UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
OFFICE OF LAND ACQUISITION AND WATER RESOURCES
WATER RESOURCES DIVISION
SAN FRANCISCO, CALIFORNIA

WATER SUPPLY SURVEY

AT

BIG MEADOW
YOSEMITE NATIONAL PARK
CALIFORNIA

By
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Administrative Report
for U.S. Government use only

September 1971

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ILLUSTRATIONS

TABLES

I - INTRODUCTION

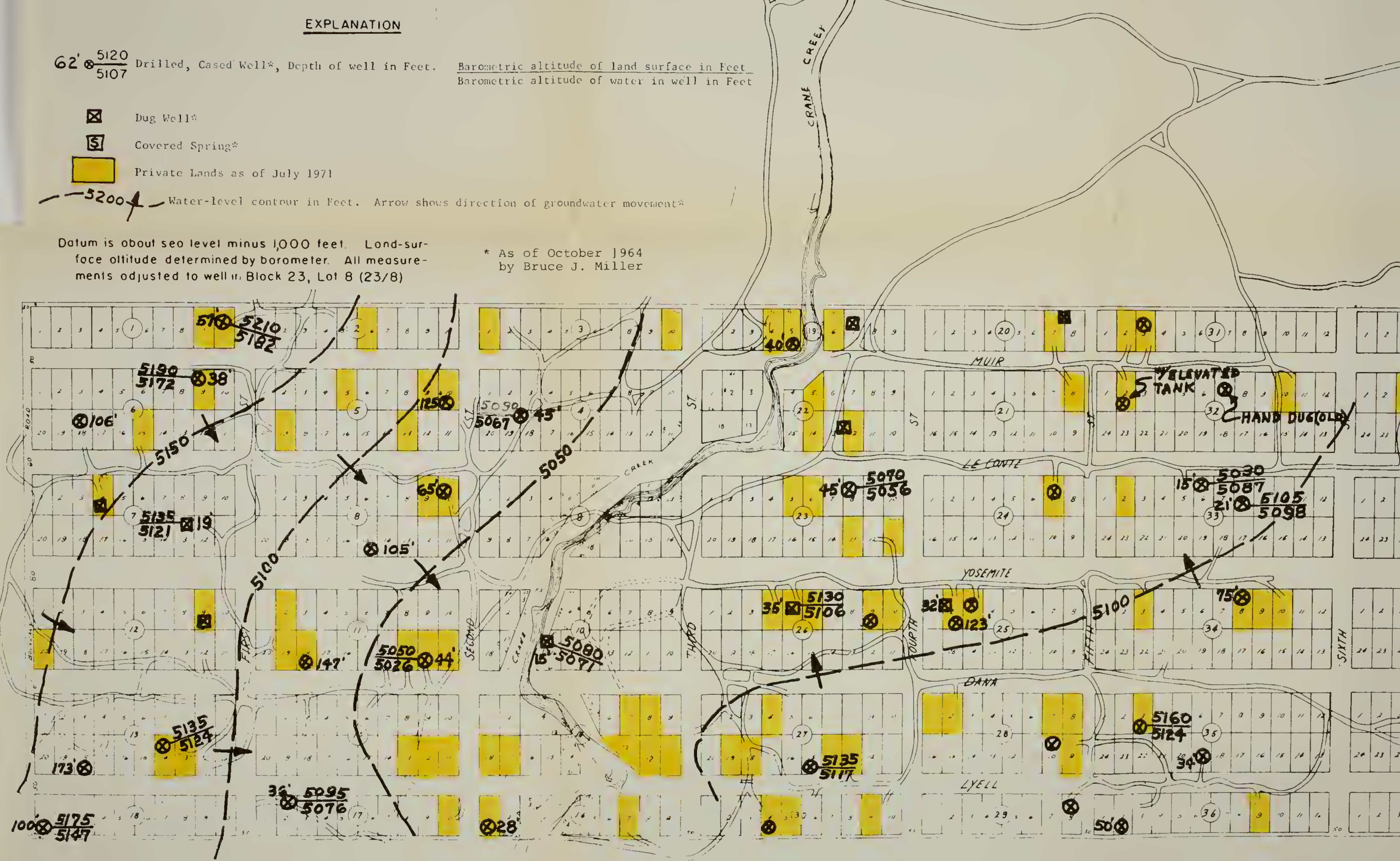
In accordance with the proposed General Development of the Master Plan Preliminary Working Draft of July 1971, Big Meadow is proposed as a major development area in support of the park resources. Many of the Services and concession support facilities, parking facilities and overnight and food service units are scheduled to be transferred from the valley to Big Meadow. In accordance with the Western Regional discussions with Chief of Water Resources Division at the Regional program meeting of May 28, 1971, a 5.0 million gallons per day maximum demand 1/ could be needed in the Big Meadow Area to support the future growth and the proposed relocation of facilities. The high water demand is further complicated by the small drainage basin and topographic location of the site on the north side of the Merced River Gorge which is situated between El Portal, Merced River and Tuolumne Grove, and with the U.S. Forest Service lands on the west.

A review has been made of the ground and surface water available on and off the park. A recent visitation was made to the Big Meadow-Foresta Subdivision and vicinity of Yosemite National Park on August 2-6, 1971, for the purpose of gathering information for a study on available potable water supplies. This report presents the results of the field investigations, research and review made on the park water supply problems in that area.

II - EXISTING FACILITIES

No existing usable water or sewer system is available in the Big Meadow Area. The area is underdeveloped and generally consists of approximately 300 acres of cleared irrigated pasture land with a ranch house and two barns and in the tree covered area, known as Foresta, are found various types of summer cottages. Private local water systems do exist for the individual dwellings in the Foresta Subdivision with small quantities of water being supplied by shallow (drilled or dugged) wells. A few of the local water systems obtain water directly from Crane Creek. The majority of these local water supplies (approximately 50 in number) consists of untreated systems and do not safely comply with the present U.S. Public Health Service Drinking Water Standards. See Figure 1, Foresta Subdivision Plat "B", Water Wells and Private Lands, for location of the local water supplies and wells.

Individual septic tanks of various designs and pit-type toilets are found throughout Foresta Subdivision and as such create an unsafe condition for contamination of both surface and groundwater supplies. The Service is presently acquiring all private lands and local water supplies in the general area.



WATER WELLS & PRIVATE

LANDS-FORESTA

SCALE: 1" = 200'

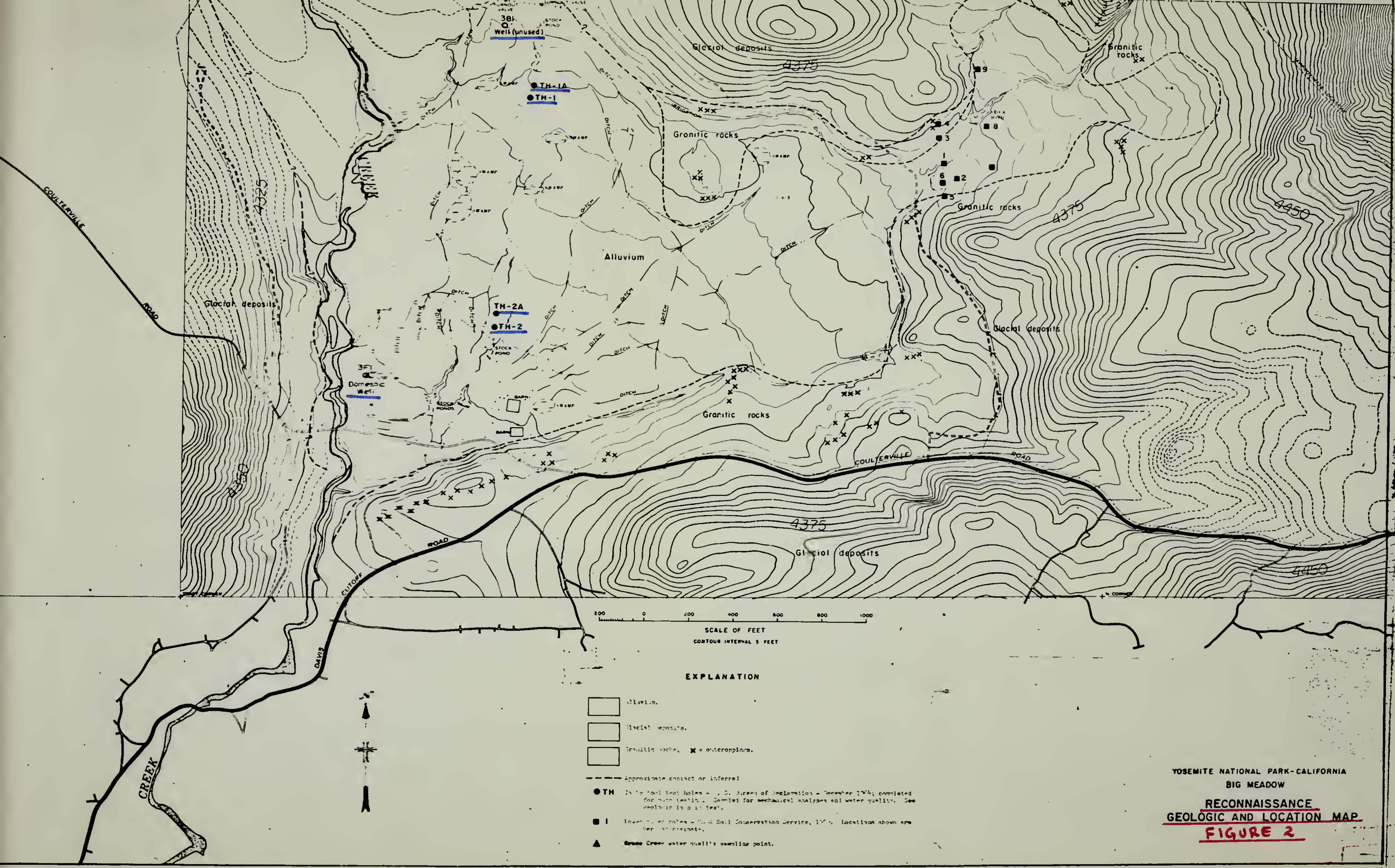
FIGURE 1

FORESTA SUBDIVISION
PLAT B' MARIPOSA COUNTY, CALIFORNIA LAND RECORDS
SEC 2 & 3, T3S, R20E, MDB&M.
PREPARED BY YOSEMITE NATIONAL PARK, CALIFORNIA
DRAWN BY WARREN J. HARDING

The ranch pasture and clearing on the north side of the Coulterville Road in Big Meadow is irrigated by a perimeter irrigation ditch which is supplied at a rock diversion dam on the upper portion of Crane Creek northwest of the meadow. See Figure 2, Reconnaissance Geologic and Location Map, for a general location of the irrigation system. A detailed location of the irrigation ditch and pipe line may be found on Sheets 3, 4, and 5 of Drawing Number NP-YOS-3718. As a result of the continued irrigation the meadow is marshy and becomes swampy on the eastern portion throughout the year.

The geology of the area is shown on Figure 2, Reconnaissance Geologic and Location Map. The three geologic units [2/] which are exposed in the area are, from oldest to youngest, (1) the basement complex of pre-Tertiary age, (2) glacial deposits of Pleistocene age, and (3) alluvium of Recent age. The basement complex consists of dense, impermeable granodiorite and outcrops are found in the area north, east, and south of Big Meadow, and presumably underlies both the glacial deposits and the alluvium at shallow depths. The glacial deposits, which overlies the basement complex and probably underlies the alluvium, consists, for the most part, of very angular boulders of granodiorite, as much as 5 or 6 feet in diameter, with fine-grained clay and silt filling most of the space and voids between the boulders. The thickness of the deposits are unknown, but, on the basis of the physiography of the area, it is estimated to range from 10 to 100 feet thick. The alluvium overlies the basement complex and the glacial

YOSEMITE NATIONAL PARK-CALIFORNIA
BIG MEADOW
RECONNAISSANCE
GEOLOGIC AND LOCATION MAP
FIGURE 2



YOSEMITE NATIONAL PARK-CALIFORNIA
BIG MEADOW
RECONNAISSANCE
GEOLOGIC AND LOCATION MAP
FIGURE 2

deposits and, where exposed along the banks of Crane Creek, consists of well-sorted medium to coarse sand. Eastward from the creek, the alluvium becomes progressively finer grained, more poorly sorted, and less permeable than it is in the western part of the outcrop area. On the basis of the physiography of the area, the alluvium is estimated to be about 50 feet thick and thins to a featheredge along the margin of Big Meadow.

The land surrounding the meadow is gently rolling and is typical forest land. Precipitation (see Table 1) averages approximately 35-50 inches per year (including snow) and is concentrated from October through May. During the summer the climate consists of warm days and cool nights (see Table 2).

Pump test results of the four cable tool test wells shown on Figure 2 have not been released for publication by the authorizing agency, however general information [3/] acquired during drilling operations of the test wells indicates the groundwater storage capacity of Big Meadow is approximately 75 acre-feet with an expected total yield of 150,000 GPD from wells drilled in the area known as the Meyer Ranch. The capacity [2/] of the basin, which is approximately 2 square miles, would no doubt provide a greater yield. A sustained yield of 25 to 100 gallons per minute can be expected from [7/] properly designed wells. Chemical analysis (see Table 3) of water samples taken from wells in both Foresta and Big Meadow and from Crane Creek indicates the presence of excessive amounts of iron exceeding the acceptable limits set for drinking water by the U.S. Public Health Service Standards.

TABLE 1
* PRECIPITATION - INCHES
YOSEMITE NATIONAL PARK

Month	Mean Monthly	Greatest Monthly	Least Monthly	Greatest Daily	Mean Snowfall
Jan.	6.33	24.62	0.95	4.18	27.5
Feb.	6.33	19.52	0.18	5.10	21.6
Mar.	5.42	20.98	0.61	3.23	18.1
Apr.	2.88	9.73	0.01	2.45	3.9
May	1.46	7.90	0.00	1.80	0.5
Jun.	0.63	3.14	0.00	1.80	0.0
Jul.	0.18	1.59	0.00	1.07	0.0
Aug.	0.17	1.36	0.00	0.90	0.0
Sep.	0.74	7.09	0.00	3.03	0.0
Oct.	2.00	10.71	0.00	2.40	0.2
Nov.	3.25	15.07	0.00	5.63	2.9
Dec.	5.61	16.79	0.23	5.94	18.0
Annual	35.00				92.7

TABLE 2
* TEMPERATURE - DEGREES FAHRENHEIT
YOSEMITE NATIONAL PARK

Month	Highest	Mean Daily	Mean Daily Maximum	Mean Daily Minimum	Lowest
Jan.	66	35.1	46.3	23.7	- 6
Feb.	81	39.6	52.6	26.5	1
Mar.	90	44.9	59.7	30.0	9
Apr.	96	51.2	67.2	35.1	12
May	99	56.5	73.0	40.2	15
Jun.	103	63.4	81.5	45.4	22
Jul.	104	70.7	90.2	51.2	33
Aug.	110	69.5	89.4	49.3	31
Sept.	103	63.2	82.7	43.7	24
Oct.	96	54.0	72.0	36.1	19
Nov.	85	43.6	58.5	28.7	10
Dec.	72	36.3	47.4	25.1	- 1
Annual	110	52.3	68.4	36.2	- 6

*Source: U.S. Department of Commerce, Weather Bureau, based on 44-48 years of records.

CHEMICAL ANALYSIS - BIG MEADOW WELLS
YOSEMITE NATIONAL PARK

Constituent (mg/L unless noted)	Wells 2/ *Big Meadow 3S/20E-3F1	Wells 2/ Foresta Block 44/Lot 16	Crane Creek 2/ Below Big Meadow
pH	6.8	6.4	7.8
Water Temperature, Degrees F	50°F	52°F	54°F
Specific Conductance, micromhos	130	143	56
Total Dissolved Solids (calc.)	110	88	52
Total Dissolved Solids (Residue at 180°C)	108	72	56
Bicarbonate (HCO_3)	74	86	32
Boron (B)	0	0	0
Calcium (Ca)	12	8.2	6
Carbonate (CO_3)	0	0	0
Chloride (Cl)	2	3.2	0.2
Fluoride (F)	0	0	0.2
Iron (Fe)	6.8	49	0.81
Magnesium (Mg)	2.2	0.6	0.5
Nitrate (NO_3)	0.8	0.2	0
Potassium (K)	1.5	0.6	1.4
Silica (SiO_2)	41	22	22
Sodium (Na)	13	11	5.2
Sulfate (SO_4)	1.0	0	0
Hardness as $CaCO_3$	39	23	17
Noncarbonate Hardness as $CaCO_3$	0	0	0
Date of Test	10/6/64	10/7/64	10/6/64
Well Depth	59 ft	72 ft	-

*Meyer's Well

See Table 9 for USPHS Limits

TABLE 3

III - FUTURE REQUIREMENTS

The present water demand for Yosemite Valley is 2,400,000 GPD 1/ as determined for the peak months of July and August. The maximum peak day flow is 3,200,000 GPD 1/ with peak short period flows over 4,000,000 GPD 1/. Based on the Master Plan a major portion of the facilities presently in Yosemite Valley will be relocated to Big Meadow. The water requirements for these facilities will accordingly be transferred to Big Meadow. The daily water demand, as shown on Table 4, Estimated Water Use for Yosemite Valley, is expected to increase as changes take place in the number of visitations, the number of permanent and seasonal NPS employees, the number of concessioner employees and other non-NPS residents, types and numbers of living quarters (both temporary and permanent for NPS, concessioner and other support facility employees), the types and number of housekeeping units and campsites, and the various kinds of support facilities. Likewise the future increases or changes noted in Table 4 will be reflected at Big Meadow.

1. Visitation:

Annual Park visitation has been steadily increasing following World War II for both day and overnight use 4/ except for minor decreases in the last three years due to traffic congestion, Service limitation on the number of

ESTIMATED WATER USE FOR [1/] YOSEMITE VALLEY

	DAILY WATER DEMAND - GPD	
	EXISTING	FUTURE
PARK HEADQUARTERS AREA		
NPS residence	25,000	5,000
Elementary school	2,000	--
Office, Stores	3,800	3,800
Visitor center	35,000	50,000
Irrigation	150,000*	150,000
	215,800	208,800
YOSEMITE VILLAGE AREA		
Lewis Memorial Hospital	3,200	4,000
Tecoya residences	20,000	5,000
Service station	5,000	--
Degnan's restaurant	45,000	50,000
Village Store restaurant	18,800	20,000
Dormitories	20,000	20,000
Offices, Stores	8,800	2,500
Camp 6	8,000	--
Day visitors	15,000	30,000
Irrigation	150,000*	150,000
	293,800	281,500
YOSEMITE LODGE AREA	243,100	289,000
Irrigation	600,000*	600,000
AHWAHNEE HOTEL	82,850	92,500
Irrigation	200,000*	200,000
CURRY VILLAGE AREA	221,800	253,500
Irrigation	200,000*	200,000
OLD VILLAGE AREA	1,500	--
CAMPGROUND AREA	118,500	137,500
TOTAL USAGE	2,177,350	2,262,800
SYSTEM LOSS	200,000	
TOTAL REQUIREMENT	2,377,350	

* Total Irrigation 1,300,000 (59.7% of Total Usage)

TABLE 4

overnight accomodations and nationwide economic reasons. The future annual visitation, however, is expected to increase 1/ by as much as 80 percent in the next ten years to a possible 40,000 daily visitor population during the peak months of July and August. Table 5, Travel Statistics, reflects the monthly visitation over the past five years and includes the annual visitor days, annual visitation by entrances and annual overnight visitation.

2. Employees:

As noted in Table 6, Permanent and Seasonal Employees, the total number of Service employees and dependents, concessioner and other non-Service employees results in a sizeable impact on the Park. The total number of permanent and seasonal employees has resulted in a slight increase over the past years and the total number will continue to increase to maintain pace with the increase in visitation, the concentration of facilities and visitors accomodations and the trend from overnight to day use visitation.

3. Housing and Quarters:

The present number of NPS temporary and permanent employees quarters will no doubt increase as funds are made available to accomodate the increase in the number of Service employees. Due to the environmental impact on the valley floor, various visitor and existing employees accomodations in the valley are scheduled for relocation in accordance with the Master Plans (Preliminary Working Draft, July 1971) and, likewise, proposed new quarters

TRAVEL STATISTICS [5/]
YOSEMITE NATIONAL PARK

	1967	1968	1969	1970	1971
MONTHLY VISITATION					
January	51,807	56,435	40,895	54,298	45,250
February	46,121	63,667	48,177	68,031	66,502
March	59,495	66,323	49,462	95,044	75,034
April	40,956	127,731	89,837	96,236	155,052
May	173,051	250,549	261,344	299,337	289,783
June	342,818	383,464	346,705	389,907	308,345
July	483,920	448,593	378,798	367,298	344,300(EST)
August	456,614	438,456	458,008	429,845	402,900(EST)
September	244,748	214,487	348,373	250,067	234,400(EST)
October	147,760	124,488	139,162	114,223	107,100(EST)
November	83,737	60,396	81,201	71,128	66,700(EST)
December	70,457	46,488	49,367	41,779	39,200(EST)
Total Entering Park	2,201,484	2,281,077	2,291,329	2,277,193	2,134,566(EST)
ANNUAL VISITOR DAYS					
Total	4,122,251	4,189,741	4,065,455	3,812,710	--
ANNUAL VISITATION BY ENTRANCES					
Arch Rock Ent.-Hwy 140	820,764	702,577	810,708	704,029	--
So. Ent.-Hwy 41	664,511	787,798	664,662	711,247	--
Big Oak Flat Ent.-Hwy 120 (East)	310,732	308,124	378,437	417,086	--
Tioga Ent.-Hwy 120(West)	373,583	454,250	399,572	380,645	--
Hetch Hetchy	31,894	28,328	37,950	64,186	--
Total	2,201,484	2,281,077	2,291,329	2,277,193	--
ANNUAL OVERNIGHT VISITATION					
Public Campgrounds	1,123,712	1,139,610	984,060	791,329	--
Back Country Camping	77,654	77,799	114,143	120,094	--
Yosemite Pk & Curry Co.	682,101	647,455	632,548	578,739	--
Private Accommodations-Wawona	37,300	43,800	43,375	45,355	--
Total	1,920,767	1,908,664	1,774,126	1,535,517	--

TABLE 5

PERMANENT AND SEASONAL EMPLOYEES 5/
YOSEMITE NATIONAL PARK

	Permanent	(Peak) Seasonal	(Peak) Total
NPS Employees(July 1970)	125	272	397
NPS Dependents			
Yosemite Valley	1,200	850	2,050
El Portal	500	100	600
Hodgdon Meadow	12	50	62
Wawona	30	175	205
Wawona, Section #35	25	1,800	1,825
Tuolumne Meadows	--	125	125
High Sierra Camps	--	50	50
Total NPS	1,892	3,422	5,314
Concessioner and Other Non-NPS Employees and Residents			
Yosemite Park & Curry Co.	450	833	1,283
Degnan-Donohoe	2	46	48
Best's Studio	4	3	7
El Portal Market	2	1	3
El Portal Inn	5	4	9
El Portal Motor Service	1	0	1
Lewis Memorial Hospital	17	4	21
Dr. Woessner	2	1	3
U.S. Magistrate	1	2	3
U.S. Post Office	10	5	15
Pacific Telephone & Telegraph	3	2	5
Ministers	4	13	17
Public Schools(Yosemite Valley & El Portal)	14	0	14
Total Non-NPS	515	914	1,429
Total	2,407	4,336	6,743

TABLE 6

will be located at other locations out of the valley floor. The closest major housing facilities for both Service and non-Service employees are located at El Portal on State Highway 140 and at Wawona near Mariposa Grove on State Highway 41. Additional minor housing developments are also found at Hodgden Meadows off of State Highway 120 at Big Oak Flat Entrance Station and at the Cascade Area on the Merced River, however, many individual NPS quarters are found at various locations throughout the park. The closest available housing and visitors accomodations off the park are located at Mariposa, 29 miles west of El Portal on State Route 140. Table 7, Housing and Quarters, reflects the numbers and types of units available in and out of Yosemite Valley but within the park. As can be seen, a large majority of all the quarters and housing units are located in the valley with the exception of campground sites.

4. Facilities:

A replacement of certain facilities now existing in Yosemite Valley is planned in accordance with the Master Plan, Preliminary Working Draft of July 1971. All existing support and access facilities will be relocated from Yosemite Valley that is economically feasible and only those facilities will remain or be provided which are in keeping or directly related to the visitor-use of the natural resources 4/. The Baxter, McDonald and Company Report, titled, "Candidate Activities for Relocation from Yosemite Valley," proposes what support facilities and accomodations shall be relocated out of Yosemite Valley. An additional report by Metcalf and Eddy,

HOUSING AND QUARTERS 5/
YOSEMITE NATIONAL PARK

	UNITS	
	YOSEMITE VALLEY	AT OTHER LOCATIONS
NPS Quarters*	133	246
Concessioner Quarters	217**	NI
Overnight Services (Average: 3 visitors/unit)		
Ahwahnee Hotel	114	---
Yosemite Lodge	480	---
Curry Village	619	---
Curry Housekeeping	298	---
Wawona Hotel	---	79
Big Trees Lodge	---	10
Tuolumne Meadow Lodge	---	56
High Sierra Camp	---	56
Total Visitor Units	1,511	201
Teacherages (Total 8)	4	4
Campground Sites	1,058	1,498

* Includes apartments, resident houses, trailers, cabins and tents.
** Includes houses, dormitories and tents

TABLE 7

"Improvement and Additions to Water and Sererage Systems at Yosemite Valley," on December 1970, presents an evaluation of the existing water and sewerage facilities in Yosemite Valley and includes conclusions on the adequacy of the facilities and recommendations for additions and improvements. Present dominate support facilities are listed in Table 8, and show for comparison purposes what facilities are located in Yosemite Valley.

SUPPORT FACILITIES [5/]
YOSEMITE NATIONAL PARK

	UNITS	
	YOSEMITE VALLEY	AT OTHER LOCATIONS
Dining Room, Hotel	1	3
Restaurants	3	-
Cafeteria	2	-
Sandwich Shop	4	6
Delicatessen	1	-
Grocery Stores	2	3
Cocktail Lounge	3	2
17 Bed Hospital	1*	-
Service Station	2	5
Garage	1	1
Kennel	1	-
Stables	1	3
Bike Stands	2	-
Gift Shop--Studio	8	-
Post Office	3	-
Barber Shop	1	-
Beauty Shop	1	-
Swimming Pools	3	1
Tennis Courts	2	2
Skating Rink(Winter)	1	-
Golf Course	1	1
Golf Shop	-	3
Climbing School	1	1
Chapels	1	1
Church Bowl	1	-
Schools	1	2
Amphitheatres	4	5
NPS Maintenance Shops & Yards, Major	1	-
NPS District Maintenance Shops & Yards	-	2
NPS Sub-District Maintenance Shops & Yards	-	1
NPS Incinerator & Maintenance Yard	-	1

* Includes 3 physicians(2 permanent and 1 temporary) and 1 dentist.

TABLE 8

IV - AVAILABLE WATER RESOURCES

Present water sources are limited in and around the Big Meadow basin. In all cases no local supplies are available which comes close to meeting the demand, and futhermore, what local supplies are available do not comply with the U.S. Public Health Service Drinking Water Standards. The chemical substances should not be present in a water supply where the listed concentrations are in excess of those shown in Tables 9 and 10 (U.S. Public Health Service Drinking Water Standards--1962 Revision). Table 11 lists the maximum limits of chemical substances which constitute grounds for rejection of a supply. The latest report available "Ground Water Reconnaisance of the Foresta Area," dated June 10, 1964, (revised November 10, 1964) by R.H. Dale, U.S. Geological Survey, Ground Water Branch, investigates the water-supply problems of the Foresta area, provides chemical and bacteriological analyses of water in both Foresta and Big Meadow and includes discharge characteristics of Crane Creek. Since water may be made available from various sources (both ground and surface supplies) treatment will be necessary. Table 12 lists recent Flow Measurements of creeks and streams north of the Merced River in the vicinity of Big Meadow.

Utilizing information gathered in my recent field trip, from USGS (June 1964) report by R.H. Dale, letters and phone conversations with USGS Subdistrict

TABLE 9

MAXIMUM CHEMICAL SUBSTANCES LIMITS

(U.S. Public Health Service Drinking Water Standards - 1962 Revision)

Substance	Concentration (mg/l)
Alkyl Benzene Sulfonate (ABS)	0.5
Arsenic (As)	0.01
Chloride (Cl)	250.0
Copper (Cu)	1.0
Carbon Chloroform Extract (CCE)	0.2
Cyanide (CN)	0.01
Fluoride (F)	(See Table 10)
Iron (Fe)	0.3
Manganese (Mn)	0.05
Nitrate (No_3)	45.0
Phenols	0.001
Sulfate (WO_4)	250.0
Total Dissolved Solids	500.0
Zinc (Zn)	5.0

Chemical substances listed in Table 9 should not be present in a water supply in excess of the listed concentrations where, in the judgment of the Reporting Agency and the Certifying Authority, other more suitable supplies are, or can be, made available.

TABLE 10
FLUORIDE LIMITS
(U.S. Public Health Service Drinking Water Standards - 1962 Revisions)

Annual avg of maximum daily air temperatures	Recommended control limits, Fluoride concentrations (mg/l)		
	Lower	Optimum	Upper
50.0 to 53.7	0.9	1.2	1.7
53.8 to 58.3	0.8	1.1	1.5
58.4 to 63.8	0.8	1.0	1.3
63.9 to 70.6	0.7	0.9	1.2
70.7 to 79.2	0.7	0.8	1.0
79.3 to 90.5	0.6	0.7	0.8

When fluoride is naturally present in drinking water, the concentration should not average more than the appropriate upper limit in Table 10. Where fluoridation (supplementation of fluoride in drinking water) is practiced, the average fluoride concentration shall be kept within the upper and lower control limits in Table 10.

Presence of fluoride in average concentrations greater than two times the optimum values in Table 10 shall constitute grounds for rejection of the supply.

TABLE 11
MAXIMUM SUBSTANCES LIMITS FOR REJECTION
(U.S. Public Health Service Drinking Water Standards - 1962 Revisions)

Substance	Limit (mg/l)
Arsenic (As)	0.05
Barium (Ba)	1.0
Cadmium (Cd)	0.01
Chromium (Hexavalent) (Cr^{+6})	0.05
Cyanide (CN)	0.2
Fluoride (F)	(See Table 10)
Lead (Pb)	0.05
Selenium (Se)	0.01
Silver (Ag)	0.05

Presence of the substances listed in Table 11 in excess of the concentrations listed shall constitute grounds for rejection of the supply.

TABLE 12

Flow Measurements -- Yosemite National Park 6/

August 10-12, 1971

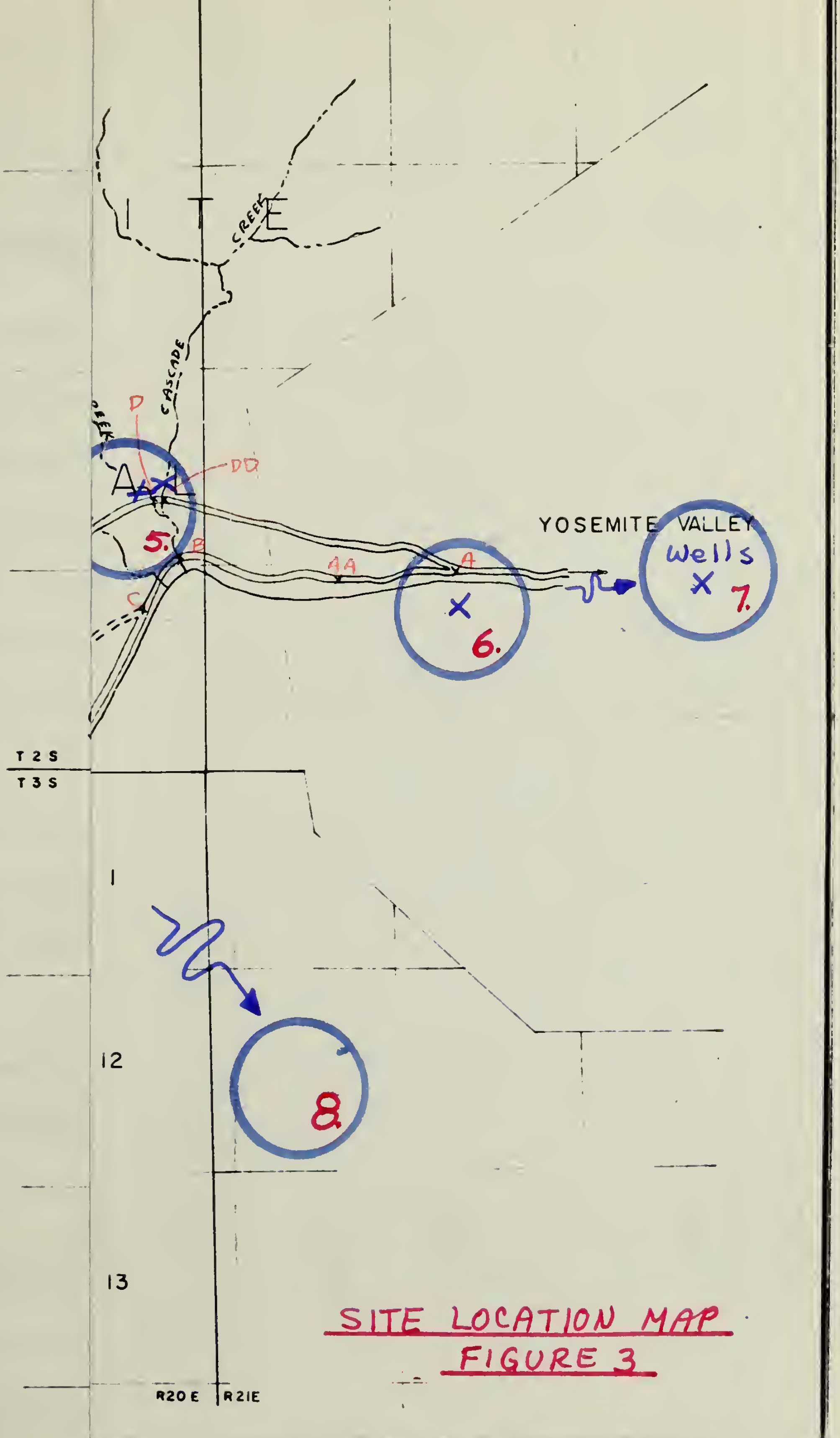
Site	Date	Gage height	Discharge (cfs)
Sentinel Creek	8-12-71	3.47	0.015 (est.)
Yosemite Creek	8-11-71	0.82	1.80
Tamarack Creek	8-12-71	0.84	0.75
Porcupine Creek	8-11-71	4.47	1.48
Smoky Jack Creek	8-11-71	1.24	0.14
Wildcat Creek	8-10-71	0.50	0.15*
Crane Creek	8-11-71	1.095	1.29*
Little Crane Creek	8-10-71	0.50	0.19*
Moss Creek	8-10-71	0.97	0.79*
Cascade Creek	8-12-71	1.27	0.51*

* Initial readings from recently established gauging stations (USGS).

(PRELIMINARY DATA SUBJECT TO REVISION)

Sacramento Office and information from the files, the following briefs were prepared on various known wells and water sources in and adjacent to Big Meadow basin and vicinity (see Figure 3). Unless otherwise noted, all quantity and cost data is based on an average annual 10 year runoff.

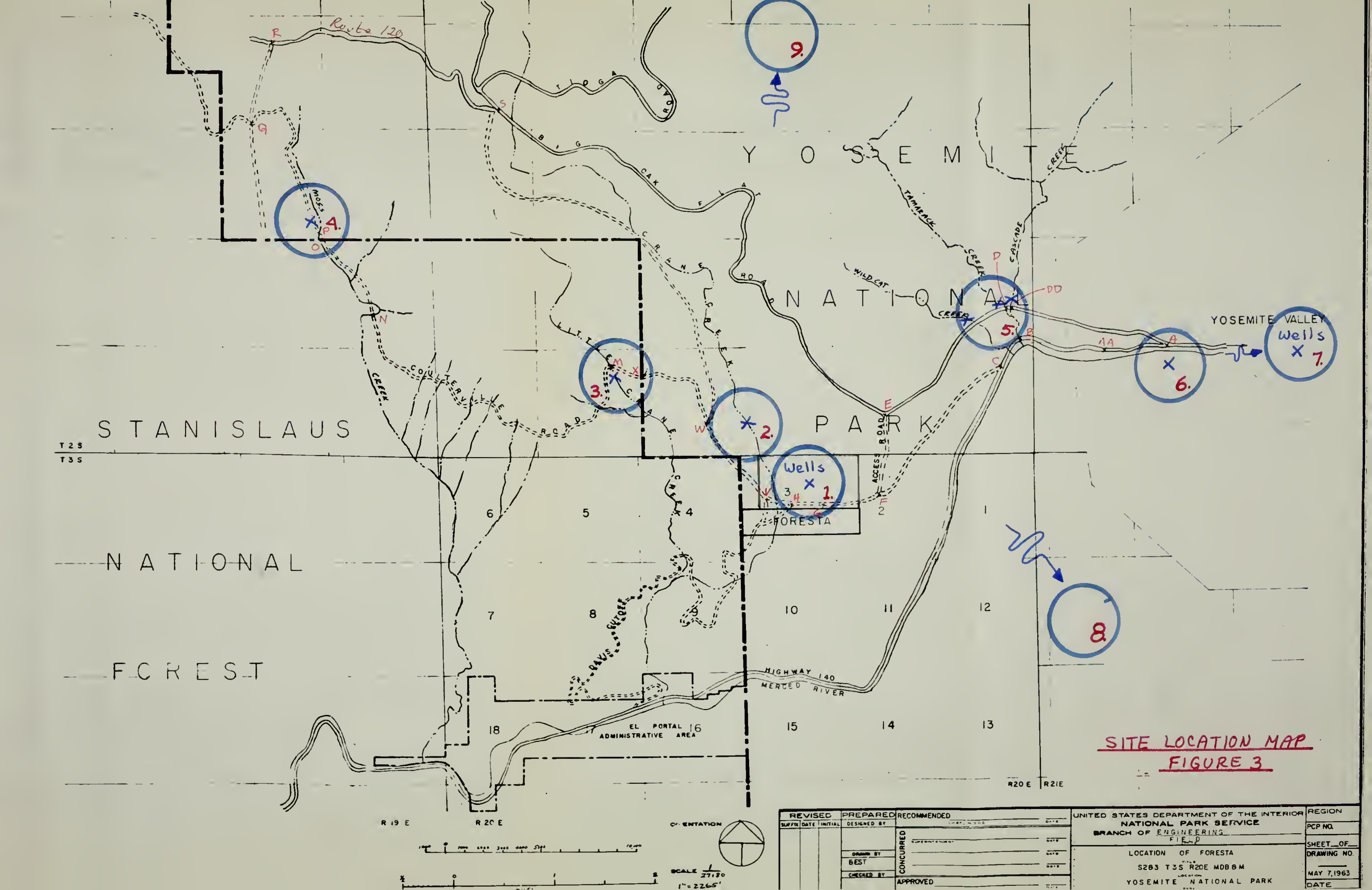
1. Drilling wells in the Big Meadow Basin, partially discussed in the USGS Report of June 1964 by R.H. Dale, will not provide a large supply of water based on the available information from the USGS Report. Figure 1 gives the location and depth of wells in the Foresta Subdivision. Figure 2 shows the location of the four U.S. Bureau of Reclamation test wells and two private wells in Big Meadow pasture. Until the information is released, complete data and pump test results on the four U.S. Bureau of Reclamation test wells (TH-1, TH-1A, TH-2 and TH-2A) is not available, however the individual yields are not expected to exceed 25-50 gpm 7/. Approximately 51 small, low capacity wells are located in the Foresta Subdivision with average periodic yields of approximately 5 gpm per well 2/ (allow 50% recovery time). It is the opinion of USGS Water Resources Division 7/ that carefully designed wells may yield 25-100 gpm, and based on the estimated total storage capacity (75 acre-feet) of the aquifer, three-to-four wells in the basin could provide 216,000 gallons per day (GPD) of sustained discharge. In order to drill three wells and provide pumping facilities, capital costs in the amount of $82,000 (estimated) are required for the wells in the area. Chemical analyses of water from existing wells in the area indicate as much as 6.8 mg/L concentration of iron in Big Meadow to



SITE LOCATION MAP
FIGURE 3

UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE BRANCH OF ENGINEERING FIELD	REGION PCP NO. SHEET__OF__
LOCATION OF FORESTA S2&3 T3S R20E MDB&M YOSEMITE NATIONAL PARK	DRAWING NO. MAY 7, 1963 DATE

IC DATA......



SITE LOCATION MAP
FIGURE 3

49.0 mg / L in Foresta (see Table 3) which exceeds the minimum allowable standards of 0.3 mg/L. For comparison purposes the capital unit cost amounts to $380 per 1,000 gallons per day (Does not include operating, maintenance or amortization costs).

2. <u>Crane Creek</u> extends through Big Meadow northwesterly to Crane Flat. Table 13 reflects the annual runoff and minimum flows above Big Meadow from 1924 to 1964. Estimated runoff during August through December is 0.67 cfs (435,000 GPD), likewise the minimum runoff for the balance of the year can be expected to be greater than 2.1 cfs (1,350,000 GPD). As a result, using two-thirds of the measurable flow, available water from this source amounts to 290,000 to 900,000 GPD. Chemical analysis of this water (see Table 14) is similar to ground water obtained from wells in the Big Meadow basin, however, iron concentration is within acceptable limits. Capital costs are estimated in the amount of $56,000 and the capital unit costs for 1,000 gallons per day are $193 and $62. See Figure 3 for location of this available water supply. Vertical control of the facilities are as follows:

Elevation, Pump and Intake Structure	4410
Elevation, Holding Reservoir Site	4550
Elevation, North Junction Davis Cutoff (V)	4312

3. <u>Little Crane Creek</u>, located on U.S. Forest Service lands west of Big Meadow and approximately 2-1/2 miles out the Coulterville Road, is relatively small, however, from data gathered during the August survey an estimated

ESTIMATED ANNUAL RUNOFF [8/]
CRANE CREEK ABOVE BIG MEADOW

Water Year	Annual Runoff 1000 AF	Minimum Fall Flow cfs
1924	1.9	0
1925	6.1	1.0
1926	3.7	.4
1927	7.3	1.1
1928	4.9	.5
1929	3.1	.1
1930	3.0	0
1931	1.5	0
1932	7.0	.3
1933	3.4	.1
1934	2.1	0
1935	8.4	.6
1936	7.5	1.0
1937	8.6	1.3
1938	17.8	3.0
1939	3.7	.7
1940	8.2	1.5
1941	11.1	2.2
1942	11.0	2.3
1943	10.5	1.9
1944	5.3	1.3
1945	9.0	1.8
1946	7.9	1.6
1947	4.1	.7
1948	4.4	.9
1949	4.1	.7
1950	4.7	.6
1951	9.1	1.2
1952	12.8	2.2
1953	5.0	1.1
1954	5.3	1.0
1955	3.4	.4
1956	12.2	1.6
1957	4.9	1.0
1958	10.9	2.0
1959	3.2	.3
1960	3.3	.2
1961	1.7	0
1962	5.8	.3
1963	7.6	1.0
1964	3.2	.3
41 Yr. Total	258.7	3.82
Average	6.4	.7

TABLE 13

CHEMICAL ANALYSIS - CRANE CREEK [2/]
DIVERSION DAM ABOVE BIG MEADOW
YOSEMITE NATIONAL PARK

October 6, 1964

Constituent	mg/L (unless noted)
Bicarbonate (HCO_3	20
Boron (B)	0.1
Calcium (Ca)	3.4
Carbonate (CO_3)	0
Chloride (Cl)	0.5
Flouride (F)	0
Iron (Fe)	0.13
Magnesium (Mg)	0.4
Nitrate (NO_3)	0.4
Potassium (K)	1.1
Silica (SiO_2)	21
Sodium (Na)	4
Sulfate (SO_4)	0
Hardness as $CaCO_3$)	10
Noncarbonate Hardness as $CaCO_3$	0
Total Dissolved Solids (calculated)	41
Total Dissolved Solids (Residue at 180°C)	40
Specific Conductance	39 micromhos
pH	7.4
Water Temperature	55°F

TABLE 14

0.45 cfs (291,000 GPD) total flow can be expected during the months of August through November with an increase runoff during the balance of the year amounting to 0.9 cfs (582,000 GPD). A recent guaging station installed by the USGS has provided only one reading to date (see Table 12) which indicates low flows are expected. Available water in the amount of two-thirds of the total flow is 200,000 GPD for August through November and 400,000 GPD for the balance of the year. According to reliable verbal information from the US Geological Survey 9/ the chemical analysis of this water supply is expected to be similar to water from Crane Creek above Big Meadow. See Figure 3 for location of this water source. Capital costs to develop and transport the Little Crane Creek water supply is $105,000 with capital unit costs for 1,000 gallons per day at $525 and $263. Vertical control of facilities are as follows:

Elevation, Intake Structure (M)	4530
Elevation, Pump (M)	4500
Elevation, Holding Reservoir Site	4550
Elevation, North Junction Davis Cutoff (V)	4312

4. Moss Creek is located west of Little Crane Creek and drains from the Merced Grove south across U.S. Forest Service lands to El Portal (see Figure 3). The lower part of Moss Creek is used as a water supply for El Portal. It has been noted that a greater flow is available at the Merced Grove than is available at El Portal. It is likely the loss of water is due to evaporation and percolation into the fractured bedrock. This same

situation exists for Cascade, Tamarack and Wildcat Creeks. For this reason, water available in the upper drainage area (see Figure 3) at Merced Grove would not wholly effect the total maximum discharge at El Portal since most of this water would be lost before reaching the lower runoff area. In addition, various tributaties below the Merced Grove feed the lower portion of the creek. Data gathered during the August survey on the upper drainage area at Merced Grove indicates approximately 0.56 cfs (361,000 GPD) total runoff can be expected during the months of August through November with an increased runoff during the balance of the year amounting to 1.10 cfs (711,000 GPD). Data from a recent gauging station installed by the USGS (see Table 12) confirms the estimated minimum total flow. The available water, amounting to two-thirds of the total runoff, is 240,000 to 480,000 GPD. Acording to reliable verbal information from the U.S. Geological Survey 9/, the chemical analysis of water at this supply point is acceptable and no doubt is similar to the El Portal supply taken from the lower portion of the stream. Capital costs to develop and transport the water from this supply is $255,000 and the capital unit costs for 1,000 gallons per day are $1,063 and $531. The greatest capital investment is required to provide water from this source than from any of the sources outlined in this report. (See Table 15, Available Water Supply Summary.) Vertical control of the facilities are as follows:

Elevation, Pump and Intake Structure (P)	5250
Elevation, High Point on Coulterville Road	5225

AVAILABLE WATER SUPPLY SUMMARY

BIG MEADOW

Water Source	Yield 1000 GPD Aug-to-Nov	Yield 1000 GPD Dec-to-July	Capital Cost	Capital Unit Cost (1000 GPD)
. Big Meadow Wells	216	216	$ 82,000	$ 380
. Crane Creek	290	900	56,000	193 - 62
. Little Crane Creek	200	400	105,000	525 - 263
. Moss Creek	240	480	255,000	1,063 - 531
. Cascade, Tamarack and Wildcat Creeks	765	1,105	354,000	465 - 320
Holding Reservoirs(2)	–	–	280,000	–
Sub-Total, 1-5	1,711	3,101	1,132,000	
. Merced River	1,000	3,000	690,000	690 - 230
. Yosemite Valley Wells	2,400	–	625,000	490
Holding Reservoir	–	–	410,000	–
Total, 1-7	5,111		2,857,000	
. South, Merced River	1,000	3,000	565,000	565 - 188
. Hetch Hetchy	6,000	6,000	4,800,000	800

TABLE 15

Elevation, Little Crane Creek Supply (M)	4530
Elevation, Top or Ridge	4810
Elevation, Holding Reservoir Site	4550
Elevation, North Junction Davis Cutoff (V)	4312

5. Cascade, Tamarack and Wildcat Creeks provide the largest runoff of any of the available water sources in the vicinity. The upper drainage areas of these streams are located approximately three miles northeast of Big Meadow and north of Big Oak Flat Road (see Figure 3). Data gathered from recent gauging stations installed by the USGS (see Table 12) and from information collected during the August survey indicates a total runoff of 1.80 cfs (1,160,000 GPD) can be expected during the months of August through November with an increased runoff of 2.55 cfs (1,660,000 GPD) during the balance of the year. The available water amounting to two-thirds of the total runoff, is 765,000 to 1,105,000 GPD. No recent chemical analysis is available, however, as verbally advised by the USGS [9/] the chemical content is similar to Crane Creek supply above Big Meadow. Capital costs to develop and transport the water from the three sources is $354,000 and the capital unit costs are $465 and $320 for 1,000 gallons per day. Vertical control of all the facilities from the three supplies are as follows:

Elevation, Pump and Intake Structure, Cascade Creek (DD)	4420
Elevation, Pump and Intake Structure, Tamarack Creek	4440
Elevation, Jct. Foresta Access & Big Oak Flat Roads (E)	4775

Elevation, Holding Reservoir Site	4590
Elevation, North Junction Davis Cutoff (V)	4312

6. Merced River (in accordance with the Metcalf and Eddy Report on December 1970, Improvements and Additions to Water and Sewerage Systems at Yosemite Valley) has an estimated dependable yield for water supply purposes [1/] of about 1.5 cfs (1,000,000 GPD) at the Happy Isles supply intake which is above the junction of Tenaya Creek in Yosemite Valley. Table 16 shows the daily data on the cubic feet per second discharge of the Merced River, October 1967 to September 1968, at Pohono Bridge some 7-1/2 miles below Happy Isles and Tenaya Creek and approximately one mile above the Diversion Dam at the junction of Big Oak Flat Road with Highway 140. The daily discharge (cfs) data along with other flow data shown on this table adequately supports that more than 1.5 cfs of water is available throughout the low flow periods (August through November) of the year. During the balance of the year (December through July) an estimated dependable yield for water supply purposes will exceed 4.6 cfs (3,000,000 GPD). The water is soft and contains no objectional mineral or chemical constituents as confirmed by chemical analysis (see Table 17). The capital costs for the collection, pumping and delivery system, utilizing the Coulterville Road (see Figure 3) for a pipeline to Big Meadow, is $690,000. The capital unit cost for 1,000,000 GPD demand is $690 per 1,000 gallons per day and is reduced to $230 per 1,000 gallons per day for a 3,000,000 GPD demand. The vertical control of the facilities are as follows:

MERCED RIVER DISCHARGE [10/]
POHONO BRIDGE, YOSEMITE VALLEY

CATION.--Lat 37°43'01", long 119°39'55", on left bank 150 ft upstream from Pohono Bridge, 0.4 mile upstream from Artist Creek, and 4.8 miles southwest of Yosemite National Park Headquarters.

AINAGE AREA.--321 sq mi.

CORDS AVAILABLE.--October 1916 to September 1968. Monthly discharge only for October and November 1916, published in WSP 1315-A.

GE.--Digital water-stage recorder. Datum of gage is 3,861.66 ft above mean sea level, datum of 1929. Prior to Sept. 5, 1918, graphic water-stage recorder, at datum 1.8 ft higher. Sept. 5, 1918, to Sept. 30, 1955, graphic water-stage recorder, at datum 1.0 ft higher. Oct. 1, 1955, to Oct. 8, 1964, graphic water-stage recorder at present datum.

ERAGE DISCHARGE.--52 years, 591 cfs (427,900 acre-ft per year).

TREMES.--Maximum discharge during year, 2,020 cfs Apr. 30 (gage height, 6.13 ft); minimum daily, 13 cfs Sept. 30.
1916-68: Maximum discharge, 23,400 cfs Dec. 23, 1955 (gage height, 21.52 ft from floodmarks in well), from rating curve extended above 16,300 cfs on basis of computation of flow over diversion dam for Yosemite powerhouse, 1 mile downstream at gage heights 20.1 and 20.98 ft, present datum; minimum, 3.3 cfs Sept. 29, Oct. 1, 1924.

MARKS.--Records excellent. No diversions between stations at Happy Isles Bridge and Pohono Bridge. One cfs sewage effluent returns between stations (see REMARKS for sta. no. 11-2645.).

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968

AY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	91	37	54	85	103	441	871	1,740	1,310	192	92	23
2	88	36	56	78	113	378	656	1,780	1,370	175	87	22
3	87	36	64	70	120	362	535	1,680	1,400	167	77	22
4	89	35	73	68	122	374	520	1,620	1,200	161	68	22
5	88	35	92	65	123	378	569	1,620	1,040	150	63	22
6	85	35	79	64	119	337	499	1,320	801	147	58	22
7	82	35	85	61	115	306	501	1,230	667	153	53	21
8	77	35	81	61	113	303	561	1,210	639	148	49	21
9	72	35	81	64	126	280	697	1,230	541	156	46	21
10	68	35	85	64	124	255	903	1,060	507	167	43	20
11	65	35	85	66	123	245	1,110	1,040	532	147	43	20
12	62	35	83	66	123	254	1,140	1,030	571	128	42	20
13	58	35	47	68	122	249	1,050	874	590	120	44	19
14	55	36	63	70	119	233	1,010	841	565	117	44	19
15	52	39	70	134	110	230	1,080	883	604	116	44	19
16	51	40	66	155	120	236	955	908	626	112	42	18
17	49	40	61	123	155	229	785	1,030	628	107	38	17
18	48	44	63	116	188	226	655	1,150	581	102	35	17
19	47	63	66	113	222	216	625	1,440	552	94	34	16
20	45	68	65	114	673	209	601	1,600	521	90	35	16
21	44	62	63	118	655	215	537	1,720	449	85	34	16
22	44	59	66	124	521	232	507	1,340	401	82	34	16
23	43	55	70	125	557	222	553	1,000	396	78	34	15
24	42	53	72	126	582	242	677	838	373	74	32	15
25	41	51	79	132	494	270	799	844	339	71	31	15
26	40	49	90	127	487	275	1,110	1,170	312	68	30	15
27	40	47	103	119	456	302	1,410	1,460	296	65	29	14
28	39	49	108	95	455	396	1,570	1,720	285	65	27	14
29	38	49	104	105	437	596	1,740	1,750	264	70	26	14
30	38	52	96	108	------	783	1,800	1,530	224	79	24	13
31	37	------	92	105	------	816	------	1,310	------	90	23	------
OTAL	1,805	1,315	2,362	2,989	7,777	10,090	26,026	39,968	18,584	3,576	1,361	544
EAN	58.2	43.8	76.2	96.4	268	325	868	1,289	619	115	43.9	18.1
AX	91	68	108	155	673	816	1,800	1,780	1,400	192	92	23
IN	37	35	47	61	103	209	499	838	224	65	23	13
C-FT	3,580	2,610	4,680	5,930	15,430	20,010	51,620	79,280	36,860	7,090	2,700	1,080

AL YR 1967 TOTAL 369,340 MEAN 1,012 MAX 6,140 MIN 35 AC-FT 732,600
TR YR 1968 TOTAL 116,397 MEAN 318 MAX 1,800 MIN 13 AC-FT 230,900

Peak discharge (base, 2,900 cfs).--No peak above base.

TABLE 16

MERCED RIVER

HAPPY ISLES

CHEMICAL ANALYSIS, YOSEMITE PARK WATER - 1950 [11/]

Conductivity ($KX10^{-5}ohm^{-1}$)	2.9
pH	7.1
Total Solids (calculated)	22
Silica (SiO_2) (colorimetrics)	4
Sodium (Na)	4
Calcium (Ca)	1.6
Magnesium (Mg)	0.5
Iron, dissolved (Fe)	0.01
Aluminum (Al)	0
Manganese (Mn)	0
Boron (B)	0.1
Fluoride (F)	0
Carbonate (CO_3)	0
Bicarbonate (HCO_3)	8.5
Sulphate (SO_4)	1
Chloride (Cl)	6
Nitrate (NO_3)	0.03
Hardness, Versonate	6
Alkalinity ($CaCO_3$)	8

Notes: (1) Calcium and magnesium values obtained using versonate method. Sulphate and sodium values were calculated.
(2) Chemical analysis made by San Francisco Water Department Laboratory.
(3) Results reported in parts per million.

TABLE 17

Elevation, Pump and Intake Facilities	3810
Elevation, Junction Coulterville Road on Highway 140	3410
Elevation, Junction Foresta-Access Road	4570
Elevation, Holding Reservoir Site	4590
Elevation, North Junction Davis Cutoff (V)	4312

Up to this point the difference in elevation (vertical control) has not been a problem in moving water from a supply point to the Big Meadow area. Since the difference in elevation between the Merced River in the gorge below Big Meadow is a substantial barrier, a collection and pumping station must be selected to lift water from the floor of the valley at a minimum cost of construction, operation and maintenance. Such a site is, generally, selected which provides minimum hydrostatic pressure without over extending the length of the water line (such as locating a site up-stream), adequate room and accessability. For purposes of this report in determining capital costs, the Diversion Dam, at the junction of Big Oak Flat Road is selected as a site for the collection and pumping station. It is possible a more desirable and realistic site could be located between the NPS powerhouse and the Coulterville Road Junction.

7. <u>Wells in Yosemite Valley</u> will provide a supplemental supply for the balance of water required for the maximum daily demand. A recent test well drilled near Yosemite Lodge strongly indicates that large capacity wells are feasible in Yosemite Valley [12/]. Recent reports and communications [9/]

with the U.S. Geological Survey on ground water further substantiates that large volumes of water can be expected from drilling wells on the floor of the valley. Table 15 summarizes available water sources in Big Meadow and vicinity. As noted in Table 15, available water supplies from sources so far described in this report (Big Meadow wells, Crane Creek, Little Crane Creek, Moss Creek, Cascade-Tamarack-Wildcat Creeks and the Merced River) accounts for 2,711,000 GPD of the maximum demand. Based on the previously discussed information and the various large drainage areas discharging into the valley, six to seven large capacity wells could provide 3.7 cfs (2,400,000 GPD) sustained discharge. Capital cost in the amount of $625,000 is required to drill and develop six wells, provide pumping facilities, collection lines and supply lines to the Merced River water supply point (Item 6, Table 15) below Big Meadow. The capital unit cost for this expenditure is $490 per 1,000 gallons per day. A recent chemical analysis of the test-well drilled near Yosemite Lodge confirms a good quality water to be low in mineral content with only 20 mg/L total concentration of dissolved solids [12/]. Vertical control to the Diversion Dam is nominal. The 200 foot fall from the east end of the valley (approximate elevation 4010) west to the Merced River Gorge (Diversion Dam elevation 3810) makes it possible to pump directly from the wells into the river and eliminate the cost of three to four miles of supply line to the Diversion Dam if substantial water is available from the wells (losses due to evaporation and percolation in the river bed). The capital costs include the cost of installation of a

supply line to the Diversion Dam.

8. South of the Merced River is another potential water source worth considering, however, no on-site survey was made of the drainage areas south of the gorge. Several drainage areas adjacent to the proposed bridge site should be investigated if the bridge becomes a reality and access across the bridge is available to transport the water to the north side of the gorge. For the sake of a capital cost proposal and based on the availability of an estimated 1,000,000 GPD (August through November) to 3,000,000 GPD (December through July), the estimated capital costs to develop and transport the water from the south area of the gorge is $565,000. The capital unit costs for this estimated supply are $565 and $188 for 1,000 gallons per day.

9. Hetch Hetchy Reservoir, in the Tuolumne River Canyon approximately 15 miles to the north, was considered for the purposes of this report. The water source is owned by the Hetch Hetchy Water and Power Department of the City of San Francisco and acquiring water rights is questionable. The delivery of 6,000,000 GPD (including line losses and independent demands) would be difficult and expensive over three mountain ridges which are classified as wilderness area [4/]. Relief along the route of delivery within park boundaries would exceed 3,800 feet and require construction of an access road. The estimated capital cost to deliver 6,000,000 GPD is $4,800,000 at a capital unit cost of $800 per 1,000 gallons per day. A

supply line within the park would encounter the following vertical control:

Elevation, Hetch Hetchy Reservoir	3720 (3660)
Elevation, Entrance to Poopenaut Valley	3470
Elevation, Crossing Middle Tuolumne River	5880
Elevation, Bald Mountain Ridge	7050
Elevation, South Fork Tuolumne River	3250
Elevation, Road on Ridge	5800
Elevation, Road Junction Hodgden Ranch Road	5300
Elevation, Tioga Pass and Big Oak Flat Road Jct. (3)	6350
Elevation, Holding Reservoir Site	4590
Elevation, North Junction Davis Cutoff (V)	4312

V - SUMMARY

A summary of the available water resources in the Big Meadow area and vicinity is tabulated for comparison purposes in Table 15. The summary includes (for each water source) the available yield, total capital cost, and the capital unit cost. This summary investigates those factors effecting the proposed use of water pertinent to Big Meadow Development and outlines usable methods for an efficient water supply.

Due to Big Meadows location, construction of a major development in this area has certain physical limitations. Consideration must be given to the critical limitations of water supply, water use and waste water disposal which are all interrelated. Particular attention is directed to the total amount of water required for irrigation purposes as noted in Table 4 for Yosemite Valley. Irrigation amounts to approximately 60% of total daily water demand excluding system loss. There is no reason to expect an appreciable decrease in the percentage amount of water that will be used for irrigation purposes in the Big Meadow development. As outlined in this report, the three major demands on the water supply are domestic use, irrigation and fire protection. With such large amounts attributed to irrigation, the use of water requires comprehensive planning of water supplies and disposal of resulting waste water. The domestic use of water is

directly related to the facilities and visitor-employee use made of the area. It is noted that irrigation requirements depend on the changes made to plant life and terrain involving grading and landscaping. Both demands are continuous but variable. The water required for fire protection, however, is not a continuous demand and is normally satisfied by providing adequate storage capacity and delivery system. The fire protection requirements, generally, are greater than domestic needs, and as a non-continuous daily demand is used only during emergencies.

A review of the environmental effect was given consideration in establishing what quantities of water may be taken from each water supply source. In all cases, no more than two-thirds of any water supply source is used to meet the daily maximum demand. Gauging stations established above and below each collection point would help provide information to regulate and control the yield from each water supply source so as to minimize the environmental impact in each drainage area. By so regulating the flow of water throughout the runoff year, environmental efficiency may be established.

After reviewing and analyzing the major factors and conditions affecting a water supply and the capital costs of developing and delivering water from each available source, the following methods of supply are proposed for consideration:

<u>Method 1</u> includes construction of one water system for domestic use, fire

protection and irrigation with water supplied from (1) wells in Big Meadow, (2) Crane Creek, (3) Little Crane Creek, (4) Moss Creek, (5) Cascade-Tamarack-Wildcat Creeks, (6) Merced River and (7) Wells in Yosemite Valley (see Table 15). As noted, the total capital costs for water provided from the seven recommended sources is $2,857,000 and includes two holding reservoirs; a 1,000,000 gallon reservoir for water delivered from sources 1 through 4 and a 5,000,000 gallon reservoir for water from sources 5 through 7.

Method 2 includes construction of two separate water systems; one for domestic use and a second system for fire protection and irrigation. The domestic water system would be supplied with water from the same sources proposed in Method 1 but excluding the wells in Yosemite Valley (source 7 in Table 15). The capital cost of the domestic water system is $1,822,000 and includes two 1,000,000 gallon holding reservoirs. The secondary independent water system for fire protection and irrigation would be supplied by using recycled water provided from a waste water treatment plant (2,500,000 GPD capacity). Based on Metcalf and Eddy Report, the amount of waste water disposal is equal to the amount of domestic water used (less line loss and irrigation), however, the amount of waste water discharged into a sewer system generally is slightly less than the amount of water supplied [13/]. In the case of Yosemite Valley, leakage into old sewer lines increase the waste water discharge to approximate the domestic water use. With the installation of new sewer lines in Big Meadow, an eight percent

difference between domestic water use and waste water disposal would be appropriate for determining the quantity of waste water disposal. The capital cost of the secondary water system, including the prorated cost of additional distribution lines and facilities throughout Big Meadow development, is $1,770,000 ($1,700,000 is for waste water treatment plant 11/). The total capital cost for this method is $3,592,000.

Method 3 like Method 1 includes one separate water system for domestic use, fire protection and irrigation with water supplied from the same six sources (excluding wells in Yosemite Valley - Source 7 in Table 15) proposed in Method 2. The balance of water (5,000,000 GPD less 2,711,000 GPD for sources 1 through 6 equals 2,289,000 GPD) would be supplemented by providing a large water storage capacity of approximately 100,000,000 gallons for a forty-five day supply during the low flow periods of August to November. Storage capacities of this size could be esthetically located as foundations to buildings, parking areas, campsites and emergency helicopter landing sites for air rescue and fire fighting. Based on providing five underground storage reservoirs (300' x 300' x 30' - 20,000,000 gallons) the capital cost for storage facilities would be $4,000,000 with a total capital cost of $5,822,000 for Method 3.

Method 4 includes providing facilities (see Source 9 - Table 15) for a single water system with 6,000,000 gallons per day of water being supplied from Hetch Hetchy Reservoir (allowing 1,000,000 GPD for line loss and

additional water development for the Crane Flat area and vicinity). The capital cost of this method to and including a holding reservoir amounts to $4,800,000. The capital costs are based on providing pumping facilities and supply lines within Yosemite National Park boundaries.

A cost summarization of the above methods is outlined in Table 18.

SUMMARY OF METHODS
(Reference Table 15)

Method		
1	One Water System Using Water Sources 1-7	
	Cost Water Sources 1 through 7	$2,167,000
	Two Holding Reservoirs	690,000
	Total Capital Cost	$2,857,000
2	Two Water Systems, Recycle Waste Water	
	Cost Water Sources 1 through 6	$1,542,000
	Two Holding Reservoirs	280,000
	Sub-total	$1,822,000
	Waste Water Treatment Plant	1,700,000
	Additional Distribution Facilities	70,000
	Total Capital Cost	$3,592,000
3	One Water System With Storage (45 Days)	
	Cost Water Sources 1 through 6	$1,542,000
	Two Holding Reservoirs	280,000
	Sub-total	$1,822,000
	Storage Reservoirs	4,000,000
	Total Capital Cost	$5,822,000
4	One Water System From Hetch Hetchy Reservoir	
	Pumping Facilities and Access Road	$1,204,000
	Supply Line (22 miles)	3,394,000
	Power	202,000
	Total Capital Cost	$4,800,000

TABLE 18

VI - CONCLUSIONS

A review of the methods outlined in Section V (see Table 18, Summary of Methods), indicates no inexpensive solution is available for obtaining the proposed maximum water supply at Big Meadow. As noted, capital costs may vary from $3,000,000 to $6,000,000 to acquire and deliver water to the area. No costs are included for treating facilities, area distribution systems or storage reservoirs other than the holding reservoirs necessary for delivering water. Being an initial preliminary survey, costs are not included for maintenance, operation and amortization, however such costs are a definite factor in determining final solutions.

Method 1, as shown on Table 18 and described in Section V of this report, would be the least expensive. The supply of water would be at a minimum operating cost.

A prime factor for consideration, where use of such large quantities of water from so many sources, is the environmental impact to the vicinity and particularly, to the lower runoff areas below the sites. Due to the environmental aspects and if the maximum water demand cannot be reduced, then Method 2 (providing two water systems and recycling the waste water) warrants close analysis and consideration. As noted in the Metcalf and Eddy report, treating facilities for Big Meadow was considered as part of

one of the proposed plans for solving the sewerage problems of Yosemite Valley. Two purposes would result from using Method 2; (1) the prime water demand is reduced by approximately 45% and (2) use of nutrient rich waste water (treated to comply with all Federal, state and local standards) for irrigation purposes will benefit plant life and organically returns treated water to a natural state. It also becomes apparent that release of nutrient and phosphorus rich waste water in Crane Creek and the Merced River will increase the environmental impact to those areas. It is not difficult to remove soluble phosphorus compounds from water (by the use of alum), however, nitrogen removal has not sufficiently advanced to assure a trouble-free operation at reasonable cost. For this reason, natural means of removing soluble compounds would be more acceptable and in keeping with the environmental cycle. Considerable influence also results from storm drains and irrigation runoff of landscaped areas where non-organic fertilizers are used. The leaching of dissolved solids by this runoff water from the landscaped, irrigated and fertilized areas adds to the water pollution. Not much can be accomplished at reasonable cost, short of eliminating landscaped areas, to correct the problem of melting snow and rain water runoff, however, in the case of irrigation, saturation rates can be controlled to prevent runoff. Runoff would have a partial effect of defeating the use of recycled water. If funds are made available, a water supply system using the basic components of Method 2 is recommended for implementation in the Big Meadow Development. The capital cost savings from piping

raw sewage to El Portal and reducing in size the El Portal treatment plant would nearly justify the increased cost difference between Method 1 and Method 2.

Method 3 would be the most expensive and would require the least amount of control. Difficulty would be encountered in esthetically locating storage reservoir sites. A combination system using both Methods 2 and 3 would provide some savings in capital costs and may be worth further consideration.

Since apparently a large supply of water is available at Hetch Hetchy Reservoir, water from this source was explored for cost comparison, however, due to the wilderness areas affected and the resulting environmental effect, Method 4 was considered the least acceptable.

The various proposed water supply systems described in Section IV were developed for a ten year drought condition. Droughts experienced in 1924-25, 1931 and 1960-61 would result in certain restrictions to travel and visitation due to sanitary, health and fire danger.

It is desirable that a complete environmental survey be made of the Big Meadow vicinity and lower drainage areas prior to any construction. Water quality monitoring, including physical, chemical and biological measurements, should be initiated and periodically measured at established sampling stations and benchmarks to facilitate proper use of the water supply and control of waste water disposal.

VII - REFERENCES

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