WATER RESOURCES

CARRIZO PLAIN STRATIGRAPHIC UNITS CHART

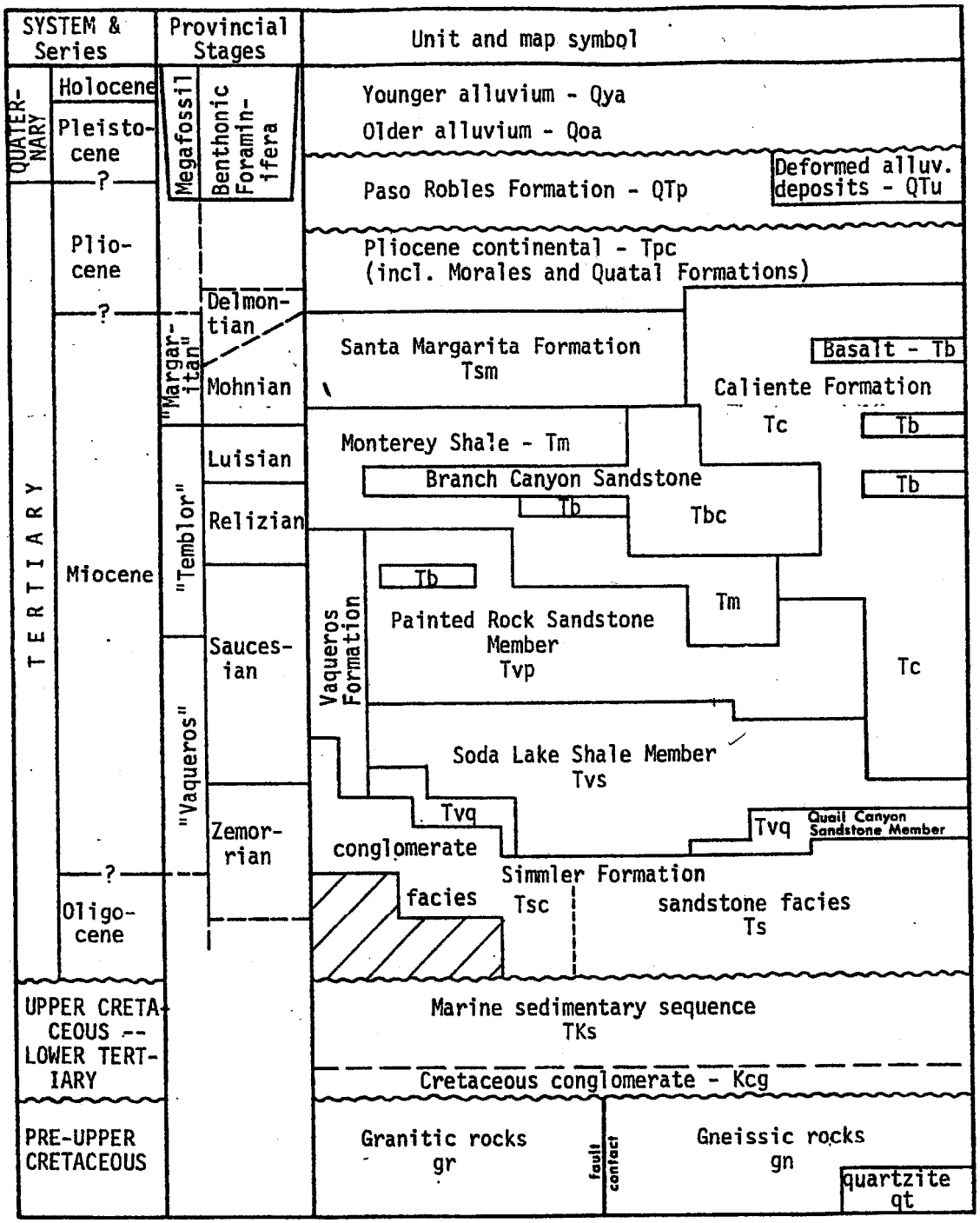


Figure 1.--Generalized chart of stratigraphic units in Caliente Range-Carrizo Plain area. Correlation of provincial megafaunal and foraminiferal stages after Addicott (1972) and Vedder (1973). Letter symbols same as symbols on plate 1 (geologic map). From Bartow, 1974.

EXISTING CESF PROJECT SITE GROUNDWATER WELL DRILLER'S REPORT

QUADRUPLICATE
RETAIN THIS COPY

5

WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

THE RESOURCES AGENCY OF CALIFORNIA

Do Not Fill In

Nº 106487

State Well No.

Other Well No. 29S/18E 28

(1) OWNER:

Name Nelson Lewis (Lottie Ely/Robt Stern)

Address P.O.Box 126

Buttonwillow, California

(2) LOCATION OF WELL:

County San Luis Obispo Owner's number, if any—

R. F. D. or Street No.

Section 28, Township 29 S, Range 18 E MD

Center of Section 28

(3) TYPE OF WORK *(check)*:

New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE *(check)*:

Domestic ☐ Industrial ☐ Municipal ☐

Irrigation ☒ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☒

Cable ☐

Dug Well ☐

(6) CASING INSTALLED:

SINGLE ☒ DOUBLE ☐

From ft.	to ft.	Diam.	Gage or Wall
0	630	16"	1/4"

If gravel packed

Diameter of Bore	from ft.	to ft.
27½"	0	630

Type and size of shoe or well ring point

Size of gravel: 3/8 & under

Describe joint welded

(7) PERFORATIONS:

Type of perforator used Louver

Size of perforations 2½ in., length, by 5/32 in.

From ft.	to ft.	Perf. per row	Rows per ft.
205	630	10	6
(75	205	6	1)

(mills Perforator 3/16 x 1)

(8) CONSTRUCTION:

Was a surface sanitary seal provided? ☐ Yes ☒ No To what depth ft.

Were any strata sealed against pollution? ☐ Yes ☒ No If yes, note depth of strata

From ft. to ft.

Method of Sealing

(9) WATER LEVELS:

Depth at which water was first found 30 ft.

Standing level before perforating ft.

Standing level after perforating ft.

(10) WELL TESTS:

Was a pump test made? ☒ Yes ☐ No If yes, by whom Bakersfield Pump

Yield: 500 gal./min. with 370 ft. draw down after 8 hrs.

Temperature of water Was a chemical analysis made? ☐ Yes ☐ No

Was electric log made of well? ☐ Yes ☒ No

(11) WELL LOG:

Total depth 630 ft. Depth of completed well 630 ft.

Formation: *Describe by color, character, size of material, and structure.*

ft.	to ft.	
0	4	soil & sandy clay
4	10	clay
10	40	sandy clay
40	55	fine sand
55	68	clay
68	86	sandy clay
86	98	fine sand
98	146	shale & clay
146	158	sandy clay
158	168	clay
168	179	sandy clay
179	198	shale & clay
198	222	clay
222	238	medium sand
238	252	clay
252	265	medium sand
265	278	sandy clay
278	289	medium sand
289	298	sandy clay
298	309	clay
309	322	medium sand
322	346	sandy clay
346	361	clay
361	374	medium sand
374	393	clay
393	406	sandy clay
406	423	coarse sand
423	439	clay
439	449	medium sand
449	462	sandy clay
462	479	clay
479	492	sandy clay
492	508	medium sand
508	522	clay
522	541	sandy clay
541	558	medium sand
558	574	clay
574	589	medium sand
589	608	sand
608	618	sandy clay
618	630	clay

Work started 6/23/65 19 , Completed 7/7/65 19

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME SLOCUM WATER WELL DRILLING (Person, firm, or corporation) *(Typed or printed)*

Address 1900 Ming Road

Bakersfield, California 93304

(SIGNED) (Charles A. Bowker, mgr) Well Driller

License No. 198639 C 57 Dated 7/20/65, 19

97649 5-63 25M QUIN ① △ SPO DWR 188 (REV. 3-54)

CALIFORNIA DEPARTMENT OF WATER RESOURCES
MONITORING WELL DATA

DATA FOR DWR MONITORING WELLS 28G, 28K, AND 28L

WELL NUMBER	TOWNSHIP	RANGE	SECTION	Basin Number	DATE	GROUND SURFACE ELEVATION	GROUND SURFACE TO WATER LEVEL	WATER SURFACE ELEVATION	NO MEASUREMENT COLLECTED
29S18E28G01M	29S	18E	28	3-19	15-Apr-69	2022	54.5	1967.5	
29S18E28G01M	29S	18E	28	3-19	13-Apr-70	2022	125.5	1896.5	
29S18E28G01M	29S	18E	28	3-19	18-Nov-70	2022	67.2	1954.8	
29S18E28G01M	29S	18E	28	3-19	27-Apr-71	2022	63.1	1958.9	
29S18E28G01M	29S	18E	28	3-19	20-Oct-71	2022	75.5	1946.5	
29S18E28G01M	29S	18E	28	3-19	10-Apr-72	2022	225	1797	
29S18E28G01M	29S	18E	28	3-19	20-Apr-72	2022	135	1887	
29S18E28G01M	29S	18E	28	3-19	09-Nov-72	2022	64	1958	
29S18E28G01M	29S	18E	28	3-19	16-Apr-73	2022	58.7	1963.3	
29S18E28G01M	29S	18E	28	3-19	15-Nov-73	2022	62	1960	
29S18E28G01M	29S	18E	28	3-19	04-Nov-74	2022	59.6	1962.4	
29S18E28G01M	29S	18E	28	3-19	28-Apr-75	-999	0	-999	7
29S18E28G01M	29S	18E	28	3-19	16-Oct-75	2022	59.7	1962.3	
29S18E28G01M	29S	18E	28	3-19	27-Apr-76	2022	93.6	1928.4	
29S18E28G01M	29S	18E	28	3-19	25-Oct-76	2022	67	1955	
29S18E28G01M	29S	18E	28	3-19	03-May-77	2022	89.5	1932.5	
29S18E28G01M	29S	18E	28	3-19	31-Oct-77	2022	63.8	1958.2	
29S18E28G01M	29S	18E	28	3-19	08-May-78	2022	53.8	1968.2	
29S18E28G01M	29S	18E	28	3-19	07-Dec-78	2022	50.9	1971.1	
29S18E28K01M	29S	18E	28	3-19	10-Oct-63	2020	31.8	1988.2	
29S18E28K01M	29S	18E	28	3-19	02-Apr-64	2020	32	1988	
29S18E28K01M	29S	18E	28	3-19	07-Oct-64	2020	33.9	1986.1	
29S18E28K01M	29S	18E	28	3-19	14-Apr-65	2020	38.9	1981.1	
29S18E28K01M	29S	18E	28	3-19	22-Oct-65	2020	31.5	1988.5	
29S18E28K01M	29S	18E	28	3-19	22-Apr-66	2020	31.7	1988.3	
29S18E28K01M	29S	18E	28	3-19	11-Oct-66	2020	31.9	1988.1	
29S18E28K01M	29S	18E	28	3-19	11-May-67	2020	32.2	1987.8	
29S18E28K01M	29S	18E	28	3-19	28-Oct-67	2020	32	1988	
29S18E28K01M	29S	18E	28	3-19	19-Apr-68	2020	32.3	1987.7	
29S18E28K01M	29S	18E	28	3-19	22-Oct-68	2020	34.3	1985.7	
29S18E28K01M	29S	18E	28	3-19	15-Apr-69	2020	25	1995	
29S18E28K01M	29S	18E	28	3-19	13-Apr-70	2020	27.8	1992.2	
29S18E28K01M	29S	18E	28	3-19	18-Nov-70	2020	28.8	1991.2	
29S18E28K01M	29S	18E	28	3-19	27-Apr-71	2020	28.2	1991.8	
29S18E28K01M	29S	18E	28	3-19	20-Apr-72	2020	28.9	1991.1	
29S18E28K01M	29S	18E	28	3-19	09-Nov-72	2020	30.2	1989.8	
29S18E28K01M	29S	18E	28	3-19	16-Apr-73	2020	28.9	1991.1	
29S18E28K01M	29S	18E	28	3-19	15-Nov-73	2020	29.2	1990.8	
29S18E28K01M	29S	18E	28	3-19	24-Apr-74	2020	30.8	1989.2	
29S18E28K01M	29S	18E	28	3-19	04-Nov-74	2020	29.5	1990.5	
29S18E28K01M	29S	18E	28	3-19	28-Apr-75	2020	30.3	1989.7	W
29S18E28K01M	29S	18E	28	3-19	16-Oct-75	2020	30.2	1989.8	
29S18E28K01M	29S	18E	28	3-19	26-Apr-76	2020	32	1988	
29S18E28K01M	29S	18E	28	3-19	25-Oct-76	2020	30.9	1989.1	
29S18E28K01M	29S	18E	28	3-19	03-May-77	2020	31.7	1988.3	

DATA FOR DWR MONITORING WELLS 28G, 28K, AND 28L

29S18E28K01M	29S	18E	28	3-19	31-Oct-77	2020	31	1989	
29S18E28K01M	29S	18E	28	3-19	08-May-78	2020	19.2	2000.8	
29S18E28K01M	29S	18E	28	3-19	07-Dec-78	2020	23.7	1996.3	
29S18E28L01M	29S	18E	28	3-19	10-Oct-63	2020	27.2	1992.8	
29S18E28L01M	29S	18E	28	3-19	02-Apr-64	2020	31.9	1988.1	
29S18E28L01M	29S	18E	28	3-19	07-Oct-64	2020	33.9	1986.1	
29S18E28L01M	29S	18E	28	3-19	14-Apr-65	2020	27.7	1992.3	
29S18E28L01M	29S	18E	28	3-19	22-Oct-65	2020	26	1994	
29S18E28L01M	29S	18E	28	3-19	22-Apr-66	2020	33.7	1986.3	
29S18E28L01M	29S	18E	28	3-19	11-Oct-66	2020	32	1988	
29S18E28L01M	29S	18E	28	3-19	11-May-67	-999	0	-999	8
29S18E28L01M	29S	18E	28	3-19	19-Apr-68	2020	31.1	1988.9	
29S18E28L01M	29S	18E	28	3-19	22-Oct-68	2020	33	1987	
29S18E28L01M	29S	18E	28	3-19	15-Apr-69	2020	19.9	2000.1	
29S18E28L01M	29S	18E	28	3-19	13-Apr-70	2020	24	1996	
29S18E28L01M	29S	18E	28	3-19	18-Nov-70	2020	29.3	1990.7	
29S18E28L01M	29S	18E	28	3-19	27-Apr-71	2020	24.9	1995.1	
29S18E28L01M	29S	18E	28	3-19	20-Oct-71	2020	29	1991	
29S18E28L01M	29S	18E	28	3-19	20-Apr-72	2020	22.8	1997.2	
29S18E28L01M	29S	18E	28	3-19	09-Nov-72	2020	26.3	1993.7	
29S18E28L01M	29S	18E	28	3-19	16-Apr-73	2020	24.8	1995.2	
29S18E28L01M	29S	18E	28	3-19	15-Nov-73	2020	25.1	1994.9	
29S18E28L01M	29S	18E	28	3-19	24-Apr-74	2020	26.8	1993.2	
29S18E28L01M	29S	18E	28	3-19	04-Nov-74	2020	26.1	1993.9	
29S18E28L01M	29S	18E	28	3-19	28-Apr-75	2020	27.2	1992.8	
29S18E28L01M	29S	18E	28	3-19	16-Oct-75	2020	26.8	1993.2	
29S18E28L01M	29S	18E	28	3-19	27-Apr-76	2020	29.4	1990.6	
29S18E28L01M	29S	18E	28	3-19	25-Oct-76	2020	28.6	1991.4	
29S18E28L01M	29S	18E	28	3-19	03-May-77	2020	39.8	1980.2	
29S18E28L01M	29S	18E	28	3-19	31-Oct-77	2020	29.5	1990.5	
29S18E28L01M	29S	18E	28	3-19	08-May-78	2020	16.6	2003.4	
29S18E28L01M	29S	18E	28	3-19	07-Dec-78	2020	20.4	1999.6	

CARRISA PLAIN SOLAR PROJECT (ARCO SITE)
GROUNDWATER INVESTIGATION AND ANALYSIS

Bechtel Civil & Minerals, Inc.

Interoffice Memorandum

To T. A. McCormick

File No.

Subject Carrisa Plains Test Well
Job 16413

Date June 15, 1984

From C. R. Farrell

Of H&CF/Geology

Copies to M. J. Adair
L. R. West

At 45/31 Ext.

Attached is a summary of the work done to construct and test a production well at the Carrisa Plain Solar Project site.

I contacted Don's Drilling Co. on Friday, June 14, 1984 concerning the sealing of the first well drilled. Mr. D. Redfairn said that he filled the casing to near surface with drill cuttings, mud and the broken up pieces from the concrete pump base. He cut off the well casing about three feet below ground surface, filled the balance of casing with a grout plug, and welded a metal cap on the casing top. He reported this to the county regulatory agency.

CR Farrell

C. R. Farrell

CRF:as
Attachment

12118

PRODUCTION TEST WELL

CARRISA PLAINS SOLAR PROJECT

JUNE 1984

Bechtel National, Inc. requested Bechtel Civil and Minerals, Inc. to investigate the possibility of developing a water supply from ground water for the Solar Energy Plant at Carrisa Plains, California. The water supply requirement is estimated to be about 115 gpm (gallons per minute). A preliminary literature review followed by discussions with local farmers indicated that the ground water resources at the proposed site should be sufficient to meet the water requirements. Near-surface ground water (to a depth of approximately 100 feet) is reported to be poor quality but sands and gravels below that depth yield good quality to wells. A program for well construction and aquifer testing was developed and approved. The drilling contract was awarded to Don's Drilling Co., Bakersfield, Calif. in March, 1984. The contractor mobilized on March 5 and the test/production well was completed on May 5. The following paragraphs describe briefly the drilling, construction, and testing of the test well.

Exploration

Three 5-1/4-inch diameter exploratory pilot holes were drilled before a sufficiently thick interval of coarse-grained and apparently permeable materials was encountered to justify construction of a well. The first pilot hole, W-1, located about 1000 feet north of the southern section

line and approximately half way between the east and west section lines, was first drilled to a depth of 500 feet. An E-log, which measures the SP (self potential) and apparent electrical resistivity of the materials was run in the hole. A review of the E-log and the drill cuttings indicated that very little sand or gravel was present except in the bottom portion of the hole. It was decided to drill an additional 100 feet (to 600 feet) to determine if additional sand or gravel might be encountered. The hole was drilled to a total depth of 620 feet, and a second E-log was run. The E-log verified the indications of the drill cuttings that little to no permeable material was present at this site. The pilot hole was backfilled and a second exploratory site was selected.

The second pilot hole, W-2, was located about 120 feet south and 120 feet east of the north-west corner of the section. This hole was drilled to 600 feet and E-logged. The hole encountered only clay and silt below about 120 feet. Based on the E-log and the drill cuttings this hole was also backfilled and abandoned.

The third pilot hole, W-3, was located about 120 feet north and 120 feet east of the south-west corner of the section. It was drilled to 620 feet and an E-log was run. The E-log, as well as the drill cuttings, were favorable, indicating lenses of sand and gravel from 460 to 610 feet. Based on these results it was decided to ream the pilot hole and construct the 12-inch diameter test well.

Construction of well

The well is a gravel-packed well, consisting of a 19-inch diameter hole in which a 12-inch diameter casing and screen assembly is installed. A filter gravel was placed below a depth of 190 feet in the annular space between the wall of the drilled hole and the casing/screen assembly. A bentonite seal was installed from 185 to 190 feet. The annulus was backfilled with gravel above that seal to 50 feet below the land surface and a cement-grout surface seal was installed from 50 feet to land surface. A concrete pump base, 6 feet by 6 feet and 1-foot thick was installed at the ground surface.

The well casing and screen assembly consists of 60 feet of galvinized low carbon steel screen and 560 feet carbon steel casing. The screen is a continous wire wrap type, manufactured by U.O.P. Johnson Co. with .020-inch openings. The screen was installed in three sections located at depths of 490-500 feet, 530-555 feet, and 575-600 feet below the land surface.

The well was developed by jetting the screen, and by washing and surging with air. After nine days of cleaning and development by these means it was determined that the well was clean enough for final development with the test pump.

The test pump was installed and final development began on April 10. At 11:20 a.m. April 11, while developing, the pump discharge rate suddenly increased from about 80 gpm to almost 200 gpm and the water

0944-

level in the well rose about 120 feet. In less than 5 minutes the pump locked-up and ceased pumping. The contractor then removed the pump. It was found that the well had filled in to a depth of 460 feet below land surface with sand and gravel. The caved material was washed out to a depth of 585 ft with a 9-7/8-inch bit where an obstruction was encountered, preventing further clearing of the well. It was concluded that the well screen was broken at that depth.

The cause of the break in the screen, based on the events that occurred, was apparently the bridging of gravel filter during installation, leaving a void in the annular space at some point above the break. During development with the pump, the bridge collapsed, and the impact of falling gravel from above caused the screen to break at a depth of 585 feet. Because the casing/screen assembly could not be pulled to repair the screen, the contractor elected to drill a new well. He backfilled and sealed the initial well in accordance with state and county regulations.

The drill rig was moved about 36 feet north of well W-3 and a second 19-inch diameter hole (W-3A) was drilled to a depth of 620 feet. The casing and screen assembly in well W-3A includes 500 feet of 10-inch diameter carbon steel casing, 50 feet of 8-inch diameter galvinized low carbon steel wire wrapped screen, and 67 feet of 8-inch diameter carbon steel casing. The 10-inch casing is joined to the 8-inch casing/screen assembly by a 10x8-inch reducer. The screen has .030-inch openings and was installed in two sections located at depths of 530-550 feet and

570-600 feet below the land surface. A washdown valve seals the bottom of the casing/screen assembly. Gravel filter material was placed in the annular space between drill hole and the well assembly with considerable care to avoid bridging. The filter is from 620 feet to 220 feet below the land surface. A grout plug was installed from 220 feet to 215 feet. The annulus above the plug is filled with gravel to a depth of 50 feet below the land surface. The well was completed by installation of a grout surface seal from 50 feet to ground surface and construction of the pump base.

Development of Well 3A proceeded in a similar manner to that of Well 3. Installation of the test pump and final development was accomplished without difficulty. Removal of fines and sand from the well was realized.

Well Test and Methods of Analysis

After the completion of development an aquifer pumping test was performed. The pumping test provides an in-situ measurement of the transmissivity of the aquifer, which is important in determining the long term yield of the well. The test was performed in accordance with recognized methods for conducting a constant-discharge type test.

The aquifer pumping test data were analyzed by methods based on the Theis solution of non-steady ground water flow to a well in response to a constant pumping rate. The Theis solution can be written in the following form (Freeze & Cherry, "Groundwater", Prentice Hall, Inc., 1979:

$$s = \frac{Q}{4\pi T} W(u)$$

where: s = drawdown in the well (feet),

Q = discharge from well (ft^3/day),

T = transmissivity (ft^2/day),

$W(u)$ = well function of u,

$$u = \frac{r^2 S}{4Tt}$$

r = distance from well, feet,

S = storativity, dimensionless, and

t = time, days.

The Jacob approximation of the Theis solution was applied in the analyses. Semilog graphical plotting of the data is used in this method. Both drawdown in response to pumping and recovery of the water level following cessation of pumping provide data with which to analyze aquifer capacity.

Drawdown data obtained during pumping is plotted against the log of time since pumping began. A straight line is developed, the slope of which is related to the transmissivity. The recovery semilog plots are

similar to the time-drawdown solution. Residual drawdown (s') data are plotted against the logarithm of the ratio of time since pumping started (t) and time since pumping stopped (t'). With these data a straight line is also developed, the slope of which is related to the transmissivity.

The test commenced at 9:45 a.m. May 2, 1984 pumping continued for 72 hours. Initially the pumping rate was set at 305 gpm. After 90 minutes, the rate had to be reduced to approximately 265 gpm because of mechanical problems with the diesel engine that operated the pump. The water level in the well was measured during the test with an air line. The pumping rate was measured with an orifice plate on the discharge pipe.

The depth to water below ground surface before commencing the aquifer test (static level) was 40 feet. After 90 minutes of pumping at a rate of 305 gpm the water level in the well was drawn down to a depth of 373 feet (drawdown of 333 feet). Because of mechanical problems with the diesel power source, the pumping rate was decreased at that time, and for the balance of the pumping period (total pumping duration of 4335 minutes, or 3 days) the pumping rate varied from 254 to 268 gpm. WIth the drop in pumping rate, the water level in the well quickly recovered to 340 feet depth, and then began dropping again, slowly, as pumping continued at the lower rate. The water level depth in the well at the end of the pumping period was 368 feet.

Evaluation of Aquifer Capacity

The analyses of the pumping test data indicate that the transmissivity of the aquifer (the sands and gravels encountered between 460 and 610 feet) is approximately 2800 gallons per day per foot (375 ft^2/d) and the estimated well efficiency during the test was 0.60. It is not possible to measure the aquifer storativity accurately with the data collected from the pumping well. However, the occurrence of the sands and gravels within thick clay/silt layers, and the potentiometric level (represented by the water level in the well) above the aquifer indicate it is confined to semiconfined. A storativity of 0.001 can be applied for estimating aquifer capacity. These aquifer characteristics, the measured responses of the test well, and assuming no recharge occurs to replenish the aquifer, provide a conservative basis for estimating the capacity of the aquifer to provide the long-term design water requirement (115 gpm).

Adjusting the well performance to a rate of 115 gpm, and projecting the drawdown interference after 20 years of continuous pumping indicates that it would be less than 200 feet at the well, and less than 50 feet at a distance of 1000 feet from the well. The aquifer is capable of providing the water requirement and the extraction would not interfere with existing users.

Bechtel Civil & Minerals, Inc.

Interoffice Memorandum

To T. A. McCormick

File No.

Subject Capacity of the Test Well
Carrisa Plain Solar Project
job #16413

Date June 25, 1984

From C. R. Farrell

Of H&CF/Geology

Copies to M. J. Adair(w/o enc.)
L. R. West (w/o enc.)

At 45/31 Ext.

In the meeting Thursday, June 21, 1984 you asked that I evaluate the capability of the test well at the Carrisa Plain site to meet a maximum seasonal water requirement of 190 gpm for 4 months (June - September) and a 24-hour peak demand of 250 gpm. These maximum demands are for the design long-term mean of 115 gpm. In addition, you asked that I provide an estimate of the long-term maximum capacity of the well. Long-term is assumed to be represented by a 20-year operational period. The following summarizes those estimates. Copies of the pumping test data and calculations on which the estimates are based are enclosed.

Review of the data and analyses of the pumping test conducted at the well (well 3A) in May indicates that it is capable of yielding the design water requirement (115 gpm) and could meet the seasonal and peak maximum demands.

The maximum long-term capacity of the well is estimated based on several assumptions, or conditions. These include:

1. Pump set at 490 feet depth.

2. Potentiometric surface of the ground-water basin declines at a rate of 1 foot per year (storage depletion by others).

3. Initial efficiency of well is maintained.

4. Seasonal and peak demands are proportional to those demands determined for design water requirements (115 gpm).

Based on these conditions, the maximum long-term mean capacity of the well is calculated to be 170 gpm.

CR Farrell

CRF/jt

C. R. Farrell

CALCULATION COVER SHEET

PROJECT Carrisa Plain Solar Power JOB NO. 16413 DISCIPLINE Geology

SUBJECT Ground water supply - test well analysis FILE NO.

CALC.NO.

ORIGINATOR J. C. Isham DATE 5/10/84

CHECKER C. R. Farrell DATE 6/10/84 NO. OF SHEETS 10

RECORD OF ISSUES

NO.	DESCRIPTION	BY	DATE	CHKD	DATE	APPRD	DATE	DATE FILMED
0	Analysis of well test	JCI	5/10/84	CRF	6/15/84	CRF	6/22/84	

PRELIMINARY CALC. ☐ COMMITED PRELIMINARY DESIGN CALC. ☒

SUPERSEDED CALC. ☐ FINAL CALC. ☐

STATEMENT OF PROBLEMS:

1. Analyze pumping test to determine aquifer characteristics
2. Determine capacity of aquifer to provide design water requirements and estimate of maximum yield of well

SOURCES OF DESIGN CRITERIA:

Project: average water requirement of 150 AcFt/yr or approximately 115 gpm, and maximum seasonal demand of 190 gpm during summer period: June - September (4 months)

SOURCES OF FORMULA & REFERENCES:

"Ground Water and Wells", Johnson Division, UOP Inc., 1980

0510 (11-74)

BECHTEL

CALCULATION SHEET

DATE 6/10/84

DESIGN BY J.C. Isham DATE 5/10/84 CHECKED BY CRFarrell SHEET NO. 1 of ~~8~~ 10

PROJECT Carrisa Plains Solar JOB NO. 16413

SUBJECT Analysis of W3A pumping Test. CALCULATION NO. FILE NO.

Analyses the drawdown & recovery data by the Jacob method from Johnson's Ground Water & Wells, UOP Inc, 1980

Drawdown data

$$T = \frac{264 \times Q}{\Delta s}$$

Recovery data

$$T = \frac{264 \times Q}{\Delta s'}$$

where:

T = Transmissivity (gal/day/ft)

Q = Pumping rate (gal/min)

Δs = Drawdown over one log cycle of time since pumping started (ft)

$\Delta s'$ = Residual drawdown over one log cycle of the ratio of t/t' (ft)

t = Time since pumping started (min)

t' = Time since pumping stopped (min)

0510 (11-74)

BECHTEL

CALCULATION SHEET

DATE 6/10/84

DESIGN BY J. C. Isham DATE 5/10/84 CHECKED BY CR Farrell SHEET NO. 2 of 9

PROJECT Carrisa Plains Solar JOB NO. 16413

SUBJECT W3A Pumping Test CALCULATION NO. FILE NO.

1) Analysis of Drawdown data (See Page 3)

The test started at 0945 on 5/2/84 at a rate of 305 gpm. After 90 mins. of pumping at 305 gpm the rate had to decreased due to mechanical problem with the diesel engine that drives the pump.

The analysis of the early data 0-90 mins. indicates a T of 1300 gpd/ft (curve "a")

From 90 to 4335 mins. the pumping rate varied from 254 to 268 gpm. The average pumping rate through out the entire test was approx. 265 gpm.

The analysis of the later data 1550 - 4335 mins. indicates a T of 2000 gpd/ft (curve "b")

An average T from the drawdown data is 1650 gpd/ft

K+E SEMI-LOGARITHMIC 46 6012
4 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.

Job # 16413

Time/Drawdown Plot

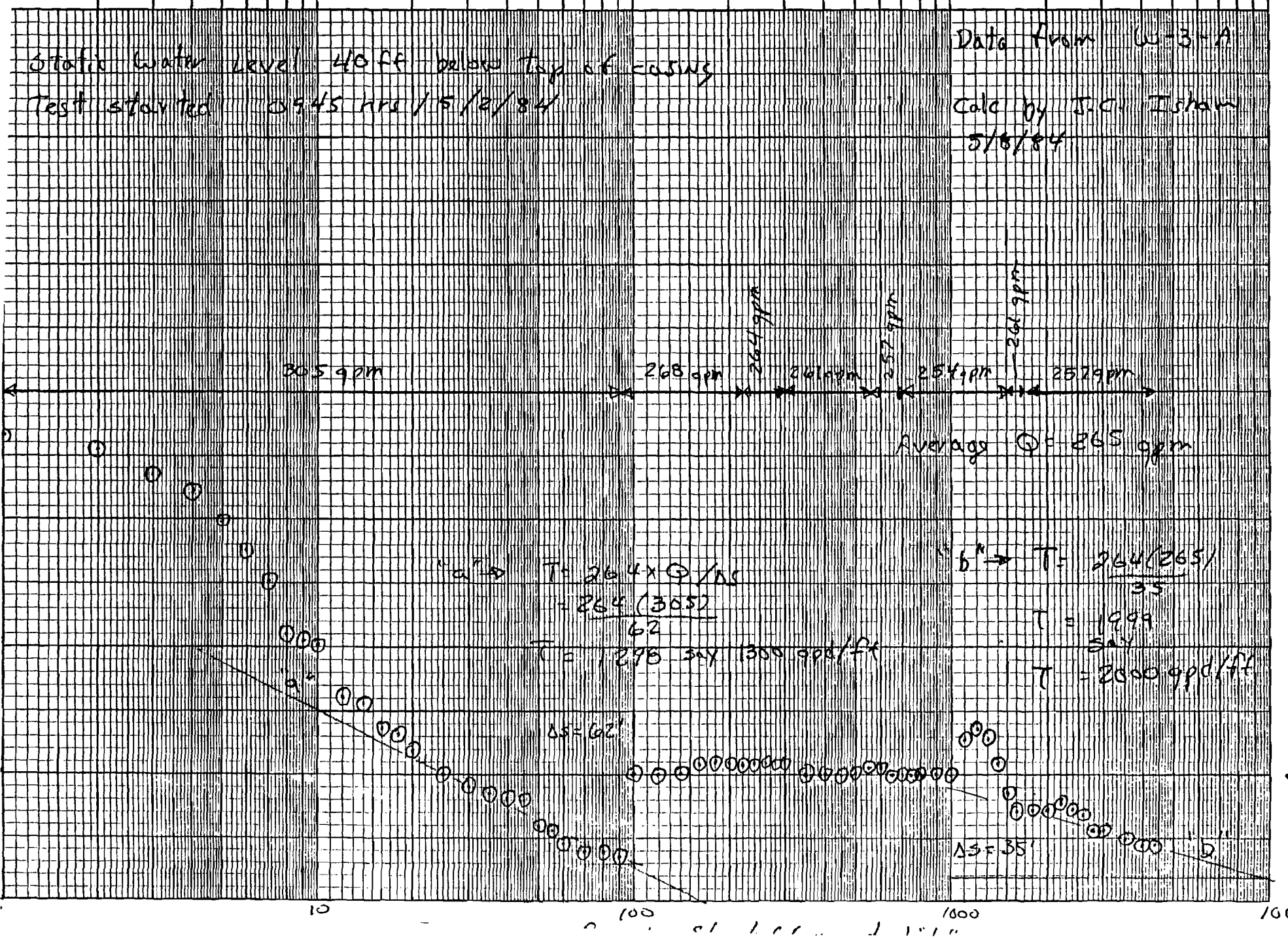
Pumping Test on Well W-3-A

Static Water Level 40 ft below Top of casing

Test started 0545 hrs 1/5/2/84

Data from W-3-A

Calc by J.C. Isham
5/8/84



0510 (11-74)

BECHTEL

CALCULATION SHEET

DESIGN BY J.C. Isham DATE 5/10/84 CHECKED BY CRFarrell DATE 6/10/84 SHEET NO. 4 of 8 10

PROJECT Carrisa Plains Solar JOB NO. 16413

SUBJECT W3A Pumping Test CALCULATION NO. FILE NO.

2) Analysis of Recovery Data (See Page 5

The pump was stopped at 1000 on 5/5/84 after 4335 mins. of operation. The average pumping rate was approx. 265 gpm.

Two curves are drawn through the recovery data

Curve "c" is a fit of the early and late time recovery data. This curve indicates a T of 2400 gpd/ft.

Curve "d" is a fit of only the early time recovery data. This curve indicates a T of 3200 gpd/ft.

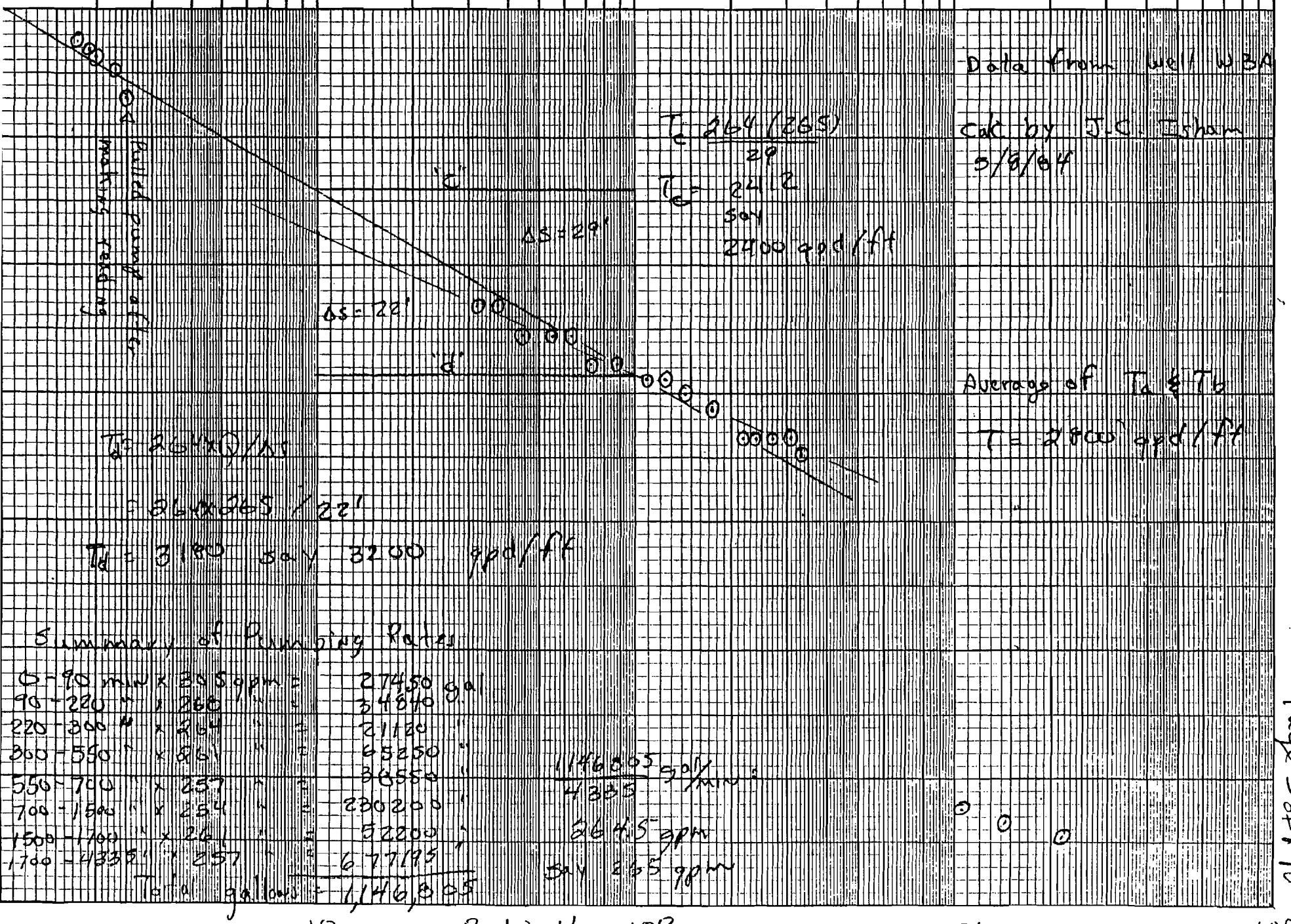
An average T from the recovery data is 2800 gpd/ft

K+E SEMI-LOGARITHMIC 46 6012
4 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.

Carrisa, Tiajno
Job # 16413

Recovery Plot

Pumping test on Well W-3-A



Data from Well WBA

Calc by J.C. Isham
5/8/84

$T_c = \frac{264(265)}{29}$

$T_c = 2412$
say
2400 gpd/ft

Average of T_a & T_b

$T = 2800$ gpd/ft

$T_d = 264 \times Q / \Delta s$

$= 264 \times 265 / 22'$

$T_d = 3180$ say 3200 gpd/ft

Summary of Pumping Rates

0-90 min	x 305 gpm	=	27450 gal
90-220 "	x 268 "	=	34840 "
220-300 "	x 264 "	=	21120 "
300-550 "	x 261 "	=	65250 "
550-700 "	x 257 "	=	38550 "
700-1500 "	x 254 "	=	230200 "
1500-1700 "	x 261 "	=	52200 "
1700-4335 "	x 257 "	=	677195 "
Total gallons		=	1,146,805

$\frac{1146805}{4335}$ gal/min =

264.5 gpm

say 265 gpm

Page 5 of 10

10 Rated t/c 100 1000 10000

0510 (11-74)

BECHTEL

CALCULATION SHEET

DATE 6/10/84

DESIGN BY J.C. Isham DATE 5/10/84 CHECKED BY CRF SHEET NO. 6 of ~~8~~ 10

PROJECT Carrisa Plains Solar JOB NO. 16413

SUBJECT W3A Pumping Test CALCULATION NO. FILE NO.

Because problems involved in the intreprotion of all of the drawdown data:

1) change in pumping rate
2) early curve to short for a good analysis of T.
3) what caused the relatively sharp rise & fall of water Level between 1000 & 1300 mins.

it is believed that the recovery data gives a better measurement of Transmissivity of the aquifer. T= 2800 gpd/ft

Using the data from the pumping test ie: 330' of drawdown after 90 mins. & a T of 2000 gpd/ft The projected drawdown after 20 years of pumping is shown on page 7

K+E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A. 46 6212

Job # 16413

Drawdown at design pumping rate, 115 gpm

assume T = 2800

$T = 264\ Q/\Delta s$

$2800 = \frac{264(300)}{\Delta s}$

$\Delta s = \frac{264(300)}{2800}$

$\Delta s = 28.3$ ft say 30 ft

assume T = 2000

$\Delta s = \frac{264(300)}{2000}$

$\Delta s = 39.6$ ft

say 40 ft

From pumping test (Q = 300 gpm)

Projected Drawdown Curves

T = 2800

T = 2000

Design pumping rate (average): 115 gpm

measured drawdown @ 4335 min. = 328' (pg @ 205 gpm)

$\frac{DD(115)}{328} = \frac{115}{205}$ $DD(115) = 192$ ft.

$\Delta s(115) = \frac{264 \cdot 115}{2800} = 10.8$ say 11 ft

Years → 1 year 10 years 20 years

10000 100000 1,000,000 10,000,000

K+E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS MADE IN U.S.A. KEUFFEL & ESSER CO.

Carrisa Plain Project
job # 16413 June 14/84

$$s = \frac{Q}{4\pi T} \ln\left(\frac{2.25\,Tt}{r^2 S}\right)$$

$T = 335\ ft^2/d$
$S = 0.001$
$r = 0.5'$
$t = 3$ days
$Q = 265\ gpm = 5.10E^4\ ft^3/d$

$$s = \frac{5.10E^4}{4\pi\,335} \ln\left(\frac{2.25 \cdot 335 \cdot 3}{(0.5)^2\ 0.001}\right)$$

$= 194'$ (theoretical)

$= 328'$ (measured in well)

efficiency: $\frac{\text{theoretical DD}}{\text{measured DD}} = \frac{194}{328}$

$= 60\%$

$$\Delta s = \frac{528\,Q}{T} = \frac{528 \cdot 115}{2800}$$

$= 21.7$ say $22'$

theoretical DD after 20 years @ ~~well~~ distance of 100 ft from well: (pumping 115 gpm)

$$s = \frac{2.214E^4}{4\pi\,335} \ln\left(\frac{2.25 \cdot 335 \cdot 7300}{(100)^2\ 0.001}\right)$$

$= 69.5$ say $70'$

at well ($r = 0.5$)

$s = 125'$

$s_{60} = 125/0.6 = 208'$

1 10 100 1000 10,000

Distance from well (feet)

p. 8 of 8 10

0510 (11-74)

BECHTEL

CALCULATION SHEET

DATE

DESIGN BY [illegible] DATE 6/20/[illegible] CHECKED BY SHEET NO. [illegible]

PROJECT Carrisa Plain Solar Power JOB NO. 16413

SUBJECT Ground Water Supply CALCULATION NO. FILE NO.

Determine maximum probable yield (long-term = 20 years) of test well:

Assumed conditions:

1. Pump set at depth of 490' (10 feet above reducer to 8-inch ϕ casing)
2. Initial depth to water is 40'
3. No recharge to ground water basin
4. Decline of potentiometric surface in basin (depletion of storage by others) is 1'/yr, or 20' in 20 years
5. Well efficiency maintained @ initial level (60%)
6. Maximum seasonal demand is 190/115 of the long-term mean and is for 4 months duration (based on project calculation of 190 gpm during June – Sept for mean of 115 gpm).

Then: Available drawdown is 490 - 40 - 20 = 430' (at 20 yr

Approach:

1. Calculate additional drawdown of maximum season for design long-term mean (115 gpm) and add to drawdown at 20 years of 115 gpm (180 feet, from p. 7 of calc).
2. Solve for maximum long-term mean as proportional to drawdown of 115 gpm with maximum seasonal correction

Added drawdown @ 20 years:

$$s = \frac{Q}{0.6\,4\pi T} \ln\left(\frac{2.25\,Tt}{r^2 S}\right)$$

0510 (11-74)

BECHTEL

CALCULATION SHEET

DATE

DESIGN BY C Farrell DATE 6/22/84 CHECKED BY SHEET NO. 10 of 10

PROJECT Carrisa Plain Solar Power JOB NO. 16413

SUBJECT Ground Water Supply CALCULATION NO. FILE NO.

$T = 2800\ gpd/ft = 335\ ft^2/d$

$S = 0.001$

$r = 0.5'$

$t = 4\ months = 120\ days$

$$s = \frac{1.444E^4}{0.6 \cdot 4 \cdot \pi \cdot 335} \ln\left(\frac{2.25 \cdot 335 \cdot 120}{(0.5)^2 \cdot 10^{-3}}\right)$$

$$= \underline{112\ ft}$$

$Q = 190 - 115 = 75\ gpm$

$= 1.444E^4\ ft^3/d$

Then:

$$\frac{\text{Maximum (long-term mean)}}{115\ gpm\ (\text{long-term mean})} = \frac{430'\ (\text{available drawdown})}{150 + 112}$$

$$Max = \frac{115 \cdot 430}{292} = 169.35\ gpm$$

say $\underline{\underline{170\ gpm}}$

AQUIFER PUMPING TEST

OBSERVATION WELL W-3A

PROJECT Carrisa Plains JOB No. 16413

TEST TYPE CONSTANT DISCHARGE DATE TEST BEGUN 5-2-84

PUMPING WELL W-3A DIST. TO PPG WELL same ( )

SCREEN DEPTH ( ): PPG WELL 530-550-570-600 OBS. WELL

FLOW MEAS. METHOD 6X4 ORIFICE PUMP Johnson #4137 8" dia - 17 stage

PUMPING RATE / HISTORY

PUMPING PERIOD

REFERENCE POINT AIRLINE 3' ABOVE L.S. ELEVATION

LOCATION (approx. top of casing) OBSERVER Layne Western, West & Ishan

STATIC W.L. 15.16 FT PH 5.51 CONDT 1500 WATER TEMP 74°

	TIME (24 HR) DAY	TIME-AFTER PUMP ON (MIN)	DEPTH TO WATER (FT)	DRAW DOWN (FT)	DISCHARGE ( )	TIME (24 HR) DAY	TIME-AFTER PUMP ON ( )	DEPTH TO WATER ( )	DRAW DOWN ( )	DISCHARGE ( )
	9:45 AM	0	40'	0'	START PUMP	12:05 PM	140	340'	300'	268
	9:46	1	206'	166'	305	12:25	160	336'	296'	268
	9:47	2	213'	173'	305	12:45	180	336'	296'	268
	9:48	3	222'	182'	305	1:05	200	336'	296'	268
	9:49	4	229'	189'	305	1:25	220	336'	296'	268
	9:50	5	241'	201'	305	1:45	240	336'	296'	264
	9:51	6	252'	212'	305	2:05	260	336'	296'	264
	9:52	7	264'	224'	305	2:25	280	336'	296'	264
	9:53	8	285'	245'	305	2:45	300	336'	296'	264
	9:54	9	287'	247'	305	3:30	350	340'	300'	261
WD TEST	9:55	10	289'	249'	305	4:20	400	340'	300'	261
0.10 cc	9:57	12	310'	270'	305	5:10	450	340'	300'	261
	9:58	14	313'	273'	305	6:00	500	340'	300'	261
	10:01	16	322'	282'	305	6:50	550	338'	298'	261
	10:03	18	324'	284'	305	7:40	600	338'	298'	257
0.20 cc	10:05	20	331'	291'	305	8:30	650	340'	300'	257
	10:10	25	340'	300'	305	9:20	700	340'	300'	257
0.30 cc	10:15	30	345	305'	305	10:10	750	340'	300'	254
	10:20	35	347'	307'	307	11:00	800	340'	300'	254
	10:25	40	350'	310'	305	11:50	850	340'	300'	254
0.40 cc	10:30	45	350'	310'	305	5-3-84 12:40 AM	900	340'	300'	254
	10:35	50	361'	321'	305	1:30	950	340'	300'	254
	10:40	55	363'	323'	305	2:20	1000	340'	300'	254
	10:45	60	368'	328'	305	4:00	1100	326'	286'	254
	10:55	70	370'	330'	305	5:40	1200	322'	282'	254
	11:05	80	370'	330'	302	7:20	1300	326'	286'	254
	11:15	90	373'	333'	302	9:00	1400	336'	296'	254
	11:25	100	340'	300'	268	10:40	1500	347'	307'	254
0.40 cc	11:45	120	340'	300'	268	12:20 PM	1600	354'	314'	261

AQUIFER PUMPING TEST

OBSERVATION WELL W-3A

PROJECT Carrisa Plains JOB No. 16413

TEST TYPE CONSTANT DISCHARGE DATE TEST BEGUN 5-2-84

PUMPING WELL W-3A DIST. TO PPG WELL same ( )

	TIME (24 HR DAY)	TIME-AFTER PUMP ON ( )	DEPTH TO WATER ( )	DRAW DOWN ( )	DISCHARGE ( )	TIME (24 HR DAY)	TIME-AFTER PUMP ON ( )	DEPTH TO WATER ( )	DRAW DOWN ( )	DISCHARGE ( )
	12:20PM	1600	354'	314'	261					
	2:00	1700	354'	314'	261					
	3:40	1800	354'	314'	257					
	5:20	1900	354'	314'	257					
	7:00	2000	354'	314'	257					
	8:40	2100	354'	314'	257					
	10:20	2200	352'	312'	257					
5-4-84	12:00AM	2300	354'	314'	257					
	1:40	2400	354'	314'	257					
	3:20	2500	354'	314'	257					
	5:00	2600	356'	316'	261					
	6:40	2700	363'	323'	257					
	8:20	2800	363'	323'	257					
	10:00	2900	363'	323'	257					
	11:40	3000	363'	323'	257					
	1:20PM	3100	363'	323'	257					
	3:00	3200	363'	323'	257					
	4:40	3300	363'	323'	257					
	6:20	3400	363'	323'	257					
	8:00	3500	366'	326'	257					
	9:40	3600	366'	326'	257					
	11:20	3700	366'	326'	257					
5-5-84	1:00AM	3800	366'	326'	257					
	2:40	3900	368'	328'	257					
	4:20	4000	368'	328'	257					
	6:00	4100	368'	328'	257					
	7:40	4200	368'	328'	257					
	9:20	~~4300~~ 4295	368'	328'	257					
	10:00	~~4400~~	368'	328'	257	Pump	off			
		4335								

AQUIFER PUMPING TEST

OBSERVATION WELL W3A

PROJECT Carrisa Plains JOB No. 16413

TEST TYPE Recovery Data DATE TEST BEGUN 5-2-84

PUMPING WELL W3A DIST. TO PPG WELL same ( )

SCREEN DEPTH ( ): PPG WELL OBS. WELL

FLOW MEAS. METHOD PUMP

PUMPING RATE / HISTORY Average Pumping Rate 265 gpm

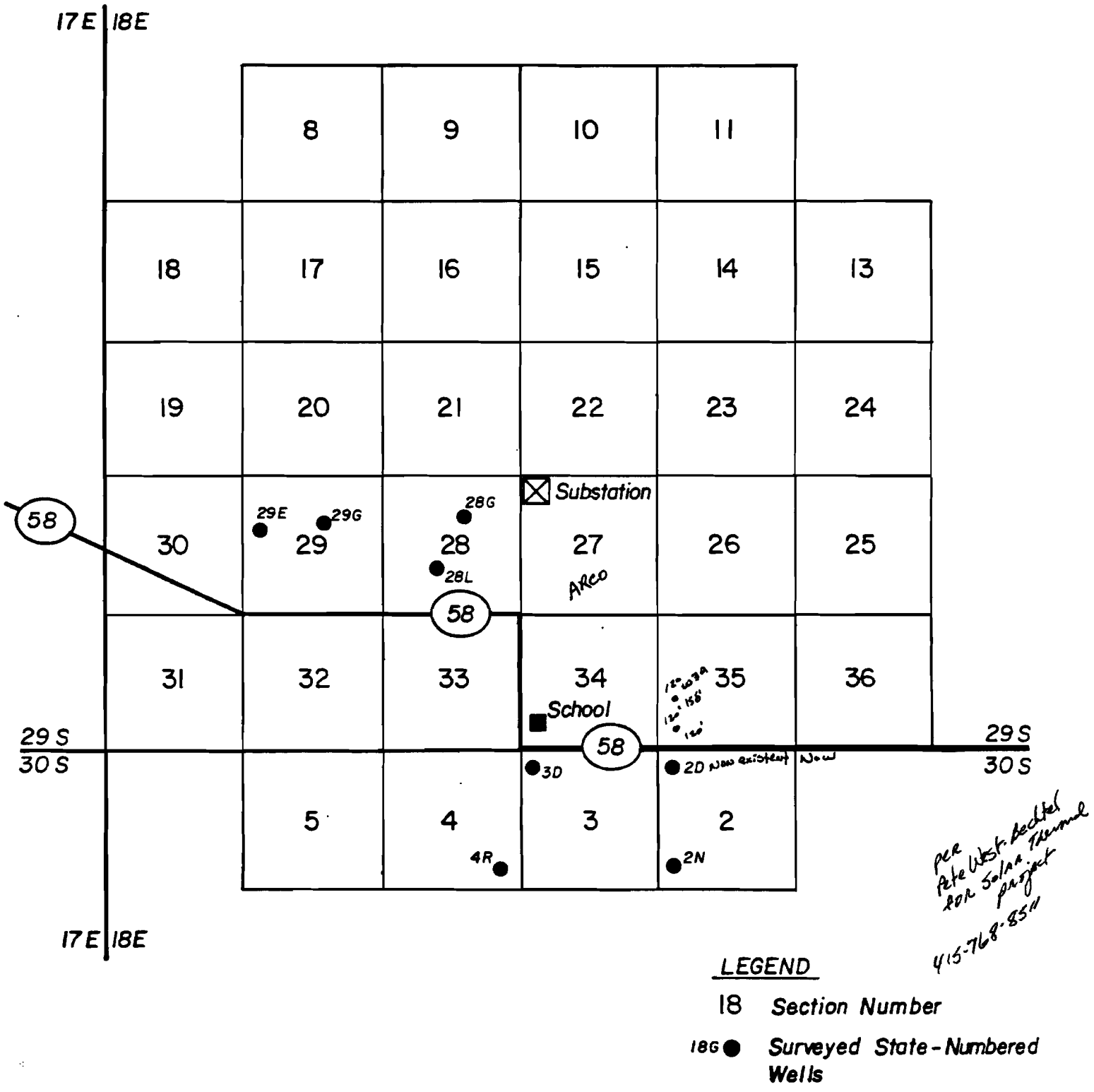
PUMPING PERIOD 4335 mins

REFERENCE POINT air line 3' above G.S. ELEVATION

LOCATION OBSERVER J.C. Isham

static Water Level 39.5

	TIME (24 HR DAY)	TIME-AFTER PUMP ~~ON~~ off (min)	DEPTH TO WATER (ft)	DRAW DOWN (ft)	DISCHARGE t/t' (t/t')	TIME (24 HR DAY)	TIME-AFTER PUMP ~~ON~~ off (min)	DEPTH TO WATER (ft)	DRAW DOWN (ft)	DISCHARGE t/t' (t/t')
5-5-84	1000	0	368	328.5		Reading adjusted to old R.P.				
		1	208.1	168.6	4335	1700	3300	49.2	9.7	2.31
		2	168.9	129.4	2169	1900	3420	48.9	9.4	2.27
		3	166.6	127.1	1446	5-8-84 0025	3745	48.2	8.7	2.16
		4	164.2	124.7	1085	0800	4200	47.0	7.5	2.03
		5	changed			1000	4320	46.9	7.4	2.0
		6	air	bottle		1430	4590	46.3	6.8	1.94
		7	No readings			1800	4800	45.8	6.3	1.9
		8				2300	5100	45.5	6.0	1.85
		9				5-9-84				
	1010	10				1120	5840	44.3	4.8	1.74
		12	108.8	69.3	362	1320	5960	43.9	4.4	1.73
		14	106.5	67.0	311					
		16	106.5	67.0	272					
		18	106.5	67.0	242					
	1020	20	106.5	67.0	218					
		25	101.9	62.4	174					
	1030	30	99.6	60.1	146					
		35	97.3	57.8	125					
	1040	40	97.3	57.8	109					
		50	94.9	55.4	88					
	1100	60	94.9	55.4	73					
		70	90.3	50.8	63					
	1120	80	90.3	50.8	55					
		100	90.3	50.8	44					
	1200	120	85.7	46.2	37					
		140	85.7	46.2	32					
5/7/84	1000	2880	53.4	13.9	2.5					
	Pulled	Pump	/New	R.P.						



LEGEND

18 Section Number

18G ● Surveyed State-Numbered Wells

CARRIZO PLAIN

LOCATIONS OF SURVEYED WELLS

1" = 1 mile

Engineering Research
005.41

Carrizo Plain Groundwater Quality
Solar Thermal Project

September 23, 1982

MR. R. E. PRICE:

Here is a copy of the April 19, 1982, letter to Mr. H. M. Howe: Attention Mr. D. A. Deniston, describing Carrizo Plain water availability and quality. Also, included is a rewrite of a portion of the above letter which includes a table of ranges and averages for the important parameters listed in Table 1 of the April 19 letter.

Because well depths are variable or unknown and we have no well logs to accompany this data, I cannot recommend these values for a design basis. I will pursue obtaining the appropriate well logs as soon as the project is authorized and well owners can be contacted. This will provide additional information to interpret water quality data. However, in the event that the logs that can be obtained do not provide sufficient information to give us confidence in existing water quality data, installation of an onsite monitoring well will be necessary.

This well will be designed specifically for groundwater quality monitoring. It will intersect all water bearing strata down to bedrock. This could be up to 600 feet for this area. Separate water quality sampling of each water bearing aquifer as well as a composite of the entire water column will be possible.

A conservative cost per foot for such a well would be $30. This includes drilling operating costs, and direct and nondirect costs for two operators, and one geologist. It also assumes an average drilling rate of 40 feet per day. Any drilling logs we receive will provide additional information on expected drilling rates and, subsequently, estimated costs.

ORIGINAL SIGNED

D. P. GRIFFIN

DPG

DPG(551-305):bav

Attachment

cc w/attach.: TAJenckes

cc w/o attach.: KABeede
DADeniston
RCKarfiol
TMTurner

TMT

+ 62-6218 (REV. 6/79)

PG&E

FOR INTRA—COMPANY USES

From Division or Department: Engineering Research

File No.: 005.41

Re Letter of Subject: Solar Thermal
Carrizo Plain and Cuyama Valley
Water Availability

To Division or Department:

April 19, 1982

MR. H. M. HOWE:

Attention Mr. D. A. Deniston

This letter describes the availability of groundwater to supply a proposed solar thermal power plant which is to be located near one of two existing Company substations. One of the substations is in the northern portion of the Carrizo Plain (San Luis Obispo County), and the second is near the City of Cuyama in the south central portion of the Cuyama Valley (San Luis Obispo and Santa Barbara Counties). Figure 1 shows the approximate locations of these substations.

The Carrizo Plain and Cuyama Valley Groundwater Basins are part of the Department of Water Resources (DWR) Central Coastal Hydrologic Study Area. The Cuyama Basin is listed by DWR as subject to critical conditions of overdraft. The DWR definition of overdraft is: "A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts."

The Carrizo Basin does not have an overdraft problem; DWR believes that it "has a potential for limited to moderate additional development." In addition, the basin is considered to be an undeveloped groundwater reservoir by the U.S. Geological Survey (USGS).

Carrizo Plain Basin

This basin's groundwater storage capacity, as listed by DWR in 1975, is 400,000 acre-ft. The usable capacity is one-fourth of the storage capacity or 100,000 acre-ft. The basin's estimated safe seasonal yield is 600 acre-ft per year which is equal to the natural recharge of the basin.

Groundwater wells in the Carrizo Basin yield instantaneous average flows of 500 gallons per minute (gpm) with maximum flows of 1000 gpm. 500 gpm flowing for a year's time is equivalent to over 800 acre-ft per year, greater than the amount of water required (500 to 600 acre-ft) to supply the proposed solar power plant.

Wells in the area of the substation have depths ranging from 175 to 600 feet. A well located approximately two miles south of the substation was pump tested by PGandE in 1966. The well had a standing water depth (water table) of 138 feet. During the pump test, a 60 hp motor pumped 2.68 acre-ft of groundwater in 24 hours. The pumping lowered the water table to approximately 235 feet at the well.

We have requested DWR to transmit to us well log information of state-numbered wells in the area of the substation. This information will provide us with more complete data as to the depth of the wells, depths to water, and well pumping yields. The state-numbered wells within a 32 square area (approximately three-mile radius) about the Company substation located north of Highway 58 are shown by Figure 2. There are other groundwater wells in the area; however, only the eight wells shown have state well-numbers and consequently have DWR well data.

Available groundwater quality data for each of the eight wells, for selected sampling dates, were tabulated. These are shown by Table 1. Data summarized by sections (one square mile) and for the total area are shown by Table 2.

The hardness of the groundwater in mg/l varied from 154 to 363 with an overall average of 240 as $CaCO_3$. The calcium ion concentration in mg/l varied from 34 to 71 with an overall average of 58. The overall water quality of the groundwater was better in Township 30 South, Range 18 East-Sections 3 and 4 and Township 29 south, Range 18 east-Section 29. These sections are located in the south and west portions of the area and one to over two miles from the substation.

In general, the presently available data indicate adequate, easily accessible, and good quality groundwater is available near the proposed Carrizo Plain site.

Cuyama Valley Basin

The Cuyama Basin groundwater storage capacity, as listed by DWR in 1975, is 2,100,000 acre-ft. The usable capacity is one-fifth of the storage capacity or 400,000 acre-ft. The basin's safe seasonal yield is 6,600 acre-ft per year. In the late seventies, use of the basin's groundwater was 54,000 acre-ft per year which is eight times the safe seasonal yield. Groundwater levels have declined 60 to 200 feet in the central and western portions of the basin between 1950 and the late seventies. As discussed earlier, the Cuyama Valley Basin is subject to critical overdraft with resulting continual decline of groundwater levels. The DWR reports, "No sound alternatives for stemming this declining trend short of adjudication are apparent. Importation of water from distant sources for agricultural use appears to be beyond the payment capacity of crops currently raised or suitable to the area."

In 1975, well depths ranged from 100 to 300 feet and the instantaneous pumping yields of typical basin wells were high, averaging 1,100 gpm with a maximum of 1,440 gpm.

The known state-numbered groundwater wells within a 29 square mile area around the Company substation near Cuyama are shown by Figure 3. There are other groundwater wells in the area; however, only the wells shown have state well-numbers and consequently have DWR well data. We have requested DWR to transmit to us well log information of the state-numbered wells. This information will provide us with more complete data as to the depth of the wells, depths to water, and well pumping yields.

Available groundwater quality data for 21 state-numbered wells, for selected sampling dates, were tabulated. These are shown by Table 3. Data summarized by sections and for the total 29 square mile area are shown by Table 4.

Total hardness in mg/l varied from 253 to 1917 with an average of 1188 as $CaCO_3$. Calcium ion concentration in mg/l varied from 75 to 465 with an average of 252. The best quality water is found in Sections 21 of Township 10 North, Range 26 West, and all of the sections shown of Township 10 North, Range 25 West. The poorest quality groundwater is found in Sections 22 and 24 of Township 10 North, Range 26 West. The Company substation is located in Section 24.

The present available data indicate the groundwater of the Cuyama Valley Basin near the proposed site is only of fair quality. Groundwater is presently available in quantity, but the basin's overdraft problem may interfere with the long-term availability of groundwater for power plant use.

Hydrologic data for this letter was obtained from the California Department of Water Resources (DWR) Water Data Information System, DWR's Bulletins 18 and 118, Ground Water Basins in California; the State Water Resources Control Board's Central Coastal Basin Water Quality Control Plan; and the U.S. Geological Surveys' Professional Paper 813-E, Summary Appraisals of the Nation's Ground-Water Resources - California Region. The DWR's Fresno and Los Angeles offices were also contacted for additional information.

To assist in locating groundwater wells, an index to the Township and Range System of California is attached as Figure, 4 and the State Well-Numbering System is attached as Figure 5.

T. M. Turner
T. M. TURNER

TMT(551-459):sm
Attachment
cc w/attach: THillesland RCKarfiol/DPGriffin
TAJenckes

Table 1

Northern Carrizo Plain Groundwater Quality
(Quality of well waters located within three miles of Company substation)

	Well Location (Township/Range-Section + Well No.)					
	29S/18E-28G01	29S/18E-28L01	29S/18E-28L01	29S/18E-28L01	29S/18E-28L01	29S/18E-28L01
Date	10/22/68	10/22/65	10/11/66	11/04/67	10/22/68	11/18/70
Temperature, °F/°C	-/-	69/21	66/19	62/17	-/-	56/13
pH, Field	-	-	-	-	-	-
pH, Lab	7.4	7.9	8.0	8.2	8.1	8.0
Electrical Conductivity Field, mhos/cm	-	-	-	-	-	-
Lab, mhos/cm	1387	1143	1150	1123	875	1191
Calcium Ion, mg/l	75	71	-	72	39	81
Magnesium Ion, mg/l	27	20	-	16	15	18
Sodium Ion, mg/l	180	145	-	148	125	143
Potassium Ion, mg/l	2.0	1.0	-	1.0	1.0	.0
Alkalinity as $CaCO_3$, mg/l	4	136	131	137	127	147
Sulfate Ion, mg/l	533	260	-	239	119	223
Chloride Ion, mg/l	98	74	70	74	81	65
Nitrate Ion, mg/l	2.3	80.0	70.0	87.0	70.0	130
Boron, mg/l	.54	.68	-	.59	.57	.75
Fluoride Ion, mg/l	.7	.6	-	.6	.8	.6
Silica, mg/l	-	-	-	-	-	-
Total Dissolved Solids, mg/l	957	750	-	727	564	805
Total Hardness, mg/l	298	259	-	246	151	276
Noncarbonate Hardness, mg/l	294	121	-	109	24	129
Sodium Absorption Ratio	4.5	3.9	-	4.1	4.4	3.7

Table 1 - contd.

	Well Location (Township/Range-Section + Well No.)					
	29S/18E-28L01	29S/18E-28L01	29S/18E-28L01	29S/18E-29E01	29S/18E-29G01	30S/18E-02D01
Date	11/04/74	10/25/76	10/31/77	10/21/53	10/04/72	10/22/68
Temperature, °F/°C	62/16.7	59/15	60/16	-/-	-/-	-/-
pH, Field	-	-	-	-	-	-
pH, Lab	8.3	8.0	8.2	8.1	8.3	7.4
Electrical Conductivity Field, mhos/cm	-	-	-	-	-	-
Lab, mhos/cm	1111	1156	1040	885	1053	1478
Calcium Ion, mg/l	71	78	80	47	49	118
Magnesium Ion, mg/l	17	20	19	15	16	28
Sodium Ion, mg/l	148	142	150	135	147	187
Potassium Ion, mg/l	1.2	.8	.2	0	1.6	1.0
Alkalinity as $CaCO_3$, mg/l	148	155	167	153	142	136
Sulfate Ion, mg/l	215	236	239	166	197	515
Chloride Ion, mg/l	75	80	77	57	69	83
Nitrate Ion, mg/l	104	97.0	88.2	34.3	33.0	38.3
Boron, mg/l	.67	.69	.65	.60	.64	.75
Fluoride Ion, mg/l	.6	.5	.6	.7	.8	.7
Silica, mg/l	-	-	-	-	-	-
Total Dissolved Solids, mg/l	727	797	847	635	691	1102
Total Hardness, mg/l	247	274	278	179	169	410
Noncarbonate Hardness, mg/l	90	122	111	26	47	274
Sodium Absorption Ratio	3.9	3.7	3.9	4.6	4.7	4.0

Table 1 - contd.

	Well Location (Township/Range-Section + Well No.)					
	30S/18E-02N01	30S/18E-02N01	30S/18E-02N01	30S/18E-02N01	30S/18E-02N01	30S/18E-02N01
Date	03/12/54	10/02/58	07/30/59	10/04/60	04/19/61	10/31/61
Temperature, °F/°C	-/-	-/-	68/20	68/20	70/21	58/14
pH, Field	-	-	-	-	-	-
pH, Lab	7.7	7.2	7.2	7.7	7.7	8.0
Electrical Conductivity Field, mhos/cm	-	-	-	-	-	-
Lab, mhos/cm	602	792	685	875	810	836
Calcium Ion, mg/l	52	60	58	74	69	66
Magnesium Ion, mg/l	16	25	22	24	21	24
Sodium Ion, mg/l	60	33	58	70	71	81
Potassium Ion, mg/l	1.0	3.0	2.0	1.0	1.0	2.0
Alkalinity as CaCO3, mg/l	152	194	158	191	184	180
Sulfate Ion, mg/l	73	69	110	149	30	151
Chloride Ion, mg/l	39	64	45	52	48	57
Nitrate Ion, mg/l	43.0	6.0	31.0	30.0	45.0	31.0
Boron, mg/l	.18	.20	.20	.40	.19	.16
Fluoride Ion, mg/l	.6	.4	.1	.5	.3	.3
Silica, mg/l	-	20.0	30.0	33.0	35.0	32.0
Total Dissolved Solids, mg/l	396	505	500	384	691	541
Total Hardness, mg/l	187	255	235	285	259	263
Noncarbonate Hardness, mg/l	35	59	77	92	75	63
Sodium Absorption Ratio	1.9	2.3	1.0	1.8	2.9	2.3

Table 1 - contd.

	Well Location (Township/Range-Section + Well No.)					
	30S/18E-02N01	30S/18E-02N01	30S/18E-02N01	30S/18E-02N01	30S/18E-02N01	30S/18E-02N01
Date	10/22/62	10/10/63	10/07/64	10/22/65	11/04/67	10/22/68
Temperature, °F/°C	67/19	66/19	-/-	69/19	62/17	-/-
pH, Field	-	-	-	-	-	-
pH, Lab	7.9	8.0	7.8	7.9	8.2	8.0
Electrical Conductivity Field, mhos/cm	-	-	-	-	-	-
Lab, mhos/cm	720	670	765	884	866	909
Calcium Ion, mg/l	61	48	62	77	77	76
Magnesium Ion, mg/l	20	28	20	22	19	24
Sodium Ion, mg/l	60	62	63	60	83	86
Potassium Ion, mg/l	1.0	1.0	1.0	1.0	2.0	1.0
Alkalinity as $CaCO_3$, mg/l	162	166	166	180	175	167
Sulfate Ion, mg/l	15	125	117	158	150	176
Chloride Ion, mg/l	39	41	36	34	62	62
Nitrate Ion, mg/l	36.0	36.0	40.0	39.0	40.0	45.0
Boron, mg/l	.20	.32	.24	.26	.20	.29
Fluoride Ion, mg/l	.4	.1	.4	.3	.4	.3
Silica, mg/l	40.0	31.0	38.0	-	-	-
Total Dissolved Solids, mg/l	430	494	440	600	570	625
Total Hardness, mg/l	234	235	237	293	270	289
Noncarbonate Hardness, mg/l	72	69	71	95	95	121
Sodium Absorption Ratio	1.7	1.8	1.8	2.1	2.2	2.5

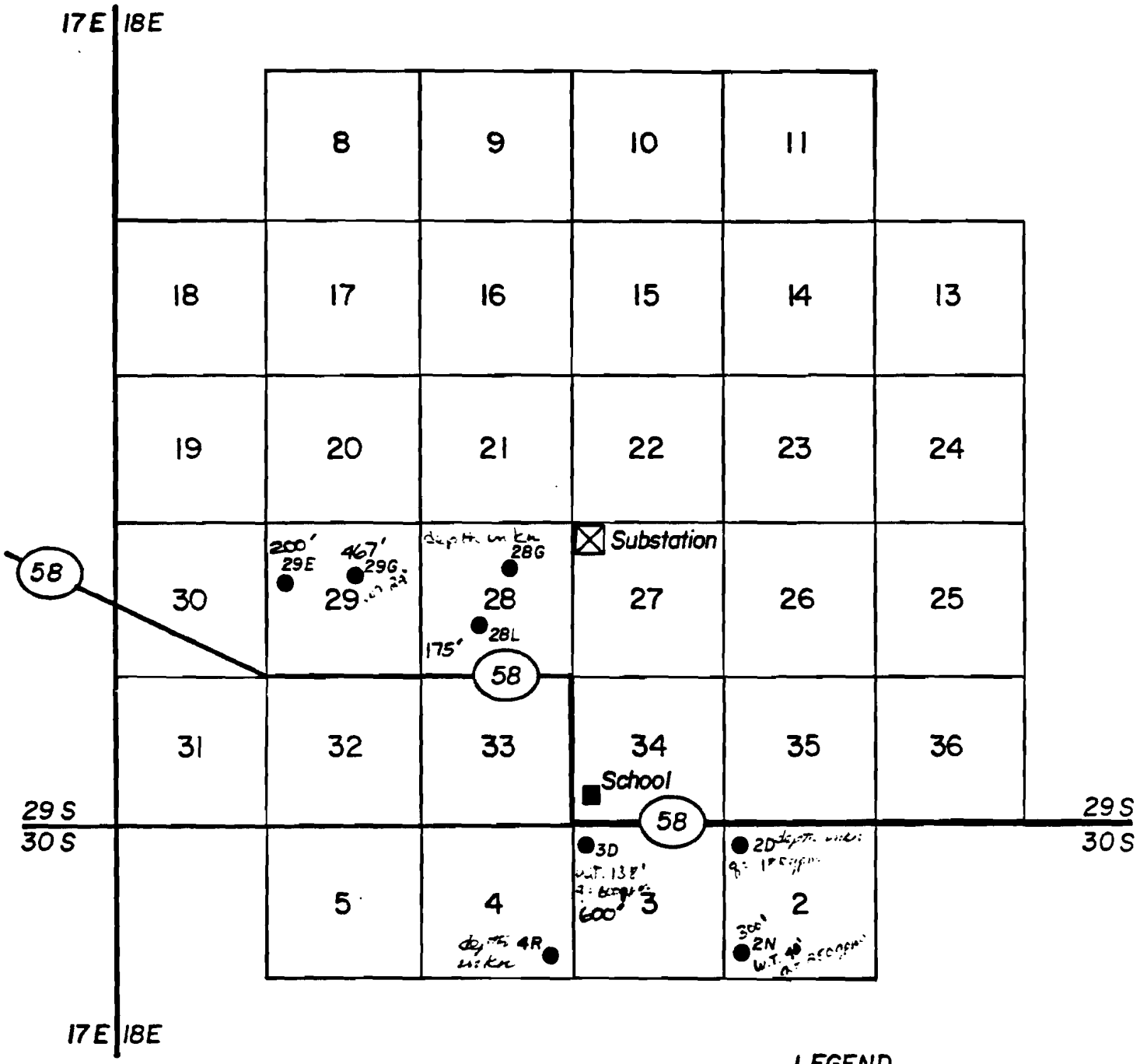
Table 1 - contd.

	Well Location (Township/Range-Section + Well No.)		
	30S/18E-02N01	30S/18E-03D01	30S/18E-04R01
Date	11/18/70	11/09/72	10/22/68
Temperature, °F/°C	62/17	68/20	-/-
pH, Field	-	-	-
pH, Lab	7.8	7.9	7.9
Electrical Conductivity Field, mhos/cm	-	-	-
Lab, mhos/cm	1030	513	514
Calcium Ion, mg/l	94	43	34
Magnesium Ion, mg/l	20	15	12
Sodium Ion, mg/l	101	38	52
Potassium Ion, mg/l	.0	1.5	1.0
Alkalinity as $CaCO_3$, mg/l	180	136	136
Sulfate Ion, mg/l	205	85	83
Chloride Ion, mg/l	74	32	32
Nitrate Ion, mg/l	55.0	36.3	56.3
Boron, mg/l	.26	.07	.07
Fluoride Ion, mg/l	.3	.3	.3
Silica, mg/l	-	-	-
Total Dissolved Solids, mg/l	706	356	346
Total Hardness, mg/l	317	169	154
Noncarbonate Hardness, mg/l	131	31	23
Sodium Absorption Ratio	2.5	1.9	2.0

Table 2

Northern Carrizo Plan
Average Well Water Quality Within Three Miles of Substation
(Averaged by Sections and by Total Area)

	Section Summary Well Location (Township/Range-Section)					Total Area Summary
	29S/18E-28	29S/18E-29	30S/18E-02	30S/18E-03	30S/18E-04	
No. of Wells Surveyed	2	2	2	1	1	8
Dates Sampled	10/65-10/77	10/53-10/72	3/54-10/77	11/72	10/68	10/53-10/77
Temperature, °F	62	-	65	68	-	65
pH	8.0	8.2	7.8	7.9	7.9	8.0
Electrical Conductivity, mhos/cm	1131	969	844	513	514	864
Calcium Ion, mg/l	71	48	69	43	34	58
Magnesium Ion, mg/l	19	15	22	15	12	18
Sodium Ion, mg/l	148	141	77	38	52	101
Potassium Ion, mg/l	.9	.8	1.2	1.5	1.0	1.1
Alkalinity as $CaCO_3$, mg/l	142	148	173	136	136	150
Sulfate Ion, mg/l	258	182	161	85	83	171
Chloride Ion, mg/l	77	63	51	32	32	56
Nitrate Ion, mg/l	81	34	37	36	56	47
Boron, mg/l	.64	.62	.27	.07	.07	.4
Fluoride Ion, mg/l	.6	.8	.4	.3	.3	.5
Silica, mg/l	-	-	32	-	-	32
Total Hardness, mg/l	254	174	363	169	154	240
Noncarbonate Hardness, mg/l	125	37	95	31	23	72
Sodium Absorption Ratio	4	4.7	2.1	1.9	2.0	3.2
Total Dissolved Solids, mg/l	772	663	563	356	346	583



LEGEND

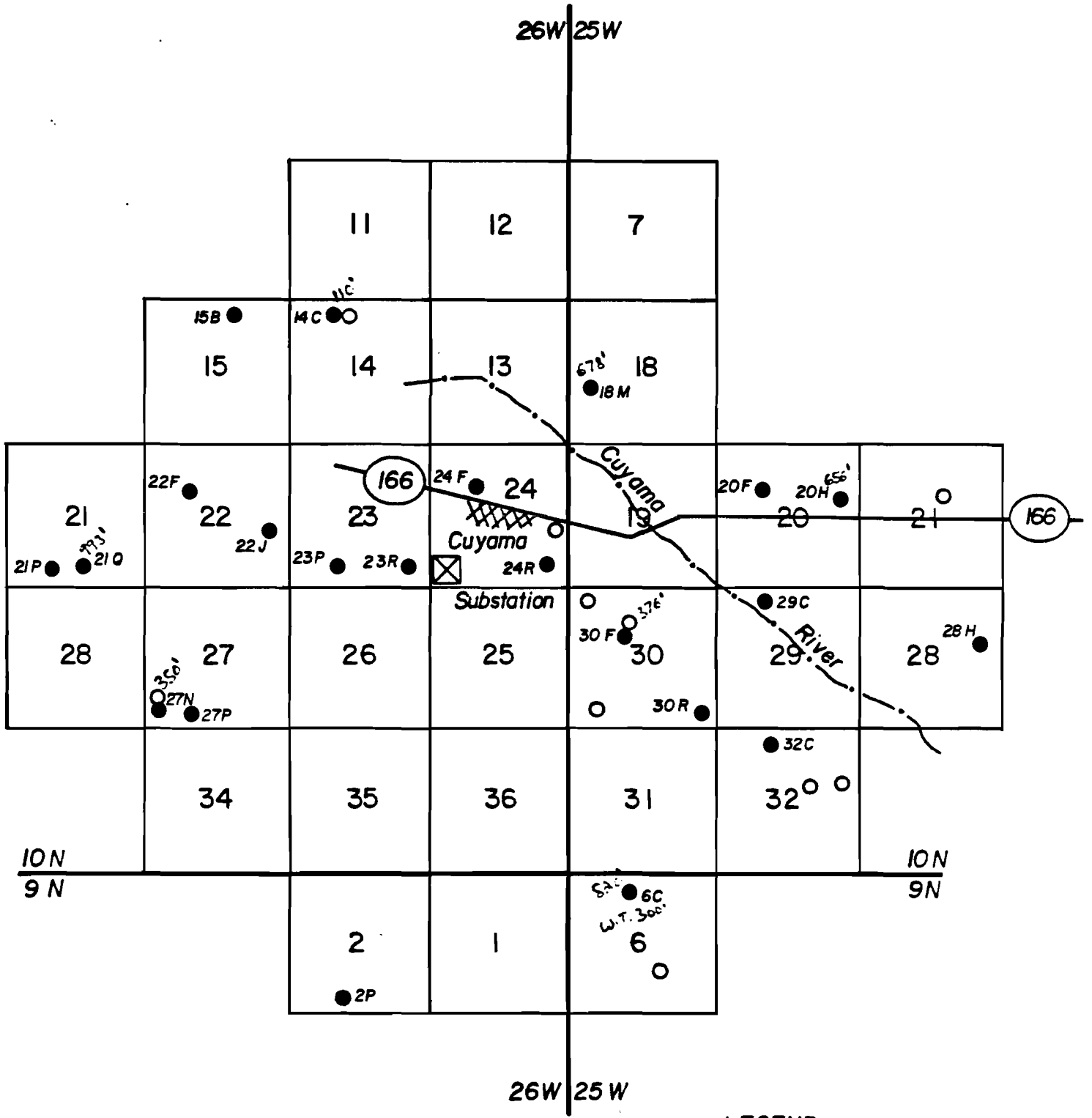
18 Section Number

18G ● Surveyed State-Numbered Wells

CARRIZO PLAIN

LOCATIONS OF SURVEYED WELLS

1" = 1 mile



LEGEND

18 Section Number

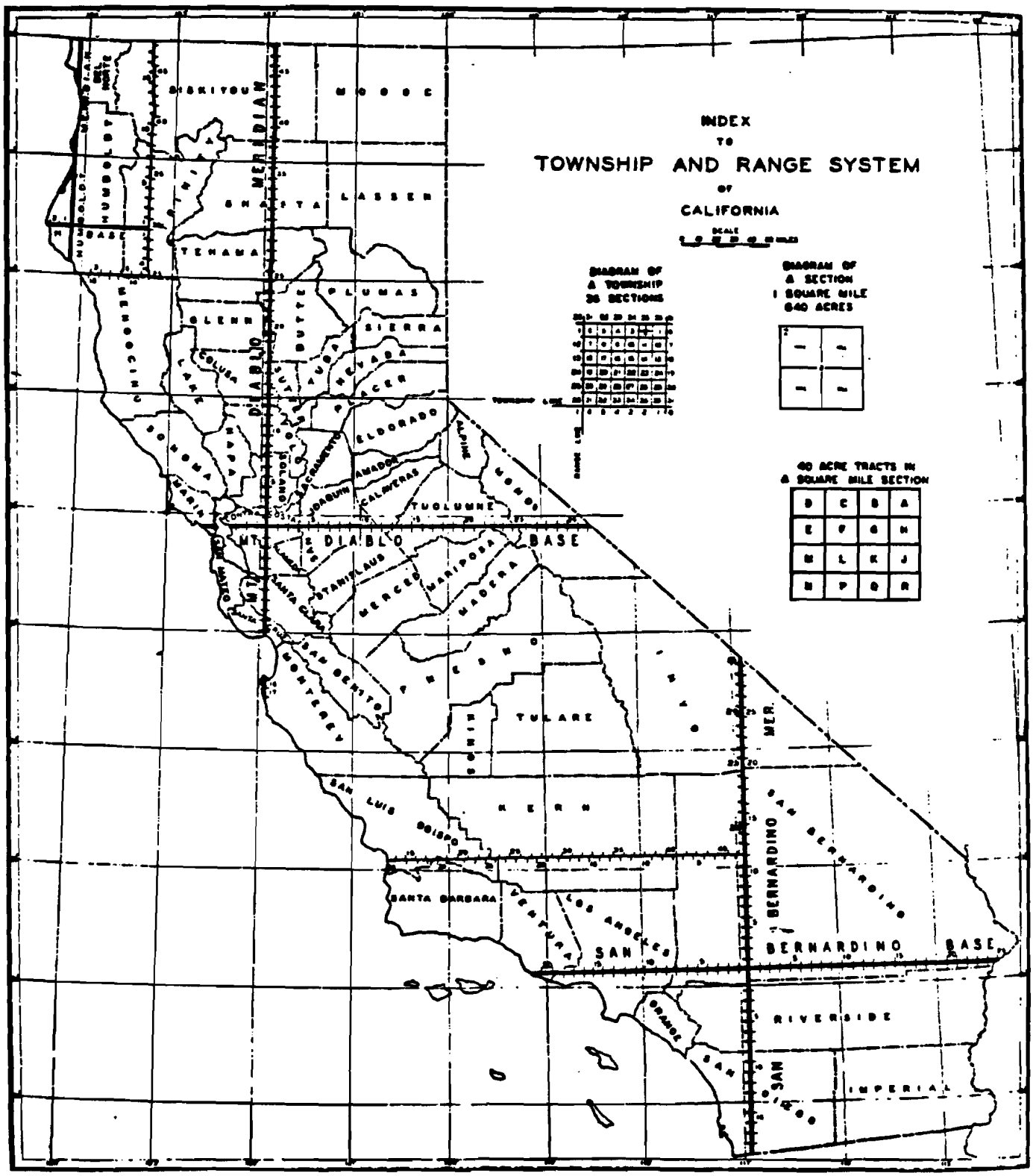
O State-Numbered Wells

18G ● Surveyed State-Numbered Wells

CUYAMA VALLEY

LOCATIONS OF SURVEYED WELLS

1" = 1 mile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SAN BERNARDINO BASE
SAN BERNARDINO MER.
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL

Figure 4

California, 95814.

Information on how geothermal resources can be used may be obtained from the Geothermal Energy Office, California Energy Commission, 1111 Howe Avenue, Sacramento, California, 95825.

Persons who desire or can provide additional information on thermal springs and wells in California are encouraged to contact the Geothermal Resources Officer, California Division of Mines and Geology, Sacramento District Office, 2815 O Street, Sacramento, California, 95816 in order that we may update this map and related files.

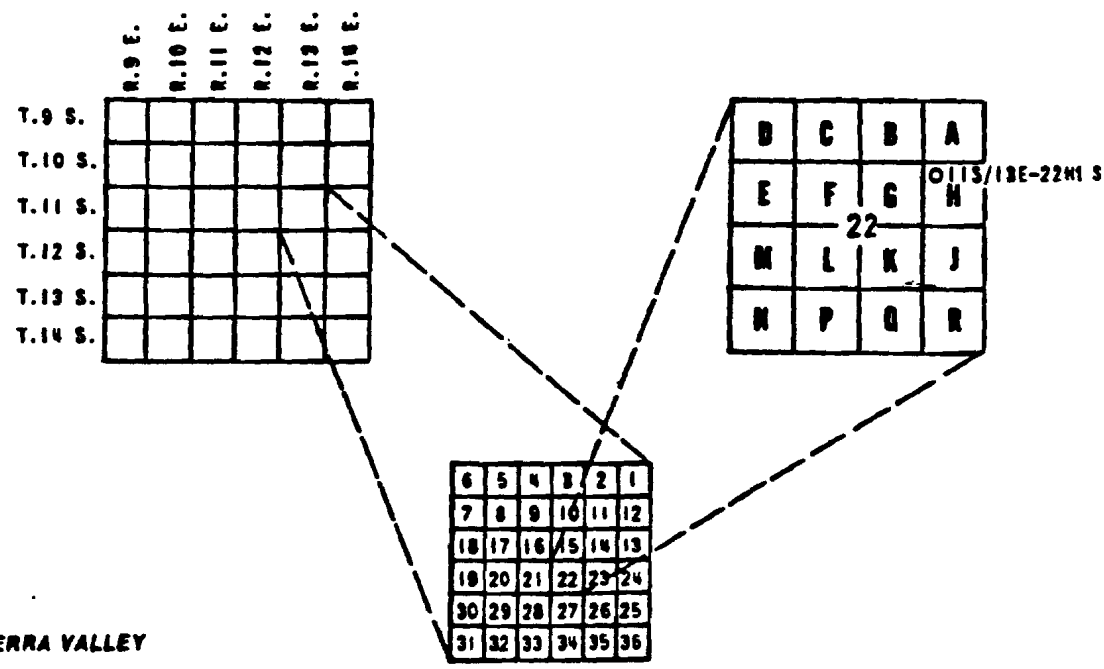
KEY TO TABLE OF THERMAL SPRINGS AND WELLS

County code number	Name	Latitude north	Longitude west	Temperature, °Celsius (F = Fahrenheit)	Flow, liters per minute	Total dissolved solids, milligrams per liter	Depth, meters
IN- 8	UNNAMED SPRINGS	X38 29.70	117 53.60	20°	57	2150*	—
IN- 9	DIRTY SOCKS HOT SPRING (WELL)	38 19.75	117 58.90	34°	380	6530	183
IN-10	DEVIL'S KITCHEN FUMAROLE	36 02.08	117 47.92	97°		2500	—

The majority of column headings in the above key are self-explanatory. Position information is given in degrees, minutes, and decimal parts of minutes of latitude and longitude. An X preceding the position indicates an approximate position. An asterisk indicates a computed estimate of total dissolved solids. A bar (—) symbol in the depth column indicates a spring orifice discharging at the surface. As numerous wells are named by the California well-numbering system, a brief description of that system follows.

WELL-NUMBERING SYSTEM USED IN CALIFORNIA

The well-numbering system used in California is in accordance with the township-section system of the U.S. Bureau of Land Management. As shown by the example (well number 11S/13E-22H1 S) in the accompanying diagram, that part of the number preceding the slash indicates the township (T. 11 S.); the number following the slash indicates the range (R. 13 E.); the number following the hyphen indicates the section (sec. 22); the letter following the section number indicates the 40-acre subdivision (H) of the section. The last number is a serial number for wells in that 40-acre subdivision; in this case, it indicates the first well to be listed in the SE 1/4 NE 1/4 sec. 22, T. 11 S., R. 13 E. The final letter, separated from the rest of the number by a space, indicates the base line and meridian. Base line and meridian designations are as follows: M, Mount Diablo; S, San Bernardino; H, Humboldt.



SIERRA VALLEY

At least two dozen thermal water wells ranging from 25° to 93°C occur in this large valley. Many of them are artesian. The hot water probably rises along large buried faults that cross the valley. Although a few small towns lie on the edge of the valley, it is largely rural and supports several large cattle ranches. Possible applications include agricultural and

Figure 5

Suggested Rewrite - Water Availability Section of The Siting Summary for the Carrizo Plain Area - T. Turner 6/23

Groundwater is the only source of water supply to the Carrizo Plain Basin. The basin groundwater storage capacity, as listed by the California Department of Water Resources (DWR) in 1978 is 400,000 acre ft. One fourth of this storage capacity or 100,000 acre ft is listed by DWR as useable and available for limited to moderate additional development. Groundwater wells yield flows of 500 to 1000 gal/min. Well depths range from 175 to 600 feet.

The water quality of the study area groundwater for six selected parameters is shown by the following table:

Parameter	minimum	maximum	average
Total Dissolved Solids, (mg/l)	346	1100	583
Total Hardness, (mg/l)	151	410	240
Alkalinity as $CaCO_3$, (mg/l)	4	194	150
Sulfate Ion, (mg/l)	15	533	171
Calcium Ion, (mg/l)	34	118	58
Magnesium Ion, (mg/l)	12	28	18