; piped to a tank 0.55 mile to the east). To the north, in T. 22 N., R. 18 E., almost no cattle graze at present (Chris Erb, U.S. Bureau of Land Management, oral commun., 1977).

Assuming that cattle and horses consume about 10 gallons per day, total consumption by all livestock in the valley probably is less than 5 acre-ft/yr.

Exported and Imported Ground Water

As of 1979, no water is exported from or imported to the valley. However, a permit has been granted for the transbasin diversion of 436.86 acre-ft/yr to Lemmon Valley (table 14, footnote b). Similarly, two permits have been issued for the import of ground water from the Nevada part of adjacent Long Valley (table 14, footnote c); the precise amount is not specified, but the quantity theoretically could be as great as 700 acre-ft/yr.

Hydrologic Effects of Development

Prior to development, the hydrologic system in Cold Spring Valley was in a state of long-term dynamic equilibrium; average inflow equalled average outflow, and the quantity of water in storage fluctuated to only a small degree, in response to climatic variations. Development of the water resources has disrupted this equilibrium, but to only a minor extent as yet (1979).

Surface Water

Two of the valley's principal streams are used for irrigation south of Highway 395. Effects of this development include increased evaporation, transpiration, and percolation of the streamflow, and decreased inflow to, and evaporation from, White Lake. The net effect is minor, however, because even under equilibrium conditions all the water was ultimately dissipated; only the sites of evaporation and transpiration, and their proportions, have been altered.

Ground Water

Development of the ground-water resource also affects the hydrologic equilibrium. Pumping removes water from the ground-water reservoir; some of this water subsequently returns to the reservoir by percolation, but the rest is dissipated by evapotranspiration. Initially, at least, this net loss owing to pumpage is in addition to the depletion by natural evapotranspiration. As a consequence, some ground water is permanently removed from storage, and water levels decline. If net depletion by pumping is less than natural recharge, the water-level decline continues until natural losses are reduced enough to bring the system to a new equilibrium in which total discharge (natural plus man-induced) again equals recharge. However, if net depletion by pumping exceeds natural recharge, water levels will continue to decline regardless of how much the natural losses are diminished, and a new equilibrium will not be attained.

Water-level changes due to development are of two general types: Seasonal or even shorter-term fluctuations caused by cyclic variations in water use; and long-term effects associated with permanent changes in ground-water storage. These man-caused effects are in turn superimposed upon natural fluctuations--both seasonal and long-term.

Water-level fluctuations in Cold Spring Valley are discussed on pages 13-20. Although seasonal variations can be pronounced in areas of ground-water withdrawal (table 4), no widespread long-term decline of significant magnitude had been detected as of 1979. This probably is due to the combined effect of

(1) comparatively low rates of ground-water withdrawal, (2) a significant proportion of recycling by percolation, and (3) average to greater than average amounts of precipitation and resultant recharge during the period 1962-75. Even the withdrawals from well 21BBDD1 at Reno Park--the most heavily pumped well in the valley--had not as yet had a pronounced effect on water levels in observation wells less than 0.7 mile away.

WATER BUDGETS

Two budgets are presented for Cold Spring Valley: Hydrologic relationships under natural conditions (prior to the influence of man); and the relationships as affected by surface-water and ground-water development through 1979.

Budget for Natural Conditions

Table 15 indicates long-term average conditions for the several elements of natural inflow and outflow in a state of hydrologic equilibrium. The table indicates that White Lake plays a significant role in the valley's water budget. Under ideal circumstances in a closed basin, long stream courses leading from the mountain front to a terminal playa permit complete or nearly complete infiltration and evaporation of runoff upstream from the playa. In the south part of Cold Spring Valley, contrastingly, stream lengths are short, and White Lake normally intercepts much of the north-flowing runoff.

The relation between budget items for natural conditions is shown schematically in figure 15A.

As table 15 indicates, an imbalance exists between the estimated totals for inflow and outflow. The imbalance is attributable, at least in part, to a net error resulting from inaccuracy of the several listed estimates, but it also may be influenced by two unestimated items, ground-water recharge upgradient from the mountain front, and runoff generated downgradient from the mountain front (figure 15A, items T and V). Because both of these items would contribute to inflow, the higher value for outflow from the system (1,700 acre-ft/yr) is considered the most correct of the two totals. Thus, both total inflow and total outflow for natural equilibrium conditions in the valley are estimated to have been about 1,700 acre-ft/yr.

Potential ground-water recharge in Cold Spring Valley is an estimated 1,000 acre-ft/yr (table 10). Table 15 suggests that less than half of that quantity actually reaches the ground-water body. The remainder is dissipated instead by evapotranspiration at White Lake.

The water budget in table 15 is markedly different from the reconnaissance ground-water budget of Rush and Glancy (1967, page 43) for three principal reasons:

1. Most importantly, table 15 accounts for the significant water-budget role played by streamflow in Cold Spring Valley (particularly as it relates to White Lake), whereas Rush and Glancy's budget dealt only with ground water.

TABLE 15.--*Water budget for natural equilibrium conditions*

Budget items (see figure 15A)	Estimated values (acre-feet per year)
INFLOW	
1. Ground-water inflow from Long Valley (page 36)	200
2. Mountain-front runoff (page 25)	1,100
TOTAL	1,300
OUTFLOW	
3. Stream-channel evapotranspiration[1]	minor
4. Ground-water evapotranspiration (table 13)[2]	500
5. Evapotranspiration of stream inflow to lake (page 30)	1,200
TOTAL	1,700
BUDGET IMBALANCE (outflow minus inflow)	400

[1] Assumed to be negligible in magnitude compared with other budget items.

[2] Does not include playa-surface evapotranspiration of temporary lake-water recharge (page 34; item Z, figure 15A).

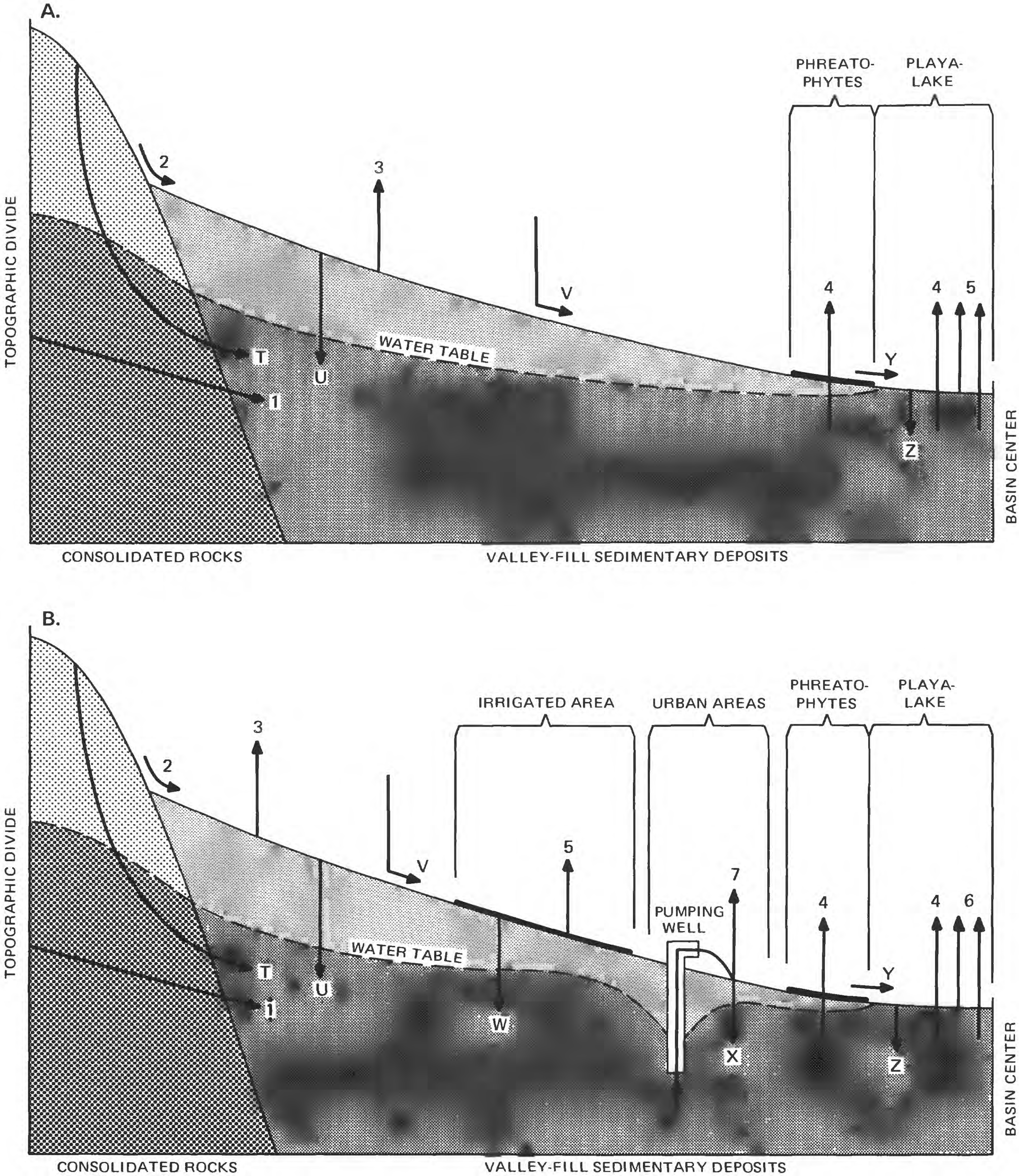


FIGURE 15.—Schematic sections showing relation between water-budget items in Cold Spring Valley for (A) natural equilibrium conditions and (B) average conditions as of 1979. Item numbers correspond to those in tables 15 and 16. Additional items: T, mountain-block recharge; U, valley-fill recharge; V, runoff generated downgradient from the mountain front; W, recharge from areas irrigated with surface water; X, well-water recharge; Y, stream inflow to White Lake; and Z, temporary lake-water recharge.

2. Table 15 includes an increment of ground-water inflow from Long Valley that was not detected in the earlier reconnaissance.

3. Ground-water dissipation by evapotranspiration (table 15) is significantly greater in magnitude than indicated by Rush and Glancy (1967, page 34).

These differences (particularly items 1 and 3) explain the major imbalance in the earlier, reconnaissance ground-water budget.

Budget for Average Conditions as of 1979

The hydrologic character of Cold Spring Valley has been altered somewhat by man during the last century. Table 16 and figure 15B reflect the small quantitative changes imposed by development, relative to the natural conditions depicted in table 15. Several budget items in table 16 remain approximately the same as in table 15: Ground-water inflow; mountain-front runoff; stream-channel evapotranspiration; and natural ground-water evapotranspiration. Because of water-resources development in the valley, however, other items in table 16 are new or have changed in magnitude.

The phrase "average conditions as of 1979" encompasses: (1) Long-term average conditions for budget items that are still little-effected by the activities of man and for surface-water irrigation in sections 32 and 33 (page 45); and (2) conditions based on ground-water pumpage as of late 1979.

The budget in table 16 indicates an imbalance of about 400 acre-ft/yr. As under natural conditions, mountain-block recharge, runoff generated below the mountain front, and a net error for the several estimates in table 16 may contribute to the imbalance. However, for conditions as of 1979, an additional item--net withdrawal of ground water by pumping (item 7)--also influences the imbalance. The net consumption of pumpage includes: About 50 acre-ft/yr for domestic and public supplies (page 45); about 15 acre-ft/yr for pasture irrigation (page 46); and less than 5 acre-ft/yr for livestock page 46). Thus the present-day hydrologic system is not quite in equilibrium because some ground water (about 70 acre-ft/yr as of 1979) is being removed from storage by man and dissipated by evapotranspiration. Under such circumstances, total outflow from the system is estimated to be about 1,700 acre-ft/yr, whereas total inflow is about 1,600 acre-feet.

Irrigation fed by stream water south of the lake does not contribute to the present-day budget imbalance. The irrigated areas and practices there have not changed markedly during the past several decades, and the ground-water/surface-water system can thus be considered to have adjusted to a new equilibrium.

TABLE 16.--*Water budget for average conditions as of 1979*

Budget items (see figure 15B)	Estimated values (acre-feet per year)
INFLOW	
1. Ground-water inflow from Long Valley (page 36) -----	200
2. Mountain-front runoff (page 25) --------------------	1,100
TOTAL --	1,300
OUTFLOW	
3. Stream-channel evapotranspiration[1] -----------------	minor
4. Natural ground-water evapotranspiration (table 13)[2] --	500
5. Evapotranspiration in area irrigated by streamflow (page 45) ------------------------------	150
6. Evapotranspiration of stream inflow to lake (page 30) ---	1,000
7. Evapotranspiration of well water (page 51) ---------	70
TOTAL (rounded) --------------------------------------	1,700
BUDGET INBALANCE (outflow minus inflow) ----------------	400

[1] Assumed to be negligible in magnitude compared with other budget items.

[2] Does not include playa-surface evapotranspiration of temporary lake-water recharge (page 34).

WATER QUALITY

General Character

Tables 20-22 list chemical analyses of water from Cold Spring Valley, and figure 14 shows the areal distribution of dissolved-solids and nitrate concentrations in ground water.[4] The data indicate that almost all water in the valley is dilute (80 to 260 milligrams per liter of dissolved solids) and characteristically dominated by calcium, bicarbonate, and presumably silica among the dissolved constituents. The principal exception is the more saline water within and immediately beneath White Lake. The closed-basin, terminal lake and its underlying sedimentary deposits are the destination of solutes transported from throughout the basin by ground water and streams. Incoming water that delivers the salts is dissipated by evapotranspiration, but the salts themselves tend to accumulate in the playa deposits or in the lake when it exists (table 21). The salinity of ground water at depth beneath the lake-playa is unknown.

Suitability for Use

The U.S. Environmental Protection Agency (EPA) has recommended several guideline standards for drinking water (1977, page 17146). The standards for constituents listed in table 21 are as follows:

Constituent	Recommended maximum concentration (milligrams per liter)
Chloride (Cl)	250
Dissolved solids	500
Iron (Fe)	.3
Manganese (Mn)	.05
Sulfate (SO_4)	250

[4] Dissolved-solids concentrations in water from many wells and springs shown in figure 14 were estimated on the basis of specific-conductance measurements. The dissolved-solids concentration, in milligrams per liter, generally is 60-70 percent of the specific conductance, in micromhos. Each estimated concentration in figure 14 was assumed to be 65 percent of the measured specific conductance.

EPA also has established values for the maximum permissible concentrations of several constituents in public drinking-water supplies (1975, page 59570). The values that apply to constituents listed in tables 21 and 22 are as follows:

Constituent	Maximum permissible concentration (milligrams per liter)
Arsenic (As)	0.05
Fluoride (F)	[a]1.8
Nitrate (as N)	10

[a] For a maximum daily air temperature that averages 65°F (18.5°C) annually.

Regarding the constituents listed above, large concentrations of chloride and iron impart an unpleasant taste, and the iron can stain porcelain fixtures and clothing. Excessive sulfate can have a laxative effect on persons who are drinking a sulfate-rich water for the first time; excessive arsenic can cause cumulative poisoning; and excessive fluoride tends to mottle teeth, especially those of children. A large amount of nitrate is dangerous during pregnancy and infancy because it may increase the possibility of "blue-baby" disease; excessive nitrate may also be a sign of contamination by percolating sewage or animal waste.

The bacteriological quality of drinking water also is a critical health consideration but is outside the scope of this report.

The hardness of a water is of concern to many users. Therefore, the U.S. Geological Survey has informally adopted the following rating:

Hardness, as $CaCO_3$ (milligrams per liter)	Rating and remarks
0-60	Soft (suitable for most uses without artifical softening)
61-120	Moderately hard (usable except in some industrial applications; softening profitable for laundries)
121-180	Hard (softening required by laundries and some other industries)
More than 180	Very hard (softening desirable for most purposes)

With few exceptions, ground water in Cold Spring Valley was suitable for domestic use and public supply as of 1979 with regard to the standards listed above. If any doubt exists in the future concerning the acceptability of a specific water supply in the valley, the Consumer Health Protection Services, Nevada Department of Human Resources, in Carson City, should be contacted.

Over a period of time, the chemical quality of pumped ground water in Cold Spring Valley may deteriorate. One process that could cause such a deterioration is the migration, toward pumped wells, of naturally occurring poor-quality water stored beneath White Lake playa. The degree to which this process will occur depends upon the location of a well, the transmissivity of saturated sedimentary deposits in the vicinity of the well, and the pumping rate. Heavily pumped wells near the playa should be the first affected. However, even in these areas, the poor-quality water can be mixed with good water moving toward the well from other directions and possibly from greater depth beneath the playa. This mixing would tend to decrease the adverse effects of the poor-quality water.

Another process that can change the quality of ground water is the recycling of pumped water that has deteriorated in quality through use. The deterioration can generally be attributed either to concentration of salts by evapotranspiration or to loading (the addition of salts to the water as it is used). When water is partly consumed by evapotranspiration, much of the original dissolved-solids content remains in solution, thereby increasing the concentration in the residual water. When water is used for irrigation, loading also can result when salts are leached from soil or added as fertilizer.

A combination of these processes can be important over the long term in urban areas served by local ground-water supplies, particularly where domestic wastes are disposed of in septic-tank/drain-field systems. The result can be ground-water contamination by recycled water of poorer quality. Generally, however, the recycled water mixes with native water of better quality, and the deterioration of pumped ground water would therefore be expected to proceed slowly. Nonetheless, when a significant deterioration in quality has occurred, any corrective measures would require a long period of time to become effective.

An example of the early stages of quality deterioration in Cold Spring Valley is the water of public-supply well 21BBDD1. Although presently (1979) acceptable chemically for domestic use, the well water deteriorated somewhat in quality during 1972-79 (table 21). The concentrations of dissolved solids and nitrate (as N) increased moderately (from 170 and 0.5 milligrams per liter to about 240 and 2.2 milligrams per liter, respectively) during the 7-year period of heavy use. This trend may continue, and it deserves periodic monitoring.

AVAILABLE WATER SUPPLY

The available water supply in Cold Spring Valley is discussed in the following sections with regard to (1) system yield, (2) storage depletion, which is sometimes referred to as the "one-time reserve," and (3) reuse of water.

System Yield

According to Worts and Malmberg (1966, page 37), the yield of a discrete hydrologic system is defined as the maximum amount of surface water and ground water, of usable chemical quality, that can be obtained economically each year from sources within the system, for an indefinite period of time. The system yield cannot be more than the natural inflow to or outflow from the system. Under practical conditions of development, the yield is limited to the maximum amount of outflow that can be captured economically each year for beneficial use.

In Cold Spring Valley, the ideal system yield can be approximated by summation of the two hydrologic outflow items for natural (predevelopment) conditions (table 15): Ground-water evapotranspiration, which was an estimated 500 acre-ft/yr (table 13); and evapotranspiration of stream inflow to White Lake, an estimated 1,200 acre-ft/yr (page 30). Thus, the optimum system yield would be on the order of 1,700 acre-ft/yr. However, this value assumes complete capture of water now dissipated mostly by natural evapotranspiration, which in reality would be extremely difficult.

All stream inflow to White Lake originates south of the lake, except under unusual circumstances. Only a small part of that flow can be captured without an adequate storage system. White Lake is not suitable for efficient capture of streamflow because (1) the large area-to-volume ratio promotes excessive water loss by evaporation, and (2) the inflow undergoes a pronounced water-quality deterioration--both chemically and physically--during its residence time in the lake. Therefore, an efficient capture of streamflow would require construction of adequate upstream storage facilities. Yet, even if such facilities were feasible, evaporation would deplete the available supply to at least some extent.

A much more conservative system yield would be equivalent to the amount of natural ground-water evapotranspiration--an estimated 500 acre-ft/yr. This quantity could also be termed the perennial ground-water yield for the valley.

A realistic value for the system yield in Cold Spring Valley lies between the conservative and optimum extremes (500 and 1,700 acre-ft/yr). For the purpose of this study, it is assumed that as much as two-thirds of the natural streamflow quantity (that is, on the order of 800 acre-ft/yr) and all of the natural ground-water discharge could be captured by using proper techniques. Thus, the resulting system yield would be as great as approximately 1,300 acre-ft/yr, of which only 500 acre-feet can be considered dependably available every year. For a further discussion of the coordinated use of ground water and surface water, see page 60.

Storage Depletion

As pointed out by Harrill (1973, page 78), no ground-water source can be developed by pumping without causing some storage depletion. The magnitude of depletion varies with the pumpage, the hydraulic properties of the system, and the distance of development from areas of recharge and discharge.

For Cold Spring Valley, the magnitude of potential depletion is considered with regard to the concept of transitional storage reserve, which has been defined by Worts (1967, page 50) as the quantity of ground water in storage that can be extracted and beneficially used during the period of transition between natural equilibrium conditions and new equilibrium conditions under the perennial-yield (or system-yield) concept of ground-water development. Thus, the transitional storage reserve is a specific part of the ground-water resource; it is a quantity that is available in addition to the annual recharge, but it can be withdrawn from storage on a once-only basis unless replenished.

Computation of the transitional storage reserve for Cold Spring Valley is based on the following assumptions. (1) Principal pumpage would be strategically located in or near the areas of natural discharge, so that water normally lost to evapotranspiration could be retained with a minimum of water-level drawdown in the pumped wells. (2) In general, water levels would be lowered to and stabilized at a depth 50 feet below land surface in areas of phreatophyte growth, which would curtail virtually all evapotranspiration from ground-water reservoir. (3) Long-term pumping would cause a moderately uniform depletion of storage throughout the valley-fill reservoir, except possibly in the very fine-grained playa deposits where transmissivity and storage coefficients are small. (4) The weighted average specific yield of the affected valley fill, including the playa, is about 12 percent (page 10). (5) Water levels would remain within the range of economic pumping lift for the intended use. (6) The pumping development would cause little or no effect on adjacent Long Valley. (7) The ground water would be of suitable quality for the desired use.

In Cold Spring Valley, the area of saturated valley fill, shown in figure 4, totals about 4,200 acres. Because the water table is at or very near land surface in some places, the ultimately dewatered thickness of saturated sedimentary deposits would be about 50 feet. Thus, the transitional storage reserve would be 4,200 x 50 x 0.12 = 25,000 acre-feet (rounded).

Considerable time would be required to capture natural discharge and attain a new equilibrium in the ground-water system. At first, virtually all pumpage would come from the transitional storage reserve, with capture of little if any natural evapotranspiration. In contrast, when ground-water levels ultimately had been lowered enough to prevent evapotranspiration (and the transitional storage reserve had been exhausted), the entire pumpage would represent capture of that discharge.

In actual practice, the upper 50 feet of ground water probably will not drain uniformly from the valley-fill reservoir, because of (1) areal differences in sediment grain size, (2) the possible effects of fault barriers, and (3) the irregular distribution of pumping. If pumping becomes too concentrated in one or more areas, local overdraft could occur, and the new equilibrium would not be attained before conditions become unfavorable for ground-water extraction in such areas.

The lowering of ground-water levels adjacent to and beneath White Lake could ultimately induce a significantly greater amount of lake-water recharge if most of the potential stream inflow is not diverted for beneficial use elsewhere in the valley. Also, the lateral movement of ground water toward wells from beneath the lake bed could cause a deterioration in the quality of the pumped ground water (page 55).

Reuse of Water

When water is pumped from the ground-water reservoir, only part is consumed. The remainder may return to the ground-water system, thereby becoming available for reuse. However, most uses result in some deterioration in water quality. In arid areas, as Harrill (1973, page 81) points out, where demand for water exceeds the readily available perennial supply, one alternative is to reuse water as much as possible and attempt to maintain satisfactory chemical quality by water treatment. Advances in water-treatment technology have made this alternative more attractive than it was several years ago.

A method for estimating the maximum sustained withdrawal in a ground-water basin, which includes an allowance for reuse, has been described by Harrill in his study of adjacent Lemmon Valley (1973, pages 123-125). The technique can be applied to Cold Spring Valley under the system-yield concept of water-resources management. Briefly, the maximum sustained withdrawal is estimated by multiplying the system yield by a reuse factor that is proportional to the percentage of water recirculated to the ground-water reservoir after use. This computation assumes that all water available on a system-yield basis would be reused repeatedly until entirely consumed and that suitable water quality would be maintained as necessary by some type of water treatment. On the basis of discussion by Harrill (1973, page 81), a theoretical recirculation percentage for Cold Spring Valley, under ideal conditions of full use of the system yield for domestic and related purposes and with nearly complete recycling of sewage effluent, might be as much as 70 percent, which is equivalent to a reuse factor of about 3. Thus, for a system yield of 1,300 acre-ft/yr, the maximum sustained withdrawal could be as much as 3,900 acre-ft/yr. In reality, a feasible amount of reuse would result in a sustained withdrawal smaller than 3,900 acre-ft/yr. Nonetheless, as Harrill points out (1973, page 82), efficient recycling can significantly extend the usefulness of a limited water supply, provided that the maintenance of acceptable water quality is economically feasible.

FUTURE DEVELOPMENT

Management of the water resources in Cold Spring Valley under a system-yield concept would involve several significant problems regarding the coordinated development of both ground-water and surface-water supplies. For example, proper utilization of the ground-water resource would require a strategic distribution of pumping to effectively capture natural discharge while minimizing local overdraft. The stream-water supply has significant limitations too; it is potentially available only during certain times of the year, and its total annual volume is highly variable. Proper management during future development of the combined resource would require careful consideration of both interrelated entities. Several aspects of water-resources development are discussed in the following sections.

Strategic Distribution of Pumping

If pumping is not properly distributed, part of the reservoir may be pumped so intensively that a serious local overdraft could develop even though the perennial yield of the overall system is not exceeded. In contrast, if the areal distribution of pumping is in approximately the same proportion as the distribution of natural discharge, and if wells are properly located near the discharge areas, the ground water destined for natural discharge could be intercepted and captured without drastic water-level declines. The following paragraph provides generalized guidelines regarding an areal distribution of pumping that will help to reduce the probability of pronounced local overdrafts.

The distribution of phreatophytes on and adjacent to the White Lake playa (figure 14) and their estimated rates of transpiration (table 13) suggest that recharge from higher altitude areas to the north and south may be about equal. Furthermore, each of those quantities may be about twice the amount of evapotranspiration fed by subsurface inflow from Long Valley (figure 14; page 36). Thus, the proportions of total ground-water evaportranspiration fed from the north, south, and west may be on the order of 40, 40, and 20 percent, respectively. The most strategic distribution of pumping would be similar areally. The total ground-water loss by natural evapotranspiration is about 500 acre-ft/yr (table 13). For optimum capture of natural discharge, therefore, the net pumpage north, south, and west of the lake should be on the order of 200, 200, and 100 acre-ft/yr, respectively, and the withdrawals should be rather evenly distributed around the playa perimeter.

Development of ground-water resources in the area of underflow from Long Valley, Calif., to Cold Spring Valley (figure 13) could have a significant effect on the quantity of ground water moving between the two basins. Thus, care presumably would be required in both valleys to avoid major disruption of the existing interbasin (and interstate) flow system.

Conjunctive Use of Ground-Water and Surface-Water Resources

The coordinated use of both ground water and surface water, termed "conjunctive use," may be the most feasible means of water-resources management in Cold Spring Valley. The general concept has been described by Harrill and Moore (1970, page 91) as follows: A quantity of water approximately equal to the system yield is used each year. During average and wet years, much of that supply is derived from streamflow. During dry years, in contrast, most of the supply is provided by ground-water pumpage. The temporary ground-water deficit that results is then replenished by excess streamflow during subsequent wet years.

In Cold Spring Valley, the capture of streamflow to augment the available ground-water supply under the conjunctive-use concept presents several problems:

1. In most years, the duration of appreciable streamflow is relatively short--several weeks at most, generally sometime during January-April (table 7). Thus, capture of most of the streamflow would require a large storage system, capable of holding 1,000-2,000 acre-feet.

2. Normally, only two streams--adjacent Spring Branch and Waltz Canyon creeks, at the far-south end of the basin (figure 14)--yield a significant quantity of flow. In contrast, the principal area of future water use may be north of the playa (that is, 3-5 miles north of the two streams).

3. Several options exist regarding the conjunctive use of streamflow as both a water supply and a source of ground-water replenishment. Above-ground storage is the least desirable option from the standpoint of evaporation losses. (For example, net evaporation from a 100-acre reservoir in sec. 4 or 5, T. 20 N., R. 18 E., presumably would be on the order of 250 acre-ft/yr.) Percolation basins on the valley fill, upgradient from principal areas of ground-water demand, also would involve water loss by evaporation, but the depletion presumably would be less than that from a storage reservoir. Artifical ground-water recharge might be the most water-conserving means of conjunctive use. An evaluation of the relative merits of the three schemes on the basis of technical and economic considerations is outside the scope of this study.

Maintaining Suitable Ground-Water Quality

Most salts currently dissolved in ground water, or available for solution by runoff and recharge, or added by man, will remain and accumulate in the basin. As discussed on page 56, these accumulating salts can cause a long-term deterioration in water quality. The deterioration would be accelerated by reuse of water.

Over the short term, utilization of dilute streamflow to augment ground water for domestic purposes, and a shift of ground-water pumping for public supply to areas away from septic-tank/drain-field clusters, would help postpone the inevitable need for a more permanent solution. Ultimately, however, the problem may become serious enough to require a thorough, expensive treatment of domestic wastes before recycling.

SUMMARY AND CONCLUSIONS

This study reappraises the water resources of 29-square-mile Cold Spring Valley. The earlier reconnaissance evaluation of a 900-square-mile area that included the valley (Rush and Glancy, 1967) was too general in scope to meet the more recent needs of water planners, developers, and administrators in this rapidly expanding suburban area only 13 miles northwest of Reno.

Depths to ground water in Cold Spring Valley currently range from less than 10 feet in the vicinity of the playa to more than 50 feet in higher altitude areas around the periphery of the valley floor.

The valley-fill sedimentary deposits locally are capable of yielding large amounts of water to wells. Reported well yields range from 10 to 2,150 gal/min, and specific capacities range from 0.2 to 12 gal/min per foot of drawdown (suggesting transmissivities on the order of 50 to at least 3,000 ft^2/d). Tertiary sedimentary deposits in the southwest part of the basin are moderately permeable in places, and reported yields to wells range from 7 to 605 gallons per minute (the latter value for 605-foot well 30DABB1 in Long Valley immediately adjacent to Cold Spring Valley; see figure 16). At the deep well, a transmissivity of 740 ft^2/d was estimated. Measured specific capacities for four much shallower wells ranged from 0.2 to 1.2 (gal/min)/ft, implying transmissivities on the order of 50-300 ft^2/d for the Tertiary deposits at those sites.

Ground-water levels fluctuate in response to climatic changes and the use of water by man. Meager data suggest that the water table rose several feet in many parts of Cold Spring Valley during the last two or three decades prior to the mid-1970's, presumably in response to climatic fluctuations. During the 4-year period between the springs of 1975 and 1979, in contrast, net declines occurred in all monitored areas of the valley except sec. 29. The characteristic magnitudes were about 2 feet in the area north of the playa, 1-2 feet northwest of the playa, and 3-4 feet to the south. These generally moderate declines may have been related in large part to the near-normal to below-normal amounts of precipitation in 1972-77, following the wet period during 1969-71. Although seasonal water-level fluctuations can be pronounced in areas of appreciable ground-water withdrawal, no net decline of alarming magnitude had been detected in the valley as of 1979.

Almost all water in Cold Spring Valley is dilute (80-260 milligrams per liter of dissolved solids). The principal exceptions are the more saline waters within and immediately beneath White Lake. Most ground water in the valley was chemically suitable for domestic use and public supply as of 1979. However, the quality may deteriorate over the long term in urban areas served by local ground-water supplies, particularly where pumped water is recycled through the use of individual septic-tank/drain-field systems.

Table 17 summarizes the estimated values for principal hydrologic budget items, under both natural conditions and average conditions based on water-resources development as of 1979. The following paragraphs discuss several aspects of the hydrologic budgets, the available water resources, and their development.

In addition to ground water originating within Cold Spring Valley itself, a small amount of underflow apparently enters the basin from adjacent Long Valley (figure 13). The ground water moves generally northeast through Tertiary sedimentary deposits that underlie the topographic divide. The amount of underflow may be on the order of 200 acre-ft/yr (table 17).

The estimated system yield in Cold Spring Valley, as much as 1,300 acre-ft/yr (table 17), is based on the assumption that all the natural ground-water discharge (500 acre-ft/yr) and as much as two-thirds of the average natural stream inflow to White Lake (800 acre-ft/yr, rounded) can be captured.

Because streamflow is such a significant item in the hydrologic budget for Cold Spring Valley, the quantity as well as the year-to-year and seasonal variability of that resource should be monitored over the long term. A streamflow gage on Spring Branch, which drains the higher-altitude flanks of Peavine Peak (figures 2, 3), would be desirable. In addition, a crest-stage gage on the White Lake playa would provide valuable information regarding total quantities of runoff reaching the lake from all parts of the valley. The hydrologically best sites for the stream and crest-stage gages would be in NE$\frac{1}{4}$ sec. 5, T. 20 N., R. 18 E., and SW$\frac{1}{4}$ sec. 21, T. 21 N., R. 18 E., respectively.

To ultimately capture all natural ground-water discharge, water levels in the valley fill would have to lowered an estimated 50 feet in areas of evapotranspiration. Assuming that this would cause a moderately uniform depletion of storage throughout the valley fill, the total amount of ground water involved would be on the order of 25,000 acre-feet (table 17). This quantity, termed the "transitional storage reserve," would be available on a once-only basis.

Most uses of ground water result in the percolation and recycling of at least some of the pumpage. An allowance for recycling permits annual pumping at a rate significantly greater than if only one-time use were allowed. In Cold Spring Valley under the most hydrologically efficient circumstances (water use dominantly domestic, with nearly complete recycling of sewage

TABLE 17.--*Summary of hydrologic estimates*

[acre-feet per year, except as indicated]

NATURAL CONDITIONS[1]	
Precipitation (table 10)	18,000*
Mountain-front runoff (page 25)	1,100*
Stream inflow to White Lake (page 30)	1,200
Potential ground-water recharge (table 10)	1,000*
Subsurface inflow from Long Valley (page 36)	200*
Ground-water evapotranspiration (table 13)	500*
AVERAGE CONDITIONS AS OF 1979[2]	
Stream inflow to White Lake (page 30)	1,000
Evapotranspiration of stream water in irrigated areas (page 45)	150
Ground-water pumpage for domestic and public supply (page 45)	250
Ground-water pumpage for irrigation (page 46)	25
Net loss of total ground-water pumpage by evapotranspiration (page 51)	70
System yield (page 57)	1,300
Transitional storage reserve (acre-feet; page 58)	25,000

[1] Quantities that remain about the same both for natural conditions and for average conditions as of 1979 are indicated by asterisks.

[2] Estimates that are same as for natural conditions (footnote 1) are not repeated.

effluent), the maximum sustained withdrawal could be as much as three times the system yield, or about 3,900 acre-ft/yr. In reality, a feasible amount of reuse would result in a sustained withdrawal of less than 3,900 acre-ft/yr but more than 1,300 acre-ft/yr. Because the recycling can cause a long-term deterioration of ground-water quality, sustained pumpage at a rate appreciably greater than the system yield would ultimately require some form of water treatment--an important economic factor.

If water wells are not properly distributed with regard to the ground-water flow system, part of the reservoir may be pumped so intensively that a serious local overdraft could develop even though the perennial yield of the overall system is not exceeded. The distribution of phreatophytes on and adjacent to the White Lake playa suggests that the amounts of ground-water loss fed from the north, south, and west may be on the order of 200, 200, and 100 acre-ft/yr, respectively. Therefore, optimum capture of natural discharge would require a similar distribution of pumping.

Conjunctive use--the coordinated exploitation of both ground water and surface water--probably is the most feasible means of water-resources management in Cold Spring Valley.

Future development of the valley should include consideration of the hazard potential of flash flooding and associated debris flows. Mountain-drainage flood plains, particularly near the canyon mouths, are among the most hazardous areas.

LOCATION SYSTEM FOR HYDROLOGIC SITES

The location system used in this report is based on a hydrographic-area number and the rectangular subdivision of lands, referred to the Mount Diablo base line and meridian. A complete designation of location consists of four units: The first is the hydrographic-area number, as defined by Rush (1968); for Cold Spring Valley, the number is 100. The second unit is a township number (with "N" indicating that the township is north of the base line); the third unit is the range number ("E" indicates east relative to the meridian); the fourth unit includes the section number, followed by letters designating the quarter section, quarter-quarter section, and so on (A, B, C, and D indicate northeast, northwest, southwest, and southeast quarters, respectively), followed in turn by a sequence number for wells and springs. For example, well 100 N21 E18 20CDAB2 is in Cold Spring Valley within a $2\frac{1}{2}$-acre tract identified as $NW\frac{1}{4}NE\frac{1}{4}SE\frac{1}{4}SW\frac{1}{4}$ sec. 20, T. 21 N., R. 18 E., and it is the second well recorded in that tract.

Almost all wells and springs referred to in this report are in T. 21 N., R. 18 E., in Cold Spring Valley. Therefore, the "N21 E18" designation is omitted except in tables 1, 14, 20, and 21, and the hydrographic-area number is omitted throughout the report. Thus, for the well referred to above, the location designation generally used in this report is 20CDAB2. Springs outside T. 21 N., R. 18 E., retain the township and range designations.

In tables 18 and 20, wells and springs are also identified by the Geological Survey site identification (ID), which is based on the grid system of latitude and longitude. The ID indicates the geographic location of each site, and provides a unique number for each. The ID consists of 15 digits: The first 6 denote the degrees, minutes, and seconds of latitude; the next 7 denote degrees, minutes, and seconds of longitude; and the last 2 digits (assigned sequentially) identify the sites within a 1-second grid.

BASIC HYDROLOGIC DATA

Basic well data for Cold Spring Valley are compiled in table 18, and selected well drillers' logs are listed in table 19. Information on springs appears in table 20. Water-quality data are listed in tables 21 and 22 (in addition, table 20 lists the water temperature and specific conductance of selected springs).

Figure 16 shows the location of wells listed in tables 18, 19, 21, and 22. Similarly, figures 2 and 16 show the location of springs listed in tables 20 and 21.

Multiple water-level measurements for observation wells in the valley, of the sort illustrated in figures 6 and 7, are available from the Geological Survey's District Office in Carson City, Nev.

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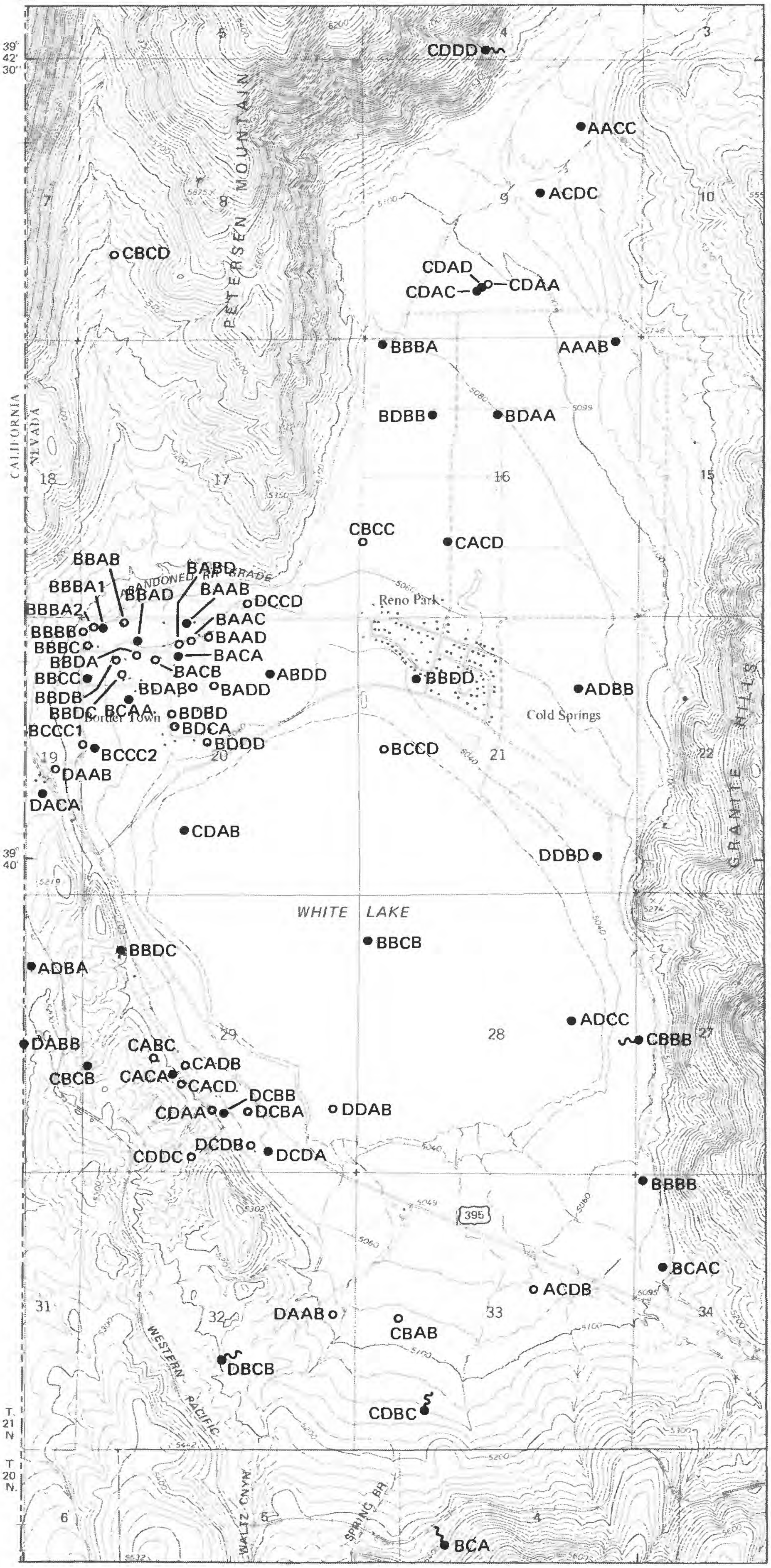

EXPLANATION

ADCC● Well, with location letters (see text section titled "Location system for hydrologic sites"). Driller's geologic log listed in table 19 of this report

CBAB○ Well, with location letters. Driller's log not listed in this report

CDDD Spring, with location letters

Base from U.S. Geological Survey 1:24,000 Reno NW, 1967 (photorevised 1974)

0 0.5 1 MILE

0 0.5 1 KILOMETER

CONTOUR INTERVAL 20 FEET

DOTTED LINE REPRESENTS 10-FOOT CONTOUR

DATUM IS SEA LEVEL

FIGURE 16.——Location of wells and springs (tables 18 and 20) in central Cold Spring Valley. Springs outside area of this figure are shown in figure 2.

TABLE 18.--*Well data*

Location: For each well, first line is an abbreviated version of location designation. Because all listed wells are in T. 21 N., R. 18 E., and (except for 30DABB1) in Cold Spring Valley, first part of complete location designation (100 N21 E18) is omitted. Second line is site ID. See text section titled "Location system for hydrologic sites."

Well depth: Depths followed by asterisk were measured by U.S. Geological Survey personnel; all others are reported depths.

Use: D, domestic; I, industrial; Ir, irrigation; O, observation; P, public supply; S, stock; U, unused or abandoned (intended or former use in parentheses).

Yield: Type of test indicated as follows: A, air-blown; B, bailed; P, pumped.

Land-surface altitude: Altitudes determined by leveling are followed by an asterisk. Other altitudes are estimated to within 5-10 feet using topographic map. Datum is sea level.

Water level: Measurements recorded to hundredths of a foot were made by U.S. Geological Survey personnel, and represent depth below land-surface datum, except where preceded by "+"; measurements recorded to nearest foot or tenth of a foot were reported by well driller. Question mark accompanies reported measurement of questionable accuracy. "Measuring point" indicates distance above or below (-) land-surface datum (in feet) and type of measuring point, for U.S. Geological Survey measurements, as follows: E, top of small extension pipe atop casing cap-plate; H, access hole on side of casing; P, access port in cap-plate atop casing; T, top of open casing.

Remarks: C, chemical analysis in tables 21 or 22; F, depth, in feet, at which first water was reported during drilling; G, geophysical logs (gamma, gamma-gamma, and neutron) in files of U.S. Geological Survey, Carson City; L, driller's geologic log in table 19; R, reported well depth when drilled; S, driller's log in files of State Engineer (State log number is indicated); T, length of time between start of pumping test and measurement of drawdown, in hours.

Location and site ID	Owner	Year drilled or dug	Well depth (feet)	Casing diameter (inches)	Use	Yield (gal/min) and drawdown (feet)	Land-surface altitude (feet)	Water level: Depth (feet)	Water level: Date measured	Water level: Measuring point	Remarks
8CBCD1 394153119593701	David Evans	1949±	170	6	U(S)	--	5,390	93.45	6-12-75	1.2H	
9AACC1 394218119574401	Silver Knolls Development Co.	1973	94½*	8	U	--	5,135	--	--	--	L; R=89; S=13884.
9ACDC1 394206119575301	do.	1974	258	--	U	--	5,115	--	--	--	L; S=13885. Insufficient water supply; uncased, destroyed.
9CDAA1 394149119580601	do.	1948	143½*	10	U(Ir)	25B/50?	5,095	54.45	5- 3-79	0.5H	C; F=90; R=181; S=400.
9CDAC1 394147119580801	do.	1974	350	16	U(P)	2,150P/177	5,095	52.21	4- 7-77	1.4E	C; F=74; L; S=13886; T=14.
9CDAD1 394148119580701	U.S. Geol. Survey (No. 10)	1974	68.4*	1½,2	O	--	5,095	53.41	5- 3-79	1.80T	G; L.
16AAAB1 394138119573501	U.S. Geol. Survey (No. 8)	1975	109.0*	1½,2	O	--	5,135	95.10	5- 3-79	1.42T	L.
16BBBA1 394137119583201	U.S. Geol. Survey (No. 9)	1974	58.6*	1½,2	O	--	5,075	38.43	5- 3-79	1.44T	G; L.
16BDAA1 394124119580401	Donnell Richards	1964	250	12	U(Ir)	--	5,080	39.48	5- 3-79	2.0T	F=53; L; S=8072.
16BDBB1 394124119581901	do.	1962	165	8	D	120B/0?	5,070	36.12	5- 3-79	1.2P	C; F=55; L; S=7181.
16CACD1 394100119581601	Reno Park Mutual Co.	1971	212*	10	P	111P/35	5,061*	28.65	5- 3-79	1.8H	G; L; R=242; S=11645.
16CACD2 394100119581602	U.S. Geol. Survey (No. 11)	1975	49.4*	1½,2	O	--	5,061*	26.93	5- 3-79	1.73T	G.
16CBCC1 394100119583601	John Arden	--	517*	6	U(D,S)	--	5,068*	34.59	5- 3-79	0.9T	R=165.

17DCCD1 394048119590501	David Evans	1949±	78?*	6	U(S)	--	5,053	22.37	4- 6-77	1.25T	R=82.
19DAAB1 394017119595201	Bordertown Club	1963±	203½*	8	U(P)	--	5,110	45.79	5-30-75	--	Destroyed in Oct. 1975.
19DACA2 394013119595502	do.	1957	125	8	P	25B/--	5,130	--	--	--	C; L; S=3975.
20ABDD1 394035119585901	U.S. Geol. Survey (No. 12)	1975	29.1*	1½,2	O	--	5,043*	11.57	5- 3-79	2.86T	L.
20BAAB1	R. E. Craig	1973	255	6	D	--	5,065	--	--	--	F=33; L; S=13016. Reported water level and temperature 51 ft and 14.5°C (58°F) before well deepened from 200 ft.
20BAAC1 394041119591901	Jack Phelps	1973	202	11,6	D	25A/120	5,060	70(?)	6- -73	--	F=22; S=13589. Perfor-ations, 162-202 ft; water temperature, 13.0°C (55°F).
20BAAD1 394042119591501	Robert Bateson	1962±	97	8	U(D)	--	5,060	24.16	3-29-78	0.7H	C.
20BAAD2 394042119591502	do.	1975	120	6	D	18B/80	5,060	21.07	3-29-78	2.1H	F=35; T=4. Perfor-ations, 80-120 ft; log available (U.S. Geol. Survey files).
20BABD1 394040119592201	--	1963	110	8	U(D)	30B/--	5,060	26.42	5- 3-79	0.3H	F=48; S=7071. Perfor-ations, 95-105 ft.
20BACA1 394039119592201	Faye Cuthbert	1969	191	6	D	40A/63	5,055	20.63	11- 9-76	0.4H	F=14; L; S=10825; T=2.5.
20BACB1 394038119592801	Leo Dufault	1962	135	6	D	--	5,055	26	7- -62	--	F=82; S=6624. Perfor-ations, 82-91, 101-119 ft.
20BADD1 394033119591301	Frank Aranyos	--	56	6	D	--	5,050	--	--	--	C.
20BBAB1 394044119593501	George Stonebarger	1961±	135±	6	U(D)	--	5,070	33.97	11- 8-76	1.0T	C; F=61; S=6229. Reported yield and water level 15 gal/min and 26 ft before well deepened from 73 ft.
20BBAD1 394041119593201	Glen Woods	1974	105	12,8	D	30B/40	5,060	20	4- -74	--	F=65; L; S=14132; T=4.
20BBBA1 394044119594001	R. D. Higgians	1970	143	8	D	--	5,075	--	--	--	F=62; L; S=11261.
20BBBA2 394044119594301	R. J. Skinner	1971	105	6	D	20B/18	5,075	35	5- -71	--	S=11530; T=0.5. Perforations, 85-105 ft.
20BBBB1 394043119594501	Donzele Foglesong	--	121	8	D	--	5,085	45.62	5- 3-79	0.6H	C.
20BBBC1 394040119594401	--	1963	101	8	D	45B/13	5,080	35.81	11-10-76	1.35E	F=44; S=7072. Perfor-ations, 82-95 ft.
20BBCC1 394034119594501	Dorothy Haff	1963	80	8	D	40B/15	5,070	30.64	5- 3-79	0.9T	F=42; L; S=6974.
20BBDA1 394039119593201	Cody Stewart	1966	105±	6	D	--	5,060	14.95	3-29-78	1.6E	C. Perforations, about 90-105 ft.
20BBDB1 394038119593701	Tom Nunn	--	140	--	D	--	5,060	--	--	--	C.
20BBDC1 394035119593501	W. E. Allgaier	1961	94	6	D	--	5,055	13.66	3-29-78	1.4H	C; F=50±. Perfora-tions, 90-94 ft.
20BCAA1 394030119593401	J. A. Harrowa	1972	94	8	D,Ir	40B/70	5,055	10	7- -72	--	F=15; L; S=12557.

TABLE 18.--*Well data*--Continued

Location and site ID	Owner	Year drilled or dug	Well depth (feet)	Casing diameter (inches)	Use	Yield (gal/min) and drawdown (feet)	Land-surface altitude (feet)	Water level: Depth (feet)	Water level: Date measured	Water level: Measuring point	Remarks
20BCCC1 394021119594501	R. B. Fladager	--	121±*	12	Ir	--	5,080	28.95	5- 3-79	3.0T	C.
20BCCC2 394021119594202	do.	1957	60	6	D	15B/--	5,070	26.68	5- 3-79	0.8H	F=48; L; S=4879.
20BDAB1 394033119591801	J. R. Muller	1960±	43±*	5	D	--	5,050	9.92	5- 1-75	0.8T	
20BDBD1 394028119592301	Richard Piper	--	23*	6	U	--	5,045	8.99	3-26-75	3.9T	
20BDCA1 394025119592301	Fred Earl	--	--	--	D	--	5,045	--	--	--	C.
20BDDD1 394022119591501	H. L. Murphy	--	30*	6	U	--	5,040	6.61	5- 3-79	0.1T	
20CDAB1 394006119592101	U.S. Geol. Survey (No. 5A)	1974	22.7*	1½,2	O	--	5,036.53*	7.11	5- 3-79	2.03T	Perforations, 5.7-15.7 ft.
20CDAB2 394006119592102	U.S. Geol. Survey (No. 5B)	1974	124.2*	1½	O	--	5,036.53*	+2.33	5- 3-79	3.23T	G; L. Water temperature, 11.0°C (52°F).
21ADBB1 394032119574401	Reno Park Mutual Co.	1971	204*	10	P	--	5,070	35.97	5- 3-79	1.6H	F=50; G; L; S=11644.
21ADBB2 394032119574402	U.S. Geol. Survey (No. 7)	1974	48.4*	1½,2	O	--	5,070	35.67	5- 3-79	1.6T	G; L.
21BBDD1 394034119582301	Reno Park Mutual Co.	1946	197	12	P(Ir)	1,000?P/--	5,045	6.82	4-12-78	1.8T	C; F=12; L; S=117.
21BCCD1 394021119583101	U.S. Geol. Survey (No. 4)	1974	22.9*	1½,2	O	--	5,035.40*	3.61	4- 6-77	2.63T	G. Perforations, 5.9-15.9 ft.
21DDBD1 394001119574001	U.S. Geol. Survey (No. 6A)	1974	21.0*	1½,2	O	--	5,045	9.18	5- 3-79	3.53T	Perforations, 7.0-17.0 ft.
21DDBD2 394001119574002	U.S. Geol. Survey (No. 6B)	1974	94.9*	1½	O	--	5,045	8.80	5- 3-79	2.44T	G; L.
28ADCC1 393930119574601	U.S. Geol. Survey (No. 1A)	1974	22.6*	1½,2	O	--	5,035.65*	2.89	5- 3-79	2.48T	Perforations, 5.6-15.6 ft.
28ADCC2 393930119574602	U.S. Geol. Survey (No. 1B)	1974	148.6*	1½	O	--	5,035.65*	+.70	5- 3-79	6.41T	G; L. Water temperature, 12.0°C (54°F).
28BBCB1 393945119583501	U.S. Geol. Survey (No. 3A)	1974	22.6*	1½,2	O	--	5,035.56*	5.48	12-11-74	2.68T	Perforations, 5.6-15.6 ft.
28BBCB2 393945119583502	U.S. Geol. Survey (No. 3B)	1974	125.5*	1½	O	--	5,035.56*	--	--	2.85T	G; L. Water level not yet static as of 1-20-76 (slow recovery after drilling); water temperature, 10.5°C (51°F).
29BBDC1 393944119593601	J. A. Montgomery	1973	130	6	D	32A/50	5,110	41.08	3-28-78	1.1H	C; L; S=13617. Water temperature, 15.5°C (60°F).
29CABC1 393923119592801	--	--	138	6	U(D)	--	5,120	--	--	--	C.
29CACA1 393920119592401	Audry Haune	1973	208	8	D	10A/--	5,110	35	11- -73	--	F=35; L; S=13690.

29CACD1 393918119592101	R. W. Crawford	1973	168	8	D	30P/--	5,110	--	--	--	C.
29CADB1 393921119592001	H. F. Kannengieser	1973	125	8	D	--	5,080	18.07	5- 3-79	-4.9H	C. Water temperature, 10.5°C (51°F).
29CBCB1 393921119594401	Cold Springs Devel. Corp.	1976	186	12,10	U(IP)	175A/141	5,150	33.85	5- 3-79	1.5T	F=90; L; S=15540. Originally drilled to 225 ft.
29CDAA1 393913119591301	Burton Kelling	1973	230	6	D	10B/--	5,085	51.63	3-28-78	1.5H	C. Perforations, 225-230 ft.
29CDDC1 393904119591901	J. B. Evans	1966±	120±	8	D	80P/--	5,120	20.26	3-29-78	0.8H	C; T=30.
29DCBA1 393913119590501	R. J. Jones	1971	100	6	D	10B/0?	5,065	--	--	--	S=11971; T=3. Perforations, 80-100 ft.
29DCBB1 393913119591001	M. N. Olm	1972	131	9,6	D	7A/35	5,085	70(?)	2- -72	--	F=105; L; S=12241; T=1½.
29DCDA1 393906119585901	J. L. Bacon	1972	100	8	D,S	50B/60	5,050	15	7- -72	--	F=20; L; S=12510.
29DCDB1 393907119590401	W. W. Hedley	1961	100	6	D	20B/15	5,070	24.76	11-16-77	1.0H	F=42; S=6211. Perforations, 60-100 ft.
29DDAB1 393913119584401	U.S. Geol. Survey (No. 2)	1974	22.5*	1½,2	O	--	5,036.33*	5.46	5- 3-79	2.55T	G. Perforations, 5.5-15.5 ft.
30ADBA1 393940119595801	Cold Springs Devel. Corp.	1976	203	12,10	U(IP)	70A/135	5,175	71.64	5- 3-79	2.1T	F=100; L; S=15538. Originally drilled to 250 ft.
30DABB1 393925119595901	do.	1979	605	16,14	P(I)	605P/138	5,185	79.5	6- -79	--	L; S=20095; T=48.
32DAAB1 393835119584401	Josephine Sweeney	1952±	250±*	12	U(Ir)	--	5,090	17.92	5- 3-79	1.0T	
33ACDB1 393839119575501	do.	--	45.9*	12	U	--	5,070	4.56	5- 3-79	0.4T	
33CBAB1 393834119582801	do.	--	150*	12	U(Ir?)	--	5,085	31.50	5- 3-79	0.3T	
34BBBB1 393900119572801	B. A. Jackson	1975	120	14,10	U(P)	500?P/--	5,068	Flowing	5- 3-79	1.8T	C; F=50; L. Used during freeway construction.
34BCAC1 393843119572301	do.	1972	213	10	U(P)	50P/<1	5,095	9.91	5-30-75	--	C; F=38; L; S=12102; T=7. Used during freeway construction; destroyed in 1975.

TABLE 19.--*Selected well logs*

[Casing depths and perforated or screened intervals are indicated. Drillers' State license numbers are as follows: 207, Smith-Pulati, Inc., Sparks; 257, Wayne Burroughs, Reno; 287, A & B Contractors, Sparks; 334, G. W. Peterson, Sun Valley; 360, Marcin Drilling Co., Carson City; 368, Herbert R. Porter, Reno; 493, 685, and 805, W. L. McDonald & Co., Sparks; 544, Levy Matthews & Son, Sparks; 585, W. H. Blain Well Drilling, Carson City; 615, Sage Bros. Drilling Co., Reno; 699, Ron Burgess, Reno?; 4507, J. N. Pitcher Co., Reno. Asterisk indicates principal water-bearing interval, where noted by driller. In U.S. Geological Survey logs, colors are for undried cuttings, and are based on Rock-Color Chart distributed by Geological Society of America.]

Material	Thickness (feet)	Depth (feet)
9AACC1 (cased to at least 89 ft (?); driller No. 615)		
Clay, sandy	25	25
Sand, fine, silty	9	34
Clay, brown, and some gravel	47	81
"Granite," hard [more probably metamorphic rock]	8	89
No record	5½	94½
9ACDC1 (uncased; abandoned; driller No. 615)		
"Surface" clay	8	8
Sand, coarse	11	19
Clay, silty	73	92
Gravel, coarse, and cobblestone	5	97
Clay, yellow	31	128
Clay, silty, brown	89	217
Sand, fine, silty	18	235
Clay, brown	16	251
"Granite," hard [more probably metamorphic rock]	7	258
9CDAC1 (cased to 350 ft; perf. 100-350 ft; driller No. 615)		
"Surface" clay	12	12
Sand, coarse, and gravel	16	28
Clay, yellow	46	74
Sand, fine, and clay; water-bearing	54	128
Clay, sandy, brown	48	176
Gravel and sand, hard; water-bearing	87	263
Gravel, coarse, and gray clay	49	312
Sand, coarse, and gravel; water-bearing	36	348
"Granite," hard [more probably metamorphic rock]	2	350
9CDAD1 (Cased to 68.4 ft; perf. 53.4-63.4 ft; drilled by U.S. Geological Survey)		
Sand, medium to very fine, and silt; moderate yellowish brown	5	5
Same, with some fine gravel; light olive brown	6	11
Gravel, coarse, light olive brown	1	12
Same as 5-11 ft, with more gravel below about 20 ft; moderate olive brown below 14 ft, moderately dark yellowish brown below 18 ft	15	27
Silt, with some gravel, sand, and clay	8	35
Same, but more sand (?)	3	38
Same as 27-35 ft	7	45
Silt and clay, with some sand; moisture increases with depth; saturated at about 52 ft	15	60
Coarse to fine sand, with some silt, clay, and very coarse sand	9	69
16AAAB1 (cased to 109 ft; perf. 94.5-109 ft; drilled by U.S. Geological Survey)		
Sand and silt, with zones of gravel as coarse as 1/2 in.; moderately dark yellowish brown	16	16
Sand and silt, hard ?	23	39
Sand and silt, with some gravel; principal zones of fine to coarse gravel at 41-42 and 49-53 ft; moderately dark yellowish brown to moderately light brown	54	93
Clay (?)	3	96
Sand and silt (?)	7	103
Clay (?)	2	105
Gravel (1/4-1/2-in., semiangular), sand, silt, and clay, interbedded with layers of sandy clay; light brown	4	109
16BBBA1 (cased to 58.6 ft; perf. 43.6-53.6 ft; drilled by U.S. Geological Survey)		
Sand, fine, with some medium to coarse sand and silt; dusky yellow	5	5
Same, with some fine gravel	12	17
Same, but with thin layers of clay; greater amount of clay below 23 ft; color becomes moderately light olive brown with depth	42	59
16BDAA1 (cased to 250 ft; perf. 100-246 ft; driller No. 207)		
Sand with light clay and silt	53	53
Sand, fine, water-bearing	6	59
Clay, brown	12	71
Sand and gravel, loose, water-bearing*	114	185
Clay, yellow	6	191
16BDAA1--continued		
Gravel, cemented	7	198
Clay, brown	5	203
Sand and gravel, tight	17	220
Gravel, cemented	6	226
Clay	4	230
Sand and gravel (water-bearing?)	16	246
Clay, brown	4	250
16BDBB1 (cased to 165 ft; perf. 120-161 ft; driller No. 207)		
Clay, sandy, black	11	11
Clay, sandy, brown	44	55
Sand and gravel, water-bearing	37	92
Clay, sandy	18	110
Sand and gravel, water-bearing*	53	163
Shale, hard, blue	2	165
16CACD1 (cased to 242 ft; perf. 50-242 ft; driller No. 360)		
Clay	30	30
Sand, runny	80	110
Clay and rock	10	120
Sand, coarse	10	130
Sand, cemented	20	150
Sand, runny	10	160
Clay and rock	30	190
Sand, cemented	40	230
Sand	12	242
19DACA2 (cased to 120 ft; perf. 60-120 ft; driller No. 257)		
Soil	1	1
Clay, very hard, and small boulders	5	6
Clay, hard	14	20
Clay, hard, slightly sandy, water-bearing from 40 to 60 ft	40	60
Clay, sandy, water-bearing	41	101
Gravel, fine, and sand; water-bearing*	20	121
Clay, slightly sandy	4	125
20ABDD1 (cased to 29.1 ft; perf. 12.1-29.1 ft; drilled by U.S. Geological Survey)		
Sand, coarse to fine, and silt, with a little 1/8-1/2-in. gravel; yellowish gray	8	8
Clay and silt, light olive brown	4	12
Sand, coarse to fine, and silt; moderate olive brown, water-bearing	6	18
Clay, dusky grayish blue	2	20
Clay, light olive brown, and dusky yellowish gray silt, interbedded	3	23
Sand, medium to fine, silt, and clay; moderate olive brown, water-bearing	6	29
20BAAB1 (cased to 255 ft (?); perf. 143-225 ft (?); driller No. 685 to 200 ft)		
Gravel, 3/4-in., angular; and coarse sand	2	2
Sand, medium, and some clay	2	4
Gravel, as coarse as 1-in., semi-angular; and coarse sand	6	10
Clay, brown, dry	3	13
Gravel, as coarse as 1/4-in., semi-rounded; and "decomposed granite"	2	15
Gravel, 1-in., angular; and medium sand		
Clay, brown	2	17
Hardpan, dry	3	20
Gravel, 1-in., angular	1	21
Clay, brown, damp	1	22
Gravel, 3/4-in., angular; and some clay	10	32
Gravel, 1-in., semi-rounded, water bearing	1	33
Sand, medium, and clay	4	37
Gravel, 3/8-in., semi-angular	42	79
Gravel, 1-in., semi-rounded	4	83
"Decomposed granite," water-bearing	8	91
Clay, brown	15	106
Gravel, 3/8-in.	2	108
Clay, brown, and medium sand	21	129
Gravel, 1/2-in., semi-rounded, water-bearing	6	135
Clay, brown	22	157
Gravel, 1-in., semi-rounded, water-bearing	5	162
No log available	38	200
	55	255
20BACA1 (cased to 191 ft; perf. 151-181 ft; driller No. 493)		
Topsoil		
Silt and angular gravel as coarse as 1-in.	2	2
Hardpan, yellow	1	3
Clay, yellow	3	6
	6	12
20BACA1--continued		
Silt, brown	2	14
Sand, fine to coarse, and some gravel as coarse as 3/4-in.; water-bearing	4	18
Clay, soft, yellow	9	27
Sand, coarse, and gravel as coarse as 1/2-in.	6	33
Clay, sandy, soft, yellow	12	45
Sand, coarse, and angular gravel as coarse as 1-in.	3	48
Clay, sandy, soft, yellow	14	62
Clay, hard and soft, brown	40	102
Clay, sandy, soft, yellow	14	116
Clay, hard, brown	24	140
Sand, coarse, and silt; water-bearing	5	145
Clay, sandy, hard and soft, yellow	40	185
Sand, coarse, clean, water-bearing	3	188
Clay, hard, yellow	3	191
20BBAD1 (cased to 105 ft; perf. 60-90 ft; driller No. 287)		
Topsoil, sandy	6	6
Clay, sandy, and gravel	8	14
Hardpan, sandy	4	18
Clay, sandy, white	18	36
"Clay rock," brown	22	58
"Hard rock"	7	65
Sand, water-bearing	10	75
Clay, sandy, white	20	95
Clay, sandy, brown	10	105
20BBBA1 (cased to 140 ft; perf. 60-140 ft; driller No. 544)		
Sand and "decomposed granite"	1	1
Clay	11	12
Sand	2	14
Clay and gravel	15	29
Sand	4	33
Clay	6	39
Sand	2	41
Clay and gravel	21	62
Sand and boulders, water-bearing	7	69
Clay, sandy	4	73
Sand, coarse, water-bearing	25	98
Sand, medium, water-bearing	24	122
Clay, sandy	9	131
Sand, water-bearing	9	140
Clay, hard	3	143
20BBCC1 (cased to 80 ft; perf. 60-75 ft; driller No. 368)		
Topsoil	5	5
Sand and clay	37	42
Gravel, water-bearing (small amount)	3	45
Clay and sand	7	52
Sand and gravel	16	68
Gravel, water-bearing*	3	71
Sand and gravel	11	82
20BCAA1 (cased to 94 ft; perf. 70-90 ft; driller No. 585)		
Clay, hard	15	15
Sand and gravel	5	20
Clay	15	35
Sand and gravel	4	39
Clay	21	60
Sand and gravel	30	90
Clay	4	94
20BCCC2 (cased to 60 ft; perf. 20-60 ft; driller No. 4507)		
Topsoil	5	5
Clay, tight, with gravel and cobbles	16	21
Sand and clay, tight	27	48
Gravel and sand; water-bearing	10	58
Clay, yellow	2	60
20CDAB2 (cased to 124.2 ft; screen 122.0-124.0 ft; drilled by U.S. Geological Survey)		
Silt and clay, plastic, yellowish orange-brown	16	16
Silt and clay, plastic, dark grayish yellow-green	4	20
Silt and clay, non-plastic (almost concoidal break), dark yellowish brown	6	26
Silt and clay, semi-plastic, medium greenish gray	4	30
Silt and clay, non-plastic, greenish gray	15	45
Silt and clay (?)	10	55
Increasing coarseness, but probably dominated by silt, perhaps along with fine sand at depth	16	71
Increasing coarseness; may be dominated by sand, perhaps along with fine gravel at depth	17	88

Material	Thickness (feet)	Depth (feet)
20CDAB2--continued		
Sand, silt, clay, and perhaps fine gravel; color variegated light, medium, and dark olive gray	27	115
Neutron log suggests that entire interval from land surface through about 110 ft is thin-bedded		
Silt, sandy, mottled greenish black and dark olive gray	5	120
Sand, silty, mottled as above but with some dark reddish brown at bottom	5	125
21ADBB1 (cased to 203 ft; perf. 150-203 ft; driller No. 360)		
Cemented sand (?; see log for well 21ADBB2); water-bearing, 50-55 ft	55	55
Clay	35	90
Sand, cemented	15	105
Sand, "heaving"	35	140
Clay and gravel, water-bearing, 150-155 ft	15	155
Sand, runny	20	175
Clay and rock	20	195
Clay and gravel	8	203
21ADBB2 (cased to 48.4 ft; perf. 33.4-43.4 ft; drilled by U.S Geological Survey)		
Sand and silt, loose, yellowish light-olive brown	3	3
Sand and some silt, loose, yellowish light olive brown	9	12
Sand and some silt, grading to fine sand and silt, with some clay; light olive gray, moist	4	16
Sand, fine, silt and some clay; light olive gray, moist	4	20
Sand, silt, clay, and some fine gravel, moist; light olive gray, going to medium yellowish brown at about 25 ft	8	28
Silt and clay with some sand and fine gravel; medium yellowish brown; moist to 34 ft, saturated below	9	37
Gravel, medium, to clay, dark yellowish brown; sand, silt, and clay dominate below about 43 ft	12	49
21BBDD1 (cased to 197 ft; perf. 0-197 ft (?); drilled by J. C. Faretto & Son, Reno)		
Soil	2	2
Sand	12	14
Sand and gravel, cemented, with 6-in. water-bearing zones about every 2 ft	73	87
Sand, coarse, and gravel; "heavy"	20	107
Clay, blue	10	117
Sand, coarse, "heavy"	4	121
Sand, fine	19	140
Clay, blue	7	147
Sand, fine, with some "heavy" sand	17	164
Sand, fine	15	179
"Quicksand"	1	180
Sand, fine	5	185
Clay, blue	5	190
Sand, fine	5	195
Clay, blue	2	197
21DDBD2 (cased to 94.9 ft; screen 92.7-94.7 ft; drilled by U.S. Geological Survey)		
Silt and clay, grayish yellow-brown, slightly moist	6	6
Sand, silt, and clay, pale yellowish orange-brown, slightly moist	4	10
Sand, silty, well sorted, grayish dusky yellow, water-bearing	15	25
Silt and clay, sandy in places; grayish olive green, water-bearing	15	40
Silt and clay, grayish olive green, moist	6	46
Same but sandy, water-bearing	2	48
Silt and clay, grayish olive green, moist	12	60
Same but sandy in places, water-bearing	15	75
Silt and clay, sandy to gravelly in places, grayish olive green going to medium grayish red at 78 ft, water-bearing	8	83
Silt and clay, sandy, moderate reddish brown, water-bearing	7	90
Silt and clay, sandy in places, light brown to grayish red, water-bearing	5	95
Consolidated rock (igneous?) encountered at 95 ft; first hole drilled to 106 ft in consolidated rock, abandoned; second hole bottomed at 95 ft	11	106
28ADCC2 (cased to 148.2 ft; screen 146.0-148.0 ft; drilled by U.S. Geological Survey)		
Clay to very fine sand, moderate olive brown	12	12
28ADCC2--continued		
Clay and some silt, greenish gray	18	30
Clay and some silt to very fine sand, with a little coarse sand; moderate olive brown	2	32
Same, but pale grayish olive	10	42
Clay and some silt, with varying minor amounts of sand; dark greenish gray	43	85
Same grainsize, increasing somewhat in coarseness with depth	15	100
Same grainsize as 42-85 ft	26	126
Coarser; apparently dominated by fine sand; pale yellowish brown	15	141
Clay and some silt to fine gravel, firm (non-plastic); no evidence of bedding at 147 ft; light brown	8	149
28BBCB2 (cased to 125.5 ft; screen 123.3-125.3 ft; drilled by U.S. Geological Survey		
Clay with a little silt; thin, mica-rich silty layers; light olive gray-brown	15	15
Same, darkening to greenish black at about 25 ft	26	41
Same, but more compact ("tighter")	4	45
Same grainsize; tighter layers at 76-101 and 107-125 ft and much looser (plastic) layer at 101-107 ft; medium to dark greenish gray	80	125
29BBDC1 (cased to 130 ft; perf. 90-130 ft; driller No. 493)		
"Topsoil"	20	20
Boulders, small, sand, and some thin clay layers	100	120
Gravel	10	130
29CACA1 (cased to 208 ft; perf. 95-203 ft; driller No. 699)		
Topsoil, clayey	2	2
Clay, sandy	33	35
Sand and gravel, water-bearing	1	36
Clay, sandy	39	75
Clay and rock	3	78
Clay, blue	13	91
Sand and gravel, water-bearing	3	94
Clay, blue	18	112
Clay and rock	4	116
Sand, water-bearing	1	117
Clay, sandy	9	126
Clay and rock	5	131
Clay, sandy	8	139
Sand and gravel, water-bearing	3	142
Clay, sandy	16	158
Sand and gravel, water-bearing	3	161
Clay, blue	7	168
Clay, sandy	6	174
Gravel, "heavy," water-bearing	2	176
Clay, blue	8	184
Clay, sandy	9	193
Sand and gravel, water-bearing	3	196
Clay, sandy	5	201
Sand and gravel, water-bearing	3	204
Clay, blue	4	208
29CBCB1 (cased to 186 ft; perf. 84-186 ft; driller No. 805)		
Topsoil with brown clay	15	15
Clay, hard and soft, brown	28	43
Clay, sandy, yellow	17	60
Sand, fine to coarse, and gravel; loose; with some clay layers	16	76
Sand, fine to coarse	14	90
Sand, fine to coarse, very loose, with some yellow silt; water-bearing	46	136
Same, with some brown clay layers	27	163
Clay layers, blue, and coarse sand layers; water-bearing	27	190
Sand, fine to coarse, loose	35	225
29DCBB1 (cased to 131 ft; perf. 105-130 ft; driller No. 493)		
Topsoil, loamy, with "decomposed granite"	2	2
Clay, sandy, brown	5	7
Silt, brown	8	15
Clay, sandy, brown	25	40
Sand, coarse, with brown clay layers	49	89
Sand, coarse, and rounded gravel as course as 1-1/2 in.; water-bearing at 105-112 ft	26	115
Sand, coarse, and rounded gravel as coarse as 3/8 in., with some yellow clay layers; water-bearing	15	130
Clay, hard, blue	1	131
29DCDA1 (cased to 100 ft; perf. 76-96 ft; driller No. 585)		
Clay, sandy	20	20
Sand and clay, water-bearing	15	35
Clay	15	50
Sand and gravel (water-bearing?)	5	55
Clay, sandy	25	80
Sand and gravel (water-bearing?)	5	85
Clay	5	90
Sand and gravel (water-bearing?)	6	96
Clay	4	100
30ADBA1 (cased to 203 ft; perf. 103-203 ft; driller No. 805)		
Topsoil	3	3
Clay, brown, and some sand	25	28
Clay, sandy, brown	37	65
Sand, fine to coarse, with brown clay layers	25	90
Same, with yellow clay layers; water-bearing (about 10 gal/min) at 100 ft	30	120
Clay, brown, and some sand	7	127
Sand and gravel as coarse as 1/2-in., loose; water-bearing*	13	140
Clay, sandy, yellow, with sand layers	20	160
Sand; mostly coarse, clean above 205 ft, finer below; water-bearing in places	65	225
Clay, hard and soft, sandy, yellow	25	250
30DABB1 (cased to 605 ft; screen 135-150, 170-195, 205-240, 250-270, 315-405, 455-470, 510-535, 550-565, 585-600 ft; driller No. 805; log, for adjacent test hole, by SEA Engineers, Reno)		
Clay, sandy, light to dark brown, with some gravel	48	48
Sand, fine, brown, with some gravel	4	52
Gravel, fine, multicolored	6	58
Clay, brown, with some gravel	18	76
Sand, fine, brown, with red and green gravel	12	88
Clay, brown, with some rock chips	10	98
Gravel, fine, multicolored	6	104
Sand, medium, brown, with multicolored, subangular to subrounded gravel	6	110
Clay, sandy, brown; sand is medium to coarse	30	140
Sand, medium, multicolored, with some gravel and minor clay	10	150
Clay, gravelly, light brown; gravel is fine-grained	20	170
Gravel, fine, with 20 percent clay; multicolored	15	185
Sand, medium, with 20 percent gravel; white, yellow, and brown	25	210
Gravel, medium, with 40 percent medium sand and 10 percent clay; multicolored	5	215
Sand, medium, subangular to subrounded, with 10 percent gravel and minor clay; white, yellow, brown, and gray	100	315
Sand, coarse, to fine gravel; subangular to subrounded, with 20 percent clay; multicolored	30	345
Sand, medium to coarse, subrounded, multicolored	15	360
Sand, coarse, gravelly, white, yellow, gray, black, and brown; gravel is fine-grained	27	387
Clay, sandy, brown	6	393
Sand, medium, subangular to subrounded, with minor clay; multicolored	82	475
Sand, fine to coarse, subangular to subrounded, with as much as 20 percent clay; multicolored	60	535
Clay, brown	13	548
Gravel, medium, sandy, with some cobbles and minor clay; black	18	566
Clay, brown	20	586
Clay, sandy, green, black, blue, and brown; sand is medium-grained	30	616
Sand, fine, with 20 percent clay and some cobbles; black, blue, and green	16	632
Sand, medium, and clay; brown, blue, and green; sand about 50 percent	10	642
Clay, brown	9	651
Sand, medium, gravelly, multicolored	9	660
Sand, medium, and clay with some cobbles; brown; sand about 50 percent	23	683
34BBBB1 (cased to 120 ft; perf. 60-120 ft; driller No. 334)		
Surface soil	5	5
Clay	45	50
Rock, fractured, water-bearing	50	100
Granitic rock, solid	20	120
34BCAC1 (cased to 213 ft; perf. 148-208 ft; driller No. 360)		
Hardpan; water-bearing at 38-50 ft	50	50
Clay and sand; water-bearing at 65-70 ft	20	70
Rock; water-bearing at 100-150 ft	80	150
Rock	15	165
Clay and rock	15	180
Clay and some rock; water-bearing at 195-200 ft	20	200
Clay and rock	13	213

TABLE 20.--*Spring data*

Location and site ID	Name	Altitude (feet above sea level)	Use (D, domestic; S, stock)	Date	Flow (gal/min)	Water temperature (°C)	Water temperature (°F)	Specific conductance (micromhos)
N20 E18 4BCA1 393751119581601	--	5,350-5,450	S	8-25-75	[a]10	--	--	--
N21 E18 4ACBD1 394306119575701	Cold	5,510	S	9-26-74	20	15.0	59	169
N21 E18 4CDDD1 394233119580701	Streib	5,350	S	6-16-75	3.3	14.0	57	167
N21 E18 27CBBB1 393927119573001	--	5,049	S	11- 8-76	.0	--	--	--
N21 E18 32DBCB1 393826119591101	--	5,180	D	10- 1-74	--	13.5	56	126
N21 E18 33CDBC1 393817119582101	--	5,140	S	11- 9-76	.6	13.5	56	150
N22 E18 21ABDD1 394551119575001	Mud	6,380	S	10- 1-74	<.1	--	--	--
N22 E18 22CCD1 394515119572301	--	5,980	S	6-16-75	2.2	10.5	51	308

[a] Estimated. All others were measured.

TABLE 21.--*Chemical analyses of well, spring, and lake water*

Location	Source (with well depth where appropriate)	Date sampled	Analyst[1]	Milligrams per liter: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)[2]	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate as N	Arsenic (As)	Total iron (Fe)	Dissolved solids[3]	Hardness as $CaCO_3$	Specific conductance (micromhos)
N21 E18 9CDAA1	Well (143½ ft)	1962	N	--	--	[a]25		159	25	17	--	--	--	--	252	125	360
9CDAC1	Well (350 ft)	[b]2- 6-74	H	25	8	21	3	146	7	9	0.2	0.8	0.000	0.08	175	95	--
20BAAD1	Well (97 ft)	7-26-66	G	23	12	[a]11		124	12	13	--	--	--	--	180E	108	276
20BADD1	Well (56 ft)	7-10-72	H	22	1	[a]38		144	13	7	.0	.7	.015	.48	194	60	--
20BBAB1	Well (135 ft±)	2- 5-71	H	29	4	[a]31		154	5	9	.3	3.1	.000	.03	202	88	--
20BBBB1	Well (121 ft)	6-28-71	H	32	9	[a]21		173	3	7	.0	1.9	trace	.18	208	116	--
20BBDB1	Well (140 ft)	[b]1974	H	50	22	82	3	327	58	29	.3	5.0	.005	.12	461	216	--
20BDCA1	Well	12-14-70	H	19	6	[a]40		171	4	6	.2	2.1	.000	.10	189	72	--
21BBDD1	Well (197 ft)	11-29-72	H	35	11	[a]12		163	11	7	.3	.5	.000	.02	170	132	--
		[c]5- 1-75	G	31	10	16	3.3	157	14	5.7	.2	.87	.002	--	200C	120	297
		11-12-75	G	--	--	--	--	--	--	--	--	.81	--	--	200E	--	300
		11-10-76	G	--	--	--	--	--	--	--	--	.80	--	--	200E	--	304
		12- 5-77	G	--	--	19	--	--	--	6.5	--	1.5	--	--	210E	--	311
		5- 3-79	G	--	--	22	--	--	--	8.3	--	2.2	--	--	240E	--	351
29ACBC	White Lake	[d]5-16-70	G	2	1	520	5.2	[2]756	121	186	2.0	--	--	--	1,270C	9	2,200
29CABC1	Well (138 ft)	6-18-62	H	22	7	[a]22		120	.5	5	--	.5	--	.13	161	84	--
29CACD1	Well (168 ft)	[e]7-31-75	H	4	0	25	4	[2]32	6	3	.2	.0	.015	.30	114	10	--
29CDDC1	Well (120 ft±)	3-30-66	H	30	11	[a]32		193	19	6	--	1.2	--	.66	249	120	--
34BBBB1	Well (120 ft)	[f]10- 9-75	H	22	5	22	1	[2]83	1	5	.0	1.6	.000	.04	157	76	--
34BCAC1	Well (213 ft)	12-12-72	H	32	0	[a]23		132	6	6	.0	1.9	.010	.00	168	80	--
N22 E18 22CCD1	Spring	[g]6-16-75	G	32	12	12	4.2	169	6.2	7.3	.1	2.2	.002	--	201C	130	315

[1] G, Water Resources Division, U.S. Geological Survey; H, Bureau of Laboratories and Research, Nevada Division of Health, Reno; N, Nevada Soil and Water Testing Laboratory, University of Nevada, Reno.

[2] Carbonate concentrations below detection limit, except 40 mg/L for White Lake (29ACBC) and 14 mg/L for wells 29CACD1 and 34BBBB1.

[3] "C" indicates calculated sum, with bicarbonate multiplied by 0.492 to make result comparable with "residue" determination. "E" indicates estimated value based on specific conductance. All other values represent residue on evaporation at 105°C.

[a] Sodium plus potassium, computed as difference between determined negative and positive ions; expressed as sodium. Assumes that concentrations of undetermined negative ions are small.

[b] Additional determination: Total manganese (Mn), 0.00 mg/L.

[c] Additional determinations: Boron (B), 0.030 mg/L; phosphorus (P), 0.12 mg/L; silica (SiO_2), 39 mg/L; water temperature, 12.0°C (54°F).

[d] Lake-surface altitude, 5,037.1 feet; lake volume, about 1,300 acre-feet; dissolved-solids content of lake, about 2,300 tons. Additional determinations: Carbonate (CO_3), 40 mg/L; boron, 1.3 mg/L; phosphorus, 3.3 mg/L; silica, 13 mg/L; water temperature, 19.0°C (66°F) at 1300 hr.

[e] Additional determination: Carbonate, 14 mg/L.

[f] Additional determinations: Carbonate, 14 mg/L; total manganese, 0.01 mg/L.

[g] Additional determinations: Boron, 0.006 mg/L; dissolved iron, 0.02 mg/L; dissolved manganese, 0.000 mg/L; phosphorus, 0.01 mg/L; silica, 34 mg/L; water temperature, 10.5°C (51°F).

TABLE 22.--*Specific conductance and nitrate concentration of surface and ground water*[1]

Location	Source (with well depth or flow quantity and water temperature as appropriate)	Date	Specific conductance (micromhos)	Nitrate as N (mg/L)[2]
N20 E18 5BAAC	Streamflow in Waltz Canyon [16 gal/min, 13.0°C (55°F)]	11- 9-76	118	--
N21 E18 16BDBB1	Well (165 ft)	1-19-76	348	2
19DACA2	Well (125 ft)	11-10-76	308	3
20BAAD1	Well (97 ft)	1-19-76	275	6
20BBDA1	Well (105 ft±)	1-19-76	398	3
20BBDC1	Well (94 ft)	1-19-76	298	2
20BCCC1	Well (121 ft±)	1-20-76	373	6
29BBDC1	Well (130 ft)	1-19-76	237	1
29CADB1	Well (125 ft)	1-19-76	226	0
29CDAA1	Well (230 ft)	1-19-76	311	0
29CDDC1	Well (120 ft±)	1-19-76	332	1
32ADDA	Streamflow from Waltz Canyon [about 0.8 ft^3/s, 14.5°C (58°F)]	3-29-78	205	--
33BACD	Irrigation runoff [about 0.2 ft^3/s, 18.0°C (64°F)]	4-12-78	304	--
33BBBD	Streamflow from Waltz Canyon [about 0.05 ft^3/s, 16.5°C (62°F)]	4-12-78	244	--
33CCDD	Runoff from springs in N20 E18 4BCA and 4BB [2 gal/min, 10.5°C (51°F)]	11- 9-76	238	--

[1] Field determinations. Similar data for springs are listed in table 20.

[2] Nitrate plus nitrite, expressed as nitrogen; nitrite concentration assumed negligible.

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