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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division

WATER-RESOURCES RECONNAISSANCE OF WHISKEYTOWN
NATIONAL RECREATION AREA, CALIFORNIA

Prepared in cooperation with the
National Park Service

ADMINISTRATIVE REPORT
For U.S. Government use only

Menlo Park, California
1969



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By
R. W. Page

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Menlo Park, California
March 12, 1969

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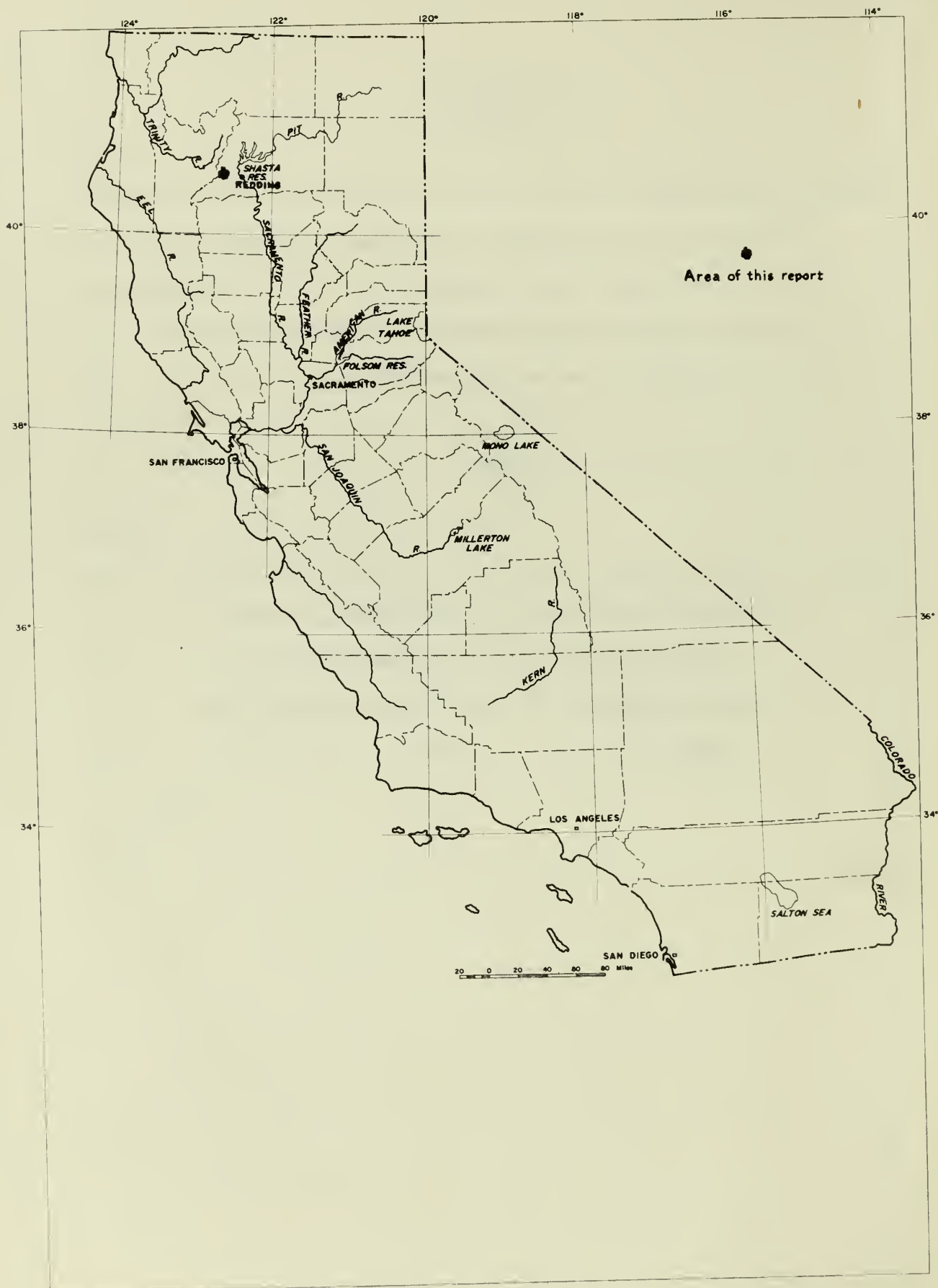


FIGURE 1.— Index map.

WATER-RESOURCES RECONNAISSANCE OF WHISKEYTOWN

NATIONAL RECREATION AREA, CALIFORNIA

By R. W. Page

ABSTRACT

The Whiskeytown National Recreation Area lies about 6 miles west of Redding, Calif. in an area of extreme relief. In 1967, the area accommodated about 414,000 people and used about 4,600,000 gallons of water. The major source of water was Whiskeytown Lake. Minor sources were ground water and water from creeks.

Geologic units in the area consist of the Copley Greenstone, Balaklala Rhyolite, Bragdon Formation, Mule Mountain stock, Shasta Bally batholith, and unconsolidated deposits. Where penetrated by wells, those units yield small to moderate quantities of water.

Clear Creek has the largest drainage basin (115 square miles) from which water flows into the area and a larger streamflow in the autumn, winter, and spring than in summer. Other creeks in the area have much smaller drainage basins yet probably have streamflow patterns similar to that of Clear Creek. Creeks with very small basins are intermittent.

With the exception of iron in the water of one well, the analyzed constituents in the water of the area do not exceed the limits recommended by the U.S. Public Health Service. Bacteriological suitability of the water for drinking was not determined.

For future recreation and service sites, Whiskeytown Lake is the best source for water; the next best source is water from selected creeks.

INTRODUCTION

Locations and Features

The Whiskeytown National Recreation Area lies about 6 miles west of Redding along U.S. Highway 299W (fig. 2). It is an area of extreme relief, ranging in altitude from 6,209 feet at Shasta Bally to about 825 feet along Clear Creek in the SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, T. 31 N., R. 6 W. (fig. 2). The relief has been accented by the numerous creeks which have carved deep, steep-sided valleys into the surrounding hills and mountains.

Many of the creeks are perennial and flow directly into Whiskeytown Lake. Thus, Whiskeytown Lake with an area of about 5 square miles serves as a surface-water reservoir for much of the surrounding area. The principal sources of inflow to the lake are water from Clear Creek and water from the Trinity River which has² been piped in via the Clear Creek pressure tunnel.

In 1967, as shown below, the developed areas were used by about 414,000 people. During that same time, about 4,600,000 gallons of water were used, mostly during the summer (fig. 3)(written commun., H. W. Hunt, Chief Ranger, 1968). At the Whiskeytown Marina, water is piped from a spring and pumped from a well near the lake (fig. 2). The other three areas are supplied with water pumped from the lake.

Area	:	Number of	:	Water used ₁ /
	:	visitors	:	(gallons) _a
	:		:	
Brandy Creek Marina		300,107		829,400
Headquarters--overlook		68,398		1,738,100
Oak Bottom Marina		21,267		1,955,000
Whiskeytown Marina		23,839		76,950
Total		413,611		4,600,000

1. Includes irrigation use. Metered pumpage from Park Service Records.
- a. Value rounded to 1 percent accuracy.

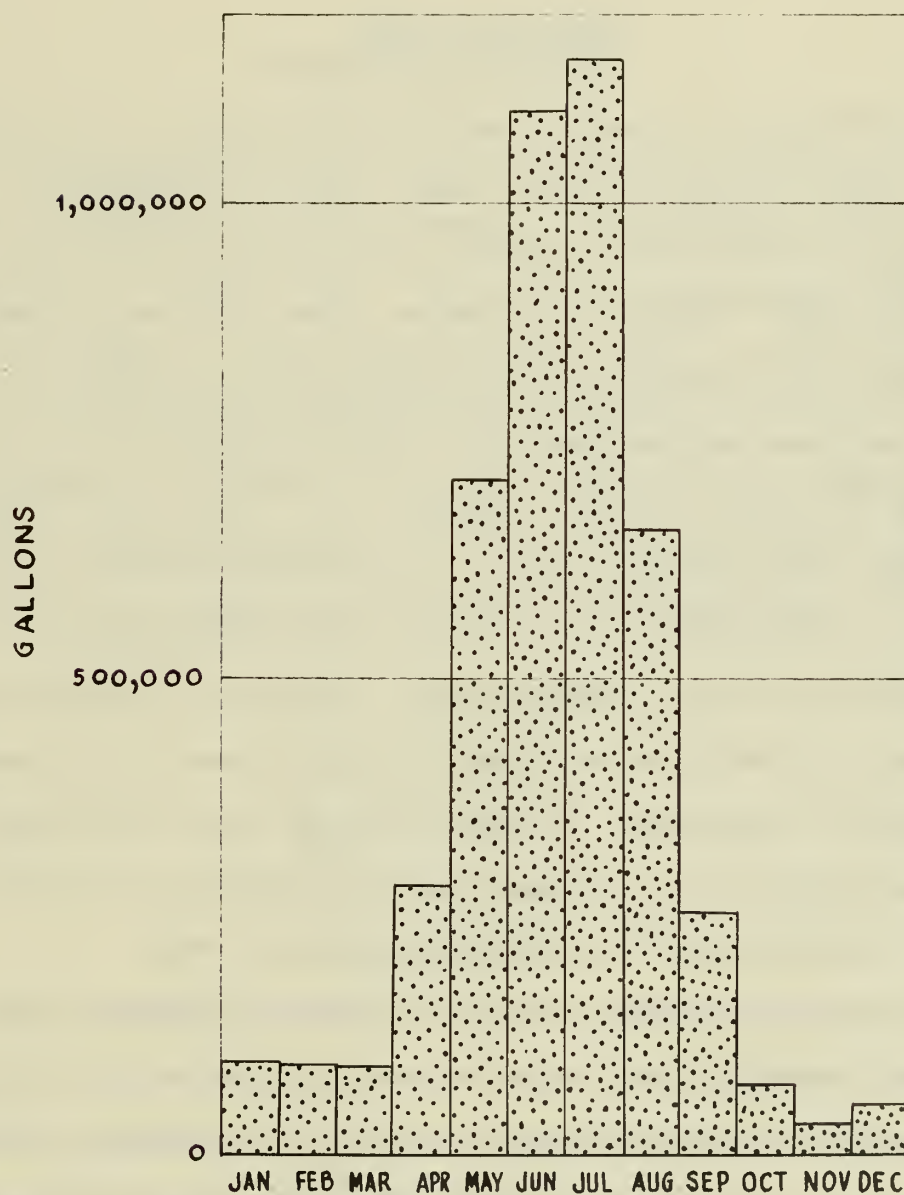


FIGURE 3.— Graph showing monthly demand for water in 1967.

Purpose and Scope

At the request of the National Park Service, the U.S. Geological Survey, Water Resources Division, made a study for the purpose of exploring the water-supply potential of the Whiskeytown National Recreation Area. Fieldwork was started in April 1968 and completed in September 1968. In addition to studying the general area, four specific sites, that have been designated for future development, were inspected. The four sites are, in order of priority: (1) A site on the east side of Whiskey Creek near Red Gulch, (2) a site near Tower House, (3) a site near Dry Creek, and (4) a site near Davis Gulch (oral commun., L. J. Mitchell, Project Manager, 1968). In addition to inspection of the four specified sites, all known wells in the area were canvassed, estimates and measurements of streamflows were made, water samples for chemical analysis were collected, four known springs were visited, and a brief reconnaissance for additional springs was made.

National Park Service personnel including Mr. Mitchell and Mr. Hunt were very helpful in providing background data, and Mr. H. D. Cornell, Park Ranger, was very informative as a guide. In addition, residents in the area were very cooperative in supplying data on water wells, springs, and creeks.

This report was prepared by the Geological Survey, Water Resources Division, in cooperation with the National Park Service as part of an investigation of the water resources of Shasta County. The work was done during 1968 under the general supervision of R. Stanley Lord, district chief in charge of water-resources investigations in California, and under the immediate supervision of Willard W. Dean, chief of the Sacramento subdistrict office.

Well-Numbering System

The well-numbering system used by the Geological Survey in California indicates the location of wells according to the rectangular system for the subdivision of public lands. For example, in the number 32N/6W-9D1, which was assigned to a well near Whiskeytown Marina, the part of the number preceding the slash indicates the township (T. 32 N.); the number after the slash the range (R. 6W.); the digits after the hyphen the section (sec. 9); and the letter after the section number the 40-acre subdivision of the section as indicated on the diagram below.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Within each 40-acre tract the wells are numbered serially as indicated by the final digit of the well number. Thus, well 32N/6W-9D1 was the first well in the $NW\frac{1}{4}NW\frac{1}{4}$ sec. 9 to be listed. The entire area is north and west of the Mount Diablo base line and meridian.

SOURCES OF WATER

Other than Whiskeytown Lake, the sources of water in the area are ground water and creeks. In order to properly evaluate sources in the area, it is necessary to determine the ground-water geology and the characteristics of streamflow.

Geologic Units and Their Water-Bearing Properties

The geology of the Whiskeytown National Recreation Area was mapped and described by Kinkel and others (1956) and Albers (1965). In addition, R. H. Dale of the Geological Survey described four well sites in and near the developed areas with particular reference to the water-bearing properties of the geologic units at those sites (written commun., 1963). In this report, although only a brief description of pertinent geologic units and structures is given, a particular reference is made to the water-bearing properties of those units.

Copley Greenstone

The Copley Greenstone of Devonian(?) age crops out **over** most of the area surrounding the lake (fig. 2). It is hard and dense and consists principally of altered volcanic rocks that have a maximum thickness of at least 3,700 feet (Albers, 1965, p. 9).

Where weathered and saturated, the Copley yields small quantities of water to wells, but its hard, dense nature and generally unfractured condition precludes any large yields of water. For example, wells 32N/6W-7C1, 7D1, and 9C1 all drilled in greenstone (fig. 2) yielded only 9, $2\frac{1}{2}$, and 1 gpm (gallons per minute). However, the driller's logs (table 1) indicate that wells 7C1 and 9C1 penetrated weathered Balaklala Rhyolite (see p. 12) near the surface and then penetrated weathered and unweathered Copley at greater depth. According to the driller, water was found at the contact of the rhyolite and the greenstone and in weathered greenstone.

Table 1.--Logs of wells

Log of well 32N/6W-7C1

[Altitude about 1,225 feet. Drilled by Grade Drilling Co. in 1963.

6-inch casing. Log by driller]

	Thickness (feet)	Depth (feet)
Fill	2	2
Rock, yellow, soft	26	28
Rhyolite, medium	20	48
Greenstone, medium	10	58
Greenstone, soft	2	60
Greenstone, very hard	3	63

Log of well 32N/6W-9C1

[Altitude about 1,230 feet. Drilled by Grade Drilling Co. in 1963.

12-inch casing. Log by driller]

	Thickness (feet)	Depth (feet)
Rock, brown, soft	10	10
Bluestone, fairly soft	30	40
Bluestone, very hard	85	125

Two springs are known to issue from the Copley. One spring occurs in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 9, T. 32 N., R. 6 W.; the other, occurs in the SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3, T. 32 N., R. 7 W. (fig. 2). Both springs are located either on or near faults. Water for use at the Whiskeytown Marina is obtained from the spring in sec. 9 and from well 32N/6W-9D1; the discharge of the spring is not known. The spring in sec. 3, known locally as the Bickford Spring, supplies water to a small house; its discharge in May 1968 was about 1 gpm. Because of the dense nature and generally unfractured condition of the Copley Greenstone, the discharge of any spring issuing from it probably would be small.

Balaklala Rhyolite

The Balaklala Rhyolite of Middle Devonian age crops out in the hills and mountains surrounding the lake (fig. 2). It overlies the Copley Greenstone and in places is transitional and intertongues with the Copley (Albers, 1965, p. 9-10). The Balaklala is hard, somewhat dense, and consists principally of volcanic flows and pyroclastic rocks that range in thickness from 0 to about 3,500 feet (Albers, 1965, p. 10).

Locally the Balaklala is shattered and where saturated, fractures yield small quantities of water to wells. For example, the yield of well 32N/6W-9N1 drilled to a depth of about 32 feet in the Balaklala was about 10 gpm (oral commun., August Herman, resident, 1968).

Three springs were noted by R. H. Dale (written commun., 1963) at the contact between the Balaklala Rhyolite and the Copley Greenstone near Red Gulch (fig. 2). The springs now have been inundated by the lake. No other springs were found in the Balaklala, although they probably exist, especially near contacts with other units. Because of its tight nature the discharge of any spring from the Balaklala probably would be small.

Bragdon Formation

The Bragdon Formation of Mississippian age crops out in the north-central and northwestern part of the area (fig. 2). It overlies both the Copley Greenstone and the Balaklala Rhyolite and consists principally of shale, mudstone, and siltstone (Albers, 1965, p. 11). The thickness of the Bragdon is probably about 6,000 feet (Albers, 1965, p. 11).

No wells that penetrated the Bragdon were found in the area. However, rock types such as those found in the Bragdon generally yield only small quantities of water to wells.

A spring occurs in fractured shale of the Bragdon Formation in the NE¹/₄ NW¹/₄ sec. 2, T. 32 N., R. 7 W. upslope from a fault (fig. 2); in April 1968, its discharge was estimated to be 2 gpm. If other springs are found in the Bragdon, they probably will have small discharges also.

Mule Mountain Stock

The Mule Mountain stock crops out in the eastern part of the area and southwest of the lake (fig. 2). The age of the Mule Mountain stock is inferred to be Late Jurassic (Kinkel and others, 1956, p. 47; Albers, 1964, p. J36), but may be as young as Early Cretaceous (Albers, 1965, p. 12-13). It consists principally of light-colored granitic rock which has intruded the overlying Copley Greenstone and Balaklala Rhyolite.

Well 32N/6W-22Q1, located near the lake, is the only well in the area known to tap the Mule Mountain stock. R. H. Dale estimated its yield to be 20 gpm (written commun., 1963). Prior to water being supplied from the lake, the well supplied water to the headquarters area (oral commun., H. W. Hunt, 1968).

The discharge of a spring which occurs upslope from a fault in the Mule Mountain stock, NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 15, T. 32 N., R. 6 W., has been measured at a third of a gallon per minute (written commun., R. H. Dale, 1962). Other springs occurring in the Mule Mountain stock probably have similarly small discharges.

Shasta Bally Batholith

The Shasta Bally batholith crops out over the southwestern part of the area. It was tentatively assigned a Late Jurassic or possibly Early Cretaceous age by Albers (1965, p. 13). The batholith consists of quartz diorite and granodiorite that has intruded overlying rocks.

The Shasta Bally batholith was not inspected during the field investigation. However, where fractured and saturated, the Shasta Bally batholith probably would yield small quantities of water to wells.

Unconsolidated Deposits

The unconsolidated deposits of Holocene age consist mostly of slope wash or colluvium, landslide debris, and stream gravels (Albers, 1965, p. 14). They crop out along streams and on hillslopes throughout the area. Furthermore, according to Albers (1965, p. 14), slope wash covers large parts of nearly every mountain and hillslope throughout the area but was mapped only where the underlying rock could not be defined with a fair degree of confidence. The exposed unconsolidated deposits observed during the field investigation did not exceed 25 feet in thickness.

Where saturated, the unconsolidated deposits yield moderate to small quantities of water to wells. For example, wells 32N/6W-20F2 and 20F3 yielded about 22 and 6 gpm, respectively, from unconsolidated deposits. Well 20F2 is about 28 feet deep and well 20F3, about 22 feet deep; both wells penetrate about 2 feet of greenstone at the bottom. For the most part, the unconsolidated deposits observed in the area were not only thin but generally unsaturated or not completely saturated. Consequently, they would not yield water to wells or would yield only small quantities.

A number of seeps occur in slope wash in the unconsolidated deposits in approximately the SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 2, T. 32 N., R. 7 W. The discharges of the seeps were small but were not estimated.

Creeks

Several creeks flow into Whiskeytown Lake (fig. 2). The largest, Clear Creek, drains an area of about 115 square miles above the gaging station at French Gulch (0.84 mile north of the area). From 1963 to 1967 the streamflow in Clear Creek averaged about 144,000 acre-feet per year. Large streamflows occur in autumn, winter, and spring (fig. 4), but small streamflows occur during the late summer, when the demand for water is large (fig. 3). The pattern of streamflow in Clear Creek paralleled the pattern of precipitation at Whiskeytown Reservoir (figs. 2 and 4). This correlation of patterns indicates that often after precipitation, an increased runoff occurs in the Clear Creek basin. Nevertheless, some precipitation goes into storage in the unconsolidated deposits and in fractures in the underlying rocks. During winter months, some precipitation goes into storage as snow. Seepage from storage probably makes up a large part of the streamflow during the dry summer and early autumn.

In September 1968, all of the other creeks and gulches in the area had a much smaller streamflow than that of Clear Creek (table 2). A direct comparison between the pattern of streamflow in Clear Creek and the patterns in other creeks throughout the area is not possible because only Clear Creek is gaged periodically. However, the pattern of streamflow in other creeks probably parallels that of Clear Creek because all of the drainage basins in the area are underlain by hard, dense, or tight rock which locally is overlain by unconsolidated deposits.

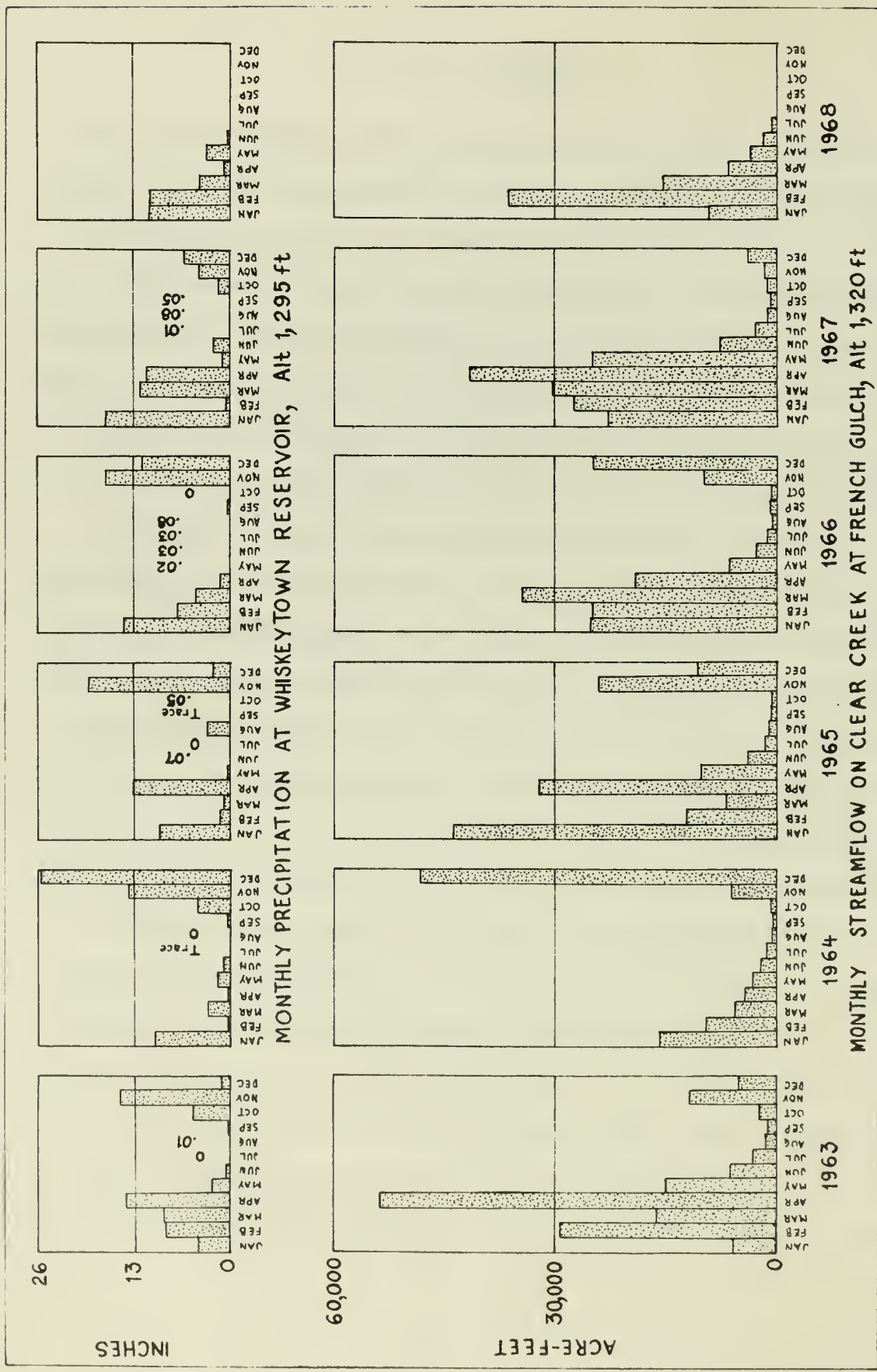


FIGURE 4. — Precipitation and streamflow graphs.

Table 2.--Streamflow and areas of drainage basins in and near

Whiskeytown National Recreation Area

Drainage basin	Area (sq mi)	Streamflow (cfs)	
		Estimated	Measured
		May 21-24, 1968	Sept. 16-17, 1968
Davis Gulch	0.03	0.002	Dry
Unnamed gulch west of Davis Gulch	.08	.004	<0.001
Red Gulch	.18	.05	(a)
Bull Gulch	.43		Dry
Slate Gulch	.52		Dry
White Rock Gulch	.52		(a)
New York Gulch	.70		Dry
Dry Creek	.80	.03	Dry
Unnamed gulch (S $\frac{1}{2}$ sec. 4, T. 32 N. R. 6 W.)	.80		.003
Liberty Gulch	1.2		<.001
Mill Creek	3.0		.40
Grizzly Gulch	3.7		<.04
Boulder Creek	5.6		.38
Whiskey Creek	9.3		.71
Brandy Creek	10		3.60
Crystal Creek	13		c2.89
Willow Creek	20		d.64
Clear Creek	115	e64-56	f11

a. Seepage only

b. Dry near Whiskeytown Lake

c. Does not include diversion of 0.63 cfs

d. Includes leakage from irrigation ditch of .06 cfs

e. Gaged

f. Gaged August 5, 1968.

According to Mr. D. L. Stanphill, a resident of the area, Mill Creek flows throughout the year. Mill Creek has a drainage basin of about 3.0 square miles. Using basin area as a crude guide, creeks located in basins larger than that of Mill Creek probably are perennial also (table 2). During a dry summer, creeks located in smaller drainage basins become dry or nearly dry because of a lack of storage in their basins.

CHEMICAL QUALITY

With the exception of iron in the water of well 36N/6W-22Q1, the analyzed constituents in the water of the Whiskeytown National Recreation Area did not exceed the limits recommended by the U.S. Public Health Service (1962). The bacteriological suitability of the water for drinking was not determined. As indicated in table 3, the water from creeks generally contains fewer dissolved solids than that from either wells or springs.

All chemical analyses in table 3 were made by the U.S. Geological Survey.

Table 3.--Chemical analyses of water in wells, springs, and creeks

Well number	Date of collection	Number above line, milligrams per liter Number below line, milliequivalents per liter															pH	Specific conductance (micromhos at 25°C)	Laboratory and sample number			
		Copper (Cu)	Zinc (Zn)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Carbonate (CO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Boron (B)				Calculated solids (sum of determined constituents)	Hardness as CaCO ₃	Noncarbonate hardness as CaCO ₃
U.S. Public Health Service drinking-water standards (1962)		1	5		0.3						250	45					500					
wells: 32N/63-771	9-19-63			44		7.5 0.37	11 0.90	13 0.57	0.3 0.01	108 1.77	0	1.0 0.02	2.2 0.06	0.3 0.02	2.8 0.05	0	135	63	0	177	7.3	44773
	9-18-63		30			4.4 2.20	16 1.32	13 0.57	.3 .01	238 3.90	4 .13	4.4 .09	2.2 0.06	.1 .01	4.4 .07	0	235	176	0	367	8.3	44774
	9-20-63		21			2.8 1.40	9.8 .81	6.0 .26	.1 .00	141 2.31	0	6.6 .14	1.5 0.04	.2 .01	1.7 .03	0	144	111	0	237	7.9	44775
	9-17-63		17			8.0 1.40	2.4 .20	4.2 .18	.6 .02	42 .69	0	.4 .01	2.3 0.06	.1 .01	3.9 .06	0	60	30	0	82	7.3	44778
	9-16-63		20			14 .70	2.6 .21	4.4 .19	.5 .01	63 1.03	0	2.0 .04	.7 0.02	.1 .01	2.5 .04	0	78	45	0	109	8.0	44777
22Q1	11-15-62		36	0.56	12 .60	4.9 .40	10 .14	0	69 1.13	0	10 .21	2.2 0.06	.3 .02	1.2 .02	0	111	50	0	133	6.6	41625	
springs: Pickford Spring T. 32 N., R. 7W. sec. 3	5-24-68	0	0.07	35	.08	20 1.00	7.7 .63	14 .61	.3 .01	118 1.93	2 .07	11 .23	.6 0.02	.1 .01	.1 .00	.02	149	82	0	213	8.3	57235
	11-14-62		28		0	18 .60	9.2 .76	9.9 .43	0	118 1.93	0	2.0 .04	3.0 0.08	.3 .02	1.3 .02	0	130	83	0	184	7.2	41623
creeks: Brandy Creek T. 32 N., R. 6W. sec. 20	11-15-62		20	.02	6.4 .32	1.5 .12	3.8 .17	.5 .01	29 .48	0	1.0 .02	4.0 .11	.2 .01	.6 .01	0	52	22	0	55	7.1	41624	
	5-21-68	0	0	19	.03	2.8 .29	1.4 .12	4.4 .15	1.0 .03	21 .51	0	1.0 .02	.5 .01	.1 .01	0	.02	47	20	0	57	7.5	57236
gulches: Reel Gulch T. 32 N., R. 6W. sec. 7	5-21-68	0	0	20	.03	5.2 .26	5.8 .48	4.6 .20	.1 .00	31 .51	0	20 .42	.4 0.01	.1 .01	.1 .00	0	71	37	12	98	7.6	57233
	5-24-68	0	0	28	.03	21 1.05	8.5 .70	4.8 .21	.3 .01	106 1.74	0	8.0 .17	.4 0.01	.1 .01	.3 .00	.01	124	88	1	186	7.2	57234
a. May have been affected by contamination of sample container.																						

a. May have been affected by contamination of sample container.

SITES FOR FUTURE DEVELOPMENT

Site Near Red Gulch

A site near Whiskey Creek just west of Red Gulch and along the lake is being prepared for 200 campsites which will accommodate from 800 to 1,000 campers (oral commun., H. W. Hunt, 1968) (fig. 2). Later on, an additional 100 campsites will be built. According to Mr. Kenneth Mitchell of the California Division of Parks and Recreation, each camper uses 5 gpd (gallons per day) of water in areas where there are minimal facilities and 40 gpd where there are showers and flush toilets (oral commun., 1968). Consequently, campers in the Red Gulch area would use a maximum of 5,000 gpd if showers and toilets were not provided; if these facilities are provided, campers would use a maximum of 40,000 gpd. When the additional campsites are built, the maximum demand will increase to 60,000 gpd.

Three sources of water are available to meet the demand, (1) a well, (2) a creek, and (3) the lake. Well 32N/6W-9C1 yields about 1 gpm or about 1,400 gpd from dense rock (table 1). If other wells were drilled in the area near Red Gulch, their yields probably would be similar. Consequently, several wells would be needed in order to meet the maximum demand. In May 1968, the streamflow in Red Gulch was estimated to be 0.05 cfs (cubic feet per second) or about 32,300 gpd; in September there was no streamflow, only small seepages. Therefore, the only source for a large, dependable supply of water for the campground is Whiskeytown Lake.

Site Near Tower House

The site near Tower House eventually is to be developed into a headquarters. At this time (September 1968) the water requirement is not known. If the area becomes comparable to the present headquarters-overlook area, then a maximum of about 15,000 gpd will be used.

Suggested sources of water for the Tower House area have been wells, springs, and creeks. No wells have been drilled in the area. However because the area is underlain by the Bragdon Formation and largely unsaturated unconsolidated deposits, yields to wells probably would be small. Springs that were reported to be along the north bank of Willow Creek actually were leakages from a small irrigation ditch (fig. 2). Three creeks flow through the area, Mill Creek, Willow Creek, and Clear Creek. The drainage basin of Clear Creek is the largest; that of Mill Creek, the smallest (table 2). For the period of record from 1963 to 1967, the smallest monthly streamflow in Clear Creek at French Gulch was about 541 acre-feet in September 1964. During that same month, the smallest daily streamflow was about 4,738,000 gpd, which would be more than adequate to supply the demand for water in the Tower House area. However, Clear Creek reportedly is polluted; therefore, tests for bacteria should be made before selecting it as a source. Willow Creek and Mill Creek are alternate sources of water for the area. Willow Creek lies along the highway and therefore is subject to pollution also. Its streamflow in September 1968 was measured at 0.64 cfs or about 410,000 gpd. Mill Creek probably could be protected from pollution. Its streamflow in September 1968 was measured at 0.40 cfs or about 260,000 gpd.

Another source of water to the Tower House area is the irrigation ditch that taps Crystal Creek and delivers water to just north of Tower House (fig. 2). That ditch in May 1968 had a flow estimated to be 0.4 cfs near the $SE\frac{1}{4}SE\frac{1}{4}$ sec. 34, T. 33 N., R. 7 W.; in September 1968 its flow was measured at 0.63 cfs or about 410,000 gpd.

Site Near Dry Creek

A site near Dry Creek is being prepared for 25 campsites which will accommodate from 125 to 200 campers. Depending on the facilities that are available, the maximum demand for water would range from about 1,000 to 8,000 gpd.

There are no wells or springs near the proposed campground. Yields to wells in that area probably would be small because the area is underlain by Copley Greenstone and Balaklala Rhyolite (fig. 2).

Dry Creek, which lies north of the proposed campground, had a flow estimated to be 0.03 cfs or about 19,000 gpd in May 1968; in September 1968 it was dry. Therefore, Dry Creek would not be a dependable source of water. A small unnamed creek lies near the campground, but its basin is only about one-half the size of the Dry Creek basin (table 2), and in September 1968 it was dry. The only dependable source of water for the campground is Whiskeytown Lake.

Site near Davis Gulch

A site near Davis Gulch is proposed as a rest stop for hikers; consequently, only a small water supply is required. In May 1968, discharge in Davis Gulch was estimated at 0.002 cfs or 1,300 gpd; an unnamed creek just west of Davis Gulch was flowing at about 0.004 cfs or 2,600 gpd. In September 1968, Davis Gulch was dry, and the unnamed creek was flowing less than 0.001 cfs or less than 650 gpd. Also, most of the flow in the unnamed creek was infiltrating into the creek bed near the lake. Consequently, there is a small underflow within the unconsolidated deposits beneath that creek that probably could be intercepted by shallow wells or sumps.

SUMMARY AND CONCLUSIONS

The Whiskeytown National Recreation Area is underlain mostly by hard, dense rocks and partly by unconsolidated deposits (fig. 2). Where saturated and fractured or weathered, the rocks yield small quantities of water to wells and springs. The unconsolidated deposits generally are thin, largely unsaturated, and yield only moderate to small quantities of water to wells. The probability of developing wells or finding and developing springs in the area to supply more than small quantities of water is very low.

Most streams in the area probably have a streamflow pattern similar to that of Clear Creek (fig. 4); that is, streamflows occurring in autumn, winter, and spring are larger than those occurring in summer. Mill Creek with a drainage basin of about 3 square miles reportedly is a perennial stream. Creeks located in drainage basins much smaller than that of Mill Creek are intermittent (table 2). Consequently, if any creek is chosen as a water supply, it should be gaged for a period of time to determine if the quantity and reliability of streamflow is adequate to supply the demand.

For installations needing a large, dependable water supply, Whiskeytown Lake should be used whenever possible.

The bacteriological suitability of the water in the area was not determined. The results of chemical analyses of water (table 3) indicate that the analyzed constituents in the water do not exceed the limits recommended by the U.S. Public Health Service except for the concentration of iron in water from well 32N/6W-29Q1.

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