URS

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07-AFC-8	
DATE	JUN 27 2008
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June 27, 2008

Ms. Melissa Jones
Executive Director
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814-5512

Subject: Carrizo Energy Solar Farm (07-AFC-8)
Hydrology and Hydrogeology Report for the Vicinity of the Proposed Carrizo Energy Solar Farm (CESF)
San Luis Obispo County, California
URS Project No. 27658060.01805

Dear Ms. Jones:

On behalf of Ausra CA II, LLC (dba Carrizo Energy, LLC), URS Corporation Americas (URS) hereby submits the Hydrology and Hydrogeology Report for the Vicinity of the Proposed Carrizo Energy Solar Farm (CESF), San Luis Obispo County, California.

I certify under penalty of perjury that the foregoing is true, correct, and complete to the best of my knowledge. I also certify that I am authorized to submit the Hydrology and Hydrogeology Report on behalf of Carrizo Energy, LLC.

Sincerely,

URS CORPORATION

Angela Leiba
Project Manager

AL:ml

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108
Tel: 619.294.9400
Fax: 619.293.7920

REPORT

HYDROLOGY AND HYDROGEOLOGY REPORT FOR THE VICINITY OF THE PROPOSED CARRIZO ENERGY SOLAR FARM (CESF)
SAN LUIS OBISPO COUNTY, CALIFORNIA

PREPARED FOR:

CARRIZO ENERGY

URS PROJECT NO. 27685060.01805

JUNE 26, 2008

REPORT

HYDROLOGY AND HYDROGEOLOGY OF THE VICINITY OF THE PROPOSED CARRIZO ENERGY SOLAR FARM (CESF) SAN LUIS OBISPO COUNTY, CALIFORNIA

Prepared for

Carrizo Energy
2585 E. Bayshore Drive
Palo Alto, CA 94303

URS Project No. 27658060.01805

June 26, 2008

URS

1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4314
619.294.9400 Fax: 619.293.7920

June 26, 2008

Mr. John Kessler
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814-5512

Subject: Hydrology and Hydrogeology of the
Vicinity of the Proposed Carrizo Energy Solar Farm (CESF)
San Luis Obispo County, California
URS Project No. 27658060.01805

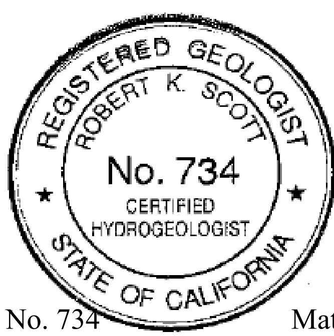
Dear Mr. Kessler:

On behalf of Ausra CA II, LLC (dba Carrizo Energy, LLC), URS Corporation Americas (URS) is pleased to provide the California Energy Commission (CEC) the following report presenting a summary and evaluation of existing data related to the hydrology and hydrogeology of the proposed Carrizo Energy Solar Farm (CESF) and vicinity. This report has been prepared at the request of the CEC specific to its comments during a public workshop held on the Carrizo Plain on March 12, 2008. Hydrologic and hydrogeologic information related to the site and vicinity that has been presented to the CEC and public to date are provided in this single document as well as additional information collected in support of our evaluations provided herein.

This report has been peer reviewed by Dr. Eric La Bolle, P.E., hydrologist with the Hydrologic Studies Program at the University of California, Davis. Dr. La Bolle also conducted the modeling appearing herein based on hydrogeologic data available for the site vicinity. If you have any questions, please contact us at (619) 294-9400.

Sincerely,

URS CORPORATION



Robert K.Scott, P.G., C.Hg. No. 734
Vice President and Principal Geologist

Matthew C. Moore, P.E.
Senior Project Engineer

RKS/MM:ml

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ACCs	air-cooled condensers
ACOE	Army Corps of Engineers
af	acre-feet
AFC	Application for Certification
afy	acre-feet/year
BFE	Base Flood Elevations
bgs	below ground surface
Calscience	Calscience Environmental Laboratories, Inc.
Carrizo	Carrizo Energy, LLC
CEC	California Energy Commission
CESF	Carrizo Energy Solar Farm
CGS	California Geological Survey
CLFR	Compact Linear Fresnel reflector
CWA	Clean Water Act
DWR	Department of Water Resources
ET	Evapotranspiration
FEMA	Federal Emergency Management Agency’s
FIRM	Flood Insurance Rate Map
GHB	general head boundaries
gpd	gallons per day
gpd/ft	gallons per day per foot
gpm	gallons per minute
GPS	Global Positioning System
K_h	horizontal hydraulic conductivities
kV	KiloVolt
K_v	vertical hydraulic conductivity
MCLs	Maximum Contaminant Levels
MSL	mean sea level
NFF	National Flood Frequency
ORP	oxidation-reduction potential
OWS	oil/water separator
PG&E	Pacific Gas & Electric
RWQCB	Regional Water Quality Control Board
SR	State Route
STGs	steam turbine generators
SVOCs	Semivolatile organic compounds
TDS	total dissolved solids
U.S. EPA	United States Environmental Protection Agency
URS	URS Corporation Americas
USDA	United States Department of Agriculture
USGS	United States Geographic Survey
VOCs	Volatile organic compounds
WUS	Waters of the United States

URS Corporation Americas (URS) has prepared this report to serve as a summary of hydrologic and hydrogeologic information that has been presented to the California Energy Commission (CEC) and the public during the facility permitting process for the Carrizo Energy Solar Farm (CESF). This report was requested by the CEC during a Public Workshop held on March 12, 2008. The site is located on the Carrizo Plain, which is an unincorporated area of San Luis Obispo County near the towns of Simmler and California Valley, California.

INTRODUCTION

URS understands that Carrizo Energy, LLC (Carrizo Energy) is considering the site for future development as a solar-powered electrical generation station. The site will occupy an entire section (640 acres). We understand the project will produce up to a nominal 177 megawatt (MW) net. The facility will be dry (air) cooled; therefore, the estimated water use for the facility is considerably less than other solar and conventional power generating facilities that require large volumes of water for cooling. It is estimated that the facility will use approximately 20.8 acre-feet/year (afy) for the following purposes: Makeup to the steam turbine system, washing of solar system reflectors and collector, potable water, service water, and fire protection.

Historically, the vicinity has been used for dry farming of wheat and barley. Cattle and sheep ranching are also common on the Carrizo Plain. Long-time residents indicate that the site has also been cultivated for the production of alfalfa, carrots and potatoes. Recently, there has been some planting of grape vineyards and olive groves. Data sources indicate that these intensive agricultural activities use considerably more water than the proposed CESF on a per-acre basis. Similarly, considerably more water is necessary to generate an equivalent amount of power for wet-cooled solar and other conventional type power-generating facilities.

SURFACE WATER HYDROLOGY

The average annual precipitation ranges from 7 to 9 inches in the Carrizo Plain basin, but rainfall data from voluntary sources in the vicinity of the CESF is closer to 10 inches (San Luis Obispo County Department of Public Works). Most of the rainfall occurs from November through May with minimal rainfall during the summer months. Because the Carrizo Plain basin is one of internal drainage (closed to surface water outflow), precipitation that does not infiltrate the soil accumulates in Soda Lake, a playa in the center of the basin that is typically dry for part of the year.

The CESF is located within the Central Coast Hydrologic Region that covers approximately 11,300 square miles in central California, including the Carrizo Plain. The Carrizo Plain watershed, including the alluvial floor of the plain, is approximately 54 miles long and 6 miles wide, and covers approximately 414 square miles, or 263,680 acres. The watershed areas tributary to the site include three areas that include the main Carrizo Plain drainage channel, (Basin 1, 31.6 square miles) and Basins 2 and 3 are directly tributary to the northerly site area (approximately 3.9 and 4.3 square miles, respectively), for a total of 41.3 square miles. The total watershed area tributary to the north end of Soda Lake is approximately 152 square miles. The site and construction laydown area occupy approximately one percent of the watershed tributary to the north end of Soda Lake.

The Project site currently consists primarily of disturbed farmland/ranchland. The portion of stormwater runoff that does not infiltrate into the ground, moves via sheet flow and follows the terrain to the south and west, and then is tributary to Soda Lake over 10 miles downstream. Portions of the main Carrizo Plain drainage within the temporary construction staging area may be jurisdictional Waters of the United States (WUS). The Applicant is currently waiting for the determination from Headquarters and the United States Environmental Protection Agency (U.S. EPA) and hoping to receive a determination by July 2008.

Post-construction, the stormwater will be directed from the paved and non-paved areas to local collection swales and infiltration areas where it will percolate and evaporate. The infiltration areas will store and infiltrate the stormwater runoff. The flows generated from the offsite watershed will be directed around the site via the proposed drainage swales. Ultimately, the runoff will flow across SR 58, confluence with the existing creek, traverse Section 33 and continue on its historical flow path in the southeasterly direction.

San Luis Obispo County hydrology and hydraulic standards were used for onsite stormwater calculations. Based upon these calculations, all proposed onsite runoff up through the 50-year storm can be stored onsite without generating runoff to the perimeter swales. The Rational Method hydrology analysis was used to compute pre- and post-project runoff volumes and flowrates onsite. The amount of potential stormwater volume generated onsite was also evaluated on an average annual basis. Under existing conditions, approximately 203 afy of stormwater identified already could occur on the site assuming an average annual rainfall of 10 inches and a runoff coefficient of 0.38. Under proposed conditions, the 640-acre site would generate approximately 213 acre-feet (af) of stormwater volume annually with a runoff coefficient of 0.40; however, there would be no surface runoff from the site under normal conditions. Similar calculations assuming an average annual rainfall of 8 inches result in a pre-project stormwater volume of 162 afy and a post-project stormwater volume of 171 afy.

United States Geographic Survey (USGS) regression equations within the National Flood Frequency (NFF) Program were used to quantify the runoff generated from the offsite watersheds based on data for the Central Coast Region. Of the 41.3 square miles of watershed, 31.6 square miles are tributary to the western boundary of the construction laydown area. Anticipated pre- and post-project surface runoff flowrates were estimated for the project construction laydown area; north end of Soda Lake; and entire Soda Lake watershed. The watershed boundary tributary to the north end of Soda Lake is approximately 152 square miles, whereas the total Soda Lake Watershed is approximately 414 square miles. The surface water runoff rate reduction due to infiltration in the solar field area is minimal in comparison to the overall watershed surface water runoff rates. Therefore, significant impacts to water resources downstream of the project and in the regional area including Soda Lake are not anticipated.

Kemnitzer (1967) is the only basin-wide surface water and groundwater study completed on the plains and served as a basis for our study. He estimated that the balance between water recharge and discharge for the Carrizo basin involves a gross annual amount of some 177,000 af, based on the average precipitation of 8 inches of rainfall annually falling upon 266,000 acres of watershed. Of this gross recharge, at least 118,000 af, or nearly 67 percent, is estimated lost through evapotranspiration and other natural processes. The remaining 59,000 af or one-third of the gross, is considered to be the net average annual groundwater recharge. Based on these assumptions, the net average annual groundwater recharge, for the project site would contribute approximately 141 afy. When considering the upstream offsite drainages directly tributary to the site (Basins 1 through 3), the total infiltration increases to 1,293 afy assuming 8 inches of annual rainfall over 9.2 square miles. These groundwater infiltration estimates far exceed the project's annual average water use of 20.8 afy. A little over 5% of the annual rainfall on the 640-acre site would be required to infiltrate to the groundwater table to equal the annual average project water use of 20.8 afy.

HYDROGEOLOGY

Many studies have been done regarding the geology of the Carrizo Plain; however, few hydrogeological studies have been conducted. The primary aquifers in the Carrizo Plain are found in alluvium, the Paso Robles and Morales Formations. Kemnitzer (1967) described two water bodies beneath the Carrizo Plain based on their quality. The groundwater with the poorest quality lies in the sediments immediately beneath Soda Lake, 10 miles south of the site. This is hydraulically isolated from the water body with better water quality. The better quality groundwater is probably best at the margins of the basin and away from Soda Lake.

Results of our study indicate groundwater supply in the site vicinity is generally produced from two zones, an upper zone that is generally less than 300 feet and a lower zone that exists at the site at a depth of approximately 450 to 600 feet below the ground surface. These are referred to as the Upper and Lower Aquifers, respectively, in this document. Based on a review of limited well information, potable water supplied to most residences and ranches for domestic use is derived from shallow wells typically within a depth of about 175 feet below ground surface (bgs) in the Upper Aquifer. Kemnitzer (1967) refers to these wells as “Household and Livestock Wells” and in 1967, he identified 89 wells penetrating the Upper Aquifer, producing about 6 afy (4 gallons per minute (gpm) with continuous pumping). Based on a well survey conducted by URS in March 2008, these shallow wells penetrating the Upper Aquifer probably yield from a few gpm up to 40 gpm.

The Lower Aquifer from which groundwater is derived for use by residents of the plains is typically present at a depth of greater than 450 feet. According to Kemnitzer (1967), these wells typically yield on the order of 500 to 1,100 gpm. He identified 11 irrigation wells in 1967 and of these, it appears that six were generally greater than 300 feet deep. These wells are typically used for irrigation and it is from this zone that Carrizo Energy would derive its water supply for the proposed CESF. No data on well yields are noted by Kemnitzer (1967).

URS personnel conducted a well survey for the area within approximately 3 miles of the proposed site. URS personnel visited residents to identify the characteristics of their wells. Although a well may have been identified during the survey, it is possible that it may no longer be operating This information was considered in the groundwater modeling conducted to evaluate the effects groundwater pumping related to this project will have on the surrounding area and the groundwater basin. As a result of the survey and other data sources, 118 wells have been identified. URS requested well data from DWR; however, release of this information is considered proprietary under California Water Code Section 13752 and our request was denied.

Groundwater quality appears to be variable within each of the aquifer zones. However, groundwater quality in the Lower Aquifer is generally inferior to the Upper Aquifer based on the limited water quality data available. URS evaluated the groundwater quality of the proposed pumping well. Some constituents exceeded their respective Primary or Secondary Maximum Contaminant Levels for drinking water established by the State. The groundwater is not suitable to serve as drinking water without further treatment. Carrizo Energy will be using this inferior quality water from the Lower Aquifer for its water supply.

Pump testing data is available for a Lower Aquifer well that was located right next to the site on the western edge of Section 27 at the former ARCO solar site. These data were used in the groundwater modeling that was conducted to evaluate the potential affects of pumping by the CESF project. The USGS model, MODFLOW was used for the groundwater modeling to simulate the potential affect of site pumping on neighboring wells and the Carrizo basin. Actual geologic and hydrogeologic conditions were used in the model. The data used were derived from the well survey completed by URS, Kemnitzer (1967) and other available sources. The model simulated groundwater flow in six layers with data on a grid 2,000 feet square. The Upper Aquifer was Layer 1 and the Lower Aquifer was Layer 3. No-flow and general head boundaries were set to approximate basin conditions. Average annual recharge was applied to Layer 1 (59,000 afy), consistent with Kemnitzer (1967). Pumping from the basin was simulated using the locations and available data for the 118 wells identified in the basin. Of these wells, it was assumed that the domestic supply wells penetrating the Upper Aquifer were pumped at an average rate of 12 gallons per minute (gpm), unless actual data were available. In these cases, the reported pumping rates were used. Those wells known to penetrate the Lower Aquifer were included in Layer 3. The proposed pumping well was included in Layer 3 pumping at a rate of 18,500 gallons per day (gpd), or approximately 13 gpm. The overall pumpage from the basin based on these assumptions was estimated to be 4,861 acre-feet/year (afy). This was approximately 25% greater than the estimate made by Kemnitzer in 1967. The pumpage from the proposed CESF well is only 0.444% of the total pumpage from the basin.

The model was run for project and no-project alternatives. Only the project scenario included the proposed CESF pumping well. The differences in the resulting heads for each model run for the basin provided an indication of the estimated drawdown associated with the proposed pumping well. Based on the results of these model runs, the maximum change in head (drawdown) in the Upper and Lower Aquifers is estimated to be approximately 0.2 and 1.6 feet adjacent to the site. These results indicate that pumping from the CESF well will not have a significant affect on neighboring wells and groundwater levels in the basin. Because the effect of pumping the CESF well will not result in a significant change in water levels, the water supplied to it will not be drawn from great distances (for example, poor quality water from the Soda Lake area ten miles away). Therefore, pumping of the CESF well will not have a significant effect on water quality in the are or the basin.

SECTION 1 INTRODUCTION

URS Corporation Americas (URS) has prepared this report to serve as a summary of hydrologic and hydrogeologic information that has been presented to the California Energy Commission (CEC) and the public during the facility permitting process for the Carrizo Energy Solar Farm (CESF). This report was requested by the CEC during a public workshop held on March 12, 2008. Where applicable, responses to CEC Data Requests and public comments specific to water resources are included in this document. The site is located on the Carrizo Plain, which is an unincorporated area of San Luis Obispo County near the towns of Simmler and California Valley, California. The location of the site is shown on the vicinity map provided as Figure 1-1.

In order to meet the CEC's and public's request for a report summarizing hydrologic and hydrogeologic information for the site and vicinity, URS' services included:

- Conducting a survey of the site vicinity to identify the locations of water wells.
- Obtaining available well information from residents.
- Conducting an additional review of readily available data in support of our hydrogeological evaluation and reviewing well information that may be provided by the public.
- Completing a surface water hydrology study.
- Tabulating chemistry data available for the site vicinity for the Upper and Lower Aquifers, as available.
- Reevaluating the input parameters to the model run presented at the workshop to show aquifer drawdown during pumping and adding aquifer recharge estimates based on published information and site recharge calculations. The model considers a six-layer system.
- Preparing a simple water budget (recharge/discharge) for the basin based on available information.

Summarizing hydrological and hydrogeological data, the results of the model and water budget in this report.

1.1 PROJECT DESCRIPTION

URS understands that Carrizo Energy, LLC (Carrizo) is considering the site for future development as a solar-powered electrical generation station. We understand the project will consist of approximately 195 Compact Linear Fresnel reflector (CLFR) solar concentrating lines, and associated steam drums, steam turbine generators (STGs), air-cooled condensers (ACCs) and associated infrastructure producing up to a nominal 177 megawatt (MW) net. A new single-circuit 230 kiloVolt (kV) overhead transmission line will interconnect the facility with Pacific Gas & Electric's (PG&E's) existing Midway Substation by looping into the existing Morro Bay–Midway 230 kV line located north and adjacent to the CESF site.

The 640 acres (one square mile) required for the power plant footprint is planned to be located on one section of land (Section 28) north of State Route (SR) 58/Carrisa Highway. The solar arrays will cover the majority of Section 28 and the steam drums will be located across the solar field. Most of the other components, as well as a warehouse and workshops, water tanks, a switchyard and other equipment, will be located within the 'power block' at the north-central side of the Section. A portion of Section 33 immediately to the south will be used as a construction laydown area.

Site grading will be performed to create level pads for the equipment and reflectors (arrays) with cuts and fills across most of the site expected to be approximately 5 feet or less, with larger cuts and fills in isolated areas. Localized grading with minor cuts and fills may be performed in the construction laydown area.

Untreated raw water for the Project will be obtained from groundwater via an existing onsite well. The design of the Project minimizes use and maximizes the recovery of process water. Blowdown and oil/water separator (OWS) clear discharge are routed to the onsite raw water storage tank for reuse. Stormwater will be collected onsite and directed to swales and detention areas for percolation into the ground. The sanitary system will consist of a buried septic tank and sanitary leach field.

1.2 PROJECTED WATER USE

Groundwater will serve as a source of water during the construction and operation of the facility. Alternative water sources such as agricultural wastewater, recycled water and surface water runoff were evaluated in the Application for Certification (AFC) and were identified as not feasible. Due to the remote location of the site and sparse population in its vicinity, there is no infrastructure (wastewater treatment facilities) that could serve as a source of reclaimed water. Additionally, there are no sources of agricultural wastewater in the vicinity of the site. Although precipitation on the Carrizo Plain is reportedly 7 to 9 inches per year, it is sporadic, infrequent and undependable. Infiltration of a portion of the stormwater that falls on the site will offset the makeup water requirement for the facility and also serve to recharge the Upper Aquifer that is used by the local community as a drinking water supply. CESF is committed to use groundwater from the Lower Aquifer for its water supply, which is of lesser quality compared to the Upper Aquifer. Projected water use during construction and operation is described in the sections below.

1.2.1 Construction

Water will be needed during the 3-year construction phase of the project. Water will be used for dust control and for compaction during grading. It is estimated that approximately 5 acre-feet (af) of water will be used for mixing concrete. The total volume of water used during construction will be less than the total estimated volume of water that will be used during the operation of the facility each year (20.8 af).

1.2.2 Operation

Groundwater will be used during operation of the facility for the following purposes:

- Makeup to the steam turbine system.
- Washing of solar system reflectors and collectors.
- Potable Water: Potable water will be supplied from a potable water skid for use by plant personnel.
- Service Water: Untreated water will be required for general site uses.

- Fire Protection.

Water usage was summarized in Table 1-1 that also appears in the AFC and the volume of process water used by the CESF is expected to be reasonably consistent. The expected average daily water consumption for the plant is approximately 18,500 gallons or 20.8 acre-feet/year (afy) assuming a full operating load of 13 hours per day. The expected peak water consumption for the facility is approximately 51 gallons per minute (gpm) or 74,000 gallons per day (gpd). This is expected to occur one day per year to clean the air-cooled condensers; however, the condensers at a similar facility in Nevada have required cleaning only once in five years. This peak water consumption is included in the annual water consumption of 20.8 af.

Table 1-1
Carrizo Energy Solar Farm Water Usage Rates

Water Use	Average Annual (gpm)[2]	Average Daily (gpm)[3]	Maximum Daily (gpm)[4]
Equipment Makeup Water Requirements			
Steam Cycle Makeup to DI Tank	27	27	50
Reflector Wash Water	5	7	13
ACC Wash Water	0.25	0.25	32
Media Filter Back Wash[5]	0.01	0.01	0.009
Misc. Drains, etc. to OWS	1.4	0.6	1
Potable Water	5.3	5.3	5.3
Total Equipment Makeup Requirements	**39**	**41**	**101**
Recovered Water[6]			
Steam Drum Flash Steam	3	3	6
Blowdown Flash Tank Condensate	24	24	44
Recovered from OWS (clear water)	1.4	0.6	1
NET RAW WATER REQUIREMENT	**10.6**	**13**	**51**

Notes:
[1]Based on two units at rated steam flow.
[2]"Average Annual" is based on 35 °C at 100 percent Load for 4,745 hours per year, reflector washing 250 days per year and ACC washing of all 50 cells, averaged over 8,760 hours.
[3]"Average Daily" is based on 13 hours per day operation, averaged over 24 hours.
[4]"Maximum Daily" is based on 13 hours per day, averaged over 13 hours, with ACC washing (10 cells over 10 hours).
[5]Based on one 20-second back flush every eight days at 64.35 liters per flush.
[6]Potable water includes water used for drinking, sanitation, and laboratory.

Onsite storage capability is sufficient for two days of full load operation to accommodate maintenance on any of the water delivery and treatment equipment. However, in the event that the system is not operational, water will be transported to the site from off-site supply sources from surrounding areas, such as San Luis Obispo, Paso Robles, or Bakersfield. During such an event, approximately three tanker trucks per day would be sufficient to sustain operations assuming average daily usage of 18,500 gallons.

1.3 WATER USE COMPARISONS

URS reviewed available water consumption data for other land uses to serve as a comparison to the water needs for the CESF. Some of these land uses are consistent with those that occur in the vicinity of the proposed site. The water uses included, residential, commercial, industrial, and agricultural for crops and livestock. Water use for other types of power generating facilities was also identified. These data appear in URS' "Responses to CEC Data Requests (#1-78)", dated February 26, 2008 (URS 2008). Water use for specific land use activities is provided below. The data were obtained through Internet sources and personal communications with experts in the agriculture and agronomy fields.

Tables 1-2 through 1-5 shows the estimated volume of water that would be used on average annually, if the property were used for the other land uses described below. In almost all instances, the amount of water used by these other land uses is considerably greater than the anticipated water use for the facility (20.8 afy) on a per-acre basis.

1.3.1 Non-agricultural Land Uses

According to published information, the standard residential property in southern California uses on average, 0.52 afy. The water is approximately equally split between use for irrigation landscaping and other household water needs. Commercial/institutional facilities are reported on average to use 1.66 afy and industrial facilities average 3.2 afy for each acre. Average urban water use for the Fresno metropolitan area considering each of the above uses averages approximately 3.2 feet per acre.

Table 1-2
Water Use Comparisons for Non-agricultural Land Uses

Activity/Property Use	Water Use
Single Family Residential	0.52 afy
Commercial/Institutional	1.66 afy
Industrial	6.27 afy
Urban	3.2 af/acre

Note:
Integrated Water Resources Plan, MWD, Report No. 1107, March 1996. From Southern California Association of Governments and San Diego Association of Governments.

1.3.2 Agricultural Land Uses

1.3.2.1 Crops

Several sources of information were consulted to identify water use for areas with a similar climate, since the amount of water needed to sustain crops is dependent on evapotranspiration. Evapotranspiration (ET) is the sum of the amount of water lost to evaporation from the soil and plant surfaces and that lost through plant transpiration. The data reported in Table 1-3 are for southern portions of the Central Valley, Imperial Valley and Arizona. Figure 1-2 is a graphical representation of agricultural water use for crops and livestock compared to the CESF on a per-acre basis and an area of equal size to the site (640 acres). Historically, the Carrizo Plain has been dry farmed to produce grain (wheat and barley), but some areas have been planted with grape vineyards and olive groves. Some cultivation of truck crops has occurred on a small scale on the Carrizo Plain. The previous owner had intended to plant truck crops on a portion of the section, including spinach, lettuce and carrots; however, the previous owner decided to forego these plans due to the E. Coli outbreak associated with spinach last year in the Salinas Valley that resulted in decreased demand (Pers. Comm.).

Table 1-3
Water Use Comparisons for Agricultural Uses

Activity/Property Use	Water Use (feet)	For 640 Acres (afy)
Alfalfa[a,d]	4.7 – 5.5	3,520
Cotton[a,d]	3.2 - 5.0	2,048 – 3,200
Barley[a]	1.3	832
Grapes[a]	2.9	1,856
Tomatoes[a,c]	3.9	2,496
Corn[a,c]	2.4	1,536
Deciduous Orchard[a]	3.5	2,240
Pasture (improved)[a]	4.5	2,880
Carrots[e]	5.4	3,467
Lettuce[e]	4.0	2,560
Spinach[e]	0.5 – 2.0	320 – 1,280
Dry Beans[e]	1.8	1,152
Olives (for oil)[e]	2.0	1,280
Olives (for eating)[e]	2.5	1,600
Dry Farming[f]	0.67	427
CESF	0.03	20.8

Notes:

[a] California Department of Water Resources, The California Water Plan Update, Bulletin 160-98. Value appearing for San Joaquin Valley unless noted.
[b] National Renewable Energy Laboratory, Parabolic Trough FAQs, www.nrel.gov.
[c] Mean based on information provided for California.
[d] "Power Plants in Arizona--an Emerging Industry, a New Water User", http://ag.arizona.edu.
[e] www.vric.ucdavis.edu.
[f] Based on average annual precipitation.

1.3.2.2 Livestock

Much of the Carrizo Plain is open range used for cattle grazing that depends on the natural grasses for a food supply. The area does not include irrigated pastureland like areas of the Central Valley. Based on communication with Mr. Jim Oltjen, Professor in the Department of Animal Science at the University of California, Davis, full-grown cattle require on average roughly 20 gallons of drinking water on a daily basis. The amount of drinking water needed depends on daily average temperature. To calculate the total annual average drinking water needs for a single head of cattle, the average monthly temperatures were used for a weather station in Buttonwillow, California as shown in Table 1-4. Based on monthly average temperatures, this would be approximately 5,513 gallons (0.017 af) of drinking water per head of cattle for a year. If the number of cattle on the 640 acres were 100 head, the annual water consumption for the cattle would be approximately 1.7 afy. This does not include the water that evaporates from the water bodies that supply drinking water to the cattle.

Table 1-4
Cattle Drinking Water Requirements Based on Temperature
(for single head of cattle)

Month	Average Temperature (ºF)[a]	Daily Drinking Water Requirements (gallons)[b]	No. of Days	Monthly Drinking Water Requirements (gallons)
January	45	12.0	31	372.0
February	51	12.8	28	358.4
March	56	13.7	31	424.7
April	61	14.7	30	441.0
May	68	16.4	31	508.4
June	76	17.5	30	525.0
July	81	17.7	31	548.7
August	80	17.9	31	554.9
September	74	17.3	30	519.0
October	65	15.7	31	486.7
November	54	13.4	30	402.0
December	45	12.0	31	372.0
Total Annual Water (gallons per year)				**5512.8**
Total Annual Water (afy)				**0.017**
Total Annual Water (feet/year)[c]				**0.42**

Notes:

[a] Average monthly temperature for Buttonwillow, CA from http://countrystudies.us/united-states/weather.

[b] For single mature (lactating) cow, 900 pounds. From "Nutrient Requirements of Beef Cattle; Seventh Revised Edition: Update 2000", Board of Agriculture.

[c] Each head of cattle requires approximately 25 acres of open rangeland (Oltjen, J., Pers. Comm.) Assumes that there would be 25 head of cattle on the site (640 acres).

Drinking water for cattle is stored in stock ponds, shallow depressions and may be supplied by local springs. During the rainy season, the water in storage maybe partially derived from precipitation. At other times of the year, these ponds may be filled using groundwater. Evaporation from the water surface in these ponds in the arid environment of the Carrizo Plain would be expected to be 4 to 6 feet each year. As an example, a one-acre stockpond would lose approximately 4 to 6 afy to evaporation.

1.3.3 Other Types of Power Generating Facilities

Typical power generating facilities use large quantities of water for cooling. Many solar facilities do use water for cooling as it is cheaper to construct than air-cooled facilities. Because Carrizo Energy has designed CESF to be air-cooled, the facility will use considerably less water per acre than a wet-cooled facility. An air-cooled facility uses about 40 times less water than a wet-cooled facility. When compared to the water used to generate a megawatt of power, the air cooled solar facility will use the least amount of water compared to other types of power generating facilities, such as new hybrid types and those with flow through cooling, conventional cooling towers and conventional coal-fired plants. Per acre of site, the volume of water that will be needed at the CESF facility is considerably less than the other non-agricultural and agricultural uses shown in Tables 1-2 and 1-3, respectively, some of which occur on the Carrizo Plain.

Table 1-5
Water Use Comparisons for Other Power Generating Facilities

Activity/Property Use	Water Use
CESF (projected; 640 acres)	0.03 afy/acre
Solar, Wet Cooling[a]	1.3 afy/acre
CESF (Average Daily)	0.12 afy/MW
Ivanpah	0.25 afy/MW
Victorville 2 Hybrid	5.6 afy/MW
Solar, Dry Cooling[a]	800 -1,000 gal/MWh
Former adjacent ARCO Facility[b]	30.9 afy/MW
Once Through Cooling[c]	300 gal/MWh
Cooling Towers[c]	12.9 afy/MW
Conventional Coal-fired[d]	11.2 afy/MW

Notes:
a. National Renewable Energy Laboratory, Parabolic Trough FAQs, www.nrel.gov.
b. Stewardship Council Land Conservation Plan, http://lcpstewardshipcouncil.org.
c Freedman, P.L. and J.R. Wolfe, "Thermal Electric Power Plant Water Uses; Improvements Promote Sustainability and Increase Profits", LimnoTech, Canadian-U.S. Water Policy Workshop, October 2, 2007.
c. A 880-MW plant reportedly uses an average of 11 million gpd, of which 80% is lost to atmosphere as steam. www.deq.virginia.gov.
One acre foot of water equals approximately 326,000 gallons.

1.4 SITE HISTORICAL USES OF GROUNDWATER

A review of historical documents by URS revealed that agricultural development on the Carrizo Plain has included primarily dry farming of wheat and barley and raising cattle and sheep. Previous property owners grew wheat on Section 28 and wheat and barley were grown on Section 33. According to the previous property owner, in addition to the two current wells on site, one that served the residences at the ranch and an irrigation well, there were two other irrigation wells on the property that each produced approximately 1,000 to 1,200 gpm. Water from these irrigation wells were used to supply water for growing alfalfa, carrots and potatoes. However, these wells experienced some caving, and required abandonment. It is our understanding in discussions with some long-time local residents that during the period of time when these wells pumped groundwater for the purposes of irrigation, no nearby residents experienced any difficulties associated with their wells (water quality, water level or well yields). We understand that 80 acres at the southeast corner of the section was used historically for growing wheat, and approximately 0.5 feet of water was used annually. This would equal approximately 40 afy, which is approximately twice the volume of water that will be used by CESF. If it were assumed that this water was applied over a 6-month period, the estimated pumping rate would be approximately 50 gpm. This pumping rate is approximately five times the flowrate expected for the CESF facility. According to a long-time resident of the site vicinity, it is our understanding that when the site was used for this purpose, there was no evidence that adjacent wells experienced any difficulties with low water levels, decreased flowrates/yields or water quality.

SECTION 2 SURFACE WATER HYDROLOGY

2.1 REGIONAL HYDROLOGY SETTING

2.1.1 Climate, Precipitation and Evapotranspiration

The following information was excerpted from "Groundwater in the Carrizo Plain", an unpublished study by William J. Kemnitzer (1967). A copy of the Kemnitzer report is provided in Appendix A.

2.1.1.1 Climate and Precipitation

The climate of the Carrizo Plain has some of the features of a desert basin notwithstanding that it is a plain within the Coastal Ranges. This anomaly is because the uplifted plain is on the inland side of the Coastal Ranges near the southern end of the San Joaquin Valley and is flanked by moderately high mountains.

Rainfall over the Carrizo Plain and its watershed, although variable, averages a little more than 8 inches annually. Nearly all of the precipitation is in the form of rain which falls mostly during the months of December through February. However, isolated thundershowers sometimes occur during the summer. Snow rarely falls on the basin floor, but does rather frequently during the winter on the summits of the adjoining mountains.

Department of Water Resources (DWR) Bulletin 118 indicates that the average annual precipitation ranges from 7 to 9 inches in the Carrizo Plain basin. There are no official County rain gauges in the vicinity of the CESF; however, the County provides access to active and historic rainfall data from other voluntary sources. Evaluation of this data indicates that the average annual precipitation in the vicinity of the CESF is closer to 10 inches. Most of the rainfall occurs from November through May with minimal rainfall during the summer months. The historic rainfall distribution for the closest (inactive) rainfall gauge to the CESF is provided in Table 2-1.

Table 2-1
Historic Seasonal Rainfall
(reported in inches)

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Yearly Total
Average	0.03	0.03	0.14	0.33	0.85	1.51	2.01	1.93	1.68	0.95	0.21	0.03	9.68
Maximum	0.52	0.63	2.07	1.76	3.06	4.90	8.62	7.21	5.10	4.60	1.44	0.34	22.30
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.88

Reference: San Luis Obispo County Public Works, Volunteer Precipitation Gauge Station, Monthly Precipitation Report.

Notes:
Station Name: Cavanaugh Ranch #78 (Inactive).
Station Location - Lat 35º21'30", Long 120º02'30", Water Years 1938/39 to 1981/82.

During the winter, temperatures below freezing are common. During the summer months daytime temperatures are frequently in the 90s and are occasionally above 100 °F. Nights are usually cool even in the summer. The long dry summers provide an adequate growing season for most crops, but the relatively high altitude of the plain results in a shorter growing season which limits the types of crops that can be cultivated. The time between frosts averages around 200 days.

2.1.1.2 Evaporation

Because the Carrizo Plain basin is one of internal drainage (closed to surface water outflow), precipitation that does not infiltrate the soil accumulates in Soda Lake, a playa in the center of the basin. These surface waters typically evaporate before the end of the summer, leaving the lake bed dry during most of the year.

Evaporation discharge of groundwater may by divided into (a) vegetal discharge and (b) soil discharge. Vegetal discharge of groundwater occurs as a result of the physiological functioning of plants. The water may be taken into the roots of plants directly from the zone of saturation or from the capillary fringe, which in turn is supplied from the zone of saturation. It is discharged from the plants by a process of transpiration. Soil discharge of groundwater occurs through evaporation directly from the soil or rocks. Discharge of this kind can only take place where the water table is close to the surface.

The above evaporation discharges apply to groundwater only. In the Carrizo Plain Basin, discharges must also include evaporation of surface waters, nearly all of which accumulate in Soda Lake and are prevented from any extensive downward percolation by the presence of a thick and largely impermeable mud and clay bottom (at Soda Lake). Most of the surface water in Soda Lake is evaporated before the end of the summer season. It is estimated that an average of nearly 45,000 af, or more than 25 percent of the total water falling upon the Carrizo watershed annually, evaporates from this lake.

The losses through natural vegetal transpiration are comparatively small, but those through planted non-irrigated vegetal transpiration are large. Soil discharge of subsurface water is large due mainly to the arid conditions prevailing in the Carrizo during most of the year. Together, vegetal and soil discharge is estimated to range from 46,000 to 72,000 afy, depending on the extent of non-irrigated crops.

2.1.2 Watershed Boundaries

The CESF is located within the Central Coast Hydrologic Region that covers approximately 11,300 square miles in central California including the Carrizo. A map showing the Carrizo basin watershed is provided as Figure 2-1. The boundaries of the basin appearing on this map include the area considered in the hydrologic and hydrogeologic model included in this study. The Carrizo Plain is a semi-arid area dominated by flat topography with sloping, and rolling hills on its margins in the southeastern part of San Luis Obispo County, California. The alluvial floor of this topographic basin is approximately 54 miles long and 6 miles wide. It is elongated in a northwest-southeast direction between two coastal ranges, the Temblor Range on the east and the Caliente-San Juan Range on the west. Elevation of the basin floor averages about 2,200 feet above mean sea level (MSL). Elevation of the Temblor Range is approximately 3,000 feet and that of the Caliente about 4,000 feet, while the San Juan section of this latter range is considerably lower at about 2,500 feet.

The Carrizo Plain watershed, including the floor of the plain, covers approximately 414 square miles, or 263,680 acres based upon watershed delineation using recent United States Geographic Survey (USGS) topographic maps of the area. Kemnitzer (1967) estimated the area of the watershed to be approximately 418 square miles.

The watershed areas tributary to the site include three areas shown on Figure 2-2. Basin 1 (as shown on Figure 2-2) includes the main Carrizo Plain drainage channel that runs through the construction laydown area and is approximately 31.6 square miles. Basins 2 and 3 are directly tributary to the northerly site area and are approximately 3.9 and 4.3 square miles, respectively, for a total of 41.3 square miles including the solar field and construction laydown area. The total watershed area tributary to the north end of Soda Lake is approximately 152 square miles (see Figure 2-1). The site and construction laydown area occupy approximately one percent of the watershed tributary to the north end of Soda Lake.

2.2 SURFACE DRAINAGE AND HYDROLOGY

2.2.1 Pre-Construction Drainage Patterns

The Project site currently consists primarily of disturbed farmland/ranchland. The Project site is generally flat, sloping gently to the southwest with elevations ranging from approximately 2,064 feet to 2,014 feet MSL. The portion of stormwater runoff that does not infiltrate into the ground moves via sheet flow and follows the terrain to the south and west, is tributary to the main Carrizo Plain ephemeral drainage channel that crosses through the southern portion of the construction laydown area, and then is tributary to Soda Lake over ten miles downstream. Portions of the main Carrizo Plain drainage within the temporary construction staging area may be jurisdictional Waters of the United States (WUS), but are not listed on the proposed 2006 Clean Water Act (CWA), Section 303(d) list of water quality limited segments (Figure 2-2). The Jurisdictional Determination Request was submitted to the San Francisco Army Corps of Engineers (ACOE) in March 2008, and was submitted to the Washington DC Headquarters of ACOE and the United States Environmental Protection Agency (U.S. EPA) in April. The Applicant is currently waiting for the determination from Headquarters and U.S. EPA and hoping to receive a determination by July 2008.

Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Map (FIRM) Community Panel Numbers 0603040550B and 0603040575B (1982) show that the CESF and temporary construction laydown area are within FEMA designated 100-year 'Zone A' floodplain areas within Sections 28 and 33. As discussed in the project description, the CESF site is generally not subject to flooding; however, an area along Tracy Lane beginning approximately 174 m (570 ft) onto Section 28 is within the 100-year flood zone. Additionally, the main Carrizo Plain drainage feature running through the southern portion of Section 33 within the temporary construction laydown area is within a FEMA designated 'Zone A' floodplain boundary. Base Flood Elevations (BFE) and hazard factors have not been determined for these areas. The BFE will be established during final engineering design if necessary for design purposes.

2.2.2 Post-Construction Drainage Patterns

Stormwater runoff for the CESF is directed from the paved (i.e., roads and parking lots) and non-paved areas to local collection swales and infiltration areas and allowed to percolate and evaporate. Area grading is used to direct the runoff into a number of localized detention/infiltration areas located throughout the Solar Farm. Given its desert nature and the very limited rainfall that occurs on the Carrizo Plain, the majority of the water from this low intensity rainfall will be absorbed into the ground. The detention/infiltration basins are integrated with the Solar farm equipment and throughout the solar field to collect any excess rainwater that is not absorbed into the ground. The infiltration areas will be used to store and infiltrate the stormwater runoff.

Rain falling in the power block area will be collected and directed to the surrounding solar field using a system of swales integrated with the site-grading plan. Rainfall from vehicle parking and paved areas in the power block will be collected and directed to an OWS prior to discharge to the raw water tank for recovery. Rainwater collected from active areas (*i.e.*, potentially contaminated by oil) is routed to an OWS. Following inspection, water from the OWS is sent to the wastewater tank and then to the water treatment system for recovery.

The flows generated from the offsite watershed will be directed around the site via the proposed drainage swales. The drainage swales will be constructed adjacent to the four sides of Section 28. The swales will direct the runoff in the southwesterly direction and outlet at the southwestern corner of Section 28. Ultimately, the runoff will flow across SR 58, confluence with the existing creek, traverse Section 33 and continue on its historical flow path in the southeasterly direction.

The Project site's perimeter swale is designed to intercept upgradient storm water runoff from adjoining land and convey that stormwater around the site, directing it to the existing natural water course located at the southwest corner of the Project site. Upgradient flows that cannot be contained in the perimeter swales will sheet flow across the site (excluding the power block) and either infiltrate or sheet flow to the southwest corner as under existing conditions. The perimeter swales are not designed to convey significant runoff from the multiple onsite detention/infiltration areas.

The depths and widths of the perimeter swale vary from approximately 3 to 7 feet deep to 50 to 124 feet wide. Slopes vary from approximately one percent to less than one-tenth of one percent. As designed, the capacity and velocity control provided by the perimeter swales provide the capability of channeling typical annual upgradient storm water around the site as well as allowing that storm water to percolate into the ground.

Ultimately, the offsite runoff and any excess onsite runoff that is not infiltrated will be conveyed into the main drainage channel. The smaller perimeter swales along the northerly section of the site currently have the capacity to convey approximately the 5 to 10-year storm event flows from the two northerly offsite drainage channels. The larger swales along the westerly and easterly portions of the site have capacity for up to the 100-year storm event. Excess flows along the northerly Project boundary will sheet flow across the site (with the exception of the power production area) and be captured in the onsite detention/infiltration areas.

There are two proposed permanent drainage crossings within the construction laydown area. These culverts will be designed to convey typical seasonal flows through the drainage.

Based upon the current layout provided in the Project AFC, portions of the northeast corner of the temporary fueling station boundaries within the construction laydown area are within the FEMA delineated 100-year, Zone A floodplain limits based upon a comparison of the fueling station boundaries with the FEMA Flood Insurance Rate Map. However, the majority of the designated area, including the fuel storage tanks, is outside the 100-year floodplain. The FEMA designated 100-year floodplain widths in this area vary from approximately 400 to 600 feet in width. Based upon the 100-year flood flowrates, available topography, and Manning's normal depth calculations, the 100-year flood depths in this area are approximately 4 to 6 feet deep. The temporary fueling area would be placed above this depth or could be protected by berms along the channel side of the facility. The permanent fueling facility on the power block (along with all other facilities on the power block) will be elevated above the 100-year flood level.

Per the biological analysis, there are no vernal pools or vernal pool habitat areas on the project site or construction laydown area. Additionally, there are no wetlands associated with the jurisdictional Waters of the United States delineation. The jurisdictional WUS delineation area is not a wetland or vernal pool that is reliant on annual flows from a biological standpoint. Therefore, the proposed hydrology condition will not adversely affect this area from a biological standpoint.

2.2.3 Surface Water Hydrology Calculations

The site is located in an unincorporated area of San Luis Obispo County, therefore, San Luis Obispo County hydrology and hydraulic standards were used for onsite stormwater calculations. San Luis Obispo County standards require the 100-year design for drainage areas greater than 4 square miles, the 50-year design storm for drainage areas from 1 to 4 square miles, and the 25-year design storm for drainage areas less than 1 square mile. Surface water hydrology calculations are provided in Appendix B.

2.2.3.1 On-Site Hydrology Calculations

Onsite rainfall would be captured on the site in the terrace detention/infiltration areas and allowed to infiltrate and evaporate. The proposed site design will create numerous detention/infiltration areas that will capture the generated stormwater runoff. The retention requirement for the County of San Luis Obispo is based on holding the 50-year storm, 10-hour intensity for 10-hour duration. Calculations were performed to verify that the multiple onsite detention/infiltration areas have adequate volume to store the stormwater runoff generated from a 50-year storm per San Luis Obispo County standards. Based upon these calculations, all proposed onsite runoff up through the 50-year storm can be stored onsite without generating runoff to the perimeter swales. The Rational Method hydrology analysis was used to compute pre- and post-project runoff volumes and flowrates onsite. The following information summarizes the pre and post Rational Method Hydrology runoff coefficients ('C' Values) used in the onsite Rational Method Analysis. Table 2-2 presents the results of the onsite rational method runoff flowrate calculations. This table was originally prepared in response to CEC Data Request 39.

- Total site area (including construction laydown area) = 1020 acres
- Percentage impervious area before construction < 1%
- Runoff coefficient before construction = 0.38
- Percentage impervious area after construction* < 5%
- Runoff coefficient after construction = 0.40

* Percentage impervious conservatively assumes entire power block, access road, and parking areas are impervious. Areas under the reflectors are pervious.

Table 2-2
On-site Stormwater Runoff Flows

Storm Event (yr)	Intensity (in/hr)	Total Existing Onsite Flows* (cfs)	Total Proposed Onsite Flows* (cfs)
2	0.50	122	128
5	0.70	170	179
10	0.80	195	205
25	1.00	243	256
50	1.10	268	282
100	1.20	292	307

Notes:
*These runoff values are based upon the Rational Method and are conservative estimates of flow for comparison purposes.
yr = year
in/hr = inches per hour
cfs = cubic feet per second

The amount of potential stormwater volume generated onsite was also evaluated on an average annual basis. Under existing conditions approximately 203 afy identified already of stormwater could occur on the 640-acre site assuming an average annual rainfall of 10 inches and a runoff coefficient of 0.38. Under proposed conditions, the 640-acre site would generate approximately 213 acre-feet (af) of stormwater volume annually with a runoff coefficient of 0.40; however, there would be no surface runoff from the site under normal conditions. Similar calculations assuming an average annual rainfall of 8 inches result in a pre-project stormwater volume of 162 afy and a post-project stormwater volume of 171 afy.

2.2.3.2 Off-Site Hydrology Calculation

USGS regression equations within the National Flood Frequency (NFF) Program were used to quantify the runoff generated from the offsite watersheds. The NFF Program includes regression equations for approximately 289 flood regions nationwide. The regression equations were developed from peak-discharge records of 10 years or longer, available as of 1975, at more than 700 gas stations throughout the State. The project site is within the Central Coast Region. Therefore, the regression equations used were specific for that region.

The total watershed including the project site and construction laydown area comprises approximately 41.3 square miles of predominately agricultural and undeveloped land. Of the 41.3 square miles, 31.6 square miles are tributary to the western boundary of the construction laydown area. Table 2-3 below updates the flowrate table previously presented in response to CEC Data Request 38. This includes more refined basin area delineations, the watershed basin downstream of the project to Soda Lake, as well as the entire Soda Lake watershed basin. The table provides the anticipated pre- and post-project surface runoff flowrates at the following three locations within the watershed: project construction laydown area; north end of Soda Lake; and entire Soda Lake watershed. The watershed boundary tributary to the north end of Soda Lake is approximately 152 square miles, whereas the total Soda Lake Watershed is approximately 414 square miles as shown on Figures 2-1 and 2-2. The surface water runoff rate reduction due to infiltration in the solar field area is minimal in comparison to the overall watershed surface water runoff rates, and therefore, significant impacts to water resources downstream of the project and in the regional area are not anticipated, as indicated in Table 2-3. There will be no significant change in runoff to Soda Lake post-construction.

Table 2-3
Pre- and Post-Project Off-site Flowrates

Location	Basin Area (square miles)	2-year Storm (cfs)	5-year Storm (cfs)	10-year Storm (cfs)	25-year Storm (cfs)	50-year Storm (cfs)	100-year Storm (cfs)
Basin 1	31.6	22	134	328	784	1390	2220
Basin 2	3.9	3	20	49	120	214	349
Basin 3	4.3	3	21	53	130	231	377
Basin 4 (Site)	1.6	2	9	23	57	100	163
Pre-project Total at the Site	41.3	28	171	417	995	1770	2810
Post-project Total at the Site	40.3	28	167	408	974	1730	2750
Basin 5	110.7	71	424	1020	2410	4280	6710
Pre-project Total at North end of Soda Lake	152	95	566	1360	3200	5670	8870
Post-project Total at North end of Soda Lake	151	95	563	1350	3180	5640	8820
Basin 6	262	151	902	2170	5090	9060	14200
Pre-project Total Soda Lake Watershed	414	229	1370	3270	7650	13600	21200
Post-project Total Soda Lake Watershed	413	229	1360	3260	7640	13600	21100

Notes:

1. Offsite flowrates calculated using the National Flood Frequency Program Regression Equations using an annual average precipitation of 10 inches per year.
2. Post Project Total basin area does not include the approximately 0.6 square mile construction laydown area because that area is not part of the permanent solar field.
3. The runoff pre and post-project runoff flowrates presented in the table assume that all rainfall on the site will be detained and infiltrated onsite.

Table 2-4
Annual Off-site Runoff Volumes

Location	8 Inches Annual Rainfall		10 Inches Annual Rainfall	
	Pre-Project Annual Runoff Volume (afy)	Post-Project Annual Runoff Volume (afy)	Pre-Project Annual Runoff Volume (afy)	Post-Project Annual Runoff Volume (afy)
Project Site	6,696	6,534	8,375	8,167
Entering Soda Lake	24,644	30,805	24,482	30,602

The total tributary area to the jurisdictional WUS within the construction laydown area is approximately 41.3 square miles. The associated total potential runoff flow volume is approximately 8,375 afy, assuming 10 inches annual rainfall and a runoff coefficient of 0.38. This is a conservative flow volume that does not consider storage and infiltration areas within the watershed upstream of the construction laydown area. Under the proposed condition, the onsite average annual rainfall will be collected and infiltrated/evaporated onsite, and the existing upstream flows will be routed around the site and flow to the jurisdictional Water. Under the proposed annual average condition, there will be a reduction in tributary area from 41.3 square miles to 40.3 square miles (a 2 percent decrease). Total runoff volume tributary to the jurisdictional Water under this proposed condition, would be approximately 8,167 afy, a reduction of 208 afy. Assuming an annual average rainfall of 8 inches, the potential stormwater runoff flow volumes are 6,696 afy and 6,534 afy (a reduction of 162 afy) for the pre- and post-project conditions. This is a minor reduction and is not considered significant, because this area is not a wetland or vernal pool that relies on annual flows from a biological standpoint.

A similar volume analysis for the watershed downstream of the project to Soda Lake indicates similar results in terms of surface water volume reduction due to infiltration and evaporation of annual rainfall onsite. The total tributary area to the north end of Soda Lake is approximately 152 square miles, resulting in pre-project potential surface stormwater volumes of approximately 24,644 afy and 30,805 afy assuming 8 inches and 10 inches of annual rainfall per year, respectively. The corresponding post-project volumes are approximately 24,482 afy and 30,602 afy assuming 8 inches and 10 inches of annual rainfall per year, respectively. These are considered to be minor reductions (less than 1 percent) in the overall potential annual surface water flow volumes. Therefore, significant impacts to water resources dependent upon annual surface water flow volumes downstream of the site are not anticipated.

2.2.4 Surface Water Infiltration

Kemnitzer (1967) indicates that, "The balance between water recharge and discharge for the Carrizo basin involves a gross annual amount of some 177,000 af." This figure is based on the average precipitation of 8 inches of rainfall annually falling upon 266,000 acres of watershed. Of this gross recharge, at least 118,000 af, or nearly 67 percent, is estimated lost through evapotranspiration and other natural processes. The remaining 59,000 af, or one-third of the gross, is considered to be the net average annual ground water recharge (Kemnitzer 1967).

Based upon the assumption of 1/3 of the gross recharge, the net average annual groundwater recharge, rain falling on the project site and allowed to infiltrate would contribute approximately 141 afy. This is based upon the assumption of 8 inches of annual rainfall over the 640-acre solar field. When considering the upstream offsite drainages directly tributary to the site (Basins 3 and 4 on Figure 2-1) the total infiltration increases to 1,293 afy assuming 8 inches of annual rainfall over 9.2 square miles. These groundwater infiltration estimates are well in excess of the project's annual average water use of 20.8 afy. Assuming 8 inches of annual rainfall, at little over 5% of the annual rainfall on a 640 acre area would be required to infiltrate to the groundwater table to equal the annual average project water use of 20.8 afy.

SECTION 3 HYDROGEOLOGY

There has been only one comprehensive, basin-wide evaluation of groundwater conducted in the Carrizo Plain by William J. Kemnitzer in 1967. This unpublished document serves as the basis for the regional hydrogeologic setting for the site vicinity. Other studies have been conducted by Jon Cooper specific to the area surrounding California Valley (Cooper 1990). Some information of a hydrogeologic nature performed by Mr. Cooper was provided by Mr. Kenny Tab of California Valley and has been included in our evaluation of hydrogeology and is provided in Appendix C. Another source of hydrogeologic information was a letter report prepared by Bechtel Civil & Minerals, Inc. (Bechtel) to evaluate water quality and availability for the Carrizo Plain Solar Project (ARCO) that was located on the northwest corner of the adjacent section to the east of the project site. At the time of the preparation of the AFC, this was the most informative document regarding local aquifer characteristics near the site. Appendix K from the AFC includes these reports and information is provided in Appendix D. URS has supplemented this information with the results of a well survey conducted by URS personnel for an area within approximately 3 miles of the site. The CEC requested URS to conduct a 2-mile radius search for well information at the March 12, 2008 Public Workshop.

3.1 GEOLOGIC AND HYDROGEOLOGIC SETTING

Many studies have been done regarding the geology of the Carrizo Plain. The primary geologic sources of published information used for this report include the USGS, the California Geological Survey (CGS) (formerly California Division of Mines and Geology, CGMG) and the United States Department of Agriculture (USDA), Much of the geologic information in this region is based on geologic mapping performed by Tom Dibblee, Jr. The geology described herein appears in Dibblee, Jr. (1962). Specific references include: “Regional Geologic Map of San Andreas and related faults in Carrizo Plain, Temblor, Caliente, La Panza Ranges, and vicinity, California: A Digital Database” (USGS 1999); and the “Soil Survey of San Luis Obispo County, California, Carrizo Plain Area” (USDA 2003). URS also performed a preliminary geotechnical investigation. The results were presented in a report titled, “Preliminary Geotechnical Investigation, CESF, San Luis Obispo County, California,” dated October 1, 2007 (final). The stratigraphy and structure presented below is rather elementary to set the framework for the hydrogeology that appears in this report. Some of this information was provided in the AFC for the subject project.

A regional geologic map is presented on Figure 3-1 and the associated legend is included as Figure 3-2 (Dibblee, Jr. 1999). As shown on the map, the San Andreas Fault dominates the geology in the Carrizo Plain and significantly affects the movement of groundwater in the Carrizo basin. It forms the northeast boundary of the Carrizo Plain, passing through the foothills of the Temblor Range. The San Juan, Big Spring, and Morales faults pass through the hills to the west and southwest of the plain. Faulting has caused deformation and uplift of the hills, which have been subsequently eroded.

A stratigraphic column showing the geologic units of the Carrizo Plain is provided in Appendix D. The majority of the Temblor and Caliente Ranges are composed of Miocene-age sedimentary rock consisting of sandstone, shale, conglomerate, and siltstone that have been folded. These materials were originally deposited in marine and non-marine environments. These Tertiary-age sedimentary rocks and Cretaceous-age strata overlie a granitic complex of Mesozoic age. Similarly fault movements, uplift, folding and erosion of these formations has resulted in a complicated stratigraphic sequence.

The primary aquifers in the Carrizo Plain are found in alluvium, the Paso Robles and Morales Formations. Each water-bearing stratigraphic unit is described below.

Alluvium: Quaternary-age alluvium blankets the Carrizo Plain. It is up to several hundred feet thick, and is thickest at Soda Lake. The upper Pleistocene to Holocene alluvium consists of unconsolidated to loosely consolidated sands, gravels, and silts with a few beds of compacted clays. The alluvium is highly variable in composition, and based on the preliminary geotechnical investigation conducted by URS, these sediments consist primarily of clay and clayey sand to a depth of approximately 100 feet at the site.

Paso Robles Formation: The alluvium is underlain by the Paso Robles Formation, which outcrops in the hills along the northeast side of the plain. The Paso Robles Formation is a Pleistocene-age alluvial deposit and is about 3,000 feet thick near the San Andreas Fault (USDA 2003). It consists of poorly sorted, mostly loosely consolidated gravels, sands, and silts. Both the younger alluvium and the Paso Robles Formation are derived from material eroded off the surrounding mountains. According to Kemnitzer (1967), the western portion of the basin where the formation is thinnest, appears to have the best well yields based on well log information. The lower portion of the Paso Robles Formation is fine-grained and serves as an aquitard and barrier to the mixing of fresh water with poorer quality water that may be present at depth below this formation.

Morales Formation: The Paso Robles Formation unconformably overlies the Morales Formation. The upper Pliocene Morales Formation consists of sands, gravels, and silts, which are generally more stratified and compacted than those in the overlying Paso Robles. The Morales Formation ranges in thickness from just a few feet to more than 3,000 feet. The Morales is conformable with the underlying Miocene-age strata.

Kemnitzer (1967) described that there are two water bodies beneath the Carrizo Plain based on their quality. The groundwater with the poorest quality lies in the sediments immediately beneath Soda Lake. Kemnitzer (1967) referred to this aquifer as the Soda Lake. Soda Lake is the sink for this closed basin and repeated evaporation of surface inflows results in increased salinity of the groundwater in this area. These lacustrine sediments consist primarily of clay. As such, these highly saline waters present in the sediments beneath Soda Lake are hydraulically separated from better water quality at depth. Kemnitzer (1967) referred to this water body at depth the Carrizo (aquifer). The water quality of the Carrizo is probably best at the margins of the basin and further away from Soda Lake.

3.2 GROUNDWATER SUPPLY

Groundwater supply in the site vicinity is generally produced from two zones, an upper zone that is generally less than 300 feet and a lower zone that exists at the site at a depth of approximately 450 to 600 feet below the ground surface. These are referred to as the Upper and Lower Aquifers, respectively, in this document. There are water-bearing strata below these zones, as described in Section 3.6. This naming convention should not be construed to indicate that there are no aquifers below what we are describing as the Lower Aquifer. It should be noted, some wells also produce groundwater in an interval from 100 to 200 feet bgs.

3.2.1 Upper Aquifer

Based on a review of limited well information, potable water supplied to most residences and ranches for domestic use is derived from shallow wells typically within a depth of about 175 feet bgs. Kemnitzer (1967) refers to these wells as "Household and Livestock Wells". In 1967, he identified 89 wells penetrating the Upper Aquifer. No well yields were reported for these wells, however, based on a well survey conducted by URS in March 2008, these shallow wells penetrating the Upper Aquifer probably yield from a few gpm up to 40 gpm. In the water budget of Kemnitzer (1967) for the basin, he assumed an average annual production from the 89 household and livestock wells to be approximately 6 afy. With continuous pumping, the average well yield for these wells would be approximately 4 gpm.

3.2.2 Lower Aquifer

The Lower Aquifer from which groundwater is derived for use by residents of the plains is typically present at a depth of greater than 450 feet. According to Kemnitzer (1967), these wells typically yield on the order of 500 to 1,100 gpm. He identified 11 irrigation wells in 1967 and of these, it appears that six were generally greater than 300 feet deep. These wells are typically used for irrigation and it is from this zone that Carrizo Energy would derive its water supply for the proposed CESF. He also identified three community wells. One was drilled into this Lower Aquifer. The other two were located in California Valley, with depths of 1,019 and 1,865. No data on well yields are noted by Kemnitzer (1967).

3.3 WELL SURVEY

3.3.1 Methods

URS personnel conducted a land use survey in March 2008 that included identifying the location of water wells within approximately 3 miles of the proposed site. The locations of wells were identified using a portable Global Positioning System (GPS) unit and marked on a field map. URS personnel visited residents to identify the characteristics of their wells. Many residents were not at home when URS personnel visited their homes. Residents were asked of their knowledge regarding well depth, screen intervals and pumping rates for the wells on their property. It should be noted that although a well may have been identified during the survey, it is possible that it may no longer be operating This information was considered in the groundwater modeling conducted to evaluate the effects groundwater pumping related to this project will have on the surrounding area and the groundwater basin.

URS also made a well data request to DWR through completion of a Well Completion Report Release Agreement for an Agency Study under California Water Code Section 13752. Our request was denied because URS is not an agent for an Agency, in this case the CEC. No additional data was released to URS by DWR.

3.3.2 Results

The locations of well identified during the survey are shown on Figure 3-3. A limited set of data was obtained from the residents concerning well construction and yield information. The available information is summarized in Table 3-1. This includes wells identified on USGS topographic quadrangle maps for the site vicinity. These wells are shown with a number following the well symbol on Figure 3-3. It should be noted that although a well may have been identified during the survey, it is possible that it may no longer be operating. For example, Well G1 shown on the site has been abandoned.

Table 3-1
Summary of Available Well Completion Data

Township, T##S	Range, R##E	Section	Quarter/ Other Indicator	Zone	Northing	Easting	Approx. Depth to Water (feet)	Approx. Well Depth (feet)	Depth of Screen Interval (feet - feet)	Approx. Pumping Rate (gpm)
Well Survey Data										
---	---	---	---	10S	766991	3917437	20	300	100-300	100-150
---	---	---	---	10S	765654	3918034	---	250	---	40
---	---	---	---	10S	764165	3918391	30	250	---	30
---	---	---	---	10S	764002	3920573	20	250	100-250	40
---	---	---	---	10S	763990	3920704	20	200	100-200	40
---	---	---	---	10S	763990	3920704	20	200	100-200	40
---	---	---	---	10S	764775	3920692	20	140	20-100	25
---	---	---	---	10S	772383	3912938	15	600	100-600	100
---	---	---	---	10S	772346	3912871	15	600	100-600	100
---	---	---	---	10S	227726	3914824	18	120	100-120	20
---	---	---	---	10S	227726	3914824	18	120	100-120	20
---	---	---	---	10S	227726	3914824	18	120	100-120	25
---	---	---	---	10S	227391	3915931	20	150	80-150	20
---	---	---	---	10S	228532	3915275	20	160	100-160	8
---	---	---	---	10S	228532	3915275	20	80(?)	UNK	8
Other Available Well Completion Data										
29	17	25	---	---	---	---	155	263	180 - 260	15
29	17	25	---	---	---	---	177	300	140 - 300	10
29	18	16	---	---	---	---	37	150	55 - 151	UNK
29	18	18	---	---	---	---	18	150	72 - 150	UNK
29	18	28	---	---	---	---	30	630	75 - 630	500
29	18	29	---	---	---	---	10	610	100 - 360	300
29	18	29	---	---	---	---	15	260	115 - 255	150
29	18	29	---	---	---	---	20	250	130 - 250	150
29	18	29	---	---	---	---	15	340	40 - 300	300
29	18	30	---	---	---	---	30	263	100 - 260	150

Table 3-1
Summary of Available Well Completion Data
(Continued)

Township, T##S	Range, R##E	Section	Quarter/ Other Indicator	Zone	Northing	Easting	Approx. Depth to Water (feet)	Approx. Well Depth (feet)	Depth of Screen Interval (feet - feet)	Approx. Pumping Rate (gpm)
29	18	30	Lot1	---	---	---	60	200	40 - 195	50
29	18	30	Lot2	---	---	---	40	180	60 - 180	75
29	18	30	Lot3	---	---	---	40	175	55 - 175	75
29	18	30	Lot4	---	---	---	55	160	40 - 160	50
29	18	33	---	---	---	---	44	103	43 - 103	UNK
29	18	34	---	---	---	---	UNK	460	155 - 380	UNK
29	18	34	---	---	---	---	15	102	42 - 102	UNK
29	18	34	NE1/4	---	---	---	40	204	66 - 204	UNK
29	18	35	---	---	---	---	15	160	60 - 160	200
29	19	19	NE1/4	---	---	---	26	101	30 - 102	UNK
29	19	19	W	---	---	---	18	58	18 - 58	UNK
29	19	21	SW1/4	---	---	---	22	98	38 - 98	UNK
29	19	27	NE1/4	---	---	---	36	126	0 - 126	UNK
30	18	1	N	---	---	---	42	106	50 - 102	20
30	18	1	---	---	---	---	75	140	70 - 130	UNK
30	18	1	N	---	---	---	38	150	40 - 141	30
30	18	10	---	---	---	---	15	160	20 - 160	70
30	18	11	---	---	---	---	63	111	63 - 111	UNK
30	18	12	---	---	---	---	UNK	520	100 - 520	UNK
30	18	13	---	---	---	---	55	170	110 - 170	30
30	18	13	---	---	---	---	30	160	60 - 160	UNK
30	18	14	---	---	---	---	18	285	95 - 275	100
30	18	17	---	---	---	---	38	300	60 - 275	70
30	18	24	---	---	---	---	35	100	50 - 100	UNK

Notes:
Wells identified during the survey with well data are shown in yellow on Figure 3-3.
UNK: Unknown

As a result of the survey and other data sources, 118 wells have been identified. Based on the information provided by residents, the wells that generally penetrate the uppermost zone to 100 to 200 feet bgs have well yields ranging from 8 to 20 gpm. During the most recent public hearing, one nearby resident to the proposed site indicated that his well that penetrates the upper zone has a well yield of approximately 12 gpm (Strobridge, April 14, 2008, Public Hearing). Some of the wells are screened through this interval to a depth of 200 to 300 feet. These wells appear to yield 40 to 150 gpm. The wells with higher yields appear to be used for irrigation. Of the limited information provided by residents, none of the wells appeared to be screened at a depth of 450 to 600 feet similar to the proposed pumping well at the CESF site. As indicated above, Kemnitzer (1967) identified six wells that penetrate to depths ranging from 300 to 700 feet bgs. These data served as a basis for the assumptions used in the groundwater model included in this study.

3.4 AVAILABLE WELL INFORMATION

Publicly available well information for the Carrizo Plain is limited. The information provided below relies on the following: Kemnitzer (1967), proposed pumping well data on the site, information appearing in a hydrogeologic report prepared for the formerly adjacent ARCO solar facility and well information provided by Mr. Kenny Tab for California Valley that is greater than 3 miles from the site (Tab 2008). These data are provided in Appendices C and D.

3.4.1 Groundwater Quality

Limited groundwater quality data are available for the site vicinity. Data for two on-site wells, one that penetrates the upper zone (the ranch well, T29S/R18E-28L1), and a well that has been abandoned (T29S/R18E-28G1) that pumped from the Lower Aquifer are summarized in Table 3-2. Based on the review conducted by Bechtel for the ARCO groundwater availability study conducted in 1984, limited water quality data were available for 8 wells from DWR. The data are summarized in Table 3-3. Although not located within 2 miles of the site, water quality data from wells drilled for Mr. Kenny Tab are provided in Appendix C.

The total dissolved solids (TDS) in these wells ranged from 346 to 1,102 mg/l. Other than the data for the two wells located on site 29S/18E-28G1 (abandoned Lower Aquifer well) and 29S/18E-28L1 (ranch well, 100 feet bgs), it is not known what aquifers (Upper or Lower) these other wells represent.

Table 3-2
Available Groundwater Quality Data - Site Wells
(constituents reported in mg/l, unless noted otherwise)

Well ID	Date	pH (unit less)	EC (umhos/cm)	Ca	Mg	Na	K	Total Alk	SO_4	Cl	NO_3	B	F	TDS	Hardness		SAR (%)
															Total	Non-Carbonate	
29S/18E-28G01*	10-22-68	7.4	1387	75	27	180	2.0	4	533	98	2.3	0.54	0.7	957	298	294	4.5
29S/18E-28L01**	10-22-65	7.9	1143	71	20	145	1.0	136	260	74	80.0	0.68	0.6	750	259	121	3.9
	10-11-66	8.0	1150	--	--	--	--	131	--	70	70.0	--	--	--	--	--	--
	11-04-67	8.2	1123	72	16	148	1.0	137	239	74	87.0	0.59	0.6	727	246	109	4.1
	10-22-68	8.1	875	39	15	125	1.0	127	119	81	70.0	0.57	0.8	564	151	24	4.4
	11-18-70	8.0	1191	81	18	143	--	147	223	65	130	0.75	0.6	805	276	129	3.7
	11-04-74	8.3	1111	71	17	148	1.2	148	215	75	104	0.67	0.6	727	247	90	3.9
	10-25-76	8.0	1156	78	20	142	0.8	155	236	80	97.0	0.69	0.5	797	274	122	3.7
	10-31-77	8.2	1040	80	19	150	0.2	167	239	77	88.2	0.65	0.6	847	278	111	3.9

Notes:
EC: Electrical Conductivity
Ca: Calcium
Mg: Magnesium
Na: Sodium
Alk: Alkalinity
K: Potassium
SO_4: Sulfate
Cl: Chloride
NO_3: Nitrate
B: Boron
F: Fluoride
SiO_2 Silica
TDS: Total Dissolved Solids
SAR: Sodium Absorption Ratio

* Abandoned site well with depth similar to proposed pumping well.
** Upper Aquifer well on the CESF property.

Table 3-3
Available Groundwater Quality Data - 2-Mile Radius
(constituents reported in mg/l, unless noted otherwise)

Well ID	Date	pH (unit less)	EC (umhos/cm)	Ca	Mg	Na	K	Total Alk.	SO_4	Cl	NO_3	B	F	SiO_2	TDS	Hardness Total	Hardness Non-Carbonate	SAR (%)
29S/18E-29E01	10-21-53	8.1	885	47	15	135	0	153	166	57	34.3	0.60	0.7	--	635	179	26	4.6
29S/18E-29G01	10-04-72	8.3	1053	49	16	147	1.6	142	197	69	33.0	0.64	0.8	--	691	169	47	4.7
30S/18E-02D01	10-22-68	7.4	1478	118	28	157	1.0	136	515	83	38.3	0.75	0.7	--	1102	410	274	4.0
30S/18E-02N01	03-12-54	7.7	602	52	16	60	1.0	152	73	39	43.0	0.18	0.6	--	396	187	35	1.9
	10-02-58	7.2	792	60	25	33	3.0	194	69	64	6.0	0.20	0.4	20.0	505	255	59	2.3
	07-30-59	7.2	685	58	22	58	2.0	158	110	45	31.0	0.20	0.1	30.0	500	235	77	1.0
	10-04-60	7.7	875	74	24	70	1.0	191	149	52	30.0	0.40	0.5	33.0	384	285	92	1.8
	04-19-61	7.7	810	69	21	71	1.0	184	30	48	45.0	0.19	0.3	35.0	691	259	75	2.9
	10-31-61	8.0	836	66	24	81	2.0	180	151	57	31.0	0.16	0.3	32.0	541	263	63	2.3
	10-22-62	7.9	720	61	20	60	1.0	162	15	39	36.0	0.20	0.4	40.0	430	234	72	1.7
	10-10-63	8.0	670	48	28	62	1.0	166	125	41	36.0	0.32	0.1	31.0	494	235	69	1.8
	10-07-64	7.8	765	62	20	63	1.0	166	117	36	10.0	0.24	0.4	38.0	440	237	71	1.8
	10-22-65	7.9	884	77	22	60	1.0	180	158	34	39.0	0.26	0.3		600	293	95	2.0
	11-04-67	8.2	866	77	19	83	2.0	175	150	62	40.0	0.20	0.4	--	570	270	95	2.2
	10-22-68	8.0	909	76	24	86	1.0	167	176	62	45.0	0.29	0.3	--	625	289	121	2.5
	11-18-70	7.8	1030	94	50	101	--	180	205	74	55.0	0.26	0.3	--	706	317	131	2.2
	11-09-72	7.9	513	43	15	38	1.5	136	85	32	36.3	0.7	0.3	--	356	169	31	1.9
	10-22-68	7.9	514	34	12	52	1.0	136	83	32	56.3	0.7	0.3	--	346	154	23	2.0

Notes:

EC: Electrical Conductivity
Ca: Calcium
Mg: Magnesium
Na: Sodium
Alk: Alkalinity
K: Potassium
SO_4: Sulfate
NO_3: Nitrate
B: Boron
F: Fluoride
SiO_2 Silica
Cl: Chloride
TDS: Total Dissolved Solids
SAR: Sodium Absorption Ratio

3.4.2 Groundwater Levels

There is no active groundwater level monitoring occurring near the site. However, based upon historic groundwater well data obtained from the Regional Water Quality Control Board (RWQCB), DWR, and other local well data, groundwater levels in the area have fluctuated over the years between a minimum of 4.3 m (14 feet) bgs to approximately 16 m (54 feet) bgs. Historical water levels for the northern region of the basin in 1967 are shown on a figure provided in Kemnitzer (1967; Appendix A).

The depth to groundwater was measured in the proposed pumping well on February 14, 2008. On that date, the depth to water was 37.49 feet bgs. In 1965, the water level was approximately 30 feet bgs. Depth to groundwater fluctuates seasonally as a result of recharge and discharge (groundwater pumping and outflow from the basin). Although these measurements represent only two widely separated data points, it is likely that the difference in water levels is a function of seasonal variation.

3.4.3 Proposed Pumping Well

The proposed pumping well, shown on Figure 3-3 has a DWR well ID of T29S/R18E-L03.

3.4.3.1 Groundwater Sampling Procedures

On February 14, 2008, URS personnel conducted purging and sampling of the proposed pumping well at the CESF site. Prior to purging and sampling of the well, the depth to groundwater was measured to the nearest 0.01 foot using a Solinst electronic water-level indicator. The depth to groundwater was approximately 37.49 feet bgs. A temporary pump was installed in the well to facilitate sampling. The well was purged of at least three casing volumes (approximately 19,000 gallons) prior to sampling. Parameters measured during purging included pH, temperature, conductivity and oxidation-reduction potential (ORP) using a YSI flow through cell. Once the parameters stabilized to within 10 percent between readings, purging stopped and the water level in the well was allowed to return to at least 80 percent of its original water column height. Ferrous iron was also monitored during purging. Ferrous iron was not present in the discharge at detectable concentrations (<0.2 mg/l).

Groundwater was collected using a bailer suspended using a nylon cord. The groundwater was decanted into laboratory supplied containers with preservative as required for specific analyses. The groundwater samples were sealed, labeled, placed in an insulated cooler with ice and transported under chain-of-custody procedures to Calscience Environmental Laboratories, Inc. (Calscience) a state-certified laboratory in Garden Grove, California for analyses. The bailer and sampling equipment was decontaminated prior to use by washing in a non-phosphate detergent solution followed by rinsing twice with distilled water.

3.4.3.2 Groundwater Analysis Methods

The groundwater sample was analyzed for parameters to evaluate general water quality, address CEC Data Request 50, and provide specific water quality information to the facility design engineers. The parameters analyzed (and the analytical method) were as follows:

- Anions (sulfate, chloride, nitrate, orthophosphate and fluoride) by EPA Method 300.0.

- Dissolved and total metals (calcium, magnesium, sodium, potassium, silicon, chromium, copper, iron, manganese, arsenic, cadmium, nickel, lead, zinc, aluminum, mercury, antimony, barium, beryllium, selenium and thallium) by EPA Methods 6010B and 7470A.
- Turbidity by SM 2130B.
- Alkalinity (Total, Bicarbonate and Hydroxide) by SM 2320B.
- Specific conductance SM 2510B.
- Total Dissolved Solids (TDS) by SM 2540C.
- Total Suspended Solids (TSS) by SM 2540D.
- pH by SM 4500 H+B.
- Total Phosphorous by SM 4500 P B/E.
- Carbon dioxide by SM 4500 CO2D.
- Radionuclides by EPA Method 900.0, 903.0, 905.0, 906.0, 908.0 and RA-05.
- Volatile organic compounds (VOCs) by EPA Method 8260B Semivolatile organic compounds (SVOCs) by EPA Method 8270C.
- Asbestos by EPA Method 100.2.
- Cyanide by SM 4500-CN E.

3.4.3.3 Groundwater Analytical Results

Analytical results for the groundwater sample collected from the proposed production well to address CEC Data Request 50 are summarized in Table 3-4. Primary and secondary Maximum Contaminant Levels (MCLs) for drinking water in California are provided on the table for comparative purposes. Primary MCLs are developed to address human health risk. Secondary MCLs are established primarily to address aesthetics, such as color, odor and taste. It is Carrizo Energy's intent to use inferior quality water as a supply, since it will be treated to meet specifications for site use. A copy of the laboratory analytical report and chain-of-custody form are provided in Appendix E.

Table 3-4
Groundwater Analytical Results - Proposed Pumping Well
(analytes reported in mg/l, unless noted otherwise)

Analyte	Concentration	Primary/ Secondary MCL
Title 22 Metals:		
Antimony	**0.0262**	0.006
Arsenic	<0.0100	0.05
Barium	0.019	1.0
Beryllium	<0.00100	0.004
Cadmium	<0.00500	0.005
Chromium	0.0181	0.05
Copper	<0.00500	1.0
Lead	<0.0100	0.015
Mercury	<0.000500	0.002
Nickel	<0.00500	0.1
Selenium	<0.0150	0.05
Thallium	**0.0278**	0.002
Zinc	0.0194	5.0
Base Cations:		
Calcium	107	NE
Magnesium	23.7	NE
Sodium	183	NE
Potassium	0.9	NE
Other Metals:		
Aluminum	<0.0500	1.0*
Iron	**0.733**	0.3*
Manganese	**0.0616**	0.05*
Silicon	19.8	NE
Silica	42.4	NE

Analyte	Concentration	Primary/ Secondary MCL
Anions:		
Fluoride	1.4	2.0
Chloride	66	NE
Nitrate (as N)	**13**	10
o-Phosphate (as P)	<0.10	NE
Total Alkalinity (as $CaCO_3$)	114	NE
Bicarbonate (as $CaCO_3$)	114	NE
Carbonate (as $CaCO_3$)	<1.0	NE
Hydroxide (as $CaCO_3$)	<1.0	NE
General Water Quality Parameters:		
EC (umhos/cm)	**1600**	900*
TDS	**1140**	500*
TSS	1.5	NE
pH (unitless)	6.88	NE
Total P	0.4	NE
Carbon Dioxide	6.3	NE
Other Priority Pollutants:		
VOCs (ug/l)	ND	---
SVOCs (ug/l)	ND	---
Total Cyanide	<0.050	NE
Asbestos	0.19	7
Radionuclides (pCi/L):		
Gross Alpha	9.36	15
Gross Beta	0.00	50
Sr90	1.03	8
Radium 226	0.237	5
Tritium	0.000	20000
Uranium	6.00	20
Ra-228	0.241	2

Notes:
NE: None Established.
ND: None detected; see lab report for detection limits for specific compounds.
MCL is primary, unless indicated with an asterisk (*).
BOLD indicates concentration is above MCL.

Both dissolved antimony and thallium concentrations detected in groundwater are present at concentrations above their respective primary MCLs for these metals. Nitrate (as Nitrogen) is present at a concentration that is above its primary MCL. Total manganese and iron are also present at concentrations that are above their respective secondary MCLs. Analytical results indicate that the total dissolved solids (TDS) concentration, specific conductance and sulfate in the groundwater were also above their respective secondary MCLs for drinking water. Therefore, the groundwater from the Lower Aquifer is not suitable for use as drinking water without treatment.

None of the volatile and semivolatile organic compounds (VOCs and SVOCs) were detected in the groundwater sample analyzed, therefore, none of the specific compounds was present above its primary MCL. The radionuclides analyzed were not present in the groundwater sample at levels above their respective primary MCLs. Asbestos was also not present in the groundwater sample above its primary MCL.

In December 2005, groundwater samples from the proposed pumping well were analyzed for general water quality parameters by BC Laboratories, Inc. These data are included Table 3-5.

Table 3-5
Historical Groundwater Analytical Results - Proposed Pumping Well
(analytes reported in mg/l, unless noted otherwise)

Component	Average Concentration
Bicarbonate	150
Boron	0.77
Calcium	90
Carbonate	ND
Chloride	69
Hardness (total)	290
Hydroxide Alkalinity	ND
Magnesium	17
Nitrate as N	15
Nitrite as NO_2	65
pH, Field (unitless)	8.0
pH, Lab (unitless)	7.4
Potassium	ND
Sodium	150
Specific Conductance (umhos/cm)	1100
Sulfate	330
Total Dissolved Solids	790
Total Cations	12
Total Anions	12

3.4.4 Aquifer Characteristics

The proposed pumping well is constructed of a 14-inch diameter casing that is set to a depth of 591 feet bgs. At the time the well was drilled in 1965, depth to groundwater was 30 feet bgs and the well yield was 500 gpm with 370 feet of drawdown after 8 hours. A well driller's report is provided in Appendix D.

No aquifer testing of the proposed pumping well was conducted since the well yield is known to far exceed the water needs for the project. Additionally, a pump test was conducted on a Lower Aquifer well right next to the site. The now dismantled ARCO solar site was located on the adjacent section to the east of the CESF (Section 27) from approximately the mid-1980s to the late 1990s. Research and testing was conducted prior to construction to determine whether the underlying Carrizo Plain Groundwater Basin could support the proposed water requirements for that project. A design long-term mean of 115 gpm was proposed (maximum seasonal water requirement of 190 gpm for 4 months from June to September and 24-hour peak demands of 250 gpm). A well was installed to a depth similar to that of the proposed pumping well on site with two screen intervals from 530 to 550 and 570 to 600 feet bgs. A constant-rate pump test was performed by Bechtel. A review of the data and analyses of the pumping test conducted at test well 3A (W-3A) indicated that the well was capable of yielding the design water requirements (115 gpm) and could meet both seasonal and peak demands. The static level of water in the well before pumping was 40 feet bgs and the pumping rate was set to 305 gpm initially. There was 333 feet of drawdown, resulting in a water level of 373 feet below ground surface. Pumping rates over the following 3 days varied between 254 to 268 gpm, with an average pumping rate of 265 gpm. The depth to water recovered to 340 feet bgs and then again began dropping slowly. At the end of 3 days, the water level was 368 feet below ground surface. Based on the well's performance and adjusting the well's performance to a rate of the desired 115 gpm over 20 years (projected operational period of the ARCO Site), Bechtel indicated that "the aquifer is capable of providing the water requirement and the extraction would not interfere with existing users." Similarly, Bechtel noted that preliminary literature reviews followed by discussions with local farmers indicated that the groundwater resources at the proposed site should be sufficient to meet the water requirements. Bechtel concluded that the maximum long-term mean capacity of the well is calculated to be 170 gpm. A copy of this report is provided in Appendix D. Based on the results of the aquifer test, the transmissivity of the aquifer was estimated based on the Theis solution to the non-steady state flow. Transmissivity estimated using both drawdown and recovery data ranged from 1,300 to 3,200 gallons per day per foot (gpd/ft). This range of values was used in the simple groundwater model simulation performed that is described in Section 3.6.

3.5 GROUNDWATER BUDGET

In general, there has been very little study of groundwater use and trends in groundwater elevations to identify the current status of the water budget in the Carrizo Plain basin. Some planning documents indicate that the Carrizo Plains area is currently in an overdraft situation; however, there is little confirmed or conclusive evidence that substantiates this opinion, since there is lack of information available regarding groundwater level trends per the DWR Bulletin 118 data and DWR and RWQCB groundwater well monitoring data.

Kemnitzer (1967) estimated net consumption of groundwater in the Carrizo basin in 1967 as approximately 3,364 acre-feet annually, with approximately 534 acre-feet annually from the 89 shallower wells (mostly less than 100 feet in depth) he identified that were for household and livestock use. Therefore, the total net consumption of groundwater in the Carrizo basin was estimated to be around 3,898 acre-feet a year which is about 2 percent of the gross, and 5 percent of the net average annual recharge. Kemnitzer (1967) estimated the balance between water recharge and discharge for the Carrizo basin involves a gross annual amount of approximately 177,000 acre-feet. This figure is based on the average precipitation of 8 inches of rainfall annually falling upon 266,000 acres of watershed. Of this gross recharge, at least 118,000 acre-feet, or nearly 67 percent, is estimated lost through evapotranspiration and other natural processes. The remaining 59,000 acre-feet, or 33 percent of the gross, is considered to be the net average annual ground water recharge.

That part of the net average annual recharge of 59,000 acre-feet or 33 percent into the Carrizo groundwater body which is not being utilized, is believed to pass out of the basin as underflow at its northern end into the adjacent La Yeguas and the San Juan subsurface drainage areas. Kemnitzer (1967) concluded that this overflow could be captured economically before it has opportunity to leave the basin, without lowering appreciably the overall groundwater levels. He also concluded that recovery this net recharge would then be sufficient to irrigate approximately 32,000 acres of hay and grain, alfalfa, pasture, truck and miscellaneous crops as well as to supply a modest community development in the northern half of the plain.

3.6 GROUNDWATER MODELING ANALYSIS

URS prepared a basin wide model to simulate steady-state flow and estimate the movement of groundwater in the basin and to evaluate the potential effects that the proposed groundwater withdrawals for the proposed project may have on surrounding wells and the aquifers. A simple analytical solution to steady-state groundwater flow to estimate possible effects on surrounding wells was prepared and presented at the March 12, 2008 public workshop. The analysis was preliminary and it showed that pumping in the lower zone would result in changes in water levels in the lower zone wells of generally 3 feet or less immediately adjacent to the site as a result of approximately 20 years of pumping.

The model was reevaluated to include infiltration of surface water and as requested by CEC, to include the groundwater budget and gross hydrogeologic characteristics of the basin. The model is steady state, and conservatively developed for dry periods when there is no surface water flow and no surface water in Soda Lake. Simulations were performed using the USGS Software, MODFLOW. The rationale for characterization of the groundwater system is described below.

3.6.1 Model Domain and Grid

The model domain is bounded laterally by the watershed divide for the Carrizo Plain and the top of the land surface elevation (Figure 3-4). The domain is discretized (divided) horizontally into square grid blocks 2,000 feet on each side (Figure 3-5). Vertically the water bearing formations as described in Dibblee, Jr. (1962) and Kemnitzer (1967) are divided into six layers (Figure 3-6). These layers become thicker from west to east. The water-bearing deposits of all but Layer 1 (Upper Aquifer) and Layer 3 (Lower Aquifer) terminate at the San Andreas Fault. Layer 1 represents the Upper Aquifer that supplies domestic, livestock and irrigation water to residences on the plains. This layer extends to a depth of approximately 300 feet bgs on the site. Layer 3 on the site includes the depth interval from approximately

450 to 600 feet bgs that includes the screen interval of the proposed pumping well (T29S, R18E-28L03). Layers 4 and 5 comprise deeper, high-conductivity (permeability) water- bearing formations. Layer 6 includes bedrock and low-conductivity (permeability) strata at greater depth.

3.6.2 Boundary Conditions

3.6.2.1 No Flow and General Head Basin Boundaries

The watershed divide comprises a no flow boundary with the exception of the northern end of the basin, where general head boundaries are applied to represent underflow from the basin at its northern end into the adjacent La Yeguas and the San Juan subsurface drainage areas as described in Kemnitzer (1967).

3.6.2.2 Recharge

Annual average recharge is applied to the upper layer of the model. This recharge varies spatially to represent greater precipitation rates in the northwest region of the basin (Kemnitzer 1967). The overall rate of recharge is 59,000 afy computed as the difference between the precipitation (177,000 ac-ft) and the estimated evapotranspiration (ET; including that from Soda Lake) of 118,000 afy.

3.6.2.3 Pumping

Pumping was assigned to each of the 118 wells identified in the well survey. Wells with an estimated capacity were assigned pumping at that capacity and assuming a 35% duty cycle. Domestic wells were assigned a steady rate of 12 gpm. Where no information on pumping rate was available, wells were assumed to pump at 12 gpm. The overall pumpage in model is 4,861 afy, approximately 25% greater than the estimate made in 1967 (Kemnitzer 1967). Well depths were assigned based on reported screen intervals, where available; otherwise wells were assumed to be screened in the shallow aquifer.

3.6.3 Hydraulic Conductivity (*K*)

Conceptual Model. Hydraulic conductivity (permeability) values are based on the measured data and the geologic interpretation. Flow in the Upper Aquifer (Layer 1) generally follows the topography and is directed towards Soda Lake. Historical groundwater levels in the Upper Aquifer appear in Kemnitzer (1967) provided in Appendix A. Kemnitzer (1967) suggests that there is substantial underflow in a northwest direction out of the basin. To accommodate this conceptual model, the deeper aquifers (Layers 4 and 5) must have higher horizontal hydraulic conductivities (K_h) than the Upper Aquifer and low enough vertical hydraulic conductivity (K_v) to allow for this substantial flow, as well as trends in hydraulic heads that oppose those of the upper aquifer north of Soda Lake. This conceptual model indicating high K_h in the deep aquifers is consistent with the presence of ancestral channels of a stream that flowed northward. In addition, a low K_v is consistent with the well logs that indicate substantial heterogeneity with a significant volume fraction of clay, and the need for multiple borings to find substantial high K sediments in the Upper and Lower Aquifers (Bechtel 1984). The K_h of the Upper Aquifer is expected to generally decrease near Soda Lake since it is underlain by lacustrine deposits consisting of clay and silt.

Specified K Values. The K_h varies spatially within each layer of the model. The K_h of the Upper and Lower Aquifers ranges from 0.5 to 5 feet/day. The higher end of this range is consistent with the results of the aquifer test on the adjacent ARCO well and is generally assigned to developed regions in the north basin including the site. Lower values of K_h were assigned near Soda Lake and east of the San Andreas Fault. The K_h values for Layers 4 and 5 range as high as 25.0 and 50.0 feet/day, respectively. The K_h of Layer 6 (bedrock and the bottom of the model) was specified as 0.01 feet/day. The specified ratio for K_v/K_h is approximately 1/1,000. Most of the specified K values were adjusted during calibration of the model.

3.6.4 Boundary Conditions

3.6.4.1 No-flow and General-Head Boundaries

The watershed divide comprises a no-flow boundary, with the exception of the northern end of the basin where general head boundaries (GHB) are applied (see Figure 3-5) to represent underflow from the basin at its northern end into the adjacent La Yeguas and the San Juan subsurface drainage areas as described in Kemnitzer (1967). The GHB conditions are applied using the MODFLOW GHB package. No-flow boundaries are also applied to the bottom of the model.

3.6.4.2 Recharge

Annual average recharge of 59,000 afy was applied to Layer 1 of the model. The recharge rate was computed as the difference between precipitation (177,000 af) and the estimated evapotranspiration (ET) (including that from Soda Lake) of 118,000 afy (Kemnitzer 1967). The estimated recharge varies spatially to represent greater precipitation rates in the northwest region of the basin and the ET effects of dry-land farming (Kemnitzer 1967). Recharge was applied using the MODFLOW recharge package.

3.6.4.3 Pumping

Pumping was assigned to each of the 118 wells identified in the well survey (Figure 3-3). Domestic wells were assigned a steady rate of 12 gpm. Wells with a known estimated maximum yield were assigned pumping at that yield assuming a 35% duty cycle. Where no information on pumping rate was available, wells were assumed to pump at 12 gpm. The overall pumpage in the model was 4,861 afy, approximately 25 percent greater than the estimate made in 1967 by Kemnitzer (1967). Well depths were assigned based on reported screen intervals, where, available. Otherwise, wells were assumed to be screened in the Upper Aquifer (up to 300 ft bgs). The proposed pumping well at the site is assumed to withdrawal water from Layer 3 of the model at a rate of 18,500 gpd, or approximately 13 gpm. In the no project scenario, no pumpage is assigned to this well. Wells were simulated using the MODFLOW well package.

3.6.4.4 Evapotranspiration (ET)

An estimated 118,000 afy of ET was accounted for in estimates of the recharge as described above. ET can also occur naturally when groundwater levels are near land surface (Figure 3-4). This additional ET was simulated in the model using the MODFLOW ET package for a maximum ET rate of 5.5 feet/yr and an extinction depth (the depth at which there is no ET) of 15 feet.

3.6.4.5 San Andreas Fault

The San Andreas Fault is assumed to impede the flow of groundwater from east to west. The hydraulic effects of the San Andreas fault are simulated with horizontal flow barriers (HFBs) using the MODFLOW HFB package . The locations of HFBs corresponding to the San Andreas Fault are shown on Figure 3-5.

3.6.5 Results of Analysis

The analysis results provide insight into the validity of the conceptual model of the basin, as well as the an evaluation of the possible impact of the project on groundwater in the basin and neighboring wells. Our assessment of the model results are provided below.

3.6.5.1 Conceptual Model and Calibration

A coarse hand calibration was performed to match the general character of the observed heads in the Upper Aquifer (Layer 1) and the measured head in the Lower Aquifer (Layer 3) at the proposed pumping well. Starting from the calibrated model, the conceptual hydrogeologic model of the basin proposed by Kemnitzer (1967) was tested through a series of experiments that explored a range of plausible alternative model parameters. These experiments suggest that the conceptual model of Kemnitzer (1967) overestimates flow out of the basin. Excess water that does not flow out of the basin to the north is instead taken up by groundwater ET (Tables 3-6 through 3-8). In fact, it appears that groundwater ET is not an explicit component of the water budget presented in Kemnitzer (1967). This alternative conceptual model is consistent with groundwater levels near the land surface from which groundwater ET may become significant (e.g., groundwater levels observed on site were as high as 14 bgs, see Section 3.4.2). Thus, it is noteworthy that an alternative hydrogeologic conceptual model for the Carrizo Plain is one in which there is minimal underflow from the basin. Nevertheless, the final model here assumes substantial underflow from the basin, but less than that suggested by the sole historical hydrogeologic analysis of the Carrizo Plain (Kemnitzer 1967). The results discussed in the following section are sufficient to infer the expected project impacts for alternative conceptual models of the basin. Groundwater budgets for the final model are shown in Table 3-6. Simulated groundwater levels for the Upper and Lower Aquifers are shown on Figures 3-7 and 3-8, respectively.

3.6.5.2 Project and No-project Scenarios

Scenarios include the project (with pumping from the proposed on-site pumping well, T29S/R18E-28L3) and no project (no pumping from the proposed pumping well) scenarios. The groundwater budgets from these scenarios are shown in Tables 3-6 through 3-8. The increase in pumping at the project well is approximately 21 afy, or 0.444% of the estimated total pumping from the basin. This increase in pumping from the project is offset by decreases of 0.043% (15 afy) in the total groundwater ET and 0.028% (5 afy) in the total underflow from the basin. Note that for an alternative model consistent with that proposed by Kemnitzer (1967), the pumping would result in a commensurate decrease in the underflow out the northern portion of the basin only. Similarly, for an alternative model in which there is no outflow from the basin, the pumping would result only in a commensurate decrease in the groundwater ET. Thus, results from these scenarios are not shown. The differences in heads (drawdown) between the No Project and Project Scenarios for the Upper and Lower Aquifers (Layers 1 and 3) are shown

Figures 3-9 and 3-10. The maximum change in head (drawdown) in the Upper and Lower Aquifers is 0.2 and 1.6 feet, respectively. Note that these are average values of drawdown over a model grid block (2,000 feet square). Drawdown on the property near the proposed pumping well in Lower Aquifer will be greater than 1.6 feet. These results indicate that pumping the CESF well will not have a significant affect on neighboring wells and groundwater levels in the basin. Because the effect of pumping the CESF well will not result in a significant change in groundwater levels, the water supplied to it will not be drawn from great distances (for example, poor quality water from the Soda Lake area 10 miles away). Therefore, pumping of the CESF well will not have a significant affect on water quality in the area or basin.

Table 3-6
Simulated Groundwater Budgets without Project

Budget Component	In (afy)	Out (afy)
Recharge	59,629	
Underflow		19,632
Groundwater ET		35,332
Pumping from Wells		4,665
TOTAL	**59,629**	**59,629**

Table 3-7
Simulated Groundwater Budgets with Project

Budget Component	In (afy)	Out (afy)
Recharge	59,629	-
Underflow	-	19,626
Groundwater ET	-	35,317
Pumping from Wells	-	4,686
TOTAL	**59,629**	**59,629**

Table 3-8
Change in Simulated Groundwater Budgets Due to Project

Budget Component	In (afy)	Out (afy)
Recharge	0	0
Underflow	0	-5.4 (-0.028%)
Groundwater ET	0	-15.3 (-0.043%)
Pumping from Wells	0	20.7 (0.444%)

SECTION 4 CONCLUSIONS

Based on the information described herein, URS concludes the following:

- The CESF will use considerably less water than irrigated agricultural uses that have occurred historically on the plains.
- The CESF will use considerably less water than wet-cooled solar power and conventional power generating facilities.
- Historical information suggests that previous agricultural activities on the property pumped the existing well and other wells at considerably higher pumping rates compared to that proposed for the CESF (up to 1,200 gpm vs. 13 gpm). There were no indications that previous intensive water use on the property affected nearby wells. Therefore, the proposed pumping at 1 percent of the historical pumping rate will not significantly affect water quality, water levels or well flow rates (yield) on adjacent properties. This is supported by the results of groundwater modeling conducted for the project.
- The facility will be constructed to allow infiltration of surface water that falls directly on the site. Infiltration will occur along parallel drainage swales and terraces. Surface water that infiltrates the subsurface will recharge the Upper Aquifer zone.
- The facility will use inferior quality groundwater for its water supply. The results of groundwater sampling from the proposed pumping well indicate that several parameters are above their respective drinking water standards.
- The increase in pumping from the proposed project is likely to be offset by decreases in groundwater ET and underflow out of the basin. Model simulated changes in groundwater ET and underflow out of the basin as a result of this proposed pumping were 0.043% (15 afy) and 0.028% (5 afy), respectively.
- Plausible alternative conceptual models of the basin are likely lead to results comparable to those presented herein, ie., the proposed pumping would likely result in commensurate decreases in either underflow, ET or a combination of both, with similar levels of drawdown.
- Simulated drawdown (averaged over a grid cell) due to the proposed pumping was less than 2.0 ft. in the Lower Aquifer (Layer 3), and less than 0.5 ft in the Upper Aquifer (Layer 1), with generally less drawdown off-site.
- These results indicate that pumping the CESF well will not have a significant affect on neighboring wells and groundwater levels in the basin. Because the effect of pumping the CESF well will not result in a significant change in groundwater levels, the water supplied to it will not be drawn from great distances (for example, poor quality water from the Soda Lake area 10 miles away). Therefore, pumping of the CESF well will not have a significant affect on water quality in the area or basin.

SECTION 5 UNCERTAINTY AND LIMITATIONS

Geology and hydrogeology are inexact sciences, and data and interpretations commonly contain some degree of uncertainty. The movement of groundwater is a complex phenomenon. Our findings and opinions are based on limited published information related to the groundwater conditions in the Carrizo Plain and information gathered from a variety of public sources. URS cannot verify the accuracy of well information provided by individuals during our well survey. Unless we have knowledge to the contrary, information obtained from interviews or provided by property owners has been assumed to be correct and complete. URS does not assume any liability for information that has been misrepresented. Services have been performed by URS in a manner consistent with that level of care and skill ordinarily exercised by members of the same profession currently practicing in the same locality under similar conditions. No expressed or implied representation or warranty is included or intended in our reports, except that our services were performed, within the limits prescribed by our client, with the customary thoroughness and competence of our profession.

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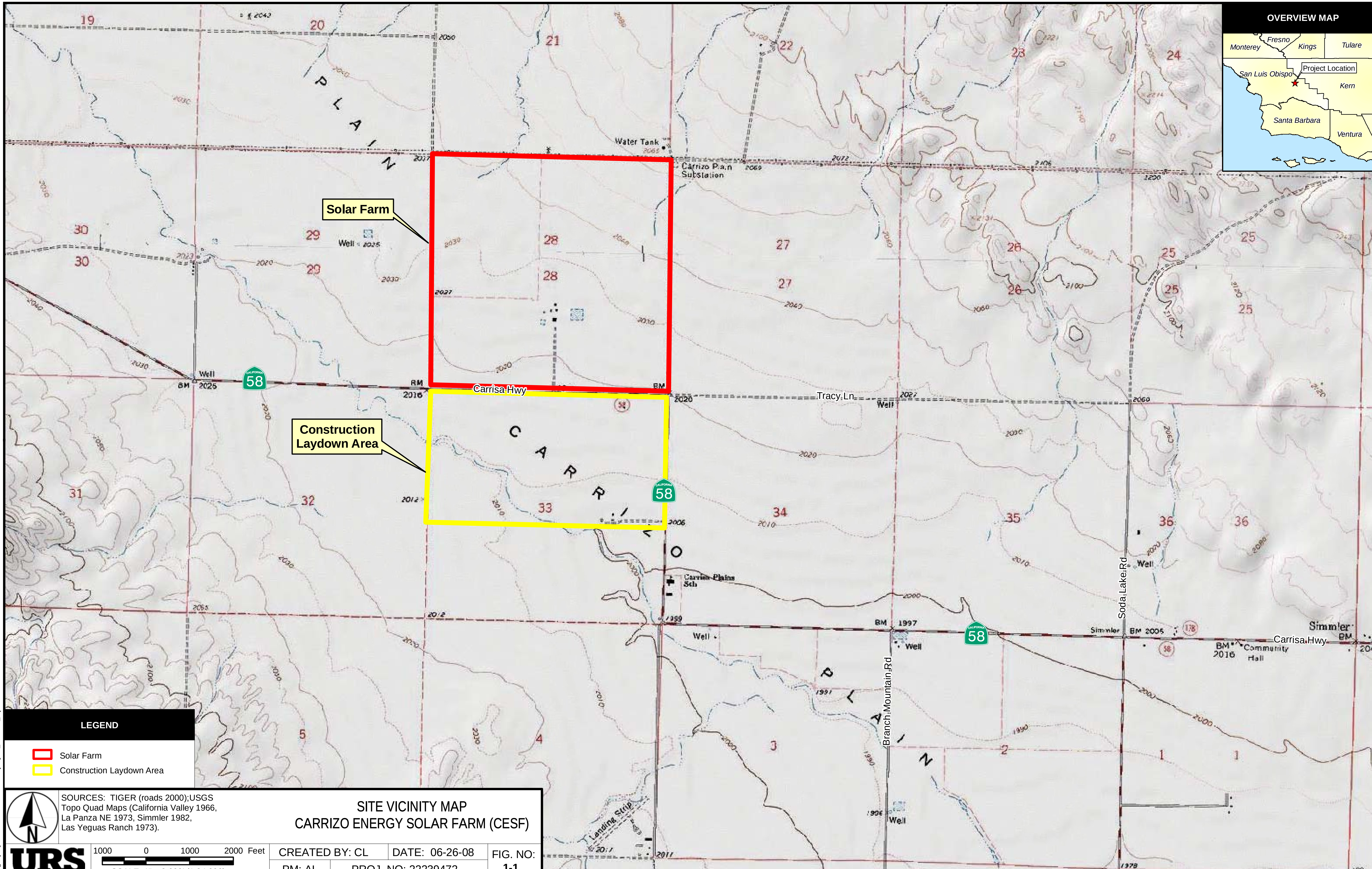

LEGEND

- Solar Farm
- Construction Laydown Area

SOURCES: TIGER (roads 2000);USGS
Topo Quad Maps (California Valley 1966,
La Panza NE 1973, Simmler 1982,
Las Yeguas Ranch 1973).

1000 0 1000 2000 Feet

SCALE: 1" = 2,000' (1:24,000)

SITE VICINITY MAP
CARRIZO ENERGY SOLAR FARM (CESF)

CREATED BY: CL	DATE: 06-26-08	FIG. NO:
PM: AL	PROJ. NO: 22239472	1-1

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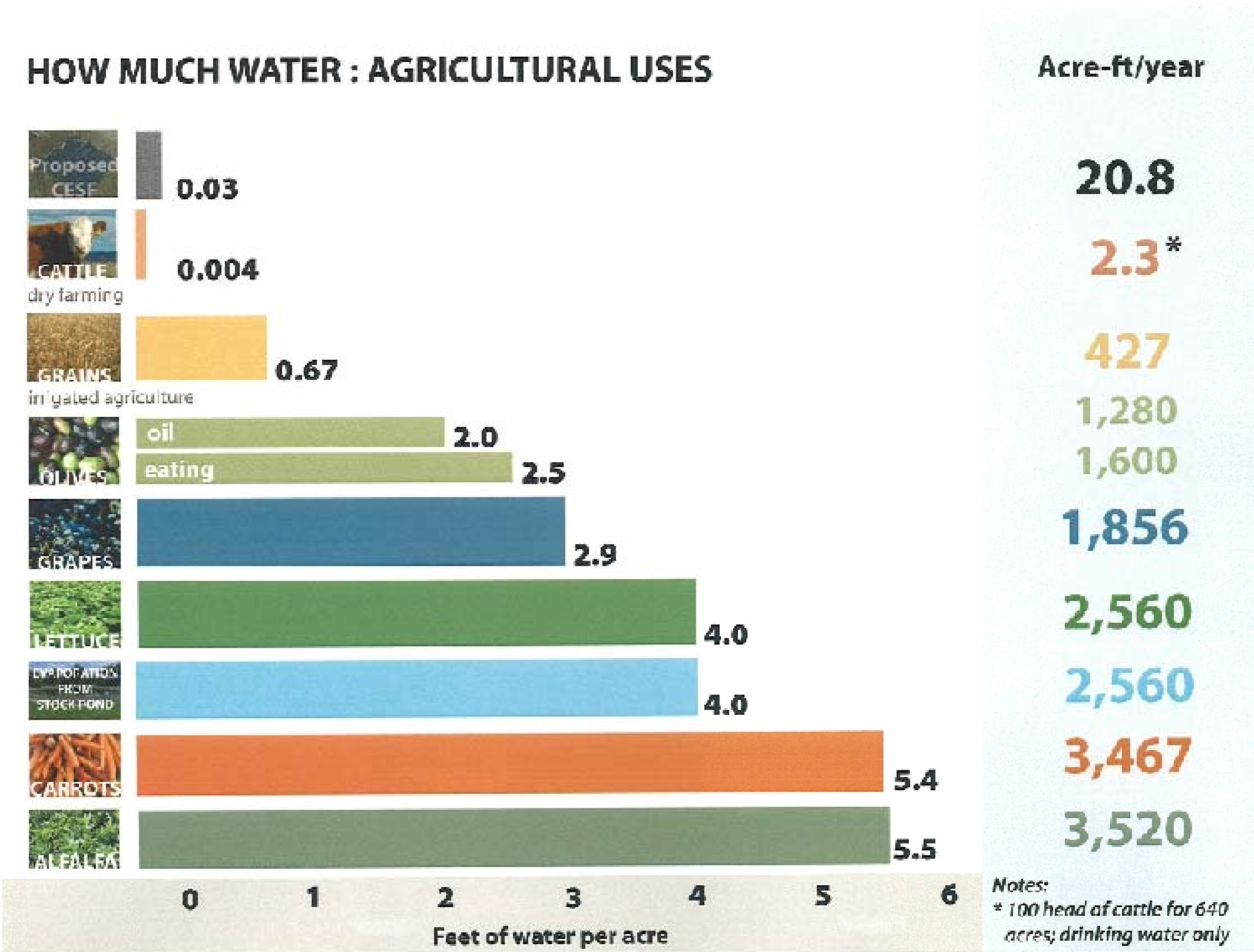

SOURCES:

GRAPHIC COMPARISON OF AGRICULTURAL WATER USES TO CESF
CARRIZO ENERGY SOLAR FARM (CESF)

URS

NO SCALE

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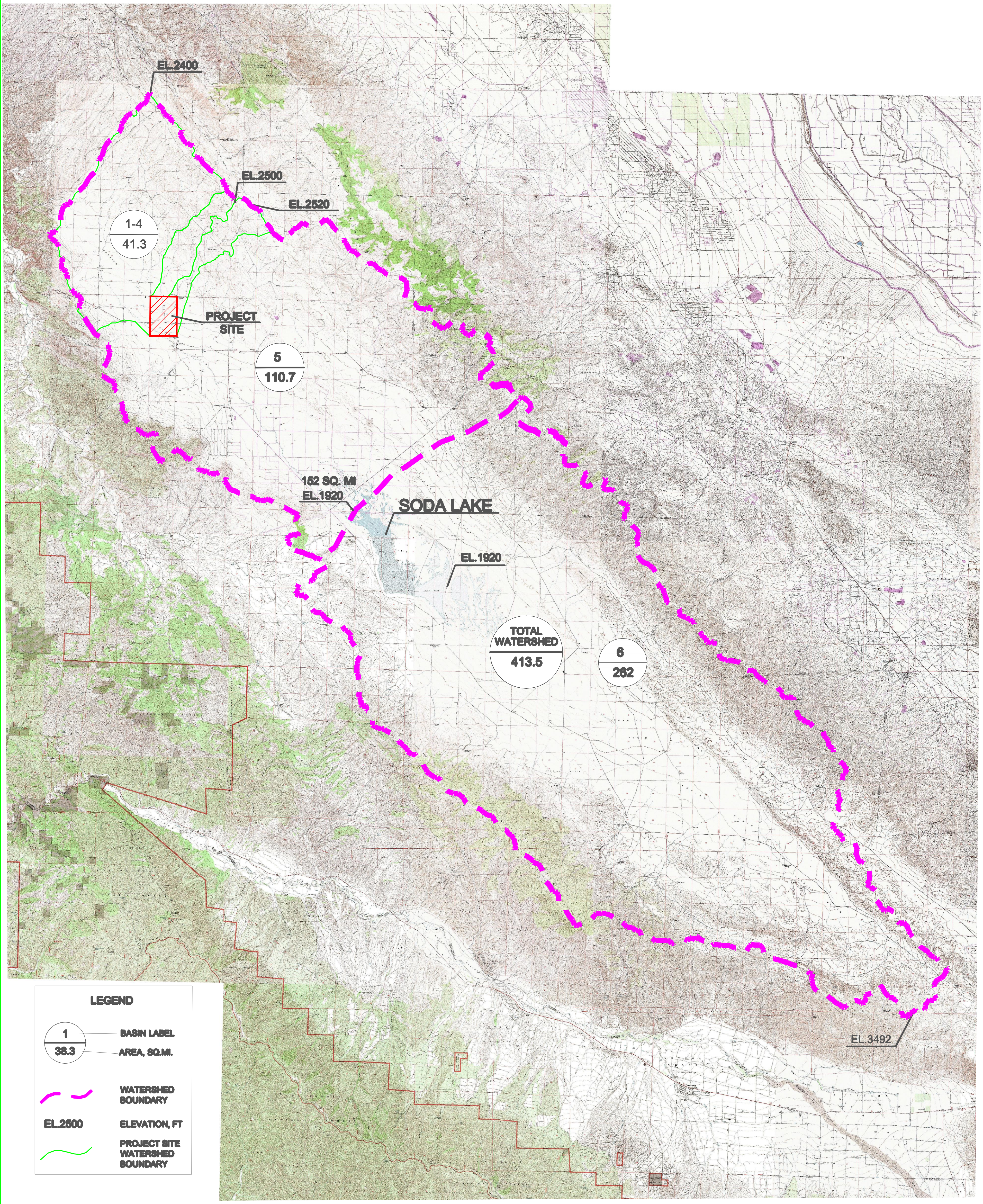

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CARRIZO BASIN WATERSHED MAP
CARRIZO ENERGY SOLAR FARM (CESF)

3000 0 3000 6000 Feet SCALE: 1"= 6000'	CHECKED BY: MM	DATE: 06-18-2008	FIGURE 2-1
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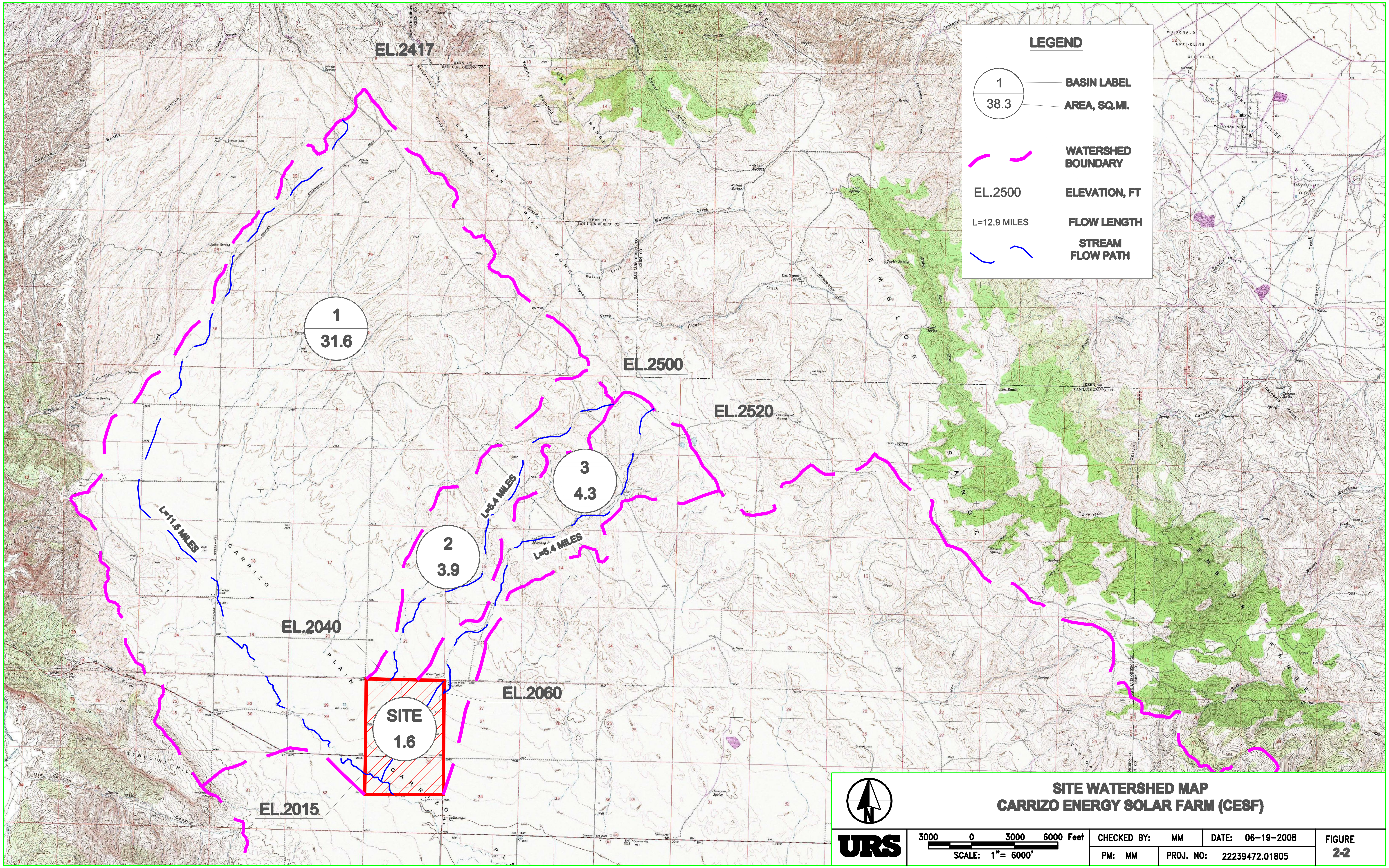
LEGEND
1
38.3
BASIN LABEL
AREA, SQ.MI.
WATERSHED BOUNDARY
EL.2500
ELEVATION, FT
L=12.9 MILES
FLOW LENGTH
STREAM FLOW PATH
EL.2417
EL.2500
EL.2520
EL.2040
EL.2060
EL.2015
1
31.6
2
3.9
3
4.3
SITE
1.6
L=11.5 MILES
L=5.4 MILES
L=6.4 MILES
CARRIZO
PLAIN
SAN ANDREAS
TEMBLOR RANGE
SITE WATERSHED MAP
CARRIZO ENERGY SOLAR FARM (CESF)
URS
3000 0 3000 6000 Feet
SCALE: 1"= 6000'
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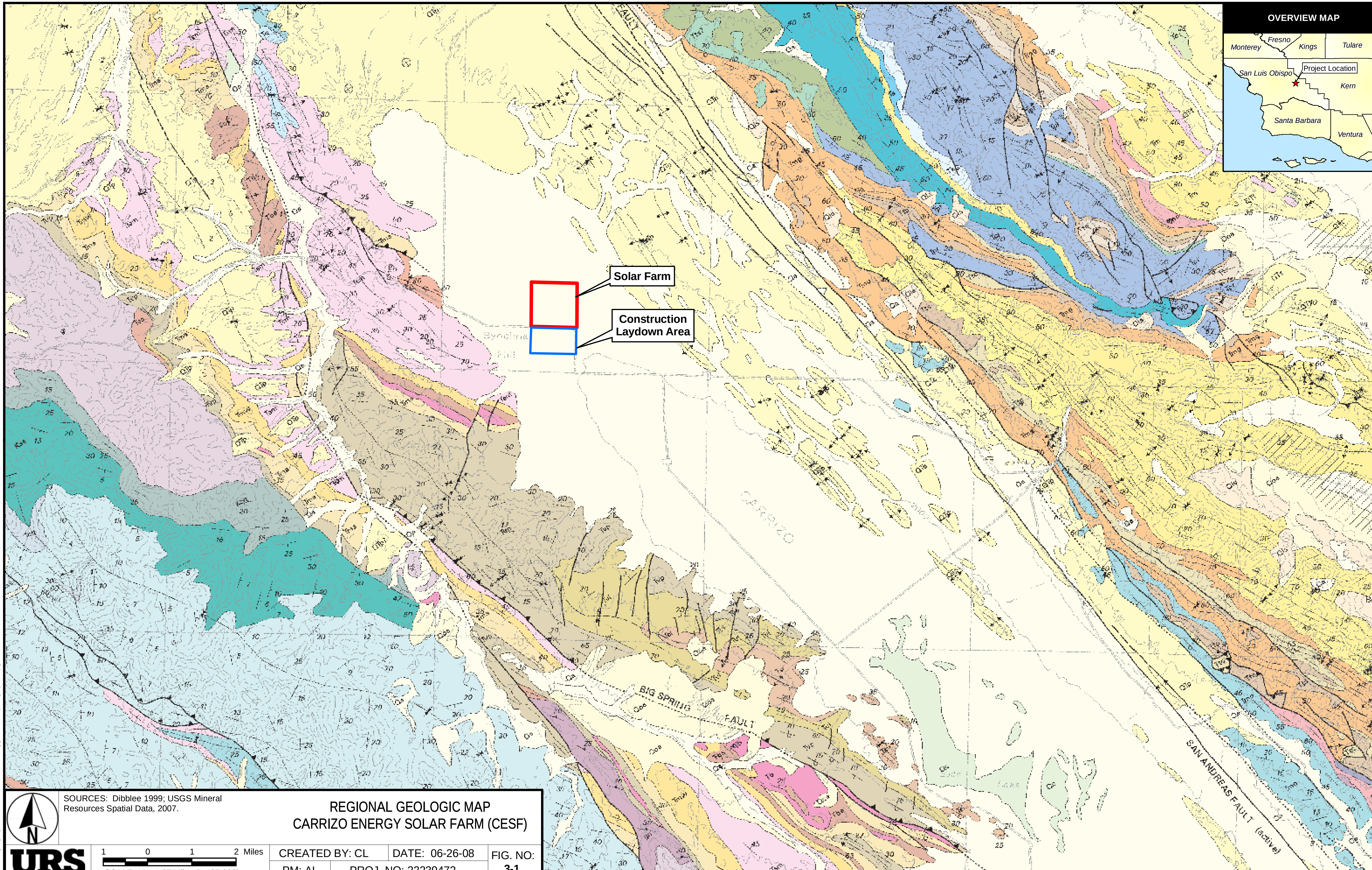
FIGURE 2-2



SOURCES: Dibblee 1999; USGS Mineral Resources Spatial Data, 2007.

REGIONAL GEOLOGIC MAP
CARRIZO ENERGY SOLAR FARM (CESF)

URS

1 0 1 2 Miles
SCALE: 1" = 1.97 Miles (1:125,000)

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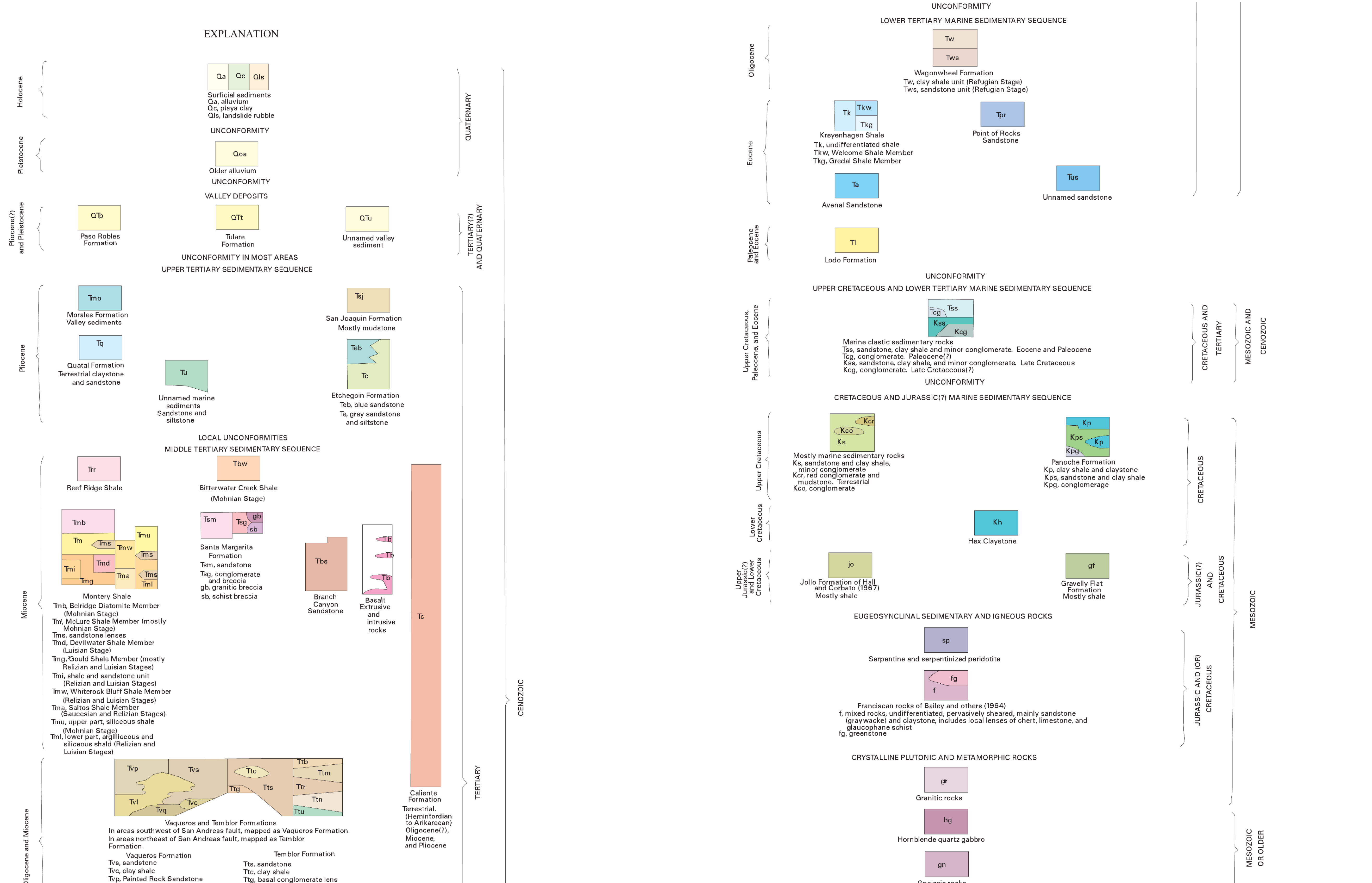
EXPLANATION



SOURCES: Dibblee 1999.

REGIONAL GEOLOGIC MAP LEGEND
CARRIZO ENERGY SOLAR FARM (CESF)

URS

NO SCALE

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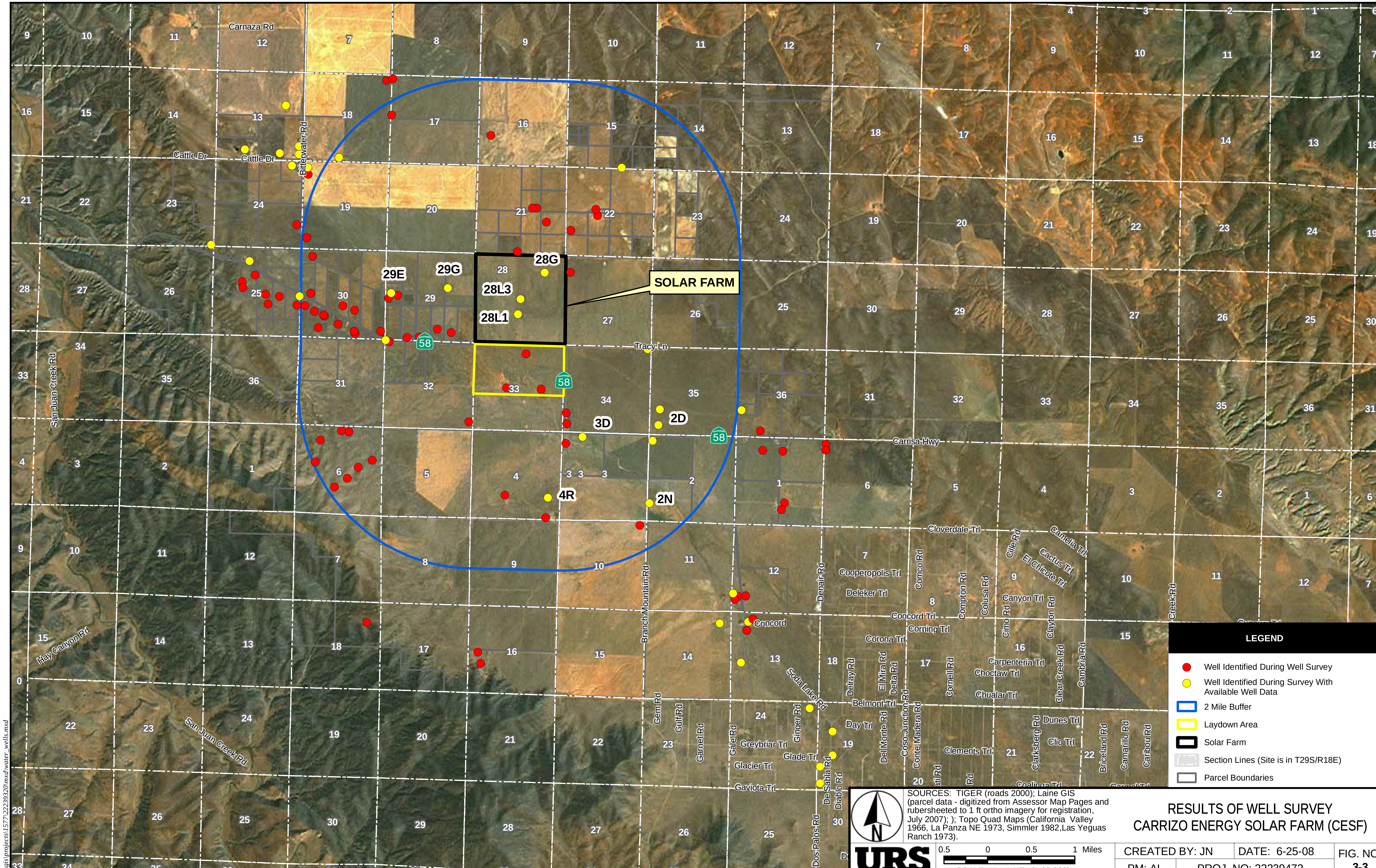

RESULTS OF WELL SURVEY
CARRIZO ENERGY SOLAR FARM (CESF)

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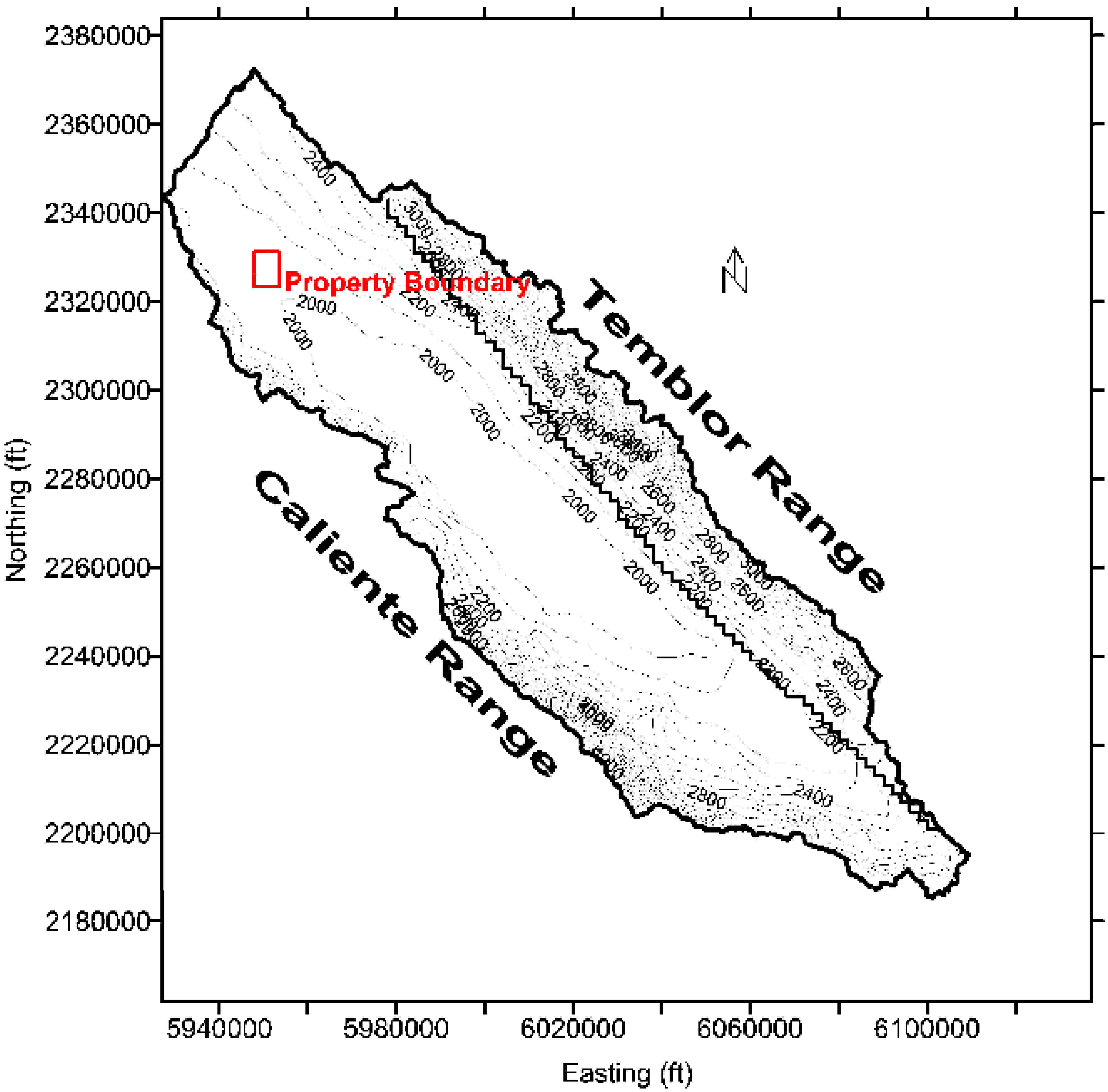

SOURCES:

CARRIZO BASIN MODEL BOUNDARIES
AND TOPOGRAPHY (FEET, MSL)
CARRIZO ENERGY SOLAR FARM (CESF)

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FIG. NO: 3-4

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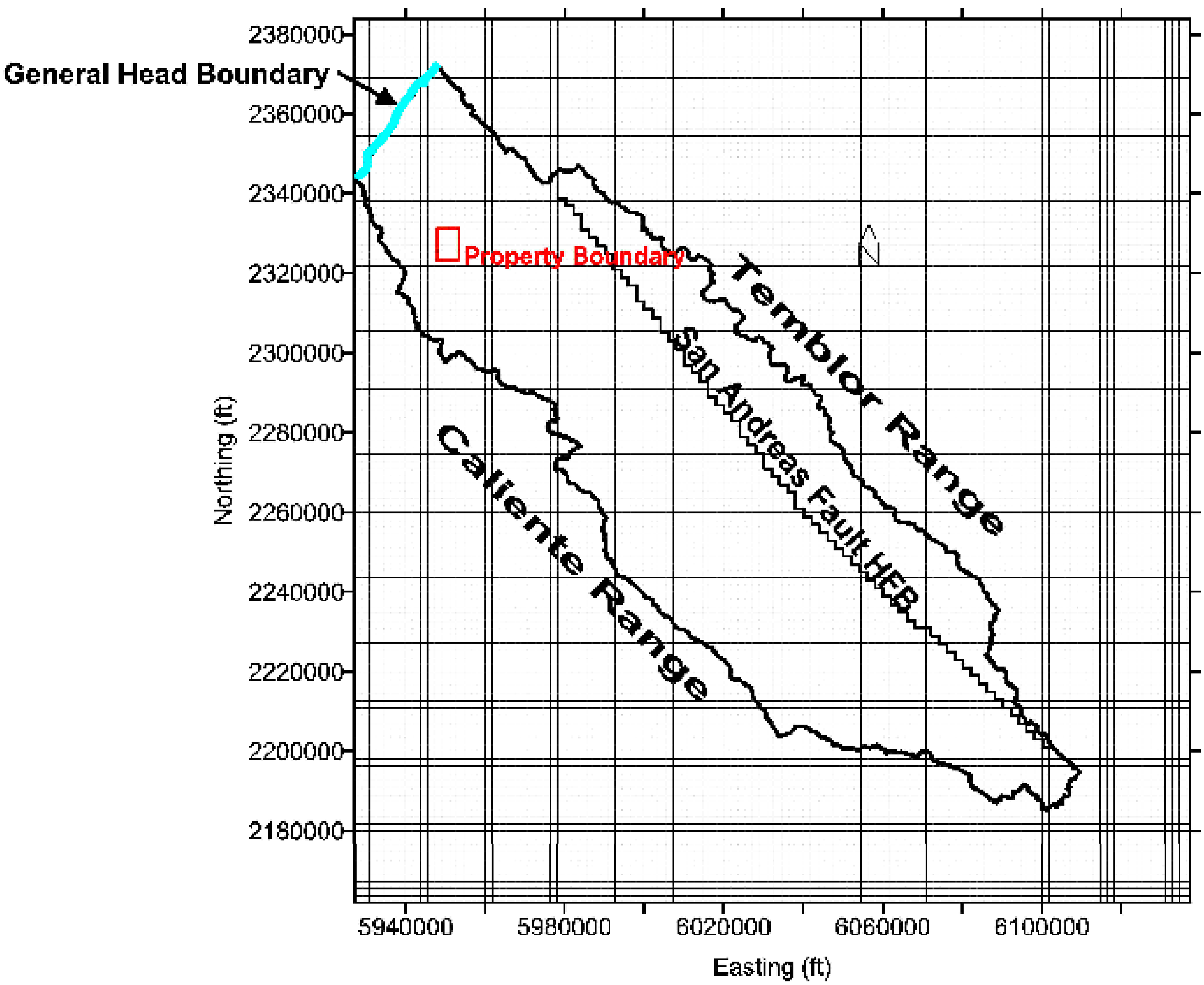

SOURCES:

GROUNDWATER MODEL GRID
CARRIZO ENERGY SOLAR FARM (CESF)

URS

NO SCALE

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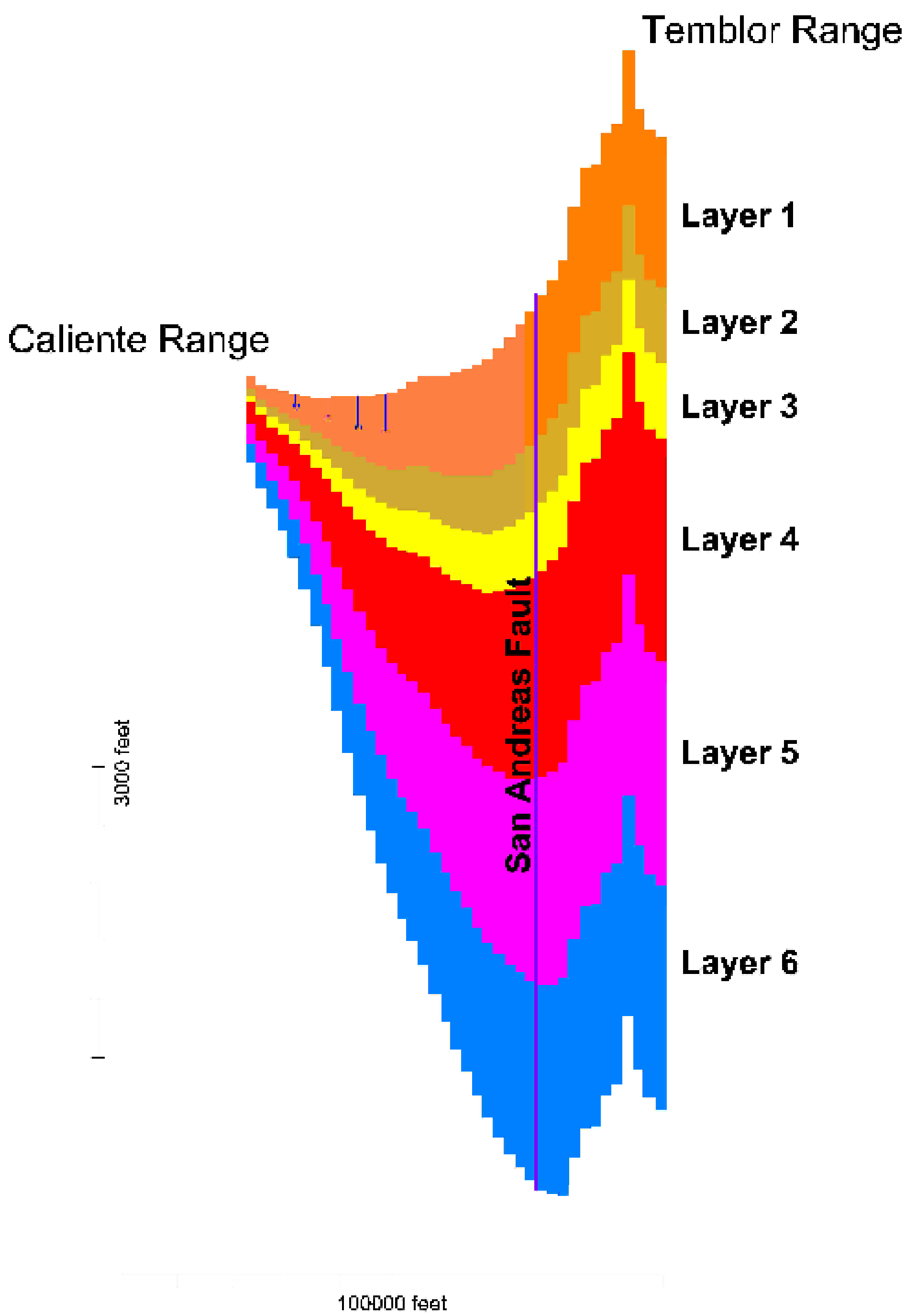

SOURCES:

GROUNDWATER MODEL GRID
CROSS SECTION
CARRIZO ENERGY SOLAR FARM (CESF)

URS

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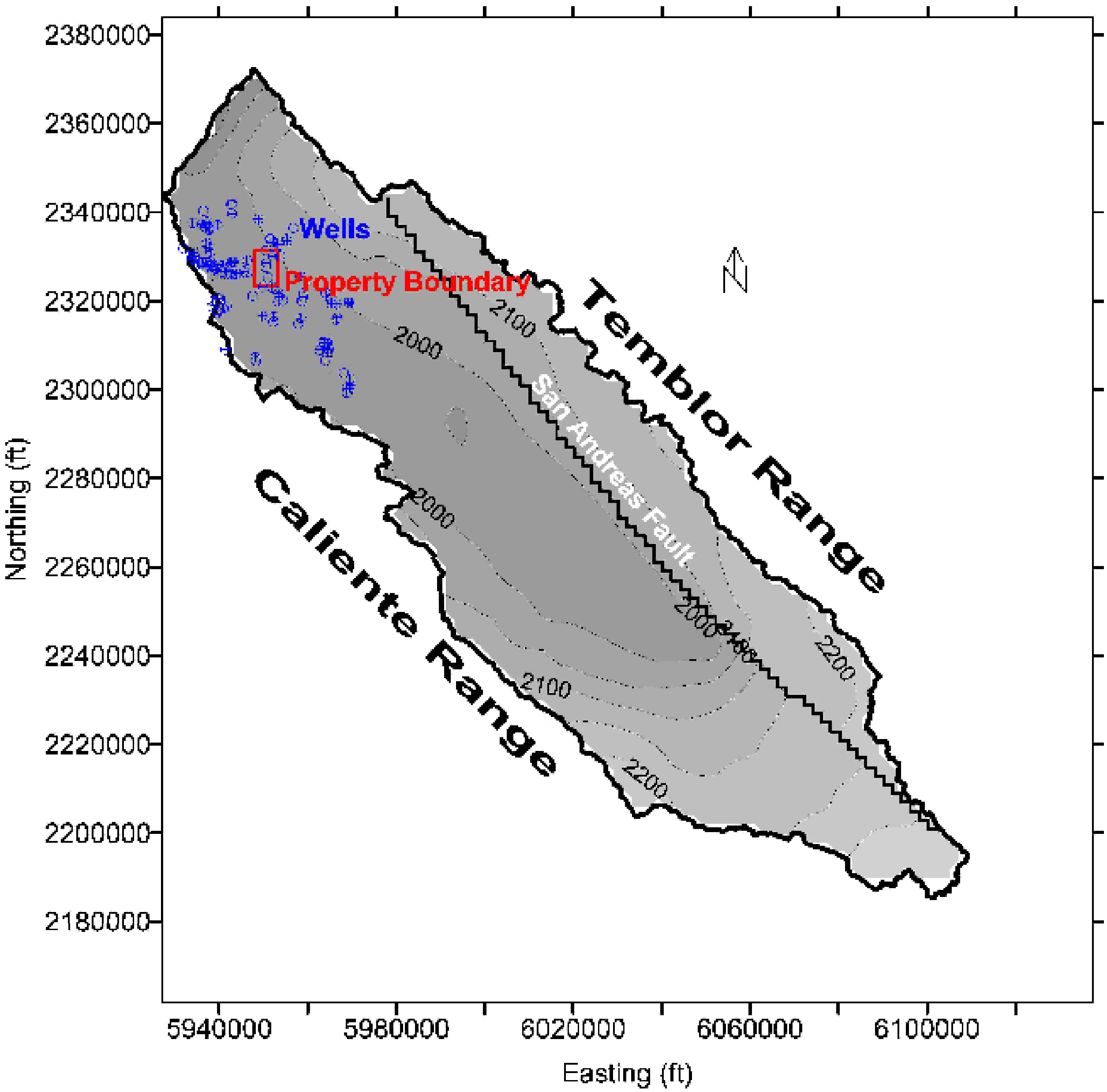

SOURCES:

MODEL RESULTS: GROUNDWATER ELEVATIONS IN UPPER AQUIFER (LAYER 1)
CARRIZO ENERGY SOLAR FARM (CESF)

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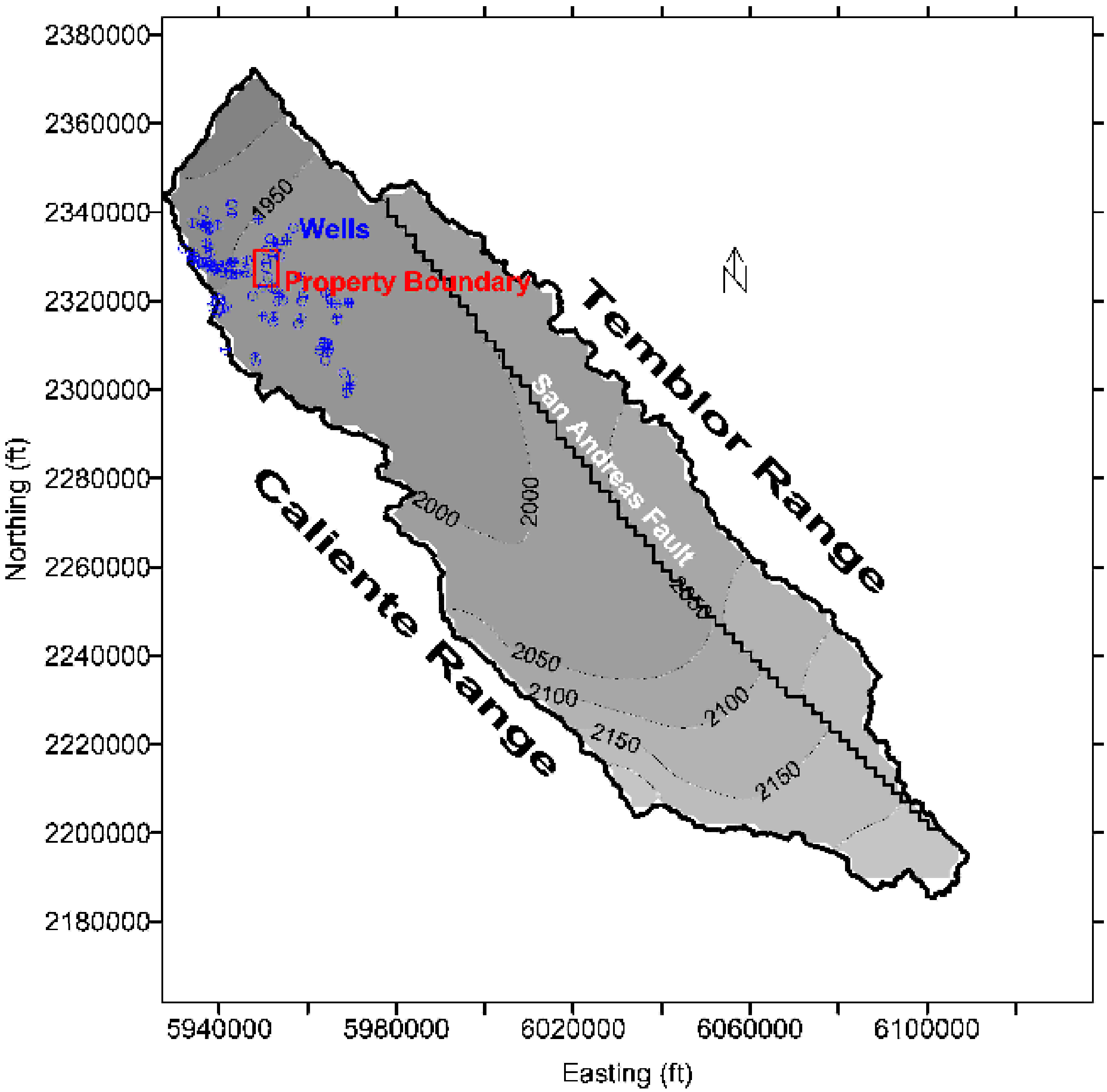

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SOURCES:

MODEL RESULTS: GROUNDWATER ELEVATIONS IN LOWER AQUIFER (LAYER 3) CARRIZO ENERGY SOLAR FARM (CESF)

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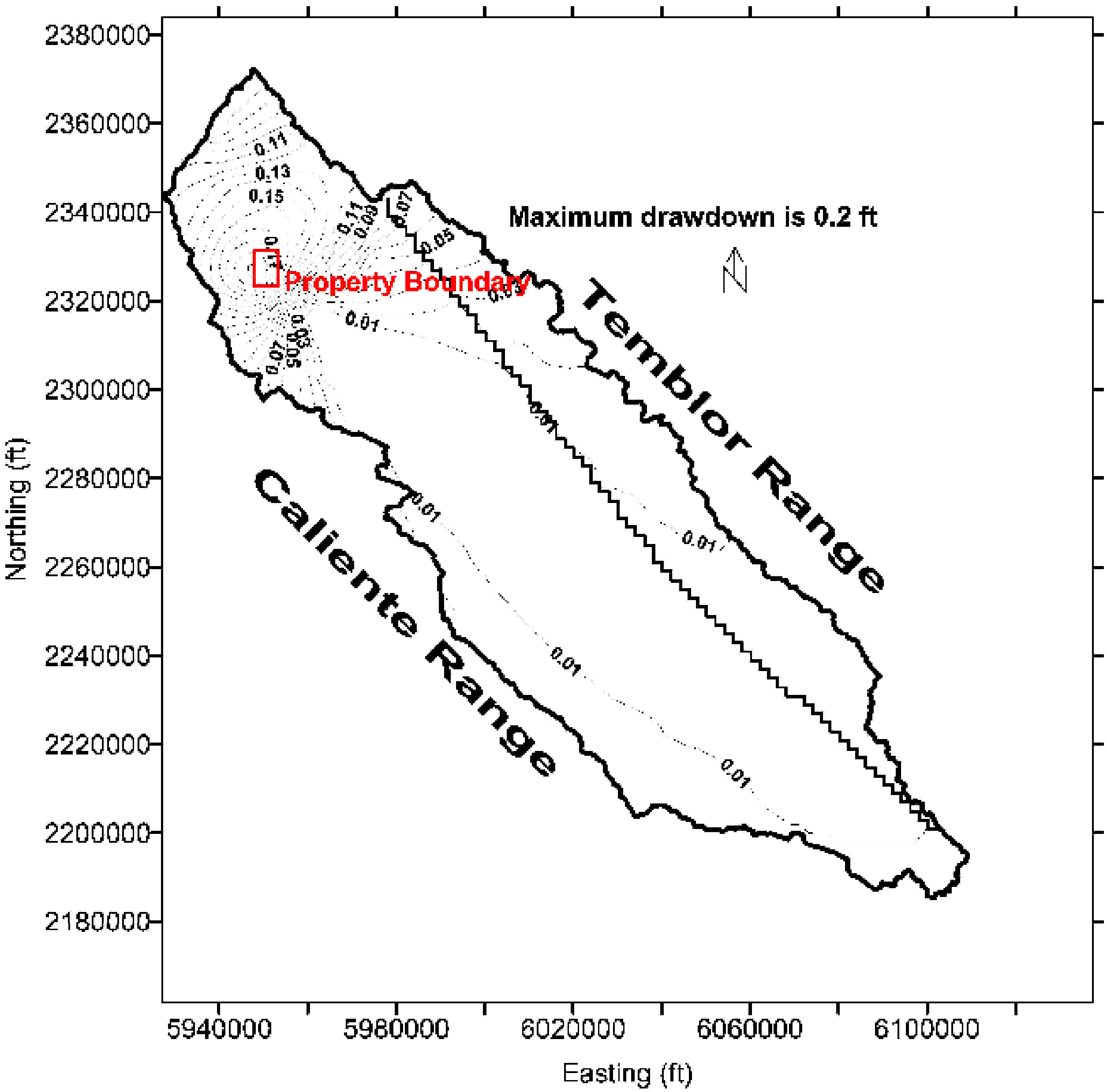
FIG. NO: 3-8



Path: G:\gis\projects\1577\22239518\mxd\hydro_fig3-9.mxd, 06/26/08, camille_lill

SOURCES:

MODEL RESULTS: DRAWDOWN CONTOURS (FEET) FOR UPPER AQUIFER (LAYER 1) CARRIZO ENERGY SOLAR FARM (CESF)

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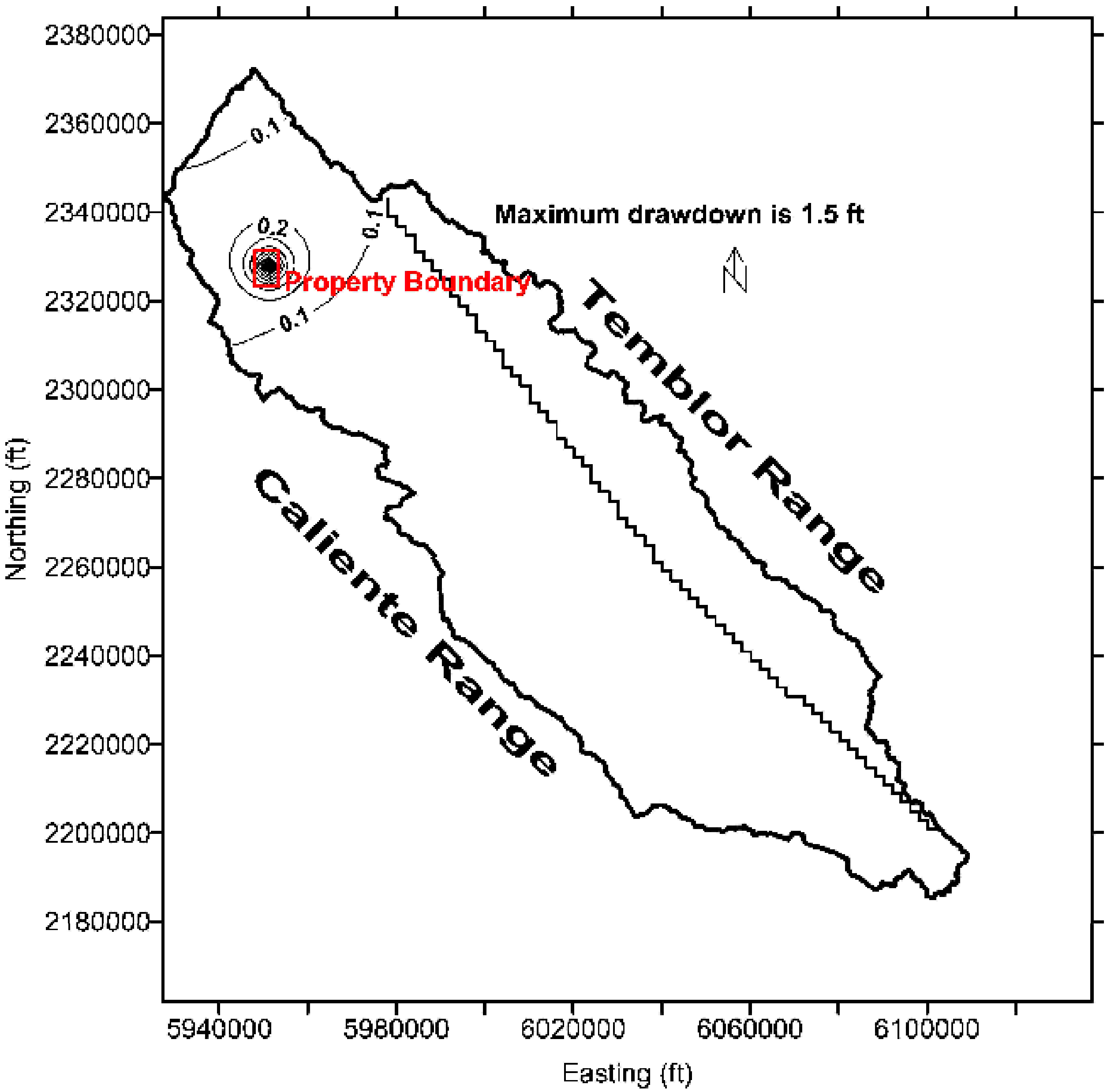
		PM: AL	PROJ. NO: 22239472

FIG. NO: 3-9



SOURCES:

MODEL RESULTS: DRAWDOWN CONTOURS (FEET)
FOR LOWER AQUIFER (LAYER 3)
CARRIZO ENERGY SOLAR FARM (CESF)

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CREATED BY: CL | DATE: 06-26-08 | FIG. NO: 3-10

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Wr J. Kemnitzer
P.O. Box 2990
Stanford U.
(415) 321-1656
321-2300, x-4444

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Ground water in the Carrizo Plain
W. Kemnitzer, Economic Geologist, Menlo Park, 1967

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GROUND WATER IN THE CARRIZO PLAIN, CALIFORNIA

by

William J. Kemnitzer[1]

ABSTRACT

The objectives of this investigation have been (1) to ascertain the degree of development of ground water in the Carrizo Plain; and (2) to determine to what extent these waters might support maximum agricultural, livestock, and community development within the area.

The Carrizo is a treeless but grassy flat to rolling plain lying at an average elevation of some 2,200 feet above sea level between two moderately high coastal ranges in southeastern San Luis Obispo County, California. It is 120 miles in a straight line northwest of the city of Los Angeles. The floor of the plain has an area of around 324 square miles, or 207,000 acres, nearly all arable and about half irrigable. It is sparsely settled, mostly by a few old-time ranch families who, since the 1880's, have dry-farmed grain and grazed cattle and sheep during the natural grass-growing season.

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[1] Economic Geologist, Menlo Park, California.

In making this investigation, Government and private sources were consulted. Four field trips of several days' duration each were made into the area. Data obtained from these sources were correlated with geological investigations made intermittently over a period of several years. It was found that no comprehensive investigations or co-ordinated plans for water development in the Carrizo have been made, despite the fact that there exists an abundance of ground water and a large area of irrigable land.

The surface of the Carrizo Plain is a basined topographic feature comprising a hydrologic unit about 56 miles long and 8 miles wide within the limits of its watershed. This topographic basin superimposes and is in concurrence with a larger crescent-shaped structural geologic basin which is about 75 miles long and 12 miles wide at its center.

The Carrizo topographic basin is shaped in non-marine formations of post-Pliocene age. They consist mostly of loosely to well-consolidated sands, gravels, silts, and clays which overlay unconformably older folded and faulted marine and continental strata. The younger non-marine beds lay in a wedge-shaped body more than 3,000 feet thick in places fronting the San Andreas fault. This body wedges out westward across the plain onto uplifted older rocks of the Caliente Range and San Juan Hills. It is within these younger non-marine formations that most of the fresh ground water of the Carrizo Plain is found.

The Carrizo Plain is dependent on precipitation mostly in the form of rainfall for its water supply. Its watershed, including the floor of the plain, comprises 418 square miles, or 286,000 acres. An average of a little more than 8 inches of rain falls annually upon this watershed. Because the Carrizo basin is closed on all sides to surface water outflow, precipitation which does not find its way underground during the short season of intermittent rains, accumulates in Soda Lake in the center of the basin. Usually, however, these surface waters evaporate before the end of the long summer, leaving the lake bed dry during most of the year. Notwithstanding, water tables have remained high beneath most of the plain because ground water development to date has been on a small scale in relation to the annual natural recharge.

At present (1967), less than 1,000 acres, all in the northwestern quarter of the plain, or less than 1 percent of the approximate total of 100,000 acres of irrigable land are irrigated mostly for alfalfa and pasture crops. Ground water for this irrigation is pumped from 9 wells. These wells range in depth from 200 to 700 feet and have output capacities rated at from 200 to 1,100 gallons per minute.

Net consumption of ground water at present is estimated at the rate of 3,364 acre-feet annually. In addition, some 534 acre-feet annually are being pumped from 89 shallower wells (mostly less than 100 feet in depth) for household and livestock use. Thus, the total net consumption of ground water in the Carrizo at present is at the rate of around 3,898 acre-feet a year which is about 2 percent of the gross, and 5 percent of the net average annual recharge. In general, the ground waters outside the Soda Lake area and the deeper waters throughout the basin are from good to fair quality, but even the best of them are moderately hard.

The balance between water recharge and discharge for the Carrizo basin involves a gross annual amount of some 177,000 acre-feet. This figure is based on the average precipitation of 8 inches (0.667 foot) of rainfall annually falling upon 266,000 acres of watershed. Of this gross recharge, at least 118,000 acre-feet, or nearly 67 percent, is estimated lost through evapo-transpiration and other natural processes. The remaining 55,000 acre-feet, or 31 percent of the gross, is considered to be the net average annual ground water recharge. (See SPECIAL NOTE, p. 5a.)

That part of the net average annual recharge of 59,000 acre-feet into the Carrizo ground water body which is not being utilized, is believed to pass out of the basin as underflow at its northern end into the adjacent La Yeguas and the San Juan subsurface drainage areas. It is believed that this overflow could be captured economically before it has opportunity to leave the basin, without lowering appreciably the over-all ground water level. Recovery of this net recharge would then be sufficient to irrigate approximately 32,000 acres of hay and grain, alfalfa, pasture, truck and miscellaneous crops as well as to supply a modest community development, mostly in the northern half of the plain. Depths of wells to capture this underflow would fall within the range of from 500 to 1,500 feet.

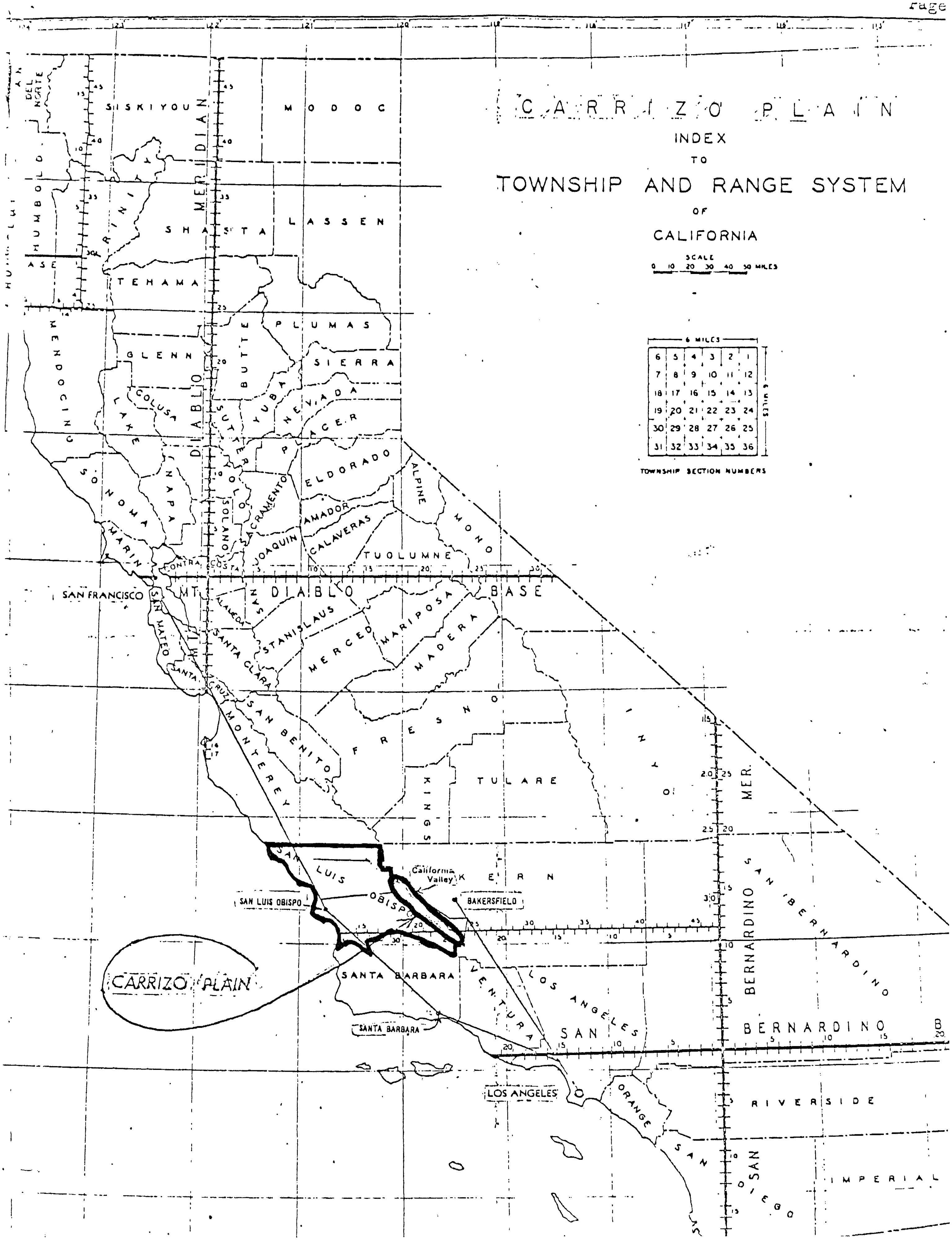
In addition to the net average annual recharge of meteoric[2/] waters available for use, certain quantities of connate[3/] waters might be drawn upon during periods of deficient recharge in order to meet requirements established on the basis of annual average recharge. Of course, the ultimate extent to which ground waters of the Carrizo might be utilized profitably will depend upon the economic results of balancing the cost of pumping water from deep wells with the revenue expected from the products of irrigation or other usage. It is here that feasibility studies involving the details of costs and revenues must be made before undertaking any extensive program of ground water development.

2/ Meteoric water is that which previously existed as atmospheric moisture or surface water, and that entered from the surface into the voids of the lithosphere. (Meinzer)

3/ Connate water is that which was deposited simultaneously with the deposition of solid sediments, and which has not since deposition existed as surface water or atmospheric moisture. (Meinzer)

SPECIAL NOTE

A first estimate of 80,634 acre-feet net average annual recharge available for use was determined by deducting from gross recharge, the vegetal discharge through native unplanted vegetation. A revised estimate of 55,232 acre-feet net average annual recharge available for use is derived by deducting from gross recharge, the vegetal discharge through planted dry-farmed vegetation. The difference is 25,402 acre-feet, based on 38,084 acres of planted vegetation (mostly dry-farmed grains) utilizing an average of 0.667 feet of seasonal rainfall. Obviously, the net average annual recharge available for use will vary according to the acreage of planted dry-farmed vegetation. (See Table 4, p. 40).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INTRODUCTION

LOCATION AND SIZE OF THE AREA

The Carrizo[4] Plain is a semi-arid area of flat, sloping, and rolling hills land in the southeastern part of San Luis Obispo County, California. The alluvial floor of this topographic basin is approximately 54 miles long and 6 miles wide. It comprises 324 square miles, or 207,000 acres of arable land, about half of which is irrigable. It is elongated in a northwest-southeast direction between two coastal ranges, the Temblor on the east and the Caliente-San Juan Range on the west.[5] Elevation of the basin floor averages about 2,200 feet above sea level. That of the Temblor Range 3,000 feet and that of the Caliente about 4,000 feet, while the San Juan section of this latter range is considerably lower at about 2,500 feet.

A number of roads lead into the Carrizo Plain but probably the most travelled connect with California State

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[4] The word "Carrizo" is the Spanish name for common reed grass. The early Spanish explorers who crossed the plain in the 16th century, applied this name to the area from the abundance of reed grass growing on the fringes of the lacusttrine areas in the central part of the plain.

[5] Actually the Temblor Range is on the northeast and the Caliente-San Juan is on the southwest but common practice is to refer to the east and the west sides of the plain or basin.

route 58 which crosses the northern part of the plain between Bakersfield on inland route U.S. 99, and Santa Margarita (9 miles north of San Luis Obispo) on coast route U.S. 101. In crossing the Carrizo Plain, State 58 intersects Soda Lake Road. About 2 miles south on this road is the settlement of California Valley, headquarters of a new community development in the plain. Here there are an inn and other conveniences for visitors and residents. About 1 mile south of this place is a small landing field for private airplanes. There is no commercial air service into the area or other means of public transportation.

From San Francisco, the shortest route into the Carrizo is southward on U.S. 101 to Santa Margarita, thence 36 miles eastward on State 58 to California Valley, a total distance of 269 miles. From Los Angeles via Santa Margarita the total distance is 254 miles, but the shortest route from Los Angeles into the Carrizo is inland over U.S. 99 via the Maricopa turnoff (95 miles north of Los Angeles and 21 miles south of Bakersfield) over State 166 to Maricopa 23 miles, thence on State 33 northwestward 21 miles to State 58, thence westward on 58 over the Temblor Range 26 miles to California Valley, a total distance of 166 miles. A summary of road distances and average driving times is given in Table 1.

The location of the Carrizo Plain is shown in Figure 1. Other features are shown on 1:250,000-scale quadrangles of the U.S. Geological Survey[6] covering Southern California, and on the San Luis Obispo County township, range and section map of the California Division of Forestry, both in separate envelopes accompanying and made a part of this report. Figure 2 shows main roads to the Carrizo Plain.

TABLE 1.- Summary of road distances and average driving times to the Carrizo Plain (California Valley) from San Francisco and Los Angeles

To Carrizo Plain (California Valley) from	Road distance (Miles)	Driving time (Hrs:min)	Remarks
SAN FRANCISCO:			
via Santa Margarita.........	269	5:35	Paved; all weather
via Paso Robles & Cholame...	265	5:25	Last 38 miles unpaved
LOS ANGELES:			
via Santa Margarita.........	254	5:10	Paved; all weather
via Maricopa & Soda Lake Rd.	172	4:30	Last 45 miles unpaved
via Maricopa & Taft.........	166	4:15	Paved; all weather

CARRIZO PLAIN AS A HYDROLOGIC UNIT

The Carrizo Plain comprises one of six hydrologic units into which the County of San Luis Obispo has been divided.[7]

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[6] Other more detailed maps on other scales covering all or a part of the Carrizo Plain may be obtained from the Geological Survey, United States Department of the Interior, Menlo Park, California.

[7] According to State Water Resources Board. San Luis Obispo County Investigation. Bull. No. 18, vol. 1, p. 27. Sacramento, Calif., May 1958.

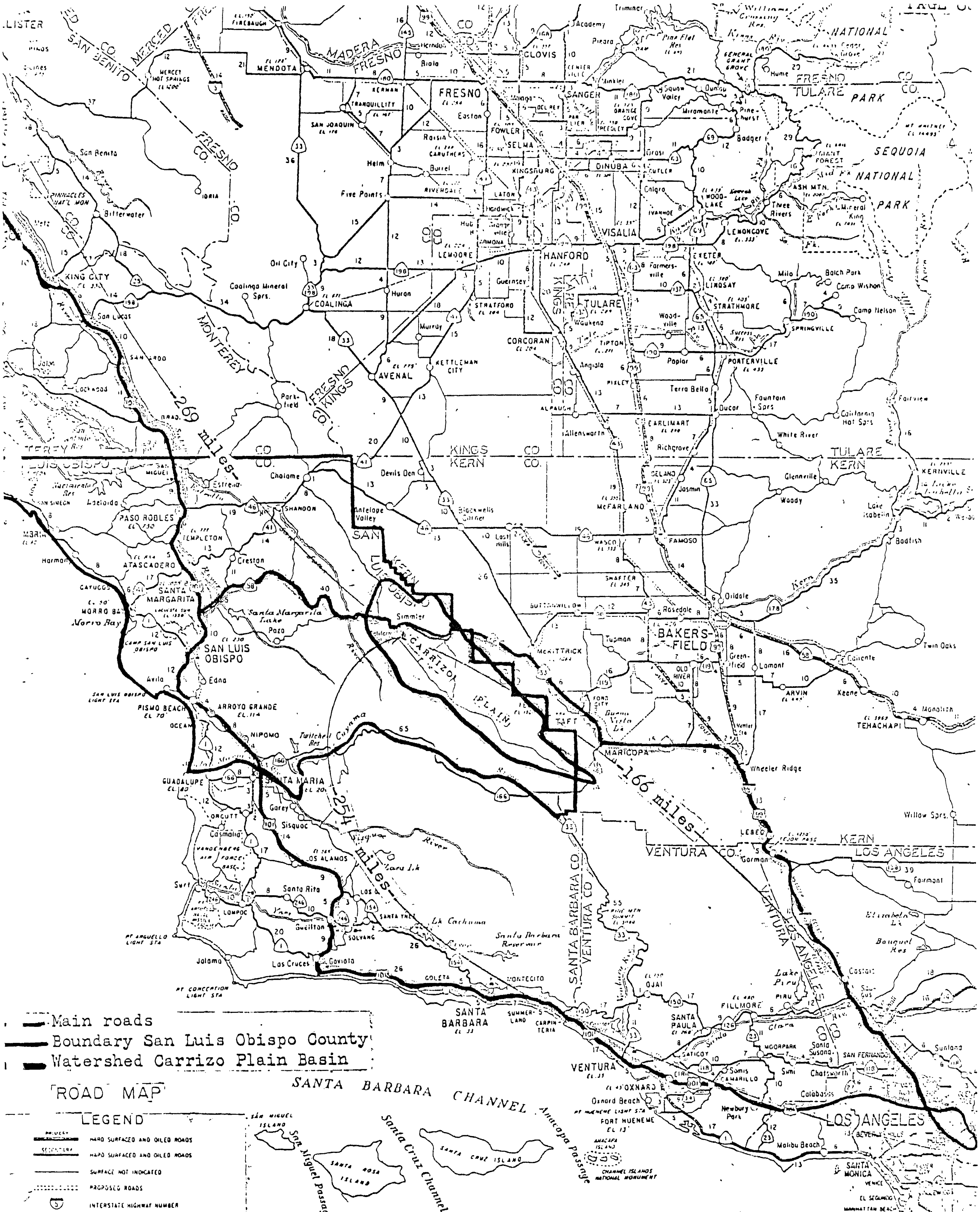

FIGURE 2.- Road map of a portion of California showing main roads to the Carrizo Plain area

The boundaries of these units have been defined after giving consideration to those factors of water supply and utilization, topography, and geology, which affect hydrologic analyses. The boundary of the Carrizo unit lies almost entirely within the County but in places along its eastern boundary, the topographic limits of the basin overlap into adjoining Kern County. This unit comprises approximately 286,000 acres within the limits of its watershed, or somewhat more than 11 percent of the total for the County. A comparison of the sizes of the six hydrologic units of San Luis Obispo County is shown in Table 2.

TABLE 2.- Hydrologic units of San Luis Obispo County, California, arranged in order of largest areas

Name of unit	Area (acres)				
	County			Total	
	San Luis Obispo	Monterey	Kern	Acres	Percent
Upper Salinas unit........	989,000	408,000	1,000	1,398,000	54.5
Coastal units[1/]...........	492,000	12,000	0	504,000	19.6
CARRIZO PLAIN UNIT........	271,000	0	15,000	[a/]286,000	11.2
Cuyama unit...............	268,000	0	0	268,000	10.4
Santa Maria unit..........	55,000	0	0	55,000	2.2
San Joaquin unit..........	54,000	0	0	54,000	2.1
Totals...............	2,129,000	420,000	1,000	2,565,000	100.0

[1/] Consists of subunits: Cambria 195,000 acres; San Luis Obispo 177,000 acres; and Arroyo Grande 132,000 acres.

[a/] Area of watershed measured from drainage divides surrounding the plain and including the floor of the topographic basin us approximately 416 square miles, or 266,000 acres according to author's measurements. Area of the post-Pliocene water-bearing mantle is approximately 350 square miles, or 224,000 acres.

DEVELOPMENT OF GROUND WATER

The development of ground water in the Carrizo Plain hydrologic unit has been slow and small. The early settlers who came into the area before the turn of the century made little effort to develop water, mainly because both surface and subsurface evidences of any large supply of fresh water were lacking. They managed to obtain enough potable water to meet requirements for household and livestock by drilling shallow wells (generally less than 100 feet in depth) in the more favorable spots near seepages and springs. They became satisfied with dry-farming and the seasonal grazing of livestock, made a comfortable living from these occupations, and generally held on to their large land holdings.

Under these conditions, and the fact that the Carrizo lay off the main road and rail transportation routes, the Carrizo has remained sparsely settled. Even at present there are only two small settlements in the plain. One is Simmler, a now practically deserted old ranch community in the north central part of the plain; and the other, California Valley, a new community real estate development several miles west and south of Simmler.

Despite the lack of extensive water development, the fertility of much of the soil has long been recognized, provided sufficient water could be placed on it. However, it was not until the close of World War II when water-well equipment again became available that any significant attempt was made to develop water for irrigation.[8] Probably the first wells for this purpose were two deeper wells drilled on the King Ranch in the northwestern part of the plain in 1945.[9]

These two wells proved irrigation to be feasible, but in the 20-year period between 1946 and 1967, only 9 additional irrigation wells were drilled, all in the same general area. Of the total of 11 irrigation wells drilled to date, 2 have been abandoned (for mechanical reasons), leaving 9 wells at present pumping water for irrigation, mostly for alfalfa and forage crops to supplement range feed available only during the short natural grass-growing season. The total area irrigated comprises around 725 acres but from three to four cuttings of some forage crops are obtained per year.

In addition to shallow water wells drilled for domestic and livestock requirements by the original settlers and the few deeper ones for irrigation, a number of mostly shallow

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[8] Very little data on irrigation are available prior to 1920, the first year in which such data were included in the Federal Census reports. Later, investigations were made by the California State Water Resources Board, but outside of the report on water in San Luis Obispo County in 1958, little data have been collected with reference to water in the Carrizo Plain.

[9] One well was drilled in section 28, T29S-R18E to a depth of 325 feet; the other in section 2, T30S-R18E to a depth of 300 feet. Output of each of these wells was rated at from 500 to 600 gallons per minute.

wells have been drilled in the area of the recent California Valley development. This community effort, however, has not added materially to water development in the Carrizo Plain. The purchase of a 2-1/2-acre plot usually carries with it the necessity of the owner to develop his own water supply. Unfortunately, most of the subdivision acreage lays on the western slopes of the plain where the main water-bearing formations are either absent or thin. As a result many of the 20-odd shallow wells drilled in this locality have not yielded satisfactory amounts of water.

As a consequence of this unsatisfactory water development, efforts are being made to develop a community supply from deeper wells drilled down-slope on the edge of the Soda Lake flat, where the water-bearing formations are thicker. Three wells have been drilled in this locality.[10/] The upper water-bearing formations in two of the wells located nearest the Soda Lake bed yielded water of poor and unsatisfactory quality. However, deeper sands yielded water of better quality. As yet the final results of this effort are not known. Just how and at what cost water from

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[10/] These wells are "Chilcote" in section 12, T30S-R18E drilled to a depth of 550 feet; and the two "Cal Valley" wells located within 135 feet of each other in section 34, T30S-R19E; the one completed at a depth of 995 feet, and the other drilled to a depth of about 1,865 feet but not known at what depth completed.

these wells is to be distributed to the community plots on higher elevations is also not known.

PURPOSE AND SCOPE OF THE INVESTIGATION

The purpose of this investigation is essentially to ascertain to what extent ground water in the Carrizo Plain may be developed to sustain maximum development of agriculture and livestock activities and related community development, thereby improving the local economy and increasing property values. It includes estimates of natural discharge, pumpage and yield of ground water, data on water levels, well records, and water quality available to the author up to January 1, 1967.

This preliminary investigation does not attempt to determine the economics of ground-water development in relation to crop, livestock, domestic, community and other requirements. It was perforce limited by time and expense to a general survey to ascertain whether the potential water resources and extent of irrigable lands were sufficient to warrant a comprehensive and detailed feasibility study of water development in the Carrizo to determine its economic potentialities as a geographic unit of importance. Such an investigation is in line with government policies for land development, particularly as adapted to the improvement and growth of good beef stock which the Carrizo Plain and adjacent areas afford.

RELATED INVESTIGATIONS AND REPORTS

Little has been published on the water resources of the Carrizo Plain. The three works listed below probably cover the subject as thoroughly as any. The author has drawn freely upon them for basic data and information but the interpretations made from them together with data collected as a result of his own efforts, are his own.

Upson, J.E. and G.F. Worts, Jr. Ground Water in the Cuyama Valley, California. Geological Survey Water Supply Paper 1110-B, in Contributions to Hydrology, 1948-1951. U.S. Department of the Interior, Washington, D.C., 1951.

Division of Resources Planning, California Department of Water Resources. San Luis Obispo County Investigation, Bull. 18, Vols. I and II. Sacramento, Calif., May 1958.

Hackel, Otto; Chairman and others. Guidebook - Geology of Carrizo Plains and San Andreas Fault. San Joaquin Geological Society. Bakersfield, Calif., 1962.

ACKNOWLEDGMENTS

Most helpful in supplying information and data relative to the area and subject of interest were authorized persons in the following organizations:

Geological Survey, United States Department of the Interior, Menlo Park, and Santa Barbara, California;

Department of Water Resources, Resources Agency, State of California, Sacramento, California; and

Flood Control and Water Conservation District, San Luis Obispo, California.

The author is grateful to the many oil companies which, with few exceptions, when requrested supplied electric logs, core descriptions and other data relating to their geological work in the area.

PHYSICAL FEATURES OF THE AREA

GEOMORPHOLOGY[11/]

Probably the most notable physical aspects of the Carrizo Plain are: (1) the large expanse of treeless but grassy flat lands in the center of the basin sloping upward to the bare rolling hills along its periphery; (2) the elongation of the basin in a northwest-southeast direction between two prominent coastal ranges, the Temblor on the east and the Caliente-San Juan on the west; (3) the notable depression in the center of the basin, occupied by the intermittent Soda Lake; (4) the well-defined straight-line escarpment of the San Andreas fault along the eastern side of the plain; and (5) the curved Caliente-San Juan uplift and fault complex marking the western limits of the basin and abutting at each end against the San Andreas fault scarp to mold the crescent-shaped Carrizo basin.

The topography of the surface terrain is largely the result of processes of deposition and erosion pertaining to

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11/ Geomorphology is that branch of physical geography which deals with the general configuration of the surface, the distribution of the land, water, etc., and the history of geologic changes through the interpretation of topographic forms.

the mantle of post-Pliocene soils, sands, gravels, silts, and clays which blankets unconformably the structural basin of older folded and faulted strata which in turn overlay a granitic basement on the west and deeper-seated metamorphic basement complex on the east.

Whereas the eroded pre-Pliocene folded and faulted strata are formed into a subsurface structural basin tilted slightly to the east and the north, the post-Pliocene cover forms a topographic surface basin with elevations considerably higher on the east and the north than on the west and south. The pre-Pliocene sedimentary beds overlay and in places overlap the basement granitic mass on the Caliente Range and San Juan Hills on the west while they terminate abruptly against the San Andreas fault on the east.

Topographically, the surface of the basin is highest at its narrow southern end. The surface elevation here reaches 2,900 feet above sea level. In the center of the basin at Soda Lake, the elevation drops to 1,900 feet. To the north the elevation rises, but to less than 2,100 feet.

The southern half of the Carrizo is an area which slopes upward from its center, gently eastward into the low Panorama Hills fronting the Temblor Range and more steeply westward into the Caliente Range. The floor of this half of the basin averages about 4 miles wide. The land is largely unfenced. Most of it is used for cattle grazing, but some of it is dry-farmed. Within an area of more than 100 square miles, there are no settlements other than a few ranch houses. Most of the roads are gravel or dirt. Some of them are impassable in wet weather.

The northern half of the basin is wider than the southern half. It averages about 7 miles in width. It contains more flat and gently sloping land, but in the northeast are low rolling hills. All of the land in the lower north half is arable. There are more ranch houses in the north than the south and the only two settlements in the Carrizo are here. Also, the only land irrigated is in this part of the plain, and practically all of the remainder is dry-farmed. The roads are mostly black-topped.

Aside from the plain itself, probably the most prominent physical features of the area are the two coastal ranges which confine the plain. The Temblor Range on the east rises to more than 1,000 feet above the plain. Elevations along its highest ridge average more than 3,000 feet above sea level. The Caliente Range on the southwest rises higher, but its northward extension into the San Juan Hills is much lower, averaging less than 2,500 feet along its highest ridge. The highest point in the Temblor is McKittrick Summit, 4,332 feet above sea level; in the Caliente is Caliente Mountain, 5,106 feet; and in the San Juan Hills, Freeborn Mountain, 3,311 feet. These ranges are usually covered with an abundance of native grasses, but other vegetation is scant. There are scattered oak and pine trees on the higher elevations, and frequently patches of brush, especially on the southwestern slopes which receive the full force of the seasonal rains.

Along the northwestern rim of the Carrizo topographic basin, the divide between the Carrizo and the San Juan drainage area is in places barely more than 50 feet above the ground level of the adjoining San Juan. Nevertheless, this low divide has been high enough to prevent any surface waters of the Carrizo from flowing out of the basin even during the heaviest rains. The rains falling upon the Carrizo watershed have formed a reservoir of ground waters which rise above the surface in the depressed Soda Lake area during most of the rainy season and remain very close to the surface at other times.

CLIMATE

The climate of the Carrizo area has some of the features of a desert basin notwithstanding that it is a plain within the Coastal Ranges. This anomoly is because the uplifted plain is on the inland side of the Coastal Ranges near the southern end of the San Joaquin Valley and is flanked by moderately high mountains.

Rainfall over the plain and its watershed, although variable, has averaged over the years, a little more than 8 inches annually. Nearly all of the precipitation is in the form of rain which falls mostly during the months of December through February. However, isolated thunder showers sometimes occur during the summer. Snow rarely falls on the basin floor but does rather frequently during the winter on the summits of the adjoining mountains.

During the winter, temperatures below freezing are common. During the summer months daytime temperatures are mostly high. Frequently they are in the 90°'s and occasionally go above 100° F. Nights are usually cool even in the summertime. The long dry summers provide an adequate growing season for most crops but the relatively high altitude of the plain results in a shorter growing season which limits the types of some crops. The time between frosts averages around 200 days.

The air of the Carrizo is unpolluted. Most of the time it is remarkably clear and exhilerating. During the winter, in the lower parts of the plain there may be occasional ground fog. However, these low, patchy fogs are usually "burned off" before mid-day.

Records of rainfall, temperature, and other meteorological data for the Carrizo are scanty. Within the Carrizo Plain and watershed, there are only two precipitation stations. The records go back some thirty years but they are not complete. However, they do reveal the main features of seasonal variations, rainfall distribution and intensity. A sample of these records is shown in Table 3. Lines of equal mean seasonal precipitation are shown in Figure 4.

TABLE 3.- Records of rainfall from precipitation stations in the Carrizo Plain, San Luis Obispo County, California

Precipitation station	Elevation (ft.)	Period of record[1/] From	To	Seasonal year Mean (inches)	Maximum Year	Maximum Inches	Minimum Year	Minimum Inches
Simmler Highway Maintenance[2/]...	2,047	1938	1954	8.1	1941	18.1	1951	4.4
Soda Lake[3/].......	1,975	1926	1954	8.7	1941	18.5	1934	5.4

1/ Data for more recent years not procured.

2/ Source: State Division of Highways, San Luis Obispo.

3/ Source: U.S. Bureau of Reclamation and San Luis Obispo Farm Advisor.

SOILS

The soils of the Carrizo vary in their physical and chemical properties in accordance with differences in parent materials, the method of formation or deposition, the age and degree of development since their deposition. The soils may be divided into three broad groups: (1) residual soils; (2) older valley fills; and (3) Recent alluvial soils.

Residual soils include those which have been developed in place on consolidated bedrock of sedimentary, igneous, and metamorphic origin. These soils are found only on the steeper slopes of the drainage area surroun ing the basin where the drainage is good; and they are usually shallow and of medium texture. Rock outcrops are frequently found.

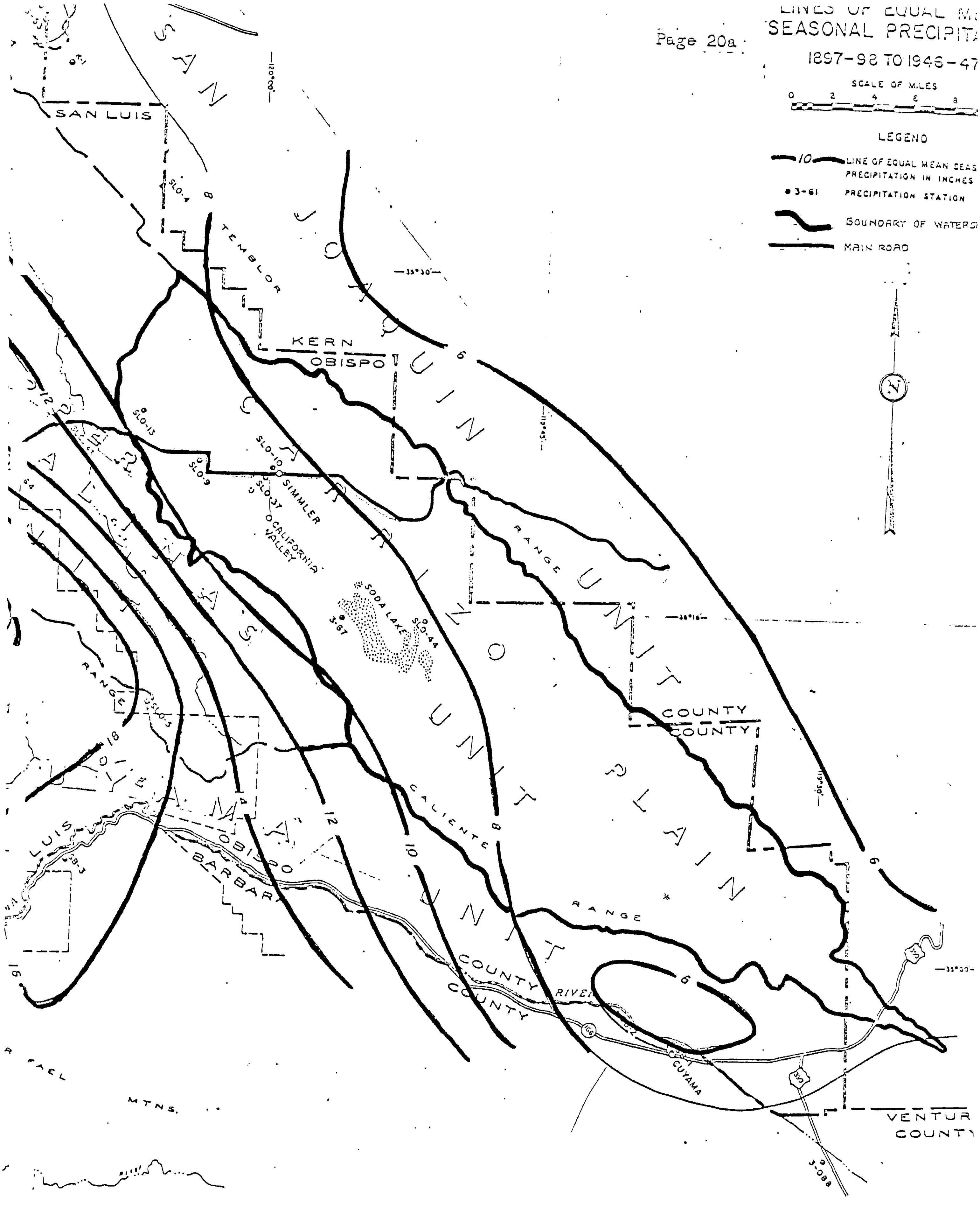

FIGURE 4.- Rainfall map of the Carrizo Plain area, California, showing lines of equal mean seasonal precipitation, period 1897-98 to 1946-47

Only a small percentage of these soils occur around the rims of the Carrizo and mostly in the southern half.

Older valley fill which comprises most of the northeastern part of the Carrizo and extends in scattered areas along both sides of the San Andreas escarpment elsewhere but is generally absent in the central part of the Plain. Since their deposition, the soils of this group have been elevated and later eroded to varying degrees. As a result, a rolling topography characterizes the areas in which these soils occur. These soils cover most of the northeastern area. Textures vary from light to medium at the surface to heavy in depth. Surface drainage is generally good but subsurface drainage is often retarded by heavier subsoils. Moisture holding capacities are fair to good in the upper zones but poor in the lower zones. In years of deficient rainfall, failures of shallow-rooted, dry-farmed crops occur. In general, however, good harvests of climatic-suited crops may be grown in the older valley fills.[12]

Recent Alluvium occupies the greater part of the Carrizo Plain arable area. It is estimated that the soils in this category, outside the Soda Lake area, cover approximately 135,000 acres, or about 38 percent of the total arable land. Soil depths vary considerably--from a few feet on the periphery of the basin to several hundred feet

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[12] Large acreages of wheat are produced in these soils. The wheat produced is a high gluten Baart wheat which brings premium prices from the flour milling industry.

in the center of the Soda Lake bed. Textures vary from light to medium outside the Soda Lake area. In this area, they are for the most part heavy impervious clays that are heavily impregnated with mineral salts. Away from the Soda Lake borders, stratified silts, sands, and gravels are often found beneath the surface, and drainage is usually good except in periods of inundation. In general, with the proper application of water and careful use of fertilizers where required, the alluvial soils of the Carrizo have a high commercial value.

GEOLOGIC FEATURES OF THE AREA

STRATIGRAPHY

Within the confines of the structural basin lying between the Temblor uplift on the eastern side of the San Andreas fault and the Caliente-San Juan uplift on the west, is a stratigraphic section of post-Jurassic rocks. Most of these are unaltered sedimentary formations but there are some metamorphic basement rocks and interstratified Miocene volcanics.

The stratigraphy (as well as the structure) is shown in the cross sections made of the basin by Dibblee.[13] Probably the most representative of these are the ones across the central part of the basin. They show a section of sedimentary deposits ranging in thickness from a few feet overlaying a granitic basement complex on the west to more than 15,000 feet on the downthrown eastern side of the structural basin fronting the San Andreas rift.

Broadly, the stratigraphic sequence in the Carrizo basin is as follows. A Mezozoic basement complex of granitic rocks,

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13/ Dibblee, Jr., T.W. "Displacements on the San Andreas Rift Zone and Related Structures in Carrizo Plain and Vicinity." Guidebook - Geology of Carrizo Plain and San Andreas Fault. San Joaquin Geological Society, Bakersfield, Calif., 1962.

exposed at the surface in places in the Caliente-San Juan uplift is overlain unconformably in varying thicknesses by Cretaceous conglomerates and sandstones, followed to a limited extent by Paleocene sandstones and shales. Overlaying the Cretaceous unconformably is the widespread Simmler formation of non-marine sandstones and siltstones of Oligo-Miocene age. The Simmler is overlaid by marine Vaqueros (lower Miocene) which is divided into the Soda Lake shale and the Painted Rock sandstone. Overlaying the Painted Rock are a wide variety of silicious shales, basalts, sandstones, and shales--some marine and some nonmarine--of the Monterey series (middle and upper Miocene). Above the Monterey is the widespread and often thick Santa Margarita sandstone of the upper Miocene.

On top of the Santa Margarita sandstone is the Rancho Pico shale followed by the Quatal clay, both lower Pliocene. These compact impervious beds where present, prevent ground waters in the overlaying Morales (upper Pliocene) and the Paso Robles (lower Pleistocene) sands, gravels, and silts from percolating downward into the older marine strata. A comparatively thin mantle, from a few to several hundred feet thick, of Recent Alluvium covers much of the Paso Robles, especially through the center of the basin and in the Soda Lake depression. However, in the northeast, the Paso Robles is exposed over most of the surface.

The most notable and important features of the stratigraphy of the Carrizo from the standpoint of ground water accumulation is the position of the fresh water-bearing Pleistocene Paso Robles overlaying in marked unconformity, the Tertiary and older beds; and the impervious nature of the lower Paso Robles which prevents percolation of ground waters downward. These younger water-bearing formations are superimposed upon the older strata in a wedge-shaped mass more than 3,000 feet thick fronting the San Andreas rift, thinning out westward on the eastern flank of the Caliente-San Juan uplift.

East of the San Andreas fault, the stratigraphy follows the same general age pattern as that west of the fault but the formations are not specifically correlative with those on the Carrizo side. An exception is the Paso Robles formation and a few of the post-Pliocene beds, thin patches of which occur on both sides of the San Andreas, notably in the southeast. East of the San Andreas, the basement complex of Mezo-Cretaceous age, consists of diorites, intrusive serpentine, and metamorphic rocks of the Franciscan series. The granite basement complex of the Caliente-San Juan does not appear east of the San Andreas fault.

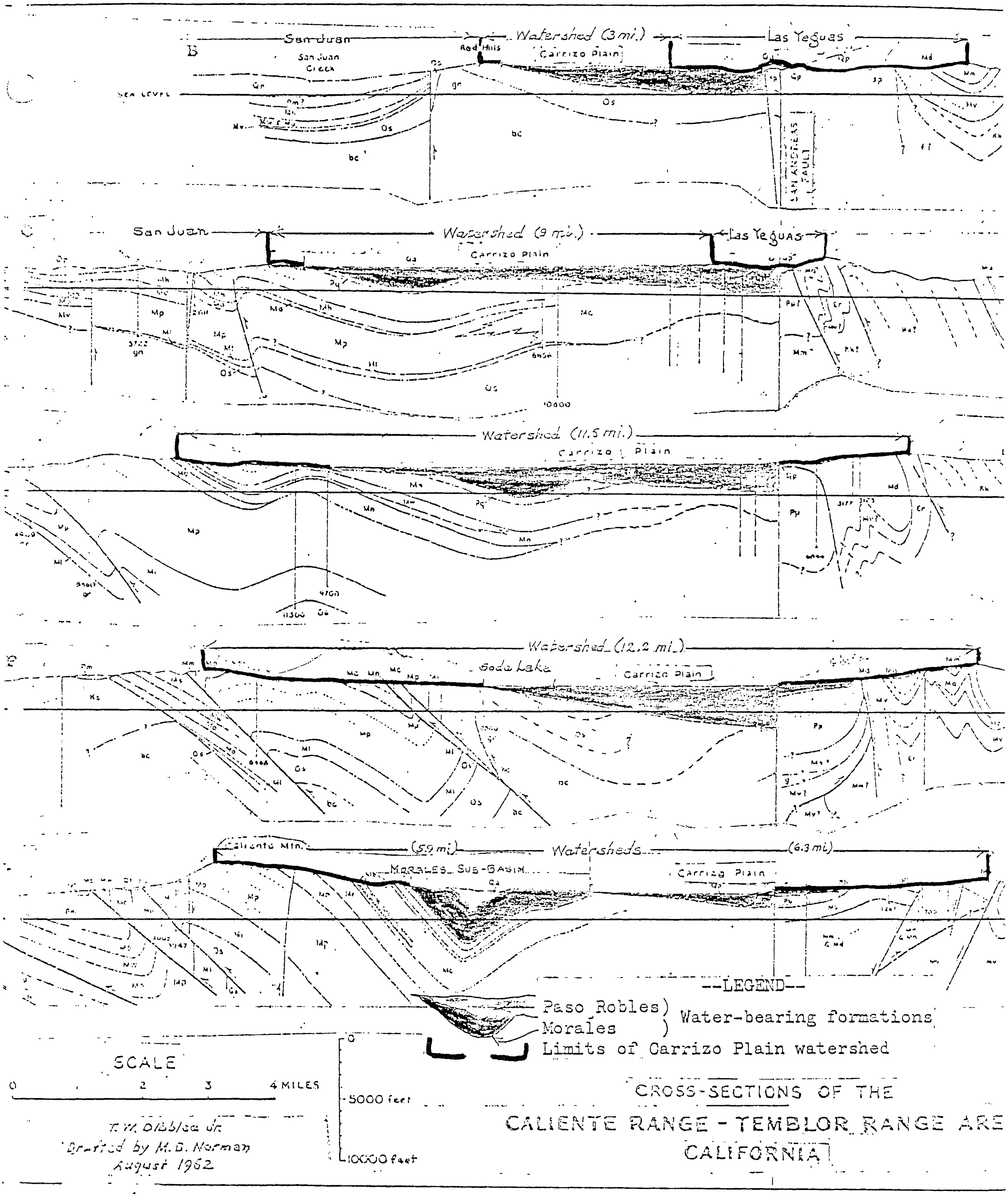


FIGURE 7.- Geologic cross-sections of the Carrizo Plain area, California, showing ground-water-bearing formations (yellow) and watershed (blue) in relation to older non-water-bearing formations and geologic structure. (Geology by Dibblee;

STRUCTURE

The geologic structure embodying the Carrizo Plain is essentially an elongated synclinorium some 75 miles long and 12 miles wide at its center, in strata of post-Jurassic age, compressed between two uplifted basement masses. This structural basin is tilted downward on the east against the San Andreas fault, and northward against the Red Hills-San Juan fault system.

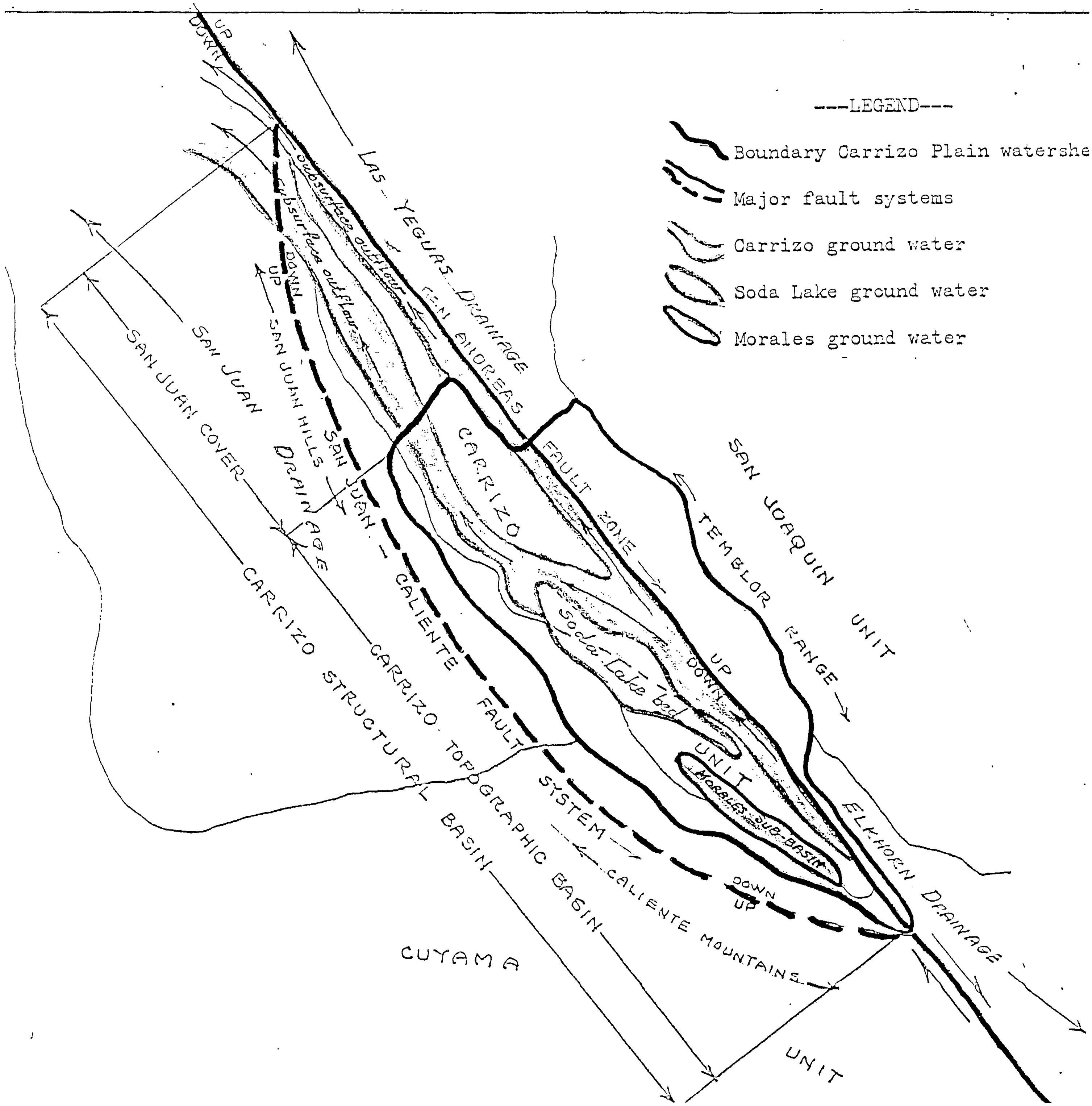
Besides marking the eastern limit of the basin, the San Andreas fault is the dividing line between the dissimilar strata on either side of the fault. Apparently, a lateral movement took place along the San Andreas rift which shifted for many miles what was originally a contiguous sequence of formations.

Subsequent to this extensive lateral movement, or possibly contemporaneous therewith, the formations on the western side of the San Andreas fault in the Carrizo area were downthrown several thousand feet. Also, probably at the same time, both the western (Caliente-San Juan) side and the eastern (Temblor) side of the basin were uplifted while compressive forces folded, faulted, and in places overthrust the pre-Pliocene sedimentary section from east to west.

In all of these orogenic movements, the San Andreas rift remained virtually in a straight northwest-southeast trending line while on the western side of the basin a complex of folding and faulting formed into an arc which encompassed a 75-mile segment of the San Andreas fault, thus forming the crescent-shaped structural basin of the Carrizo.

Following these major structural movements in the pre-Pliocene rocks, various processes of erosion and deposition took place which covered a large area with post-Pliocene boulders, gravels, sands, silts, and clays of terrestrial origin. In the Carrizo structural basin these younger non-marine beds were laid down unconformably over tilted, unevenly eroded and folded and faulted pre-Pliocene strata. Through subsequent movements along old lines of stress, these younger non-marine beds were gently folded and faulted while processes of secondary erosion and re-deposition account for the wedge-shaped superimposition of these younger continental formations unconformably upon the older marine strata.

The Carrizo Plain is unique in that it involves two basins: (1) a topographic basin superimposed unconformably upon (2) a structural basin. This situation is fortunate from the standpoint of ground water in that it affects favorably the movement and accumulation of such waters. The closed topographic basin prevents any fluvial flow from the surface basin. The top of the underlying structural basin, covered for the most part by impervious clays at the bottom of the Paso Robles and tilted eastward and northward, channels ground water underflow in those directions whenever subsurface water reservoirs are filled. Wells properly located could prevent much if not all of this subsurface outflow.



OCCURRENCE OF GROUND WATER

PRINCIPAL FORMATIONS THAT YIELD WATER TO WELLS

The Ground Water Body

The geologic formations of the Carrizo Plain may be divided into non-fresh water bearing and fresh water bearing groups. The non-fresh water bearing group includes the pre-Cretaceous granitic rocks, sedimentary rocks of the Jurassic through the lower-Pliocene, and volcanics of Miocene age.[14/] The fresh water bearing group includes most of those sands and gravels in the post-Pliocene section. The more important of these younger fresh water bearing formations are the Quaternary alluvium (Qa), the Pleistocene Paso Robles (Qp) and the upper Pliocene Morales (Pm) formations.

Broadly, there are two extensive ground water bodies in the Carrizo basin: (1) the Soda Lake; and (2) the Carrizo. The Soda Lake ground water body is confined to a

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[14/] Of course, any formation of pre-Pliocene age may yield some fresh water locally at or near surface exposure but in depth waters in these older formations yield either brackish or salty waters. They are not considered fresh-water bearing on any large scale.

comparatively shallow platter-shaped area about 12 miles long and 2 miles wide beneath the lake bed. This body lays below several hundred feet of muds and clays, and contains water highly contaminated with mineral salts. The Soda Lake ground waters are either in the lower part of the Quaternary Alluvium or upper section of the Paso Robles.

The Carrizo ground water body lies below the Soda Lake in the middle and lower parts of the Paso Robles. This confined body of ground water is overlain by materials sufficiently impervious to sever hydraulic connection with over-lying water, and moves under pressure caused by the difference in head between intake and discharge areas of the confined water body. The Carrizo ground water body spreads beneath most of the middle and eastern parts of the entire basin where the Paso Robles formation is extant. The waters of this body, unlike those of the Soda Lake range from good to fair over-all quality. (See Figure 9, p. 37a)

Quaternary Alluvium (Qa)

Recent Alluvium of the Quaternary period (Qa) covers most of the surface of the Carrizo Plain. It is estimated that this alluvium is spread in varying thicknesses up to several hundred feet over approximately 142,000 acres, or 63 percent of the basin floor. The thickest alluvium centers in the Soda Lake depression in the central part of the surface basin.

In general, the alluvial beds rest with angular unconformity on older continental deposits and locally on still older formations. There are few Quaternary Terrace deposits within the area of the Carrizo Plain. There is little or no evidence that streams or other fluvial conditions necessary for the formation of terrace deposits, ever existed after the original structural depression was formed.

Most of the alluvial beds in the Carrizo appear massive, but some are evenly stratified or slightly cross-bedded. As revealed in well logs, the alluvial deposits are highly variable in composition and thickness. In general, however, they are unconsolidated or loosely consolidated sands, gravels, and silts with a few beds of compacted clays. An exception is the Soda Lake area where they are mostly thick compacted heavily mineralized muds and clays.

The alluvium absorbs water readily in most parts of the basin, particularly where it is not already saturated; that is, where the water table is well below the surface. In the center of the basin around Soda Lake, although the more permeable upper parts of the alluvium underlying the thick layer of muds and clays may be heavily mineralized, there exist impermeable beds which prevent percolation of these contaminated waters downward into the underlying reservoir of better quality waters. In the central part of the basin, especially in the Soda Lake area, it is believed that the alluvium does not readily transmit water downward, but elsewhere precipitation absorbed by the alluvium may find its way into the underlying Paso Robles formation.

The Alluvium is not the principal water-bearing formation of the Carrizo, except possibly in the east central part of the basin where it is in direct contact with the runoff from the Temblor watershed. So far only in the western part adjacent to the narrow Caliente watershed has any water been developed from it and this not to any considerable estent. In most other parts, the top of the saturated zone is either deep in the alluvium or below its base. In some localities, even this Recent Alluvium is saturated but not very permeable. It is, therefore, necessary to drill deeper into the underlying continental deposits to obtain any appreciable amount of water. Little or nothing is directly known about the water-bearing characteristic of the undrilled alluvium over most of the basin.

Pleistocene Paso Robles (Qp)

This formation of Quaternary Pleistocene age consists of poorly sorted mostly loosely consolidated gravels, sands, and silts. It is exposed over the surface of a large section of the plain especially in the rolling hills of the northeast. Elsewhere it is covered by a mantle of alluvium. The Paso Robles is widely distributed beneath the floor of the Carrizo Plain.

The Paso Robles "wedge", more than 3000 feet thick fronting the San Andreas rift, thins out across the basin onto the Caliente-San Juan uplift. In general, well logs indicate that the Paso Robles is more permeable on the western side of the basin where it is thinnest than on the eastern side where it is thickest. However, most of the formation appears to be permeable or faulted enough to transmit and store ground water in considerable quantities.

Contours on the base of the Paso Robles show that this floor slopes in general from west to east and from south to north; is thickest in the depressed areas of the underlying older strata and thinnest over the uplifted sections of the older beds. Once the depressions in the Paso Robles are filled with ground waters, the recharge waters flow down dip eastward and northward along channels in the top of older strata at the unconformity between the base of the Paso Robles and the immediately underlying older strata.

The Paso Robles is by far the most important formation for the migration and storage of ground waters in the Carrizo basin. Though few deep wells have been completed for water in this formation, those that have, have yielded substantial amounts of fresh water of fair quality.

Pliocene Morales (Pm)

This formation, of upper-Pliocene age, is the lowest of the fresh water bearing formations in the Carrizo Plain. It crops out on the surface over relatively small areas in the northwest beyond the limits of the Carrizo surface basin but within the limits of the structural basin; and in the extreme southeast. It underlays the Paso Robles unconformably but overlays the Miocene strata conformably. Although it has not been mapped as being present beneath the entire surface of the Carrizo Plain, its presence in exploratory wells drilled for oil within the confines of the Carrizo would indicate that the Morales is more widespread than depicted by areal geology.

The Morales, like the Paso Robles, is made up mainly of sands, gravels, and silts, but generally these beds are more stratified and compact in the Morales than those in the Paso Robles. The thickness of the Morales ranges from a few feet to more than 3000 feet. Structurally, the Morales extends the length of the basin in a syncline off the eastern flank of the San Juan uplift in the northwest. It is not recognizable southward until it appears in a somewhat tightly folded syncline at the southern end of the basin off the eastern flank of the Caliente uplift.

As a water-bearing sand, the Morales may hold considerable water, but its waters are believed to be somewhat brackish due to percolation of salt waters into the formation from underlying marine beds. Notwithstanding, some of the waters in the Morales may be locally suitable for livestock and selected irrigation. However, depth to any considerable amount of water in the Morales may be prohibitive to economic recovery, and unless the volume discharge would be large, the wells would not be economical. In general, the Morales is not to be considered a major source of fresh water development in the Carrizo.

NON-WATER BEARING FORMATIONS

Formations that do not carry appreciable amounts of water or that carry water which cannot be economically recovered by means of wells consist essentially of the pre-Pliocene marine and older continental deposits. Although some of these older formations contain permeable beds, they are not generally in favorable positions or of sufficient areal extent to absorb much precipitation.

Some of the older formations may store small quantities of fresh water in cracks and joints but they do not transmit much of it. They are, therefore, not important sources for any considerable amounts of free fresh water. Even in a few localities where they are known to be substantially water-bearing, they underlay land which, for the most part, is topographically unsuited for agriculture. Only the most favorable locations in valley bottoms have been tapped by a few water wells for limited domestic and stock use. These waters are of no practical value as sources for extensive irrigation. The real value of these older beds is their structural function to transmit water to the alluvial plain.

URE 9.- Longitudinal section showing relative positions of main ground water zones in the Carrizo Plain Basin, Calif.

WATER SUPPLY AND DEMAND

BALANCE BETWEEN WATER RECHARGE AND DISCHARGE

Water supply and demand are generally expressed in hydrologic terms as water recharge and water discharge. Recharge is that water which replaces water discharged from a hydrologic unit.[15] Discharge is that water which is taken or escapes from a hydrologic unit. A hydrologic unit is a topographic basin into which water is fed by natural precipitation within the confines of a watershed limited by the topographic divides surrounding the basin.

The Carrizo Plain is entirely dependent upon precipitation for its water supply. No waters are brought in from the outside. The discharge of waters from the Carrizo results from natural processes and from pumping water from wells.

In any undeveloped ground water basin, the long-term natural recharge must equal the long-term discharge. Because the Carrizo Plain so far is a practically undeveloped closed ground water basin, it is not difficult to arrive at meaningful figures for its water recharge and discharge.

15/ More specifically, recharge may consist of waters originating naturally in the form of precipitation and flowing into the basin either by surface or subsurface channels; or by being imported into the basin from outside units via pipe lines, aqueducts or other means.

The area of the Carrizo topographic basin up to the crest of its watershed is approximately 416 square miles, or 266,000 acres. Over a long period of years, precipitation of rain over this area has averaged a little more than 8 inches annually. By multiplying the 226,000 acres of watershed by 0.667 foot (8 inches) of precipitation, the gross volume of water falling upon the area averages around 177,000 acre-feet per year.

Of course, not all of this estimated recharge of 177,000 acre-feet of water annually results in stored ground water. From this gross figure must be deducted that amount of water which is discharged from the original source by natural processes plus that which is consumed by pumping from wells.

The amount of ground water which is discharged by natural processes is estimated roughly to be around 118,000 acre-feet annually, or 67 percent of the gross. The amount of water discharged at present by pumping from wells is estimated at the rate of something less than 4,000 acre-feet a year, leaving approximately 55,000 acre-feet to be recovered before it might escape as ground water overflow at the northern end of the structural basin into the Las Yeguas and the San Juan drainage areas. The figures of estimated recharge and discharge are given in the following Table 4.

TABLE 4.- Balance sheet of estimated ground water recharge and discharge for the Carrizo Plain hydrologic unit, San Luis Obispo County, California

Item	Discharge basis: Natural vegetal	Dry-farmed vegetal
	(Acre-feet)	
NATURAL BALANCE		
RECHARGE:		
Gross annual average recharge (266,240 ac. x 0.667 ft.)1/	177,582	177,582
DISCHARGE:		
Evapo-transpiration:		
From Soda Lake natural surface catchment (8,960 ac. x 5 ft.)2/	44,800	44,800
From soil and vegetation3/	46,474	71,871
From springs and seepages (1% of 177,582 ac.-ft.)4/	1,776	1,776
Subtotal	93,050	118,447
Outflow:		
Surface fluvial	0	0
Subsurface5/	84,532	59,135
Subtotal	84,532	59,135
Total natural discharge	177,582	177,582
USE BALANCE		
NET AVERAGE ANNUAL RECHARGE:		
Subsurface outflow5/	84,532	59,130
USE DISCHARGE:		
Pumped from wells:		
For irrigation (725 ac. x 5.8 ft.)6/	4,205	4,205
Less return to ground water reservoir (20% of 4,205 ac.-ft.)7/	841	841
Net used for irrigation	3,364	3,364
For household, livestock, and community (89 wells av. 6 ft.)8/	534	534
Total pumpage net discharge	3,898	3,898
UNUSED BALANCE AVAILABLE FOR USE	80,634	55,232

1/ Basis: 266,240 ac. total area of Carrizo watershed times average annual precipitation of 8 inches (0.667 ft.) per year.

2/ Basis: water area of lake 8,960 ac. times average depth of 5 ft. at height of rainy season all of which water is evaporated during summer.

3/ Based on observations by U.S.G.S. for Cuyama Valley that natural discharge is nearly two-thirds of total discharge (pumpage plus natural discharge). Thus, 66.7 per cent of 177,582 equals 118,447 minus (44,800 plus 1,776) equals 71,871 ac. ft. estimated evaporated from soil and transpiration through vegetation.

4/ Rough estimate based on natural flow from springs and other seepages in general.

5/ Based on natural subsurface reservoirs being filled to capacity whence subsurface recharge waters will move northward along underflow conduits and overflow into the Las Yeguas and San Juan subsurface drainage areas.

6/ Basis of alfalfa and other forage crops averaging from three to four cuttings per year utilizing an average of 5.8 ft. of net applied water per acre.

7/ Based on observations by U.S.G.S. for Cuyama Valley and discounting for Carrizo conditions.

8/ Based on rough estimate for 89 wells averaging 6 ac. ft. discharge each annually.

WATER RECHARGE

Source, Movement, and Accumulation

Most of the precipitation which falls upon the surface of the Carrizo watershed, seeps into the porous alluvial cover of the basin, and percolates downward into the subsurface reservoir rocks. In times of heavy rainfall or cloudbursts, the surface flow of water may be in the form of swift-flowing rivulets or flash floods of intense but short duration. In these times, considerable water may flow into the Soda Lake depression where it forms a shallow lake sometimes covering as much as 10,000 acres but rapidly diminishing in size, and usually becoming a dry lake bed before the end of the summer.

Eventually, nearly all recharge waters find their way either over the surface or through subsurface channels into various parts of the post-Pliocene water bearing formations. However, during migration, some of the waters may be trapped in underground catchments dammed by faulting or impervious barriers, and rise to the surface in the form of springs or moisture areas.

At times of saturation, ground water discharges naturally by upward leakage into the Soda Lake depression. When this lake is filled to a certain level, the ground waters will tend to move toward the lower sections of the ground water body mainly eastward thence northward along the San Andreas fault; or northward along other structural channels to the northern end of the basin. It is when the ground water body is filled to capacity, that recharge waters will overflow the subsurface north rim of the structural basin and thus maintain the natural balance between recharge and discharge.

Quality of Waters

The quality of waters of the Carrizo Plain is naturally variable. Their quality depends largely on the path of flow and the locality of accumulation of recharge waters. For example, the ground waters of the northern and southern parts of the basin are of considerably better quality than those which migrate into the Soda Lake area. Here the continuing cycle of evaporation-recharge-evaporation over long periods of geologic time has resulted in a high concentration of dissolved minerals in the upper ground-water body above the impervious clay beds near the bottom of the lacustrine Quaternary Alluvium which here is several hundred feet thick. In the deeper ground water bodies beneath this impervious clay barrier in the Soda Lake area are waters of better quality, but the surface and upper ground waters of this area are of poor quality.

In general, the meteoric waters of the Carrizo basin deteriorate in quality as they migrate from the watershed around the periphery of the basin into the Soda Lake area. Those waters which do not reach this area, however, are of from good to fair quality. This change in ground water quality is shown in the analyses of waters from selected wells listed in the following Table 5.

TABLE 5.- Chemical and mineral analyses of ground waters from selected wells in the Carrizo Plain, California

(In parts per million unless otherwise designated)

Township-Range	T29S-R17E	T29S-R18E	T30S-R18E	T29S-R19E	T30S-R18E
Section-well number	13-R1	28-L1	12-N1	31-F1	34-N1
Identification	Cooper	E.R. King	Chilcote	Thompson Spr	Soda Lake
Date sampled	10-22-65	10-22-65	2 - 9-66	9 - 1-54	12-16-63
Temperature					
pH[1]	7.9	7.8	7.9	7.9	8.1
Conductance[2]	832	847	587	1,236	27,500
Ca	40	73	37	67	152
Mg	13	22	17	28	584
Na	125	86	70	166	9,400
K	0.9	1.0	1.2	1.2	1.0
CO_3	0	0	0	0	0
HCO_3	162	227	214	192	353
SO_4	120	144	65	271	7,096
Cl	80	51	33	103	1,085
NO_3	71	41		68	0
F	0.90	0.31	0.50	0.60	0.20
As	0.04	-	-	0.04	-
Boron	0.50	0.23	0.26	0.67	3.12
SiO_2	42	36	26	29	1.0
Total solids/sum	545	546	404	838	28,740
Hardness/NC	154	271	161	283	2,780
Effective salinity	7.24	-	-	23.32	-
Depth (ft)	200	300	550	-	[a]995
Distance to water (ft)	47	41	-	-	10
Output capacity (gpm)	100	500	500	-	-

1/ Hydrogen ion concentration.

2/ EC x 10^6 @ 25° C (Conductance) carries the unit micro mho/cm, and is an indicator of total dissolved solids. For most waters, the total dissolved solids content in parts per million can be approximated by multiplying the conductance by 0.7.

a/ Completed depth; total depth 1,028 feet.

Irrigation.

Criteria commonly used to judge the suitability of water for irrigation are (1) conductance (EC x 10^6 @ 25° C) as an indicator of dissolved solids; (2) chloride concentration; (3) sodium percent; and (4) boron concentration. Tentative standards for the classification of irrigation waters, taking into account these four factors or constituents, are listed in Table 6.

TABLE 6.- Tentative standards for irrigation waters.1/

Factor	Irrigation waters: Class I Excellent to good	Class II Good to injurious	Class III Injurious to unsatisf'ty
Conductance.......	Less than 1,000	1,000-3,000	More than 3,000
Chloride, epm.....	Less than 5	5-10	More than 10
Sodium, percent...	Less than 60	60-75	More than 75
Boron, ppm........	Less than 0.5	0.5-2.0	More than 2.0

1/ Doreen, L.D. Excerpt from paper by. Division of Irrigation, University of California, Davis, Calif., 1958

With the exception of the Soda Lake area, ground waters of the Carrizo Plain fall mostly within Class II, partly in Class I, and rarely in Class III.

Conductance. Conductance is an indicator of total dissolved solids. The presence of excessive amounts of dissolved solids in irrigation water will result in reduced crop yields. Conductance of most of the ground waters in the Carrizo Plain outside of the Soda Lake area is less than 1,000, placing them in the excellent to good category.

Chlorides. Chlorides are not considered essential to plant growth. They may be harmful in high concentrations as they cause subnormal growing rates and the burning of plant leaves. Outside the Soda Lake area, ground waters developed in the Carrizo show a range of from 30 to 100 ppm and probably average less than 60 ppm, placing them in the excellent to good category. Their epm value in general is less than 5.

Sodium. Water containing high percent sodium[16/] can have an adverse affect on the physical structure of the soil by dispersing the soil colloids and making the soil "tight", thus retarding the movement of water through the soil. This, in turn, retards the percolation of water and makes the soil difficult to work. However, because most of the soils of the Carrizo are open, deep percolation of water is easily accomplished. Sodium percent in most of the shallower Carrizo waters is rather high. They probably average 75 percent, placing them in the injurious to unsatisfactory

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[16/] Percent sodium (Na) as shown in water analysis is the proportion of the sodium cation (negative ion) to the sum of all cations. It is computed by dividing sodium content measured in equivalents per million (epm) by the sum of the calcium, magnesium, and sodium contents also measured in equivalents per million, all multiplied by 100.

category. However, the effective salinity (in epm) of most waters falls within the 7-15 range, placing most of them in the satisfactory category.

Boron. Boron in small amounts (less than 0.1 ppm) is required for the growth of most plants. However, plants usually will not tolerate more than 0.5 to 2 ppm boron depending on the crop concerned. Outside the Soda Lake area, the boron content of Carrizo ground waters rarely exceeds 0.5 ppm but is always present in smaller quantities sufficient for required growth.

Household, Livestock, and Community.

Total hardness is an important factor in determining the suitability of water for household and community use. Compounds of calcium and magnesium are the principal causes of hardness although other substances such as iron, magnesium, aluminum, barium, silica, strontium, and free hydrogen contribute to the total hardness.

Hardness is generally expressed as parts per million of calcium carbonate. Waters containing 100 ppm or less of hardness (as $CaCO_3$) are considered soft; those containing 101 to 200 ppm, moderately hard; and those in excess of 201, ppm, very hard. In general, the ground waters of the Carrizo are moderately hard to very hard, falling within the range 150 ppm to 300 ppm. It is believed that sufficient waters of not over 200 ppm hardness can be developed at selected localities for any moderately-sized community use. Of course, hard waters with proper treatment, can be reduced to acceptable limits.

As for drinking water, most of the waters outside those in the upper ground water bodies in the Soda Lake area, are potable. However, the potability of waters in the Carrizo varies widely, and appropriate analyses for such use should be made of every water developed within the basin.

Industrial and Other

The standards for domestic and municipal use apply in general to industrial use. Depending on the economics of the matter, waters can be treated to provide softening, demineralizing, and other treatment as required. However, it is not likely that the Carrizo within the predictable future will be industrially developed.

Impairment of Water Recharge

The intermittent streams which flow down from the higher portions of the Carrizo watershed and are not absorbed by the loose soils and find their way underground, gather mostly in the Soda Lake depression in the center of the basin. Ultimately, concentration of their mineral constiuents forms the saline and alkaline dry bed of solid residues. Fortunately most of the waters flowing into Soda Lake are retained and evaporated there. Due to the highly impermeable mud and clay bottom of the lake bed little of these contaminated waters percolate downward into the lesser-contaminated waters beneath the highly mineralized upper (Soda Lake) ground-water body.

Of course, locally, some contamination takes place in other parts of the basin. Increased mineralization has been noted in some localities where the ground water is exposed to faulted and fractured gouge zones containing water soluble materials. However, outside the San Andreas fault zone and along a few other major lines of faulting, impurities from these conditions do not play an important part in ground-water contamination in the Carrizo basin. Although the quality of ground waters may vary considerably from one locality to another depending on local conditions, outside of the Soda Lake area, impairment of ground waters in the Carrizo basin is believed not to be such as to preclude adaptability of most of the waters to the uses desired.

In localities where residential subdivision requires that each unit develop its own domestic water from wells, and at the same locality dispose of its own sewage by underground septic means, there is, of course, a condition for contamination which should be recognized.

Irrigation of agricultural crops requires application of water in excess of the consumptive requirement for water in order to prevent undue build-up of salts in the root zones. This excess water may contain from two to as many as ten times the salt concentrations found in the original water supply. In areas where irrigation return water can percolate to the ground water, it may constitute a source of degradation to the water supply. However, proper disposal of irrigation runoff can largely solve this problem.

WATER DISCHARGE

Natural Processes[17/]

The discharge of ground water by natural processes in the Carrizo Plain takes place mainly in three ways: (1) through evapo-transpiration (evaporation at the surface from zones of saturation, and transpiration by vegetation); (2) through springs and seepages (discharge of water in the liquid state without the agency of man); and (3) through underflow conduits. A fourth way, through surface water outflow, does not apply to the Carrizo basin.

17/ Most definitions used in the paragraphs following are those of Meinzer. Meinzer, O. E. Outline of Ground-water Hydrology with Definitions. U.S. Dept. of the Interior, Geological Survey: Water-supply Paper 494: U.S. House of Representatives, 67th Congress, 2nd Session, Doc. No. 209. Government Printing Office, Washington, D.C., 1923.

Ground-water discharge may be divided into hydraulic discharge and evaporation discharge. Hydraulic discharge of ground water is discharge of water in the liquid state directly from the zone of saturation upon the land into a body of surface water. Hydraulic discharge may be divided into (a) discharge through springs and seepages; and (b) discharge through wells and other man-made devises.[18] Evaporation discharge of ground water is discharge into the atmosphere, in a gaseous state, of water derived from the zone of saturation.

Evapo-transpiration

Evaporation discharge of ground water may be divided into (a) vegetal discharge and (b) soil discharge. Vegetal discharge of ground water is discharge through the physiological functioning of plants. The water may be taken into the roots of plants directly from the zone of saturation or from the capillary fringe, which in turn is supplied from the zone of saturation. It is discharged from the plants by a process of transpiration.[19] Soil discharge of ground water is discharge through evaporation directly from the soil or rocks. Discharge of this kind can only take place where the water table is close to the surface.

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[18] This latter category of discharge, subsection (b), is not a natural process. It is, therefore, considered below under "Pumping from Wells."

[19] Transpiration. In bot., the exhalation of watery vapor from the surface of aerial parts of plants.

The above evaporation discharges apply to ground water only. In the Carrizo Plain Basin, discharges must also include evaporation of surface waters, nearly all of which accumulate in the Soda Lake bed and are prevented from any extensive downward percolation by the presence of a thick and largely impermeable mud and clay bottom. Thus most of the surface water here is totally evaporated before the end of the long dry summer season. It is estimated that an average of nearly 45,000 acre-feet, or more than 25 percent of the total water falling upon the Carrizo watershed annually, evaporates from this lake.

Natural vegetation in the Carrizo Plain is scant, but planted vegetation of dry-farmed grains is substantial. The losses through natural vegetal transpiration are comparatively small but those through planted non-irrigated vegetal transpiration are large. Soil discharge of subsurface water is large due mainly to the arid conditions prevailing in the Carrizo during most of the year. Together, vegetal and soil discharge is estimated to range from 46,000 acre-feet to 72,000 acre-feet per year, depending on the extent of non-irrigated crops.

Springs and Seepages

There are few springs of importance in the Carrizo Plain but there are areas of substantial seepages of perched waters along some fault lines, especially during times of heavy rainfall. Even so, hydraulic discharge from these natural vents combined is not believed to be large in comparison to the whole. It is estimated at less than 2,000 acre-feet per year.

Underflow Conduits

Underflow is the movement of ground water in an underflow conduit. An underflow conduit consists of a permeable deposit which underlies a surface streamway but as herein used, the term also includes those natural subsurface conduits in the form of buried streams at or near the base of the water-bearing formations. These buried underflow conduits connect with underground reservoirs which, as they are filled with recharge waters, permit excess ground waters to flow downdip to points where such waters overflow into lower subterranean reservoirs outside the Carrizo structural basin.

As ground water is withdrawn from the water body by pumping or other means, this underflow may be lessened or prevented. In the case of the Carrizo, it is estimated that the 55,000 - 80,000 acre-feet of ground-water recharge annually, most of which currently escapes the basin as underflow, could be captured by pumping this additional amount from properly-located wells.

Surface Water Outflow

There is no surface water outflow from the Carrizo topographic basin. This situation means that all of the waters falling upon the Carrizo watershed which do not find their way underground evaporate before they do so, or are consumed through transpiration, collect in the Soda Lake depression whence they in part percolate underground but are mostly ultimately evaporated. Because there is no surface outflow, the amount of water in this lake (or the depth of the water table below the lake bed when it is dry) functions, more or less, as a barometer which indicates the degree to which the ground-water body of the Carrizo is filled.

Unlike the Cuyama hydrologic unit joining the Carrizo on the south, which has a much larger watershed and gross recharge than the Carrizo, the Cuyama has a large surface outflow mainly down the Cuyama River. As a result the Cuyama Basin has even a lesser average annual net recharge than the Carrizo.[20]

Pumping from Wells

To date, the discharge of ground water in the Carrizo Plain through pumping from wells has been small. As heretofore pointed out, the total net amount of ground water being withdrawn through wells is currently at the rate of less than 4,000 acre-feet annually, or less than 5 percent of

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[20] For the Cuyama, "Olmstead and Bradshaw estimate average yearly recharge to be about 12,000 acre-feet, and the United States Bureau of Reclamation estimates it to be not more than 8,000 acre-feet." Upson, J.E. and G.F. Worts, Jr., Ground Water in the Cuyama Valley, California. Geological Survey Water-Supply Paper 1110-B, p. 47, U.S. Department of the Interior, Washington, D.C., 1951.

the estimated maximum average annual recharge, and less than 7 percent of the minimum average annual recharge (see Table 4, p. 40).

Well Classification and Numbering

Data from the pumping of water wells together with those data from other perforations into the subsurface, such as bore holes for oil and gas, are used in determining the potentialities of ground water development. In the Carrizo Plain 89 wells have been drilled for water, 43 deep test wells have been drilled for oil and gas, and 19 shallower core holes have been drilled for stratigraphic information relating to oil and gas exploration. All of these wells have been invaluable to the interpretation of the ground water potentialities of the Carrizo. Water wells are listed in Table 8 . Following is a classification of wells, the number drilled, and range in depths for each class of well drilled in the Carrizo Plain to date.

TABLE 7.- Classification of wells, number drilled, and range in depths in the Carrizo Plain area, California, January 1, 1967

Class of wells	Number drilled		Depth range (feet)	
Water wells:				
Irrigation wells..................	11		200- 700	
Household and livestock wells.....	89		50- 100	
Community wells...................	3		550-1,865	
Total water wells........................		103.....................		50- 1,865
Wells for oil and gas:				
Exploratory wells.................	43		1,443-11,684	
Core holes........................	19		568- 3,906	
Total wells for oil and gas.............		62.....................		568-11,684
Total wells:.............................		165.....................		50-11,684

Water Wells. Water wells are numbered within each of sixteen 40-acre plots in a 640-acre section according to the chronological order in which they are located in the plot. For example, a well in Township 29 South, Range 18 East, in Section 28 and plot L, and the third well to be drilled in that plot, would be designated as T29S-R18E/S28-L3. Most of the wells in the Carrizo Plain refer to the Mount Diablo Base Line and Meridian (MDB&M) except those in the southernmost part of the plain where the numbers refer to the San Bernardino Base Line and Meridian (SBB&M). Following is a diagram showing the water well numbering system.

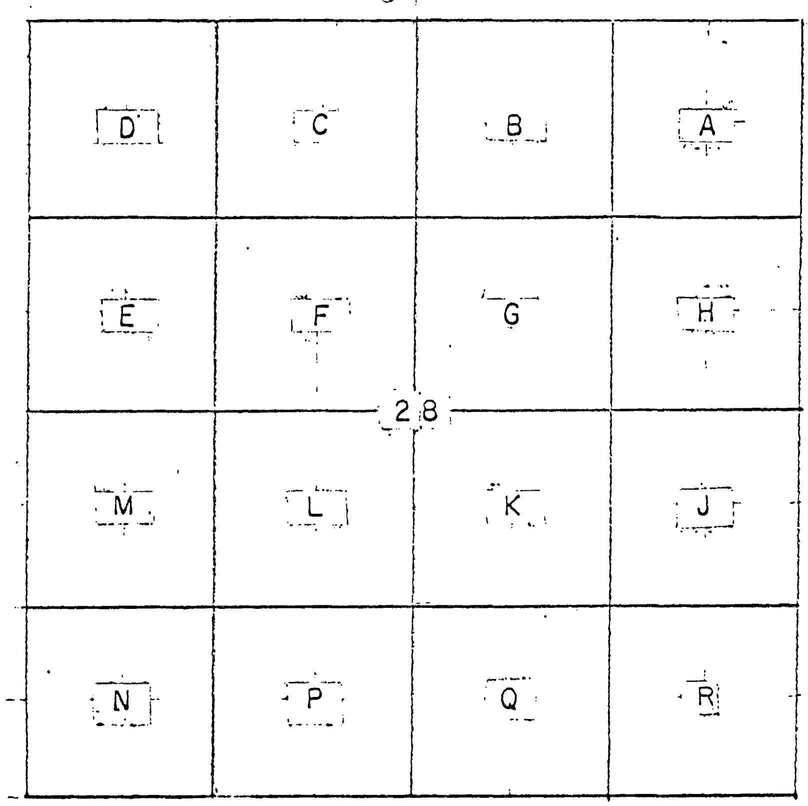

TABLE 8.- List of water wells in the Carrizo Plain area, San Luis Obispo County, California, January 1, 1967, by township, range, and section

Township-Range Sec.-well no.	Property or owner	Year completed	Total depth (feet)	Depth to water (feet)	Water level above sea-level (ft)	Rated capacity (gpm)	Remarks
T28S-R17E							
S17-C1........							Windmill
S18-L1........							Windmill
S22-F1........							Domestic 1/
T28S-R18E							
S18-A1........							Pinole Spring
S20-C1........	W.Wreden	pre-1958	105	48	2,302	-	Windmill
S20-E1........	W.Wreden	-					Windmill
S28-H1........		pre-1958			2,405		Windmill;not in u
S34-A1........	W.Wreden						Windmill
T29S-R17E							
S2-F1.........							Carnaza Spring
S11-H1........	H.Wredeh	pre-1958	200	40	2,030		Irrigation
S13-R1........	R.Cooper	pre-1958	200	35	2,006	100	Irrigation
S25-J1........		pre-1958	80	59	1,994		Windmill
T29S-R18E							
S14-D1........	C.Wreden						Mustang Spring
S16-M1........	Polin	pre-1958	100	37	2,043		Domestic
S20-E1........	Polin	pre-1958	-	19	2,015		Windmill;not in u
S21-P1........	Lewis	pre-1958	70	35	2,005		Windmill
S28-G1........	King	1964					Irrigation
S28-K1........	W.King	pre-1958	500				Irrigation;abd.
S28-L1........	W.King	pr9-1958	175	31			Domestic
S28-L2........	King	pre-1958	325				Irrigation;abd.
S28-L3........	King	1965	600				Irrigation
S29-E1........	Lewis	pre-1958	700	36	1,995	500	Irrigation
S30-N1........	Garcia	1918	80				Domestic
T29S-R19E							
S31-F1........	Beck	pre-1958	16	10			Domestic
S31-F2........	Beck						Thompson Spring
T30S-R18E							
S1 -B1........							
S1 -B2........							
S1 -G1........							
S1- D1........		pre-1958					Domestic
S1 -L1........		pre-1958					Domestic
S2 -D1........		pre-1958					Irrigation
S3 -E1........	King	pre-1958	300	41	1,944	600	Irrigation
S3 -D1........	F.King	pre-1958	600	22	1,978	1,100	Irrigation
S4 -R1........							
S9 -B1........							
S12-N1........	Chilcote	1963	550				Community
S13-M1........	Smith	pre-1958	285	13	1,968	500	Irrigation
S14-A1........							
S14-A2........		pre-1958					

(Continued...

1/ "Domestic" includes household, livestock, etc.

TABLE 8.- (Continued)

Well location Township-Range Sec.-Well no.	Property or owner	Year completed	Total depth (feet)	Depth to water (feet	Water level above sea-level (ft)	Rated capacity (gpm)	Remarks
T30RR18E (Continued)							
S17-G1.......							Domestic
S23-B1.......							Domestic
S23-D1.......							Domestic
S25-B1.......							Domestic
T30S-R19E							
S1-B1.......							Spring
S2-H1.......	Martins	pre-1958	250				Domestic;not used
S8-E1.......							Domestic
S19-K1.......							Domestic
S19-L1.......							Domestic
S19-P1.......							Domestic
S22-H1.......							Domestic
S22-K1.......							Domestic
S23-J1.......							Domestic
S23-J2.......							Domestic
S23-K1.......							Domestic
S23-M1.......							Domestic
S24-E1.......							Domestic
S25-D1.......							Domestic
S27-A1.......							Domestic
S27-B1.......							Domestic
S27-H1.......							Domestic
S29-K1.......							Domestic
S29-M1.......		pre-1958					Domestic
S29-M2.......		pre-1958					Domestic
S29-N1.......							Domestic
S29-Q1.......							Domestic
S29-Q2.......							Domestic
S30-A1.......							Domestic
S30-G1.......							Domestic
S30-G2.......							Domestic
S30-J1.......							Domestic
S30-L1.......							Domestic
S30-R1.......							Domestic
S32-C1.......							Domestic
S32-G1.......							Domestic
S32-G2.......							Domestic
S32-J1.......							Domestic
S32-J2.......							Domestic
S34-L1.......	Cal.Valley	1962	1,019	10			Community;comp.995'
S34-M2.......	Cal.Valley	1962	1,865				Community
S36-P1.......							Domestic

(Continued...

TABLE 8.- (Continued)

Well location Township-Range Sec.-Well no.	Property or owner	Year completed	Total depth (feet)	Depth to water (feet)	Water level above sea-level (ft)	Rated capacity (gpm)	Remarks
T30S-R20E							
S17-Q1.......							Domestic
S18-C1.......							Domestic
S19-M1.......							Domestic
S20-G1.......							Domestic
S20-M1.......							Domestic
S29-M2.......							Domestic
S29-E1.......							Domestic
S30-K1.......							Domestic
S31-E1.......							Domestic
S31-C1.......							Domestic
S33-N1.......							Domestic
T31S-R19E							
S 3-L1.......	Goodwin						Domestic
S10-A1.......	Goodwin						Domestic
S24-H1.......		pre-1958					Domestic
T31S-R20E							
S 4-H1.......		pre-1958					Domestic
S 5-L1.......							Domestic
S 5-R1.......							Domestic
S10-G1.......							Domestic
S11-M1.......							Domestic
S30-K1.......							Domestic
T32S-R20E							
S 4-H1.......							Domestic
S15-D1.......							Domestic
S16-D1.......							Domestic
S21-G1.......							Five Willow Spr
S22-A1.......							Domestic
T32S-R21E							
S18-A1.......		pre-1958					Domestic
T32S-R22E							
S32-L1.......							Domestic
S32-L2.......							Domestic
T11N-R26W							
S2-C1.......							Domestic

Exploratory Wells for Oil and Gas. Exploratory wells for oil and gas, and core holes for stratigraphic information relating to oil and gas are named and numbered in a fairly conformable manner but they do not correspond to the standardized system used for water wells. Wells and core holes relating to oil and gas usually first bear the name of the owner of the well, such as Shell Oil Company. This is followed by the name of the property owner or some other more or less arbitrary name like "McDonald Estate- One." Lastly, will appear any one or a combination of figures such as a number in the well owner's drilling pattern, the sequence in which the well was drilled, or the number of the Section in which the well is drilled such as 83-25. Thus this well would be designated Shell Oil Company "McDonald Estate- One" 83-25. The list of wells in Table 8 indicates the manner of naming and numbering wells in this category.

TABLE 9.- List of wells drilled for oil and gas and core holes drilled for geological information in the Carrizo Plain, San Luis Obispo County, California

Well location Township-Range Sec.-Well no.	Company	Name	Number	Total depth	Year ab'd	Elevation ground above SL(ft)	Remarks
T27S-R17E							
S17-	Shell	C.H.1/	87-17	2,995	1949	2,000	Basement
T28S-R17E							
S24-	Sunray	Wreden	1	5,087	1936	2,269	Sta Margarita 12
S29-	San Juan	Wreden	1	4,770	1917	927	
S33-	Union	Wreden	4	5,113	1949	2,107	Sta Margarita 12
T28S-R18E							
S26-	Carrizo	Carrizo	1	2,204	1950	2,325	Paso Robles 2204
S34-	Grey	Wreden	1	2,773	1965	2,419	
S36-	Reid	Intex-	67-36	5,204	1949		
T29S-R17E							
S24-	Shell	Stauffer	41-24	5,120	1955	2,062	
S24-	Shell	C.H.	46X-24			2,073	
S24-	Shell	C.H.	47X-24	810	1952	2,077	
S24-	Shell	C.H.	55X-24	781	1954	2,060	
S24-	Shell	C.H.	56X-24	644	1954	2,075	
S24-	Shell	C.H.	65X-24				
S24-	Shell	C.H.	72X-24	568	1952	2,063	
S25-	Shell	McDonald-	83-25	4,921	1953	2,039	
T29S-R18E							
S 1-	Union	Wreden	7	3,700	1949	2,515	
S 5-	Union	Wreden	5	6,655	1949	2,166	Sta Margarita 16(
S 5-	Sunray	Wreden	63-5	10,995	1952	2,176	
S10-	Young	Mustang	61X	3,676	1957	2,295	Sta Margarita 25?
S10-	Young	Jaramas	1	3,402	1958	2,278	
S30-	Shell	Lewis	56-30	9,681	1955	2,028	Temblor 1070
S30-	Shell	C.H.	76-30	3,497	1949	2,010	
S30-	Shell	McDonald-	28-30	11,684	1951	2,064	
S30-	Shell	C.H.	13X-30	880	1952	2,038	
S30-	Shell	C.H.	14X-30	1,001	1952	2,041	
S30-	Shell	C.H.	37X-30	1,216	1952	2,033	
T29S-R19E							
S20-	Associated	-	1	3,506	1918	2,337	
T30S-R18E							
S 5-	Shell	C.H.	71-5	2,245	1949	1,998	
S 5-	Shell	C.H.	58X-5	943	1954	2,080	
S 5-	Shell	C.H.	58Y-5	1,171	1954	2,057	
S 5-	Shell	C.H.	67X-5	976	1954	2,035	
S 8-	Shell	C.H.	32X-8	1,205	1954	2,145	

1/ Core hole

(Continued...

TABLE 9.- (Continued)

Well location Township-Range Sec.-Well no.	Company	Name	Number	Total depth	Year ab'd	Elevation ground above SL (ft)	Remarks
T30S-R19E							
S 8-	Shell	Smith	61-8	7,556	1955	2,144	
S15-	Shell	Twisselman	84-15	4,350	1951	1,999	
S16-	Shell	C.H.	36-16	3,906	1949	1,958	
S18-	Dawson	C.H.	2	2,091	1955	1,955	
S19-	Dawson	C.H.	1	1,506	1955	2,000	
S19-	Shell	C.H.	48X-19	628	1954	1,943	
S19-	Shell	C.H.	48Y-19	904	1954	1,945	
S22-	Shell	Smith	32-22	5,506	1954	1,950	Paso Robles 2155 (bot
S30-	Shell	C.H.	51X-30	714	1954	1,947	
S30-	Shell	C.H.	51Y-30	675	1954	1,970	
S30-	Shell	C.H.	57X-30	1,216	1952		
S30-	Shell	C.H.	41X-30	800	1954	1,943	
T30S-R20E							
S31-	Berry	-	1	2,885	1921		
T31S-R19E							
S12-	von Glahn	Soda Lake	1	2,575	1949	1,964	
T31S-R20E							
S 5-	McCarthy	Polizzoto	88-5	4,785	1949	1,944	
S20-	Richfield	Blakey	1	2,462	1942	1,924	
T32S-R20E							
S 1-	Sunray	Barnsdall-	1	5,217	1957	1,938	
S16-	Texaco	Blakey	1	6,324	1950	2,360	
S36-	von Glahn	Washburn	1	7,203	1954	2,560	
T32S-R21E							
S22-	Howell	Pam	1	86	1949		
T11N-R25W							
S19-	Carlisle	-	1	2,690	1926	2,500	Cretaceous ?
T11N-R26E							
S 2-	G.& W. Oil	-	1	1,714	1964		
S3 -	Murray	North Dome	1	2,330	1948	2,175	
S 6-	Navy Oil	Navy	2	3,024	1952		
S 6-	D & D	-	1	1,905	1950	2,400	Pleistocene 2,400 ?
S 9-	Mid Cal	Community	1	1,445	1949		Pliocene 2,200 ?
S 9-	Mid Cal	C.H.	C-9	1,190	1949		Pleistocene 2,355 ?
S12-	Texaco	KCL-Travers	1	5,999	1954		
S12-	Lewis	-	1	2,312	1920		Miocene 2,300 ?
S15-	Meeker	Smith	1	2,714	1950		Pliocene 2,692

Fluctuations in the Ground Water Level

Fluctuations in the ground water levels of the Carrizo Basin have been of low amplitude between seasonal periods of recharge and discharge mainly because pumping from wells has been relatively small and the long-term balance between recharge and discharge has been little disturbed. Depth to the ground water table in the central Soda Lake area, even when the lake bed is dry, is rarely more than 10 feet below the surface. Away from the lake bed proper, the water level is encountered at from 20 to 70 feet below the surface. Contours on the top of the Soda Lake ground water table range in elevation above sea level from 1,910 feet at its lowest point in the center of this depression, to more than 1,980 feet along its periphery.

Below the Soda Lake ground water body in the lower Recent Alluvium and upper Pleistocene Paso Robles formation is the more extensive Carrizo ground water body confined to the middle and lower Paso Robles and which has been tapped by the deeper irrigation wells in the northwestern part of the basin.[21/] Data relating to the water level of the Carrizo ground water body are limited to a few wells,

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[21/] A confined water body is a body of ground water overlain by materials sufficiently impervious to sever free hydraulic connection with overlying water, and moving under pressure caused by the difference in head between intake and discharge areas of a confined water body.

but such data as are available show that the depth to water below the surface in this area ranges from around 40 to 80 feet below the surface. Contours on the top of the Carrizo water body range from 1,970 feet above sea level just south of State Highway 58 to 2,040 feet 4 miles to the north.

In neither of these ground water bodies have enough wells been drilled or has sufficient water been discharged from wells to lower the ground waters from their original levels established by the natural balance between recharge and discharge. Measurements of drawdown[22/] and specific capacity[23/] have not been made over any regular periods of time to indicate appreciable changes in water levels. Even if such records had been kept, it is doubtful that the few wells pumping from the ground water bodies would discharge enough water between the periods of recharge and discharge to show any appreciable change or pattern in ground water levels. Contours on ground water levels of the Soda Lake and the Carrizo ground water bodies are shown in Figure .

22/ Drawdown is the lowering of the water level in a well in the local area around the well caused by pumping, measured in feet.

23/ Specific capacity is the number of gallons per minute per foot of drawdown by a pumping well.

PROSPECTIVE REQUIREMENTS IN RELATION TO POTENTIAL SUPPLY

The over-all requirements for ground water in the Carrizo Plain in the long run are certain to be in excess of the ground water supply--not because the water supply is small (which it is not) but because the area of irrigable land is so large. There exists within the Carrizo, a potential area of irrigable land of around 100,000 acres. To irrigate all of this acreage for pasture, alfalfa, hay and grain and a few other crops, would require some 172,000 acre-feet of water annually, or practically as much as the total rainfall over the Carrizo watershed.

Actually, only from less than one-third (31%) to less than one-half (45%) of the 177,000 acre-feet of water falling upon the Carrizo watershed annually, or from 55,000 acre-feet to 80,000 acre-feet of ground water annually is estimated to be available for irrigation of these selected crops, depending largely on the acreage of crops dry-farmed. As is indicated in Table 10 , these amounts of ground water recharge would be sufficient to irrigate from 32,000 to 46,000 acres of land.

It is anticipated that the predominant irrigated crops under ultimate conditions in the Carrizo will be pasture, alfalfa, hay and grain. It is anticipated that the livestock industry will increase in valuation with a

TABLE 10.- Estimates of ground water required for irrigation of selected crops in the Carrizo Plain Basin based on irrigable land and on ground water available[1]

Crop	Unit of applied water (feet of depth)[3]	On basis of irrigable land available: Land[2] available (acres)	On basis of irrigable land available: Water required (acre-feet)	On basis of ground water available — Maximum: Water available (acre-feet)	Maximum: Land required (acres)	Minimum: Water available (acre-feet)	Minimum: Land required (acres)
Pasture........	[a] 3.2	19,000	60,800	36,160	11,300	24,854	7,767
Alfalfa........	[a] 3.2	20,000	64,000	20,089	6,278	13,808	4,315
Hay and grain...	0.7	53,800	37,600	14,464	20,663	9,942	14,203
Truck and Misc..	1.7	6,700	11,390	6,428	3,781	4,419	2,599
Subtotal......	1.84	99,500	173,850	77,142	42,022	53,023	28,884
Domestic	[b] 0.8	1,000	800	3,214	4,017	2,209	2,761
Total.........	1.75	100,500	174,650	80,356	46,039	55,232	31,645

[1] No factor has been applied for return of irrigation water to the ground water body.

[2] Probable ultimate water service according to the Calif. Dept. of Water Resources, *ibid.*, p. 131.

[3] To obtain total seasonal consumption, add 0.7 ft. from precipitation.

[a] Based on average of 3 crops per year.

[b] Irrigation equivalent for domestic consumption (household, livestock, and community.

greater proportion of the animals being raised on permanent pasture. Demand will increase for supplemental feed, and proportional increases are expected for irrigated hay and grain.

Under ultimate conditions of development in the Carrizo Plain Unit, it is assumed that lands will remain in relatively large holdings as at present, and that most of the urban development serving that unit will continue to be located outside of the Unit. Of course some subdivisions may take place in the form of small plots for intermittent residence by persons desiring to take advantage of the clean air and invigorating climate but such subdivisions are not expected to result in any large permanent settlements of the urban type.

PERENNIAL YIELD

The rate at which water can be withdrawn year after year without depleting the ground water storage to such an extent that a withdrawal at this rate is no longer feasible because of increased pumping costs or deterioration of water quality is called the perennial yield.

In the case of the Carrizo Basin, the perennial yield would probably amount to the quantity of that underflow of ground water recharge which may be recovered before such water overflows the natural underground spillway at the northern end of the structural basin into the Las Yeguas and San Juan drainage areas. Such recovery could amount to from 55,000 to 80,000 acre-feet, the minimum and maximum estimates to flow annually out of the underground basin through natural underflow conduits as a result of keeping the natural balance between recharge and discharge.

In a newly-developed basin such as the Carrizo Plain, there is usually a large amount of stored water that can be drawn upon before the economic limit of pumping is approached. As this limit is approached, the yearly rate at which withdrawals can be made then becomes the difference between average yearly recharge and the average yearly natural discharge.

At the present stage of ground water development in the Carrizo, it is practically impossible to ascertain within a reasonable degree of accuracy what the economic limit of recovering such waters with the maximum of efficiency and minimum of waste might be. To arrive at a practical figure of perennial yield involves the collection of much basic data such as adequate coverage of accurate precipitation records, monthly measurements of water levels in observation wells, measurement of drawdown and water levels, and estimate of ground water flow by field tests of permeability.

SAFE YIELD

The maximum rate of net extraction from the ground water basin which, if continued over an indefinitely long period of years, and would result in maintenance of certain desirable fixed conditions, is termed the <u>safe yield</u>. The calculation of safe yield is dependent on many factors such as one or more of the following conditions:

1. Mean seasonal extraction of water from the ground water basin does not exceed mean seasonal replacement to the basin.

2. Water levels are not so lowered as to cause harmful impairment of quality of the ground water by intrusion of other water of undesirable quality, or by accumulation and concentration of objectionable elements.

3. Water levels are not so lowered as to imperil the economy of ground water users by excessive costs of pumping from the ground water basin or by exclusion of the users from a supply therefrom.

Despite any favorable balance between water supply and demand, there are always drawbacks to total water development, and especially so in the Carrizo.

With further utilization of water and the resultant lowering of ground water levels, a mixing of water and consequent degradation of the better quality water is possible. Also, the threat of an unfavorable salt balance, which is likely to build up through constant re-use of irrigation return flow if lands overlying the basin were extensively irrigated, would tend to limit the yield which could be obtained. However, only further development of ground waters from the several reservoirs of different geological ages will prove the various qualities of waters to be dealt with whence application can be so distributed and otherwise controlled through a system of unit operation or cooperation in the best interests of conservation and quality control.

It is believed that the Soda Lake depression may function as a disposal pond for irrigation runoff where most of the salts could be deposited and concentrated through evaporation as has been done naturally over the years. Thus the problem of return irrigation flows may be solved. With full development of the irrigable acreage, the lake may increase in size until a stabilized condition would be reached wherein the net evaporation from the lake surface would equal the total return flow from the applied irrigation water.

CLASSIFICATION OF LAND FOR GROUND WATER DEVELOPMENT

The total area of arable land in the Carrizo Plain spreads over the entire area of the topographic basin floor which is estimated to cover some 350 square miles, or 224,000 acres. About half of this vast acreage, or around 100,000 acres is irrigable, and there is calculated to be enough ground water available to irrigate an average of around 40,000 acres annually for pasture, alfalfa, hay and grain. Just how much of the available ground water is to be applied to which lands for what crops are factors to be determined by the economics of the problems. In general, however, it is supposed that most of the lands to be irrigated will follow the paths where most ground water can be developed, and any classification of land for ground-water development will follow that pattern.

Broadly, the classification presented herein is on the basis of soil and topography in relation to the amount and quality of the ground-water potential by areas. The Plain is divided into the North Carrizo, Central (Soda Lake) Carrizo, and South Carrizo. The areal extent of the ground-water bodies in these respective divisions of the Plain, are outlined in Figure .

NORTH CARRIZO

This area, north of the northern limits of the Soda Lake depression, offers the best soil and most favorable topography, and the best quality and largest quantity of ground water in the Carrizo. The main subterranean channel of ground water underflow curves northwestward in a band averaging something more than two miles wide through the area. Within the confines of this underflow, the water-bearing formations range in thickness from 200 to 900 feet, but porosity, permeability, and compactness of the individual water "sands" are highly variable. Water-bearing sands are often fine-grained and loosely consolidated, giving considerable trouble to inexperienced well drillers. However, with proper drilling and completion technique, wells which are favorably located and intelligently spaced should result in output capacities within the range of from 500 to 1,000 gallons per minute from depths ranging from 500 to 1,000 feet.

In addition to this northwestern belt of ground water, another underflow conduit lies along the western side of the San Andreas fault zone. Here, no deep wells have yet been drilled to test ground-water capacity or quality. It may be that the shallower waters would be too contaminated with soluble mineral salts and alkalis and that "fresh" waters would lie too deep for commercial exploitation, but both zones are worthy of tests. Depths to ground water here would be within the 500 to 1,500-feet range, but surface elevations of the well heads might be high enough to irrigate some of the hill lands.

CENTRAL (SODA LAKE) CARRIZO

This area is confined to the Soda Lake bed and its immediate borders. It is the least attractive for ground-water development from the standpoint of soil and water quality. The Soda Lake ground water body is so contaminated with mineral salts and alkalis that it would not serve for either irrigation or most other uses. These waters lie at depths of from a few feet to several hundred feet below the surface of the lake bed and only two wells are known to have tested them both unsuccessfully.

Underlying the Soda Lake water body eastward, is the deeper-seated Carrizo ground-water body which contains waters of qualities generally adaptable to irrigation and most other uses. These better waters, however, lie at depths ranging from 900 to 1,300 feet below the surface. Eastward from the Soda Lake bed, the soils improve in character but the depths to the better ground waters increase. It is a question, therefore, whether exploitation of these deeper waters in this area would be profitable.

SOUTH CARRIZO

This area affords naturally, excellent conditions for seasonal livestock grazing but not for any extensive program of irrigation. Eastward, along the San Andreas fault zone, the water-bearing Paso Robles formation is more than 3,000 feet thick, and may hold considerable water where the porosity and permeability of the beds are suitable. This zone has not been tested. Excepting possibly in the northeast quarter of the area, the Carrizo ground-water body may lie too deep below the surface to be commercially exploitable.

The southwestern part of the South Carrizo may hold considerable ground water in the "Morales Sub-Basin" (see Figures 6 and 7 on pages 30 and 30a) which is well developed here. However, no wells have yet tested this sub-basin. If sufficient water should be available, the comparatively higher elevation of the locality would afford irrigation of large acreages of the irrigable land lying at lower elevations in this area.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The conclusions drawn from this preliminary investigation of ground water in the Carrizo Plain Basin are as follows:

1. The ground water resources of the Carrizo Plain Basin have been developed enough to prove the actual existence and application of considerable ground water for irrigation and other uses. It is estimated that a minimum of less than 5 percent, and a maximum of slightly more than 7 percent, of the estimated average net annual ground water recharge is currently being pumped from wells.

2. There appear to be two distinctive ground water bodies underlying the Carrizo Plain; (1) the Soda Lake in the central part of the Plain; and (2) the Carrizo, extending beneath nearly all of the Plain. The waters of the Soda Lake ground water body are contaminated with a variety of soluble mineral salts and other impurities enough to make them practically useless for irrigation and other water requirements. The waters of the Carrizo ground water body are generally of good to fair quality and are adaptable for irrigation and most other water requirements.

3. The average net recharge of ground water to the Carrizo ground-water body will range from a minimum of around 55,000 acre-feet annually to a maximum of 80,000 acre-feet, depending largely on the amount of vegetal discharge related to the acreage of dry-farmed (non-irrigated) crops sown.

4. It is believed that the ultimate requirements for ground water in the Carrizo Plain area will be mostly for the irrigation of pasture and other forage crops and supplementary feeds for an expanded live-stock industry. A safe yield minimum of 55,000 acre-feet of ground water available annually would be sufficient to irrigate approximately 32,000 acres of land in these crops; and the maximum of 80,000 acre-feet would be sufficient for 46,000 acres.

5. During periods of recharge deficiency, the reserves in natural underground reservoirsare believed to be large enough to permit withdrawal therefrom for a number of years until the average annual natural balance between recharge and discharge is reestablished.

6, The Soda Lake bed has been functioning naturally throughout geologic time as a disposal pond for the collection of surface waters, and could serve the same purpose for surplus irrigation waters which become contaminated by re-use, and are not reabsorbed into the subsoil.

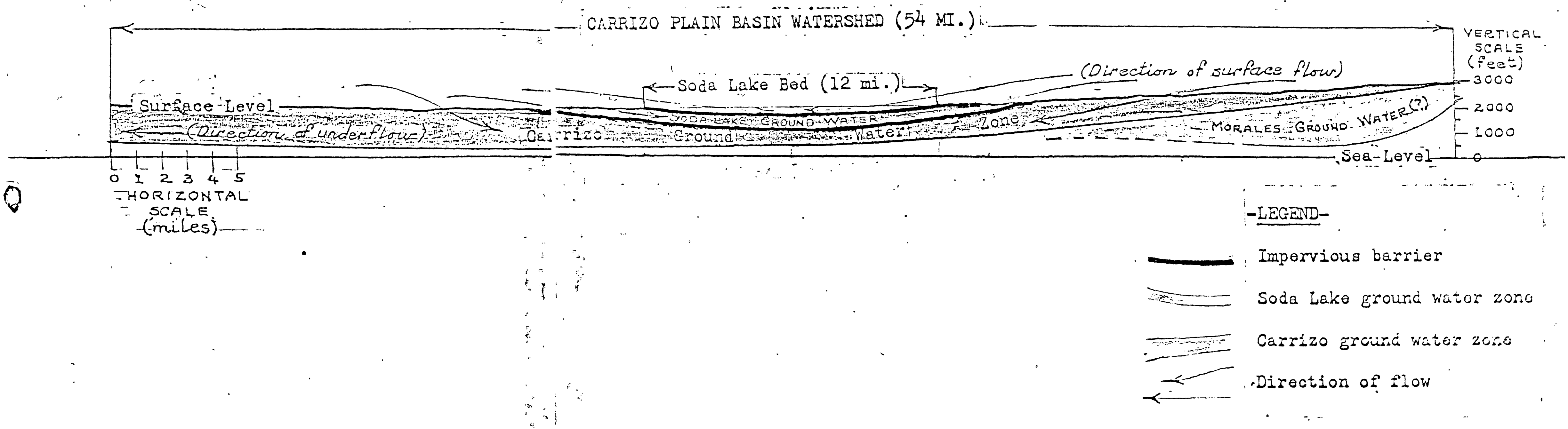


FIGURE 9.- Longitudinal section showing relative positions of the main ground water zones in the Carrizo Plain Basin, California. (Section is along a northwest-southeast line through the center of the Soda Lake depression)

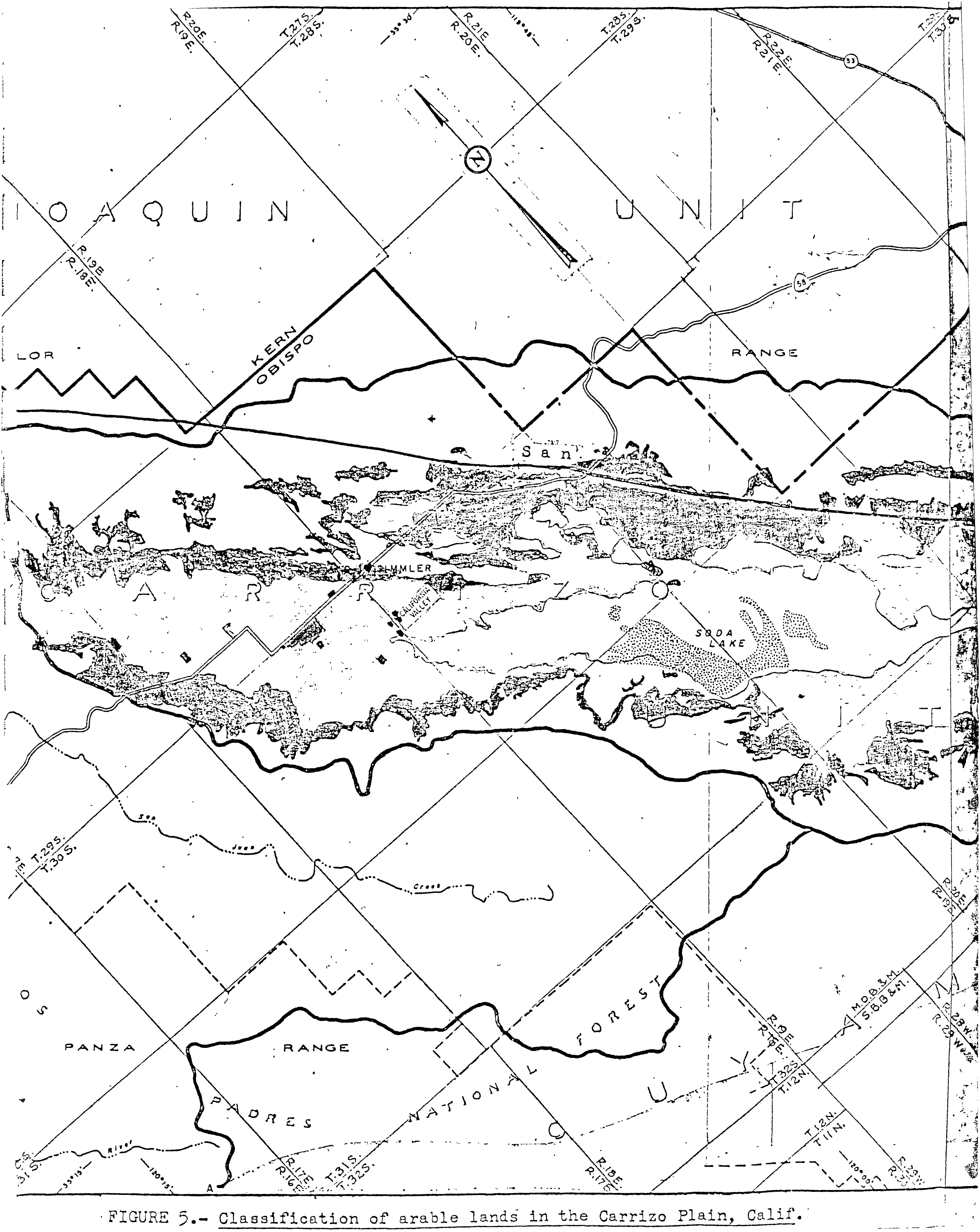
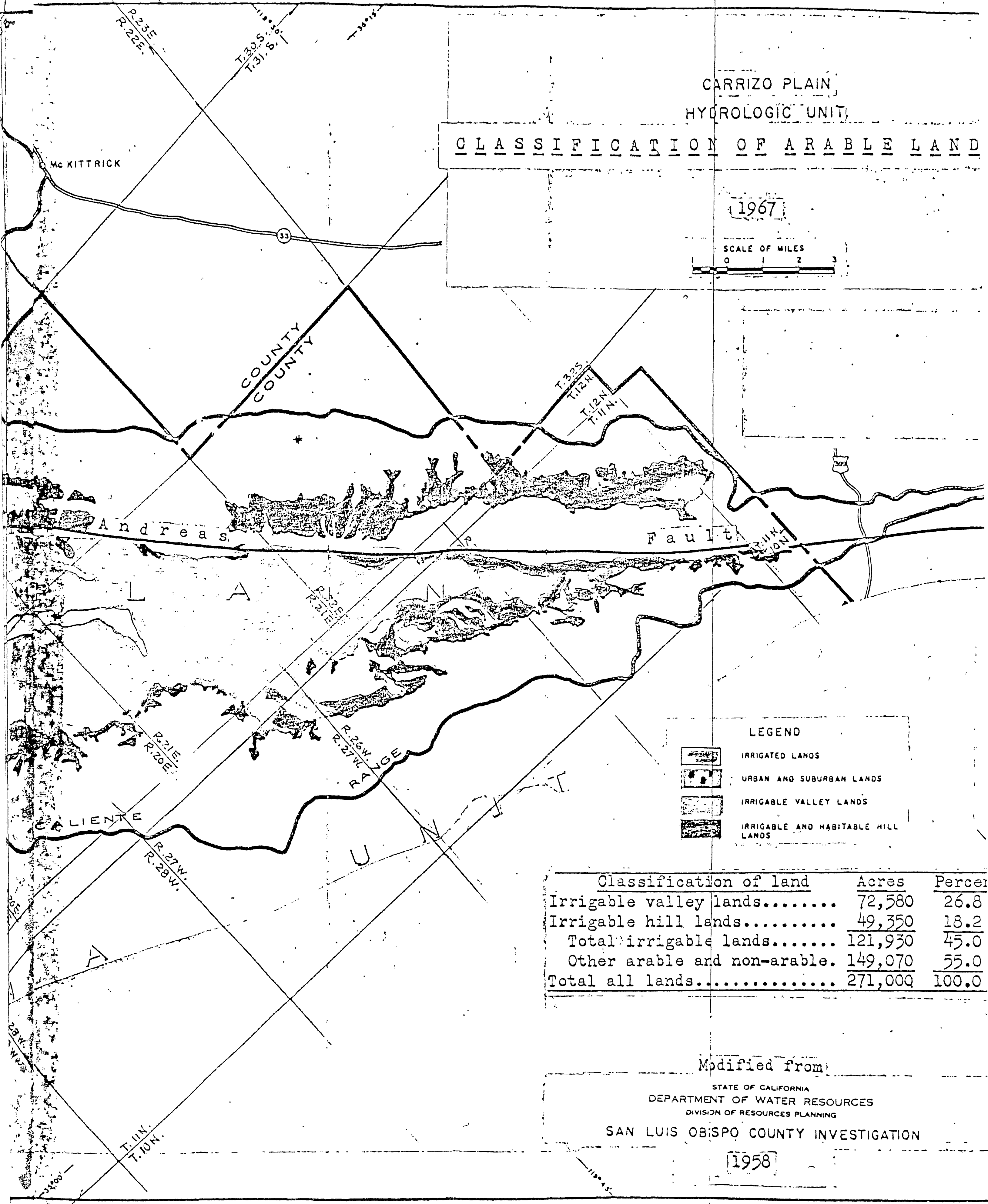


FIGURE 5.- Classification of arable lands in the Carrizo Plain, Calif.

CARRIZO PLAIN HYDROLOGIC UNIT

CLASSIFICATION OF ARABLE LAND

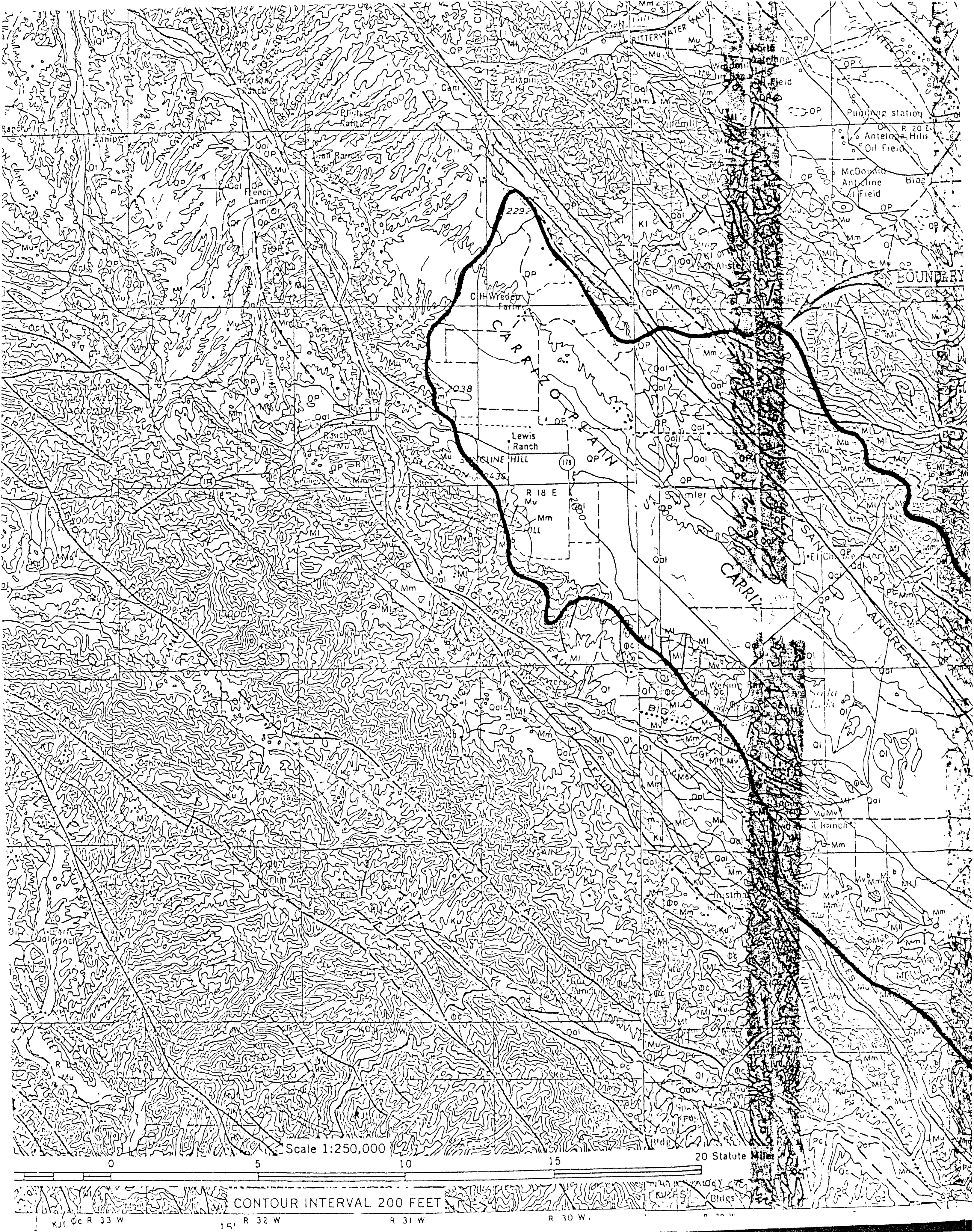
1967



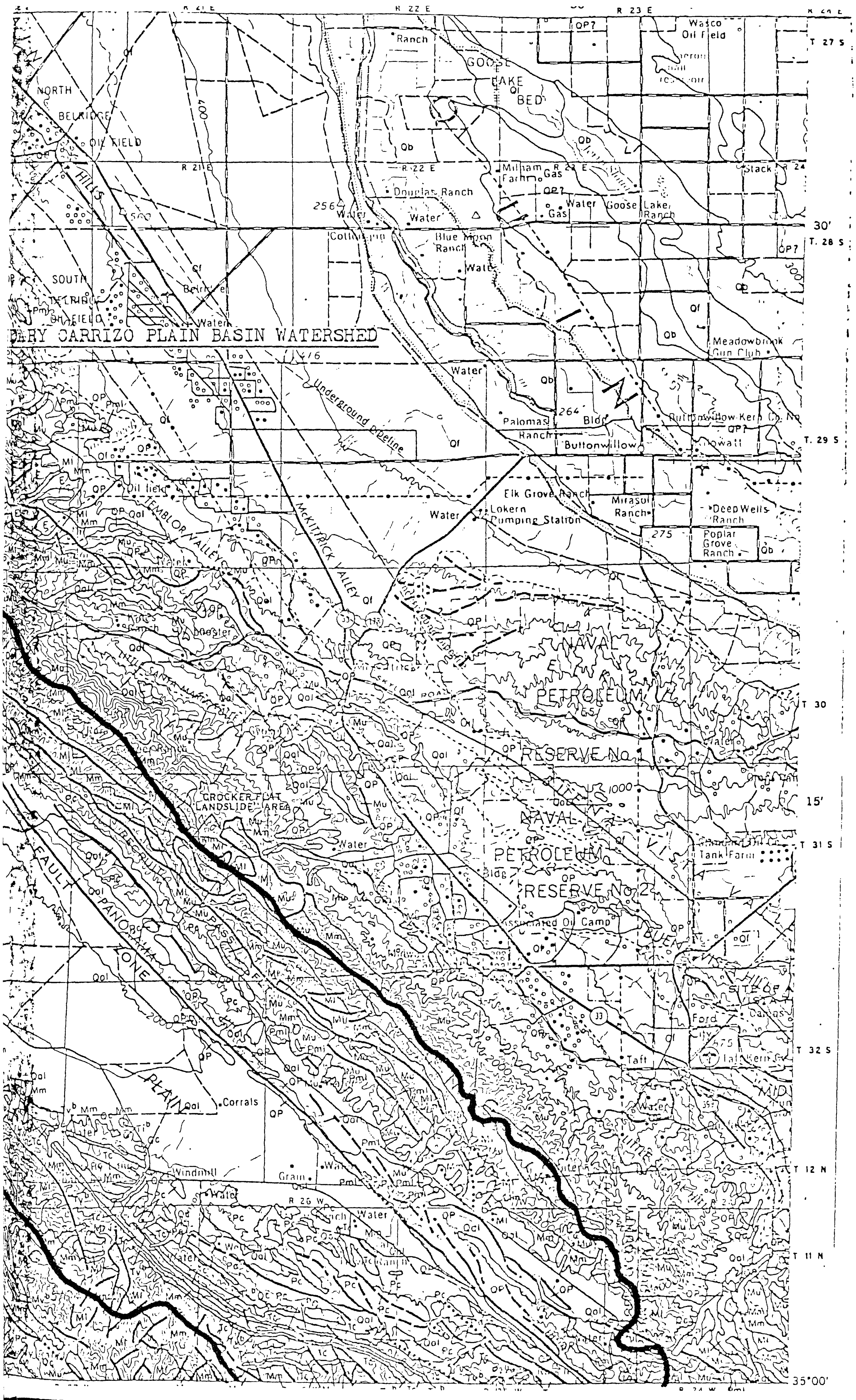
Classification of land	Acres	Percent
Irrigable valley lands........	72,580	26.8
Irrigable hill lands..........	49,350	18.2
Total irrigable lands.......	121,930	45.0
Other arable and non-arable.	149,070	55.0
Total all lands..............	271,000	100.0

Modified from

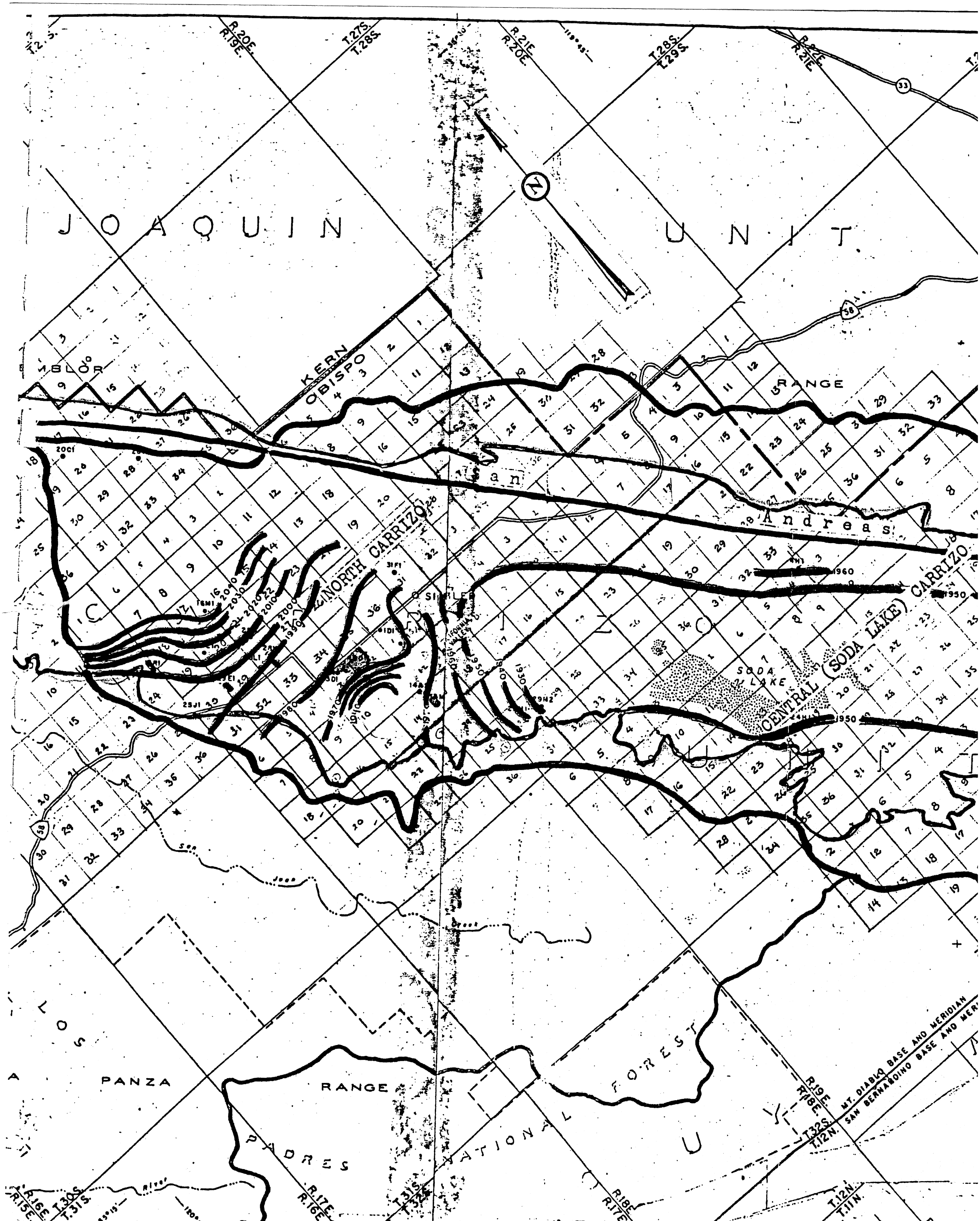
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING
SAN LUIS OBISPO COUNTY INVESTIGATION
1958

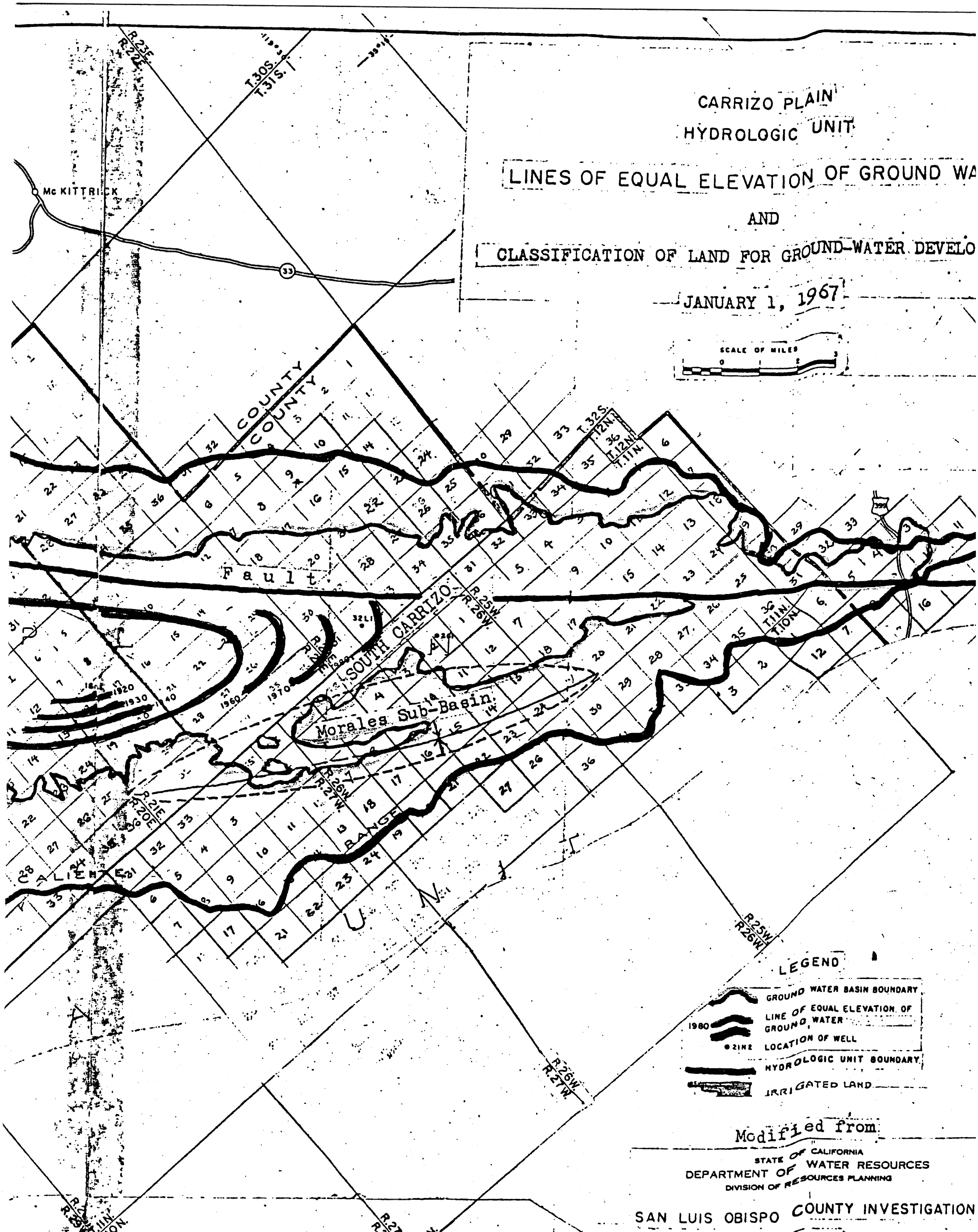


CARRIZO PLAIN
Lewis Ranch
SYNCLINE HILL
C.H. Wreden Farm
French Camp
BOUNDARY
Antelope Hills Oil Field
McDonald Anticline Field
Pumping station
SAN ANDREAS
BIG SPRING FAULT
R 18 E
R 20 E
Scale 1:250,000
0
5
10
15
20 Statute Miles
CONTOUR INTERVAL 200 FEET
R 33 W
R 32 W
R 31 W
R 30 W



R 21 E
R 22 E
R 23 E
Wasco Oil Field
Ranch
T 27 S
GOOSE LAKE BED
NORTH BELRIDGE OIL FIELD
Milham Farm
Gas
Douglas Ranch
Water
Goose Lake Ranch
Stack
30'
T. 28 S
Blue Moon Ranch
SOUTH BELRIDGE OIL FIELD
Water
CARRIZO PLAIN BASIN WATERSHED
Meadowbrook Gun Club
Underground pipeline
Paloma Ranch
Bldg
Buttonwillow
Lowatt
T. 29 S
Oil field
TEMBLOR VALLEY
McKITTRICK VALLEY
Elk Grove Ranch
Mirasol Ranch
Deep Wells Ranch
Lokern Pumping Station
Poplar Grove Ranch
275
NAVAL PETROLEUM RESERVE No 1
T 30
15'
CROCKER FLAT LANDSLIDE AREA
NAVAL PETROLEUM RESERVE No 2
T 31 S
Tank Farm
Associated Oil Camp
BUENA VISTA HILLS
FAULT ZONE
PANORAMA
PLAIN
Corrals
Taft
Ford
T 32 S
Windmill
Grain
R 26 W
T 12 N
T 11 N
35°00'


JOAQUIN
UNIT
KERN
OBISPO
EMBLOR
RANGE
San Andreas
NORTH CARRIZO
CENTRAL (SODA LAKE) CARRIZO
SODA LAKE
SIMLER
LOS
PANZA
RANGE
PADRES
NATIONAL
FOREST
MT. DIABLO BASE AND MERIDIAN
SAN BERNARDINO BASE AND MERIDIAN
T.27S.
T.28S.
T.29S.
T.30S.
T.31S.
T.32S.
T.12N.
T.11N.
R.19E.
R.20E.
R.21E.
R.18E.
R.17E.
R.16E.
R.15E.


CARRIZO PLAIN
HYDROLOGIC UNIT
LINES OF EQUAL ELEVATION OF GROUND WA
AND
CLASSIFICATION OF LAND FOR GROUND-WATER DEVELO
JANUARY 1, 1967
SCALE OF MILES
0 1 2 3
McKITTRICK
33
COUNTY
COUNTY
Fault
SOUTH CARRIZO
Morales Sub-Basin
CALIENTE
RANGE
T.30S.
T.31S.
T.32S.
T.12N.
T.11N.
T.10N.
R.23E.
R.22E.
R.21E.
R.20E.
R.25W.
R.26W.
R.27W.
1920
1930
1940
1960
1970
LEGEND
GROUND WATER BASIN BOUNDARY
LINE OF EQUAL ELEVATION OF GROUND WATER
1980
LOCATION OF WELL
21N2
HYDROLOGIC UNIT BOUNDARY
IRRIGATED LAND
Modified from
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING
SAN LUIS OBISPO COUNTY INVESTIGATION

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National Flood Frequency Program
Version 3.0
Based on Water-Resources Investigations Report 02-4168
Equations from database C:\Program Files\NFF\NFFv3.2_2004-12-14.mdb
Updated by kries 9/22/2004 at 4:03:24 PM fixed decimal place in constant
Equations for California developed using English units

Site: CESF, California
User: matt_moore
Date: Wednesday, June 18, 2008 01:13 PM

Rural Estimate: Basin 1
   Basin Drainage Area: 31.6 mi2
   1 Region
   Region: Central_Coast_Region
      Drainage_Area = 31.6 mi2
      Mean_Annual_Precipitation = 10 in
      Altitude_Index = 2.13 thousand feet
   Crippen & Bue Region 17

Rural Estimate: Basin 2
   Basin Drainage Area: 3.9 mi2
   1 Region
   Region: Central_Coast_Region
      Drainage_Area = 3.9 mi2
      Mean_Annual_Precipitation = 10 in
      Altitude_Index = 2.19 thousand feet
   Crippen & Bue Region 17

Rural Estimate: BAsin 3
   Basin Drainage Area: 4.3 mi2
   1 Region
   Region: Central_Coast_Region
      Drainage_Area = 4.3 mi2
      Mean_Annual_Precipitation = 10 in
      Altitude_Index = 2.24 thousand feet
   Crippen & Bue Region 17

Rural Estimate: Basin 4
   Basin Drainage Area: 1.6 mi2
   1 Region
   Region: Central_Coast_Region
      Drainage_Area = 1.6 mi2
      Mean_Annual_Precipitation = 10 in
      Altitude_Index = 2.03 thousand feet
   Crippen & Bue Region 17

Rural Estimate: Pre-Project Overall at Site
   Basin Drainage Area: 41.3 mi2
   1 Region
   Region: Central_Coast_Region
      Drainage_Area = 41.3 mi2
      Mean_Annual_Precipitation = 10 in
      Altitude_Index = 2.13 thousand feet
   Crippen & Bue Region 17

Rural Estimate: Pos-Project Overall at Site
   Basin Drainage Area: 40.3 mi2
   1 Region
   Region: Central_Coast_Region
      Drainage_Area = 40.3 mi2
      Mean_Annual_Precipitation = 10 in
      Altitude_Index = 2.13 thousand feet
   Crippen & Bue Region 17

Rural Estimate: Basin 5
   Basin Drainage Area: 111 mi2
   1 Region
   Region: Central_Coast_Region
      Drainage_Area = 111 mi2
      Mean_Annual_Precipitation = 10 in
      Altitude_Index = 2.1 thousand feet
   Crippen & Bue Region 17

Rural Estimate: Pre-Project Overall at North Soda Lake
   Basin Drainage Area: 152 mi2
   1 Region
   Region: Central_Coast_Region
      Drainage_Area = 152 mi2
```

Mean_Annual_Precipitation = 10 in
Altitude_Index = 2.1 thousand feet
Crippen & Bue Region 17

Rural Estimate: Pos-Project Overall at North Sodal Lake
Basin Drainage Area: 151 mi2
1 Region
Region: Central_Coast_Region
Drainage_Area = 151 mi2
Mean_Annual_Precipitation = 10 in
Altitude_Index = 2.1 thousand feet
Crippen & Bue Region 17

Rural Estimate: Basin 6
Basin Drainage Area: 262 mi2
1 Region
Region: Central_Coast_Region
Drainage_Area = 262 mi2
Mean_Annual_Precipitation = 10 in
Altitude_Index = 2.18 thousand feet
Crippen & Bue Region 17

Rural Estimate: Pre-Project Total for Entire Soda Lake
Basin Drainage Area: 414 mi2
1 Region
Region: Central_Coast_Region
Drainage_Area = 414 mi2
Mean_Annual_Precipitation = 10 in
Altitude_Index = 2.18 thousand feet
Crippen & Bue Region 17

Rural Estimate: Pos-Project Total for Entire Soda Lake
Basin Drainage Area: 413 mi2
1 Region
Region: Central_Coast_Region
Drainage_Area = 413 mi2
Mean_Annual_Precipitation = 10 in
Altitude_Index = 2.18 thousand feet
Crippen & Bue Region 17

Flood Peak Discharges, in cubic feet per second

Estimate	Recurrence Interval, yrs	Peak, cfs	Standard Error, %	Equivalent Years
Basin 1	2	22.1	150	
	5	134	110	
	10	328	96	
	25	784	96	
	50	1390	110	
	100	2220	120	
	500	5650		
	maximum: 87500 (for C&B region 17)			
BAsin 2	2	3.12	150	
	5	19.5	110	
	10	48.9	96	
	25	120	96	
	50	214	110	
	100	349	120	
	500	912		
	maximum: 19000 (for C&B region 17)			
Basin 3	2	3.33	150	
	5	21	110	
	10	52.7	96	
	25	130	96	
	50	231	110	
	100	377	120	
	500	989		
	maximum: 20600 (for C&B region 17)			
Basin 4	2	1.5	150	
	5	9.22	110	
	10	23	96	
	25	56.5	96	
	50	99.9	110	
	100	163	120	

	500	427	
	maximum: 8920 (for C&B region 17)		
Pre-Project at Site	2	28.2	150
	5	171	110
	10	417	96
	25	995	96
	50	1770	110
	100	2810	120
	500	7140	
	maximum: 103000 (for C&B region 17)		
Post-Project at Site	2	27.6	150
	5	167	110
	10	408	96
	25	974	96
	50	1730	110
	100	2750	120
	500	6990	
	maximum: 102000 (for C&B region 17)		
Basin 5	2	71	150
	5	424	110
	10	1020	96
	25	2410	96
	50	4280	110
	100	6710	120
	500	16900	
	maximum: 182000 (for C&B region 17)		
Pre-Project at North Soda Lake	2	95.1	150
	5	566	110
	10	1360	96
	25	3200	96
	50	5670	110
	100	8870	120
	500	22200	
	maximum: 214000 (for C&B region 17)		
Post-Project at North Soda Lake	2	94.5	150
	5	563	110
	10	1350	96
	25	3180	96
	50	5640	110
	100	8820	120
	500	22100	
	maximum: 213000 (for C&B region 17)		
Basin 6	2	151	150
	5	902	110
	10	2170	96
	25	5090	96
	50	9060	110
	100	14200	120
	500	35400	
	maximum: 278000 (for C&B region 17)		
Pre-Project Total Soda Lake	2	229	150
	5	1370	110
	10	3270	96
	25	7650	96
	50	13600	110
	100	21200	120
	500	52700	
	maximum: 342000 (for C&B region 17)		
Post Project Total Soda Lake	2	229	150
	5	1360	110
	10	3260	96
	25	7640	96
	50	13600	110
	100	21100	120
	500	52600	
	maximum: 342000 (for C&B region 17)		

NFF
National Flood Frequency Program

NFF - Version 3.2, 2004/09/29

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A. DESCRIPTION

NFF is a Windows program for estimating the magnitude and frequency of peak discharges for unregulated rural and urban watersheds. NFF includes about 2,065 regression equations for 289 flood regions nationwide. Peak discharges with recurrence intervals between 2 and 500 years are estimated by regression equations or statistical extrapolation. The 500-year peak discharge can be compared to regional envelope values from USGS Water-Supply Paper 1887. Typical flood hydrographs for a given T-year peak discharge and flood-frequeny curves can be obtained. Estimates for gaging stations can be obtained by determining the weighted average of estimates obtained from data for the stations with estimates obtained from regression equations, with weights based on the years of record at the gaging station and the equivalent years of record for the regression estimates. Estimates for ungaged sites can be obtained by combining the estimates from regression equations with estimates based on the flow per unit area for an upstream or downstream gaging station.

B. DOCUMENTATION

Documentation of the program history, content, theory, and application, including a users manual, is contained in:

Ries, K.G., III, and Crouse, M.Y., 2002, The National Flood Frequency Program, Version 3: A Computer Program for Estimating Magnitude and Frequency of Floods for Ungaged Sites: U.S. Geological Survey Water-Resources Investigations Report 02-4168, 42 p.

Documentation of the equations, maps, and other information needed to solve the regression equations for individual States is provided on line through links from the NFF web page (http://water.usgs.gov/software/nff.html) to the complete original State reports, fact sheets, or still-current pages from the report for the previous version of NFF:

Jennings, M.E., Thomas, W.O., Jr., and Riggs, H.C., 1994, Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993: U.S. Geological Survey Water-Resources Investigations Report 94-4002, 196 p.

C. HARDWARE REQUIREMENTS

NFF requires a computer running Windows 98 (or newer), or Windows NT Version 4.0 with service pack 5 (or higher). Adobe Acrobat Reader is required to display or print the User Manual in PDF format; however, the User Manual is available in other formats in addition to PDF. Microsoft Internet Explorer version 5.0 or newer is required to invoke the on-line help section. The amount of free disk space that is required varies greatly depending on the amount of station data stored in database files. For optimal performance, a processor running at 400 megahertz or faster with at least 128 megabytes of memory is recommended.

D. INSTALLATION

The installation program, NFFv3_2.exe, and the Access data base, NFFv3_2.mdb, should be downloaded to a temporary location on the user's computer. To install the program, double-click on NFFv3.exe in Windows Explorer or My Computer. An installation wizard will appear and prompt for a directory in which to save the program and whether or not to create a desktop icon. It is recommended that the directory for saving the program be named NFF and that the icon be created. Follow the prompts provided by the wizard to install the program.

When installation is complete, the directory that contains the program will include the following files:

```
-       NFF.exe          NFF program
-       ATCoRend.mdb     Database of colors used for graphics
-       current.nff      Program that tracks changes made
-       unins000.exe     Program that uninstalls StreamStatsDB
-       unins000.dat     Used by unins000.exe
-       NFF.chm          Help file
```

The NFFv3.2_2004-09-29.mdb file should be copied to this directory after the program is installed.

E. RUNNING NFF

NFF can be started by three methods, (1) select NFF from the Programs submenu of the Start menu, (2) double-click on the desktop icon, or (3) double-click on the program name (NFF.exe) in Windows Explorer or My Computer.

After running NFF for the first time, a file named current.nff will be created in the NFF directory. This file tracks user-provided instructions from the past session. Results of the work from the previous session will be displayed in NFF when the program is started again.

F. HELP FILE

The Help file provides full documentation on use of the program. The Help file can be started by clicking on the Help menu toward the top left of the NFF main window, or it can be started before running NFF by double-clicking on NFF.chm in WinWindows Explorer or My Computer. Users should thoroughly read the information in the Help file before trying to use the interface.

G. VERSION HISTORY

Version 3.2 - 2004/12/9 - Updated the database to NFFv3.2_2004-12-14.mdb. Added new peak-flow equations for Connecticut and Kentucky. Corrected an error in the units displayed for conveyance in the Houston urban equations from in/hr to cubic feet per second. Corrected an error in the Wisconsin Area 1 equation for the 5-year recurrence interval.

Version 3.2 - 2004/09/29 - Updated the database to NFFv3.2_2004-09-29.mdb. This database contains new peak-flow equations for Alaska, Idaho, Ohio, Tennessee, Vermont, Wisconsin, and Wyoming. Along with the new database comes the ability to display 90-percent prediction intervals with the estimates for some of the updated States.

Version 3.2 - 2003/04/30 - Fixed a problem with the weighting function for gaging stations when there are no equivalent years for the regression estimates. This version also handles the case of a scenario with regions containing different sets of return intervals. It now reports why this can't be done and recovers much better. No updates to the database were made.

Version 3.1 - 2003/02/27 - Fixed a problem with solving the national urban equations that occurred when one or more of the local rural equations were missing for the region of interest. If a rural equation, such as the 5-year flow, was missing NFF would use the flow estimate for the next available recurrence interval, such as the 10-year flow, to estimate the urban flow for the missing recurrence interval. All estimates for higher recurrence intervals would also be incorrect.

Version 3.0 - 2002/10/15 - A major change in converting user the interface from Microsoft DOS to Microsoft Windows and converting data base from a binary file to Microsoft Access (Note: Use of trade or product names is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey). Addition of weighted estimates for ungaged sites based on regression estimates for the site of interest and the flow per unit area for an upstream or downstream gaging station. Updates or corrections to equations were included for

- Alabama
- Alaska
- American Samoa
- Arizona
- Arkansas
- Colorado
- Delaware
- Georgia - rural and urban
- Hawaii
- Idaho
- Iowa
- Kansas
- Kentucky - Jefferson County urban
- Louisiana
- Maine
- Maryland
- Minnesota
- Missouri
- Nebraska
- Nevada
- New Mexico
- North Carolina - rural and urban
- Oklahoma
- Pennsylvania
- Puerto Rico
- South Carolina - rural and urban
- South Dakota
- Texas - rural
- Utah
- Virginia
- Washington
- West Virginia

Version 2.0 - 1996/09/15 - A non-USGS release that added conversions between English and metric units.

Version 1.4 - 1996/09/30 - NFF data base updated to amend incorrect values for:

- New Jersey--the constant 1 was removed from being added to the actual value entered for impervious cover, I
- New York-- incorrect exponents and an incorrect regression constant were corrected for Region 6's 25-year and 500-year equations, respectively
- Wisconsin-- the constant -2.3 was added to the data base to be applied automatically to the actual value entered for 2-year 24-hour rainfall, INTENS, for Areas 1, 3, and 5; incorrect exponents were corrected for Area 3's 5-, 25-, 50-, and 100-year equations

Version 1.3 - 1996/02/14 - Corrected labeling of flood-frequency recurrence intervals for North Dakota. The equations developed for North Dakota are for the 2-, 10-, 15-, 25-, 50-, 100-, and 500-year recurrence intervals rather than the standard 2-, 5-, 10-, 25-, 50-, 100-, and 500-year intervals.

Version 1.2 - 1995/06/02 - NFF data base updated to amend incorrect exponents in West Virginia's Region 6 equations for the 2-year and 10-year recurrence interval.

Version 1.1 - 1994/11/21 - Initial release.

H. DATA BASE

The NFF data base is a Microsoft Access data base that is write protected so that users cannot change the data. It is planned that, rather than releasing a new version of NFF each time new equations become available, the NFF data base will be updated and links to the new documentation will be provided from the NFF web site. Users should check often to determine if the data base has been updated with new equations for their areas of interest.

I. CONTACTS

Inquiries about this software should be directed to:

U.S. Geological Survey
Office of Surface Water
Kernell Ries
12201 Sunrise Valley Dr., MS 415
Reston, VA 20192

Electronic mail: kries@usgs.gov
Fax: 703-648-5722
Phone: 703-648-5307

The following documentation was taken from:

U.S. Geological Survey Water-Resources Investigations Report 94-4002: *Nationwide summary of U.S. Geological Survey regional regression equations for estimating magnitude and frequency of floods for ungaged sites, 1993*

CALIFORNIA

STATEWIDE RURAL

Summary

California is divided into six hydrologic regions (fig. 1). The regression equations developed for these regions are for estimating peak discharges (QT) having recurrence intervals T that range from 2 to 100 years. The explanatory basin variables used in the equations are drainage area (A), in square miles; mean annual precipitation (P), in inches; and an altitude index (H), which is the average of altitudes in thousands of feet at points along the main channel at 10 percent, and 85 percent of the distances from the site to the divide. The variables A and H may be measured from topographic maps. Mean annual precipitation (P) is determined from a map in Rantz (1969). The regression equations were developed from peak-discharge records of 10 years or longer, available as of 1975, at more than 700 gaging stations throughout the State. The regression equations are applicable to unregulated streams but are not applicable to some parts of the State (see fig. 1). The standard errors of estimate for the regression equations for various recurrence intervals and regions range from 60 to over 100 percent. The report by Waananen and Crippen (1977) includes an approximate procedure for increasing a rural discharge to account for the effect of urban development. The influences of fire and other basin changes on flood magnitudes are also discussed.

Procedure

Topographic maps, the hydrologic regions map (fig. 1), the mean annual precipitation from Rantz (1969), and the following equations are used to estimate the needed peak discharges QT, in cubic feet per second, having selected recurrence intervals T.

North Coast Region

$Q2 = 3.52\ A^{0.90}\ P^{0.89}\ H^{-0.47}$
$Q5 = 5.04\ A^{0.89}\ P^{0.91}\ H^{-0.35}$
$Q10 = 6.21\ A^{0.88}\ P^{0.93}\ H^{-0.27}$
$Q25 = 7.64\ A^{0.87}\ P^{0.94}\ H^{-0.17}$
$Q50 = 8.57\ A^{0.87}\ P^{0.96}\ H^{-0.08}$
$Q100 = 9.23\ A^{0.87}\ P^{0.97}$

Northeast Region

$Q2 = 22\ A^{0.40}$
$Q5 = 46\ A^{0.45}$
$Q10 = 61\ A^{0.49}$
$Q25 = 84\ A^{0.54}$
$Q50 = 103\ A^{0.57}$
$Q100 = 125\ A^{0.59}$

Sierra Region

$Q2 = 0.24\ A^{0.88}\ P^{1.58}\ H^{-0.80}$
$Q5 = 1.20\ A^{0.82}\ P^{1.37}\ H^{-0.64}$
$Q10 = 2.63\ A^{0.80}\ P^{1.25}\ H^{-0.58}$
$Q25 = 6.55\ A^{0.79}\ P^{1.12}\ H^{-0.52}$
$Q50 = 10.4\ A^{0.78}\ P^{1.06}\ H^{-0.48}$
$Q100 = 15.7\ A^{0.77}\ P^{1.02}\ H^{-0.43}$

Central Coast Region

$Q2 = 0.0061\ A^{0.92}\ P^{2.54}\ H^{-1.10}$
$Q5 = 0.118\ A^{0.91}\ P^{1.95}\ H^{-0.79}$
$Q10 = 0.583\ A^{0.90}\ P^{1.61}\ H^{-0.64}$
$Q25 = 2.91\ A^{0.89}\ P^{1.26}\ H^{-0.50}$
$Q50 = 8.20\ A^{0.89}\ P^{1.03}\ H^{-0.41}$
$Q100 = 19.7\ A^{0.88}\ P^{0.84}\ H^{-0.33}$

South Coast Region

$Q2 = 0.14\ A^{0.72}\ P^{1.62}$
$Q5 = 0.40\ A^{0.77}\ P^{1.69}$
$Q10 = 0.63\ A^{0.79}\ P^{1.75}$
$Q25 = 1.10\ A^{0.81}\ P^{1.81}$
$Q50 = 1.50\ A^{0.82}\ P^{1.85}$
$Q100 = 1.95\ A^{0.83}\ P^{1.87}$

South Lahontan-Colorado Desert Region

$Q2 = 7.3A^{0.30}$
$Q5 = 53A^{0.44}$
$Q10 = 150A^{0.53}$
$Q25 = 410A^{0.63}$
$Q50 = 700A^{0.68}$
$Q100 = 1080A^{0.71}$

In the North Coast region, use a minimum value of 1.0 for the altitude index (H). Equations are defined only for basins of 25 mi^2 or less in the Northeast and South Lahontan-Colorado Desert regions.

Reference

Waananen, A.O., and Crippen, J.R., 1977, Magnitude and frequency of floods in California: U.S. Geological Survey Water-Resources Investigations Report 77-21, 96 p.

Additional Reference

Rantz, S.E., 1969, Mean annual precipitation in the California region: U.S. Geological Survey Open-File Map (Reprinted 1972, 1975).

Figure 1. Flood-frequency region map for California. (PostScript file of Figure 1.)

U.S. Geological Survey
National Flood Frequency Program
Water-Resources Investigations Report 94-4002

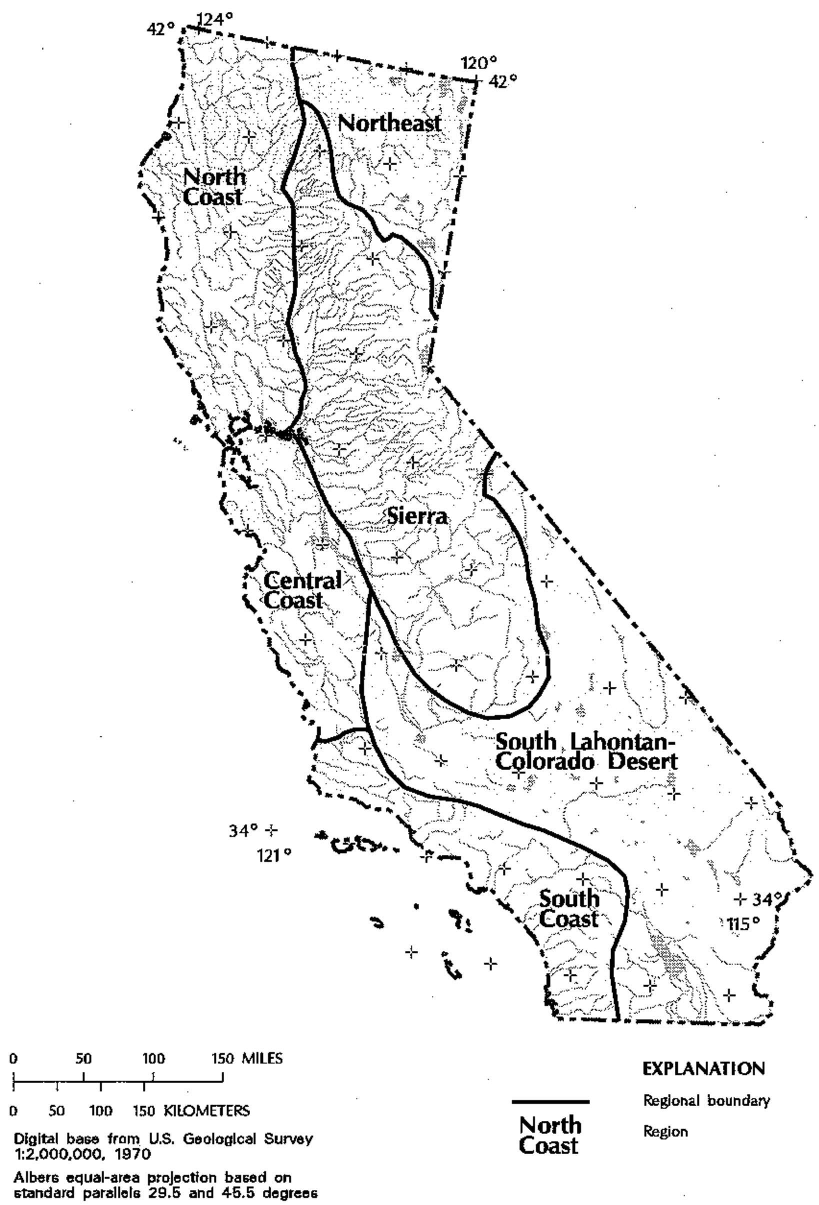
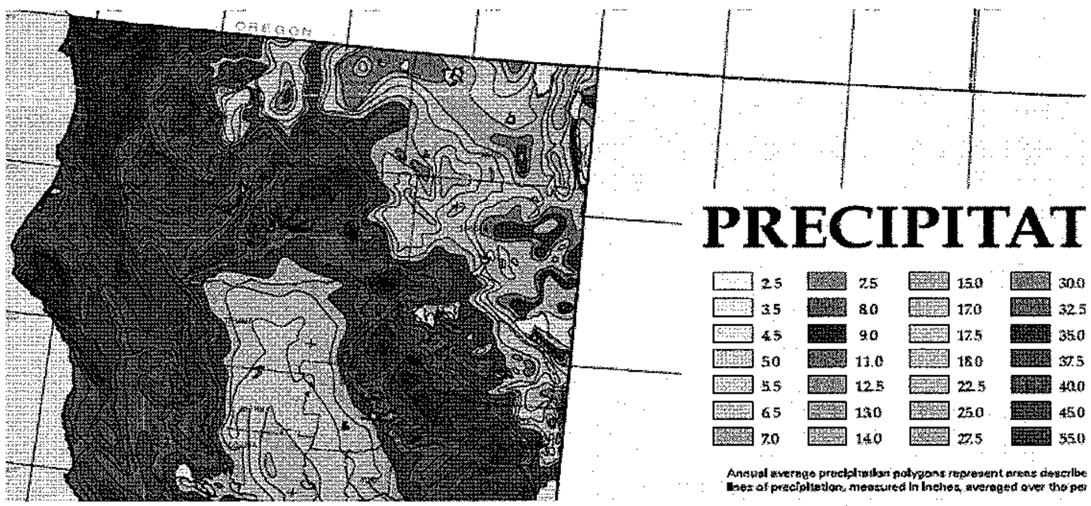


Figure 1. Flood-frequency region map for California.

- **Rivers and Water Projects Maps** (California Department of Water Resources) Contains relief maps of California showing major rivers and federal, state and local water projects that comprise the water delivery system for California.
- **Water Resources of California** (US Geological Survey) Series of six maps that show streams, lakes and reserviors; annual average precipation, and shaded relief in various combinations.
- **WaterWatch--Current Water Resources Conditions: California** (US Geological Survey) Series of maps that graphically show streamflow conditions in California. Maps are updated daily or more frequently. Individual maps show real-time streamflow compared to historical streamflow, flood and high flow conditions, daily streamflow compared to historical streamflow, 7-day average streamflow compared to historical streamflow, below normal 7-day average streamflow compared to historical streamflow, and drought watch. Mouse-over any of the 200+ recording sites to get detailed site information.

Weather and Climate



- **Average Annual Precipitation (Inches), California, 1961-1990** (Oregon Climate Service) 1995
- **Average Temperature for January/July** (Maps.com)
- ***Calfornia Annual Precipitation*** (US Natural Resources Conservation Service) 1999 (map G4361.C883 1998 .U5) Scale 1:1,850,000
- **California Average Annual Precipitation** (Maps.com)
- **California Climate Zones Map** (California Energy Commission) Shows 16 climate zones that are based on energy use, temperature, weather and other factors.
- **California Reference Evapo Transpiration (ETO) Zones** (California Irrigation Management Information System) Shows 16 reference ETO zones.
- ***California Wind Atlas*** (California Energy Commission and California Department of Water Resources) 1985 (Cal Docs E 2015 W55) Available wind data is summarized using charts, maps, and graphs.
- **California Average Annual Precipitation Zones, 1900-60** (California Dept. of Forestry and Fire Protection, Fire and Resource Assessment Program) Isohyetal map of California at a scale of 1:1,000,000 showing mean annual precipitation during the period 1900-1960. Created from the map ***Mean Annual Precipitation in the California Region*** (Rantz) 1969/reprinted 1972 (Docs I 19.2 P92 1972).
- **Late Pleistocene Map of California** (US Geological Survey) Reconstruction of landscape features about 18,000 years ago at the peak of the last Ice Age, including mountains covered by glaciers, intermontain basin lakes and exposed shoreline.
- ***Precipitation Frequency Atlas of the Western United States. Vol. 11. California*** (US National Weather Service) 1973 (Docs C 55.22 folio) Contains series of precipitation-frequency maps at a scale of 1:2 million for 6 and 24-hour durations for return periods from 2 to 100 years. Northern California

CALIFORNIA SERENGETI CORP
12900 Soda lake Road (P.O. Box 3058)
Santa Margarita, CA. 93453
Tel.805-475-2200, Lodge 805-475-2363
Fax 805-475-2203

Please Note enclosed is information about water studies that we have done In California Valley, CA and we are happy to share them with you. Info includes Triton's Report of 2002 and some New well reports after that study, if you have any question please feel free to call me at Lodge Number 805-475-2363.

Sincerely

Kenneth Tab 3/19/2008

Kenneth Tab, president

Creek Environmental Laboratories, Inc. Chain-of-Custody

141 Suburban Road, Suite C-5, San Luis Obispo, CA 93401 phone (805) 545-9838 fax (805) 545-0107 www.creeklabs.com sales@creeklabs.com

Order # 06253

Dec. 17. 2007 4:09PM Creek Environmental 805 545 0107 No. 2692 P. 1

• Please Print in Pen Corp. ☐ DW EDT ☐ LUFT EDF ☐ Custom EDD

Client Name California Serengeti	Contact Kenneth Talo	Phone 475-2363	Due Date: 24Hr 48Hr Other (Normal TAT)
Address P.O. Box 3058 City Santa Margarita State CA Zip 93453		Fax 475-2203	Cell Beeper
Project Name/Number 12900 Soda Lake Road		PO#	Copies To:
Bill to: (if different from above) Address		City	State Zip
Sampler Name (Print) Kenneth Talo	Comments: $1,000 deposit/advance received ck#1161. [initials] 11-29-07		Matrix Key: DW = Drinking Water AQ = Aqueous SL = Soil/Solid

Sample Description	Date/Time Sampled	Analysis	Matrix	# of Bottles	Preservative / Type Bottles	Creek Lab Sample #
072 201 008 N (Glade)	11-29-07 1500	GMPI, Coliform Bacteria PA	DW	5	1Q P unp - A; 8oz P HNO3 - B; ~~8oz P [illegible] - C~~; 8oz G unp - D; BT - E	15400
Unit 31 Lot 149	11-29-07 1000	↓	↓	↓	↓	15401
Unit 31 Lot 164	"	↓	↓	↓	↓	15402
072 201 008 S (Gaviota)	11-29-07 1500	↓	↓	↓	↓	15403
072 201 023 (Motel)	11-29-07 1030	↓	↓	↓	↓	15404

RELINQUISHED BY (Sign)	(Print)	(Organization)	DATE/TIME	RECEIVED BY (Sign)	(Print)	(Organization)
Kenneth Talo [signature]						
			11-29-07 1230	[signature]	[initials]	Creek Environmental Laboratories, Inc.

FOR LAB USE ONLY: Shipping Method: (Client)/ Lab/ Courier: Sample Conditions: **Temp:** 16 Intact: (Y)/N Custody Sealed: Y/(N)

REMARKS $350/ea.

Creek Environmental Laboratories, Inc. — Chain-of-Custody

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Order # 0627

• Please Print in Pen ☐ DW EDT ☐ LUFT EDF ☐ Custom EDD

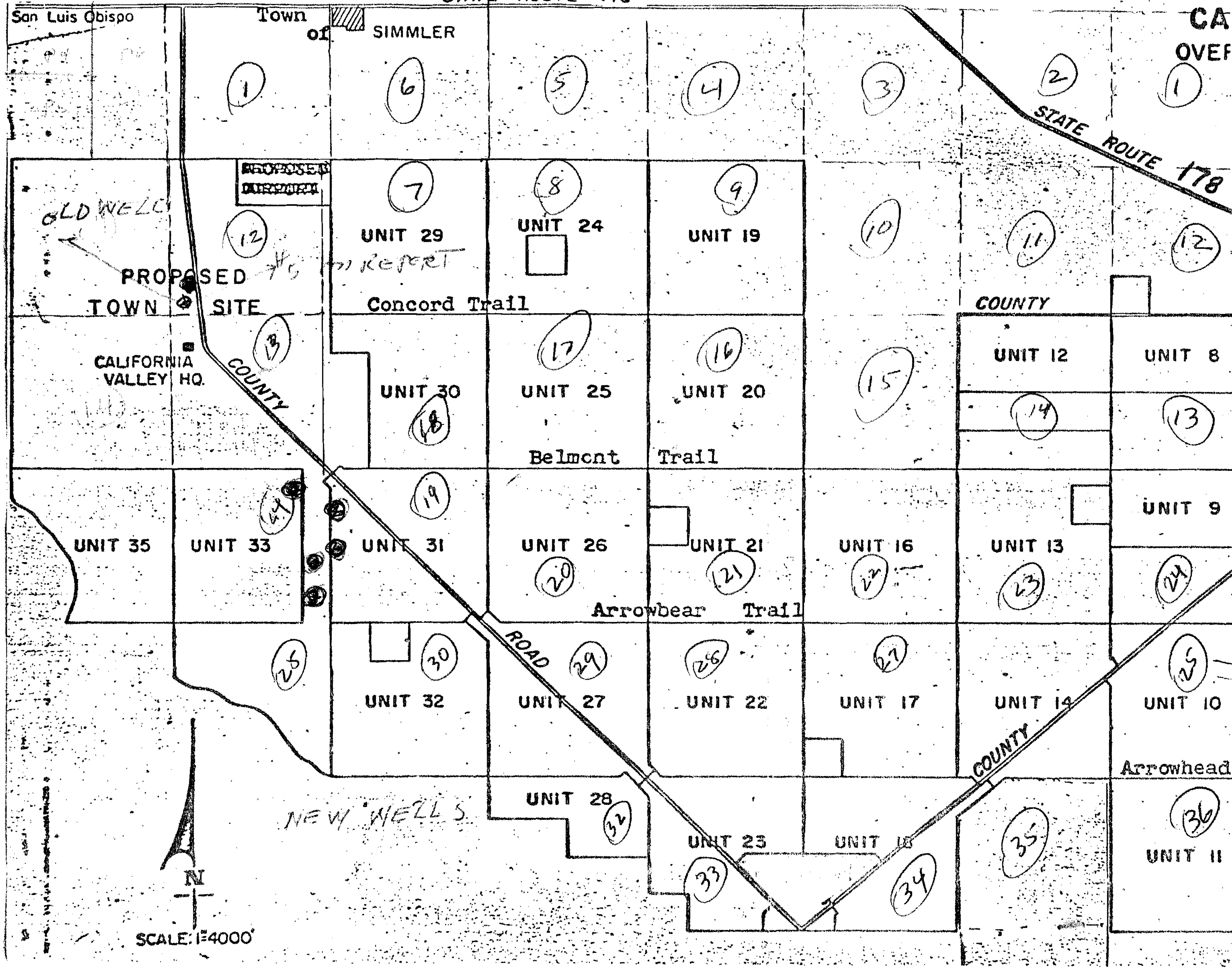
Client Name: California Serengeti	Contact	Phone	Due Date: 24Hr 48Hr Other Normal TAT
Address City State Zip		Fax	Cell Beeper
Project Name/Number		PO#	Copies To:
Bill to: (if different from above)	Address	City	State Zip
Sampler Name (Print): KENNETH TAB	Comments:		Matrix Key: DW = Drinking Water AQ = Aqueous SL = Soil/Solid

Sample Description	Date/Time Sampled	Analysis	Matrix	# of Bottles	Preservative / Type Bottles	Creek Lab Sample #
Unit 33 Lot 29	11/29/07 15:30	GMPI & P/A	DW	5		15458
Motel Room 14	11/30/07 8:30	P/A	DW	1	BJ	15459
Restarant Sink	11/30/07 8:30	"	DW	1	"	15460
Restarant Rest Room	11/30/07 8:30	"	DW	1	"	15461
Store Sink	11/30/07 8:30	"	DW	1	"	15462

RELINQUISHED BY (Sign)	(Print)	(Organization)	DATE/TIME	RECEIVED BY (Sign)	(Print)	(Organization)
Kenneth Tab	KENNETH TAB		11/30/07 10:20	[signature]	D Osborne	
						Creek Environmental Laboratories, Inc.

FOR LAB USE ONLY: Shipping Method: (Client)/ Lab/ Courier: Sample Conditions: Temp: 12° Intact: (Y)/ N Custody Sealed: Y/(N)

REMARKS:



San Luis Obispo
Town of
SIMMLER
STATE ROUTE 178
OLD WELL
PROPOSED TOWN SITE
CALIFORNIA VALLEY HQ.
COUNTY ROAD
COUNTY
UNIT 29
UNIT 24
UNIT 19
Concord Trail
UNIT 12
UNIT 8
UNIT 30
UNIT 25
UNIT 20
Belmont Trail
UNIT 35
UNIT 33
UNIT 31
UNIT 26
UNIT 21
UNIT 16
UNIT 13
UNIT 9
Arrowbear Trail
UNIT 32
UNIT 27
UNIT 22
UNIT 17
UNIT 14
UNIT 10
Arrowhead
UNIT 28
UNIT 23
UNIT 18
UNIT 11
NEW WELLS
N
SCALE: 1"=4000'

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COMMERCIAL WELL SUPPLYING MOTEL & RESTAURANT and OTHERS
#5 AT TRITON REPORT of 2002

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15404
Order: 06253
Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
072 201 023 (Motel)	Kenneth Tab	11/29/07@10:30	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Carbonate Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Bicarbonate Alkalinity as CaCO3	190	2	1	mg/L	SM 2320B	12/10/07		2344
Hydroxide Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Total Alkalinity as CaCO3	190	2	1	mg/L	SM 2320B	12/10/07		2344
Chloride	30	1	1	mg/L	EPA 300.0	11/29/07		1998
Total Cyanide	Not Detected	0.005	1	mg/L	SM 4500-CN C,E	12/10/07	12/10/07	2328
Color	Not Detected	1	1	units	SM 2120B	11/29/07		1966
Electrical Conductance	650	1	1	umhos/cm	SM 2510 B	11/29/07		1966
Fluoride	0.5	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Langlier Index (Corrosivity)	0.1	---	1	pH units	SM 2330B	12/14/07		2542
MBAS(Anionic Surfactants MW=340)	Not Detected	0.05	1	mg/L	SM 5540 C	11/30/07	11/30/07	2040
Nitrate as N	5.3	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Nitrate as NO3	23	0.4	1	mg/L	EPA 300.0			
Nitrite as N	Not Detected	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Odor	Not Detected	1	1	TON	SM 2150B	11/29/07		1966
pH	7.7	0.1	1	pH units	SM 4500-H B	11/29/07		1966
Sulfate	75	0.5	1	mg/L	EPA 300.0	11/29/07		1998
Total Dissolved Solids	410	10	1	mg/L	SM 2540 C	12/04/07		2209
Turbidity	0.1	0.1	1	NTU	SM 2130 B	11/29/07		1966
Total Coliform Bacteria	Absent	---	NA		SM 9223	11/29/07		1990
Calcium	44	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Hardness	190	1	NA	mg/L CaCO3	EPA 200.7			
Iron	0.07	0.02	1	mg/L	EPA 200.7	12/13/07		2523
Mercury	Not Detected	0.001	1	mg/L	EPA 245.1	12/06/07	12/5/07	2220
Potassium	1.6	0.1	1	mg/L	EPA 200.7	12/13/07		2523
Magnesium	19	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Sodium	76	0.05	1	mg/L	EPA 200.7	12/13/07		2523
Aluminum	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2564
Antimony	Not Detected	0.006	1	mg/L	EPA 200.8	12/10/07		2363

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Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15404
Order: 06253
Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
072 201 023 (Motel)	Kenneth Tab	11/29/07@10:30	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Arsenic	Not Detected	0.002	1	mg/L	EPA 200.8	12/10/07		2363
Barium	Not Detected	0.1	1	mg/L	EPA 200.8	12/10/07		2363
Beryllium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Cadmium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Chromium	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Copper	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363
Lead	Not Detected	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Manganese	Not Detected	0.02	1	mg/L	EPA 200.8	12/10/07		2363
Nickel	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Selenium	0.005	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Silver	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Thallium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Zinc	0.25	0.05	1	mg/L	EPA 200.8	12/10/07		2363

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

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Lab Director, Michael Ng

CREEK ENVIRONMENTAL LABORATORIES, INC.

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141 SUBURBAN ROAD, SUITE C-5 • SAN LUIS OBISPO, CA 93401 • (805) 545-9838 • FAX (805) 545-0107

PARCEL 072-201-008
WELL #1

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15400
Order: 06253
Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
072 201 008 N (Glade)	Kenneth Tab	11/28/07@15:00	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Carbonate Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Bicarbonate Alkalinity as CaCO3	180	2	1	mg/L	SM 2320B	12/10/07		2344
Hydroxide Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Total Alkalinity as CaCO3	180	2	1	mg/L	SM 2320B	12/10/07		2344
Chloride	28	1	1	mg/L	EPA 300.0	11/29/07		1998
Total Cyanide	Not Detected	0.005	1	mg/L	SM 4500-CN C,E	12/10/07	12/07/07	2323
Color	Not Detected	1	1	units	SM 2120B	11/29/07		1966
Electrical Conductance	910	1	1	umhos/cm	SM 2510 B	11/29/07		1966
Fluoride	1.3	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Langlier Index (Corrosivity)	0.0	---	1	pH units	SM 2330B	12/14/07		2542
MBAS(Anionic Surfactants MW=340)	Not Detected	0.05	1	mg/L	SM 5540 C	11/30/07	11/30/07	2040
Nitrate as N	4.5	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Nitrate as NO3	20	0.4	1	mg/L	EPA 300.0			
Nitrite as N	Not Detected	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Odor	Not Detected	1	1	TON	SM 2150B	11/29/07		1966
pH	7.5	0.1	1	pH units	SM 4500-H B	11/29/07		1966
Sulfate	220	0.5	1	mg/L	EPA 300.0	11/29/07		1998
Total Dissolved Solids	600	10	1	mg/L	SM 2540 C	12/04/07		2209
Turbidity	0.3	0.1	1	NTU	SM 2130 B	11/29/07		1966
Total Coliform Bacteria	Present	---	NA		SM 9223	11/29/07		1990
E. coli	Absent	---	NA		SM 9223	11/29/07		1990
Calcium	60	0.2	5	mg/L	EPA 200.7	12/11/07		2404
Hardness	230	1	NA	mg/L CaCO3	EPA 200.7			
Iron	Not Detected	0.1	5	mg/L	EPA 200.7	12/11/07		2404
Mercury	Not Detected	0.001	1	mg/L	EPA 245.1	12/06/07	12/5/07	2220
Potassium	1.4	0.5	5	mg/L	EPA 200.7	12/11/07		2404
Magnesium	19	0.2	5	mg/L	EPA 200.7	12/11/07		2404
Sodium	120	0.2	5	mg/L	EPA 200.7	12/11/07		2404
Aluminum	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2564

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Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15400
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Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
072 201 008 N (Glade)	Kenneth Tab	11/28/07@15:00	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Antimony	Not Detected	0.006	1	mg/L	EPA 200.8	12/10/07		2363
Arsenic	Not Detected	0.002	1	mg/L	EPA 200.8	12/10/07		2363
Barium	Not Detected	0.1	1	mg/L	EPA 200.8	12/10/07		2363
Beryllium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Cadmium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Chromium	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Copper	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363
Lead	Not Detected	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Manganese	Not Detected	0.02	1	mg/L	EPA 200.8	12/10/07		2363
Nickel	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Selenium	0.008	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Silver	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Thallium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Zinc	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

CREEK ENVIRONMENTAL LABORATORIES

Lab Director, Michael Ng

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PARCEL
WELL #2 P072-201-008

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15403
Order: 06253
Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
072 201 008 S (Gaviota)	Kenneth Tab	11/28/07@15:00	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Carbonate Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Bicarbonate Alkalinity as CaCO3	150	2	1	mg/L	SM 2320B	12/10/07		2344
Hydroxide Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Total Alkalinity as CaCO3	150	2	1	mg/L	SM 2320B	12/10/07		2344
Chloride	48	1	1	mg/L	EPA 300.0	11/29/07		1998
Total Cyanide	Not Detected	0.005	1	mg/L	SM 4500-CN C,E	12/10/07	12/07/07	2323
Color	10	1	1	units	SM 2120B	11/29/07		1966
Electrical Conductance	830	1	1	umhos/cm	SM 2510 B	11/29/07		1966
Fluoride	1.0	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Langlier Index (Corrosivity)	0.1	---	1	pH units	SM 2330B	12/14/07		2542
MBAS(Anionic Surfactants MW=340)	Not Detected	0.05	1	mg/L	SM 5540 C	11/30/07	11/30/07	2040
Nitrate as N	8.3	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Nitrate as NO3	37	0.4	1	mg/L	EPA 300.0			
Nitrite as N	Not Detected	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Odor	Not Detected	1	1	TON	SM 2150B	11/29/07		1966
pH	7.6	0.1	1	pH units	SM 4500-H B	11/29/07		1966
Sulfate	170	0.5	1	mg/L	EPA 300.0	11/29/07		1998
Total Dissolved Solids	550	10	1	mg/L	SM 2540 C	12/04/07		2209
Turbidity	8.0	0.1	1	NTU	SM 2130 B	11/29/07		1966
Total Coliform Bacteria	Present	---	NA		SM 9223	11/29/07		1990
E. coli	Absent	---	NA		SM 9223	11/29/07		1990
Calcium	69	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Hardness	290	1	NA	mg/L CaCO3	EPA 200.7			
Iron	0.16	0.02	1	mg/L	EPA 200.7	12/13/07		2523
Mercury	Not Detected	0.001	1	mg/L	EPA 245.1	12/06/07	12/5/07	2220
Potassium	1.9	0.1	1	mg/L	EPA 200.7	12/13/07		2523
Magnesium	29	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Sodium	62	0.05	1	mg/L	EPA 200.7	12/13/07		2523
Aluminum	0.17	0.05	1	mg/L	EPA 200.8	12/10/07		2564

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Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15403
Order: 06253
Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
072 201 008 S (Gaviota)	Kenneth Tab	11/28/07@15:00	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Antimony	Not Detected	0.006	1	mg/L	EPA 200.8	12/10/07		2363
Arsenic	Not Detected	0.002	1	mg/L	EPA 200.8	12/10/07		2363
Barium	Not Detected	0.1	1	mg/L	EPA 200.8	12/10/07		2363
Beryllium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Cadmium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Chromium	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Copper	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363
Lead	Not Detected	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Manganese	Not Detected	0.02	1	mg/L	EPA 200.8	12/10/07		2363
Nickel	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Selenium	Not Detected	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Silver	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Thallium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Zinc	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

CREEK ENVIRONMENTAL LABORATORIES

Lab Director, Michael Ng

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UNIT 31 LOT 149

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15401
Order: 06253
Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Unit 31 Lot 149	Kenneth Tab	11/29/07@10:00	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Carbonate Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Bicarbonate Alkalinity as CaCO3	150	2	1	mg/L	SM 2320B	12/10/07		2344
Hydroxide Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Total Alkalinity as CaCO3	150	2	1	mg/L	SM 2320B	12/10/07		2344
Chloride	81	1	1	mg/L	EPA 300.0	11/29/07		1998
Total Cyanide	Not Detected	0.005	1	mg/L	SM 4500-CN C,E	12/10/07	12/07/07	2323
Color	Not Detected	1	1	units	SM 2120B	11/29/07		1966
Electrical Conductance	2,200	1	1	umhos/cm	SM 2510 B	11/29/07		1966
Fluoride	1.1	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Langlier Index (Corrosivity)	0.4	---	1	pH units	SM 2330B	12/14/07		2542
MBAS(Anionic Surfactants MW=340)	Not Detected	0.05	1	mg/L	SM 5540 C	11/30/07	11/30/07	2040
Nitrate as N	6.6	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Nitrate as NO3	29	0.4	1	mg/L	EPA 300.0			
Nitrite as N	Not Detected	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Odor	Not Detected	1	1	TON	SM 2150B	11/29/07		1966
pH	7.5	0.1	1	pH units	SM 4500-H B	11/29/07		1966
Sulfate	1,000	5	10	mg/L	EPA 300.0	12/03/07		2077
Total Dissolved Solids	1,800	10	1	mg/L	SM 2540 C	12/04/07		2209
Turbidity	0.3	0.1	1	NTU	SM 2130 B	11/29/07		1966
Total Coliform Bacteria	Present	---	NA		SM 9223	11/29/07		1990
E. coli	Absent	---	NA		SM 9223	11/29/07		1990
Calcium	180	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Hardness	760	1	NA	mg/L CaCO3	EPA 200.7			
Iron	Not Detected	0.02	1	mg/L	EPA 200.7	12/13/07		2523
Mercury	Not Detected	0.001	1	mg/L	EPA 245.1	12/06/07	12/5/07	2220
Potassium	1.7	0.1	1	mg/L	EPA 200.7	12/13/07		2523
Magnesium	75	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Sodium	270	0.05	1	mg/L	EPA 200.7	12/13/07		2523
Aluminum	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2564

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Kenneth Tab
California Serengetti
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Santa Margarita, CA 93453

Log Number: 07-C15401
Order: 06253
Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Unit 31 Lot 149	Kenneth Tab	11/29/07@10:00	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Antimony	Not Detected	0.006	1	mg/L	EPA 200.8	12/10/07		2363
Arsenic	0.002	0.002	1	mg/L	EPA 200.8	12/10/07		2363
Barium	Not Detected	0.1	1	mg/L	EPA 200.8	12/10/07		2363
Beryllium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Cadmium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Chromium	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Copper	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363
Lead	Not Detected	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Manganese	0.04	0.02	1	mg/L	EPA 200.8	12/10/07		2363
Nickel	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Selenium	0.015	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Silver	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Thallium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Zinc	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

CREEK ENVIRONMENTAL LABORATORIES

Lab Director, Michael Ng

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UNIT 31 LOT 164

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15402
Order: 06253
Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Unit 31 Lot 164	Kenneth Tab	11/29/07@10:00	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Carbonate Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Bicarbonate Alkalinity as CaCO3	170	2	1	mg/L	SM 2320B	12/10/07		2344
Hydroxide Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/10/07		2344
Total Alkalinity as CaCO3	170	2	1	mg/L	SM 2320B	12/10/07		2344
Chloride	34	1	1	mg/L	EPA 300.0	11/29/07		1998
Total Cyanide	Not Detected	0.005	1	mg/L	SM 4500-CN C,E	12/10/07	12/07/07	2323
Color	Not Detected	1	1	units	SM 2120B	11/29/07		1966
Electrical Conductance	1,200	1	1	umhos/cm	SM 2510 B	11/29/07		1966
Fluoride	1.3	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Langlier Index (Corrosivity)	0.3	---	1	pH units	SM 2330B	12/14/07		2542
MBAS(Anionic Surfactants MW=340)	Not Detected	0.05	1	mg/L	SM 5540 C	11/30/07	11/30/07	2040
Nitrate as N	3.4	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Nitrate as NO3	15	0.4	1	mg/L	EPA 300.0			
Nitrite as N	Not Detected	0.1	1	mg/L	EPA 300.0	11/29/07		1998
Odor	Not Detected	1	1	TON	SM 2150B	11/29/07		1966
pH	7.6	0.1	1	pH units	SM 4500-H B	11/29/07		1966
Sulfate	420	5	10	mg/L	EPA 300.0	12/03/07		2077
Total Dissolved Solids	870	10	1	mg/L	SM 2540 C	12/04/07		2209
Turbidity	0.5	0.1	1	NTU	SM 2130 B	11/29/07		1966
Total Coliform Bacteria	Present	---	NA		SM 9223	11/29/07		1990
E. coli	Absent	---	NA		SM 9223	11/29/07		1990
Calcium	92	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Hardness	360	1	NA	mg/L CaCO3	EPA 200.7			
Iron	Not Detected	0.02	1	mg/L	EPA 200.7	12/13/07		2523
Mercury	Not Detected	0.001	1	mg/L	EPA 245.1	12/06/07	12/5/07	2220
Potassium	1.8	0.1	1	mg/L	EPA 200.7	12/13/07		2523
Magnesium	32	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Sodium	150	0.05	1	mg/L	EPA 200.7	12/13/07		2523
Aluminum	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2564

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Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15402
Order: 06253
Project: 12900 Soda Lake Road
Received: 11/29/07
Printed: 12/17/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Unit 31 Lot 164	Kenneth Tab	11/29/07@10:00	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Antimony	Not Detected	0.006	1	mg/L	EPA 200.8	12/10/07		2363
Arsenic	Not Detected	0.002	1	mg/L	EPA 200.8	12/10/07		2363
Barium	Not Detected	0.1	1	mg/L	EPA 200.8	12/10/07		2363
Beryllium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Cadmium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Chromium	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Copper	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363
Lead	Not Detected	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Manganese	Not Detected	0.02	1	mg/L	EPA 200.8	12/10/07		2363
Nickel	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Selenium	0.006	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Silver	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Thallium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Zinc	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

CREEK ENVIRONMENTAL LABORATORIES

Lab Director, Michael Ng

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UNIT 33 LOT 27

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15458
Order: 06279
Received: 11/30/07
Printed: 12/18/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Unit 33 Lot 27	Kenneth Tab	11/29/07@16:30	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Carbonate Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/11/07		2346
Bicarbonate Alkalinity as CaCO3	160	2	1	mg/L	SM 2320B	12/11/07		2346
Hydroxide Alkalinity as CaCO3	Not Detected	2	1	mg/L	SM 2320B	12/11/07		2346
Total Alkalinity as CaCO3	160	2	1	mg/L	SM 2320B	12/11/07		2346
Chloride	70	1	1	mg/L	EPA 300.0	11/30/07		2030
Total Cyanide	Not Detected	0.005	1	mg/L	SM 4500-CN C,E	12/10/07	12/10/07	2328
Color	Not Detected	1	1	units	SM 2120B	11/30/07		2069
Electrical Conductance	1,800	1	1	umhos/cm	SM 2510 B	11/30/07		2069
Fluoride	1.1	0.1	1	mg/L	EPA 300.0	11/30/07		2030
Langlier Index (Corrosivity)	0.4	---	1	pH units	SM 2330B	12/14/07		2544
MBAS(Anionic Surfactants MW=340)	Not Detected	0.05	1	mg/L	SM 5540 C	11/30/07	11/30/07	2040
Nitrate as N	6.6	0.1	1	mg/L	EPA 300.0	11/30/07		2030
Nitrate as NO3	29	0.4	1	mg/L	EPA 300.0			
Nitrite as N	Not Detected	0.1	1	mg/L	EPA 300.0	11/30/07		2030
Odor	Not Detected	1	1	TON	SM 2150B	11/30/07		2069
pH	7.6	0.1	1	pH units	SM 4500-H B	11/30/07		2069
Sulfate	720	5	10	mg/L	EPA 300.0	12/03/07		2077
Total Dissolved Solids	1,300	10	1	mg/L	SM 2540 C	12/05/07		2343
Turbidity	2.1	0.1	1	NTU	SM 2130 B	11/30/07		2069
Total Coliform Bacteria	Absent	---	NA		SM 9223	11/30/07		2037
Calcium	120	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Hardness	520	1	NA	mg/L CaCO3	EPA 200.7			
Iron	0.02	0.02	1	mg/L	EPA 200.7	12/13/07		2523
Mercury	Not Detected	0.001	1	mg/L	EPA 245.1	12/06/07	12/5/07	2220
Potassium	0.8	0.1	1	mg/L	EPA 200.7	12/13/07		2523
Magnesium	51	0.03	1	mg/L	EPA 200.7	12/13/07		2523
Sodium	220	0.05	1	mg/L	EPA 200.7	12/13/07		2523
Aluminum	Not Detected	0.05	1	mg/L	EPA 200.8	12/17/07		2631
Antimony	Not Detected	0.006	1	mg/L	EPA 200.8	12/10/07		2363
Arsenic	Not Detected	0.002	1	mg/L	EPA 200.8	12/10/07		2363

CREEK ENVIRONMENTAL LABORATORIES, INC.
A Minority-owned Business Enterprise
141 SUBURBAN ROAD, SUITE C-5 • SAN LUIS OBISPO, CA 93401 • (805) 545-9838 • FAX (805) 545-0107

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15458
Order: 06279
Received: 11/30/07
Printed: 12/18/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Unit 33 Lot 29	Kenneth Tab	11/29/07@16:30	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Barium	Not Detected	0.1	1	mg/L	EPA 200.8	12/10/07		2363
Beryllium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Cadmium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Chromium	0.01	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Copper	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363
Lead	Not Detected	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Manganese	Not Detected	0.02	1	mg/L	EPA 200.8	12/10/07		2363
Nickel	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Selenium	Not Detected	0.005	1	mg/L	EPA 200.8	12/10/07		2363
Silver	Not Detected	0.01	1	mg/L	EPA 200.8	12/10/07		2363
Thallium	Not Detected	0.001	1	mg/L	EPA 200.8	12/10/07		2363
Zinc	Not Detected	0.05	1	mg/L	EPA 200.8	12/10/07		2363

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

CREEK ENVIRONMENTAL LABORATORIES

Lab Director, Michael Ng

CREEK ENVIRONMENTAL LABORATORIES, INC.
A Minority-owned Business Enterprise
141 SUBURBAN ROAD, SUITE C-5 • SAN LUIS OBISPO, CA 93401 • (805) 545-9838 • FAX (805) 545-0107

MOTEL ROOM 14

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15459
Order: 06279
Received: 11/30/07
Printed: 12/18/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Motel Room 14	Kenneth Tab	11/30/07@08:30	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Total Coliform Bacteria	Absent	---	NA		SM 9223	11/30/07		2037

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

CREEK ENVIRONMENTAL LABORATORIES

Lab Director, Michael Ng

CREEK ENVIRONMENTAL LABORATORIES, INC.
A Minority-owned Business Enterprise
141 SUBURBAN ROAD, SUITE C-5 • SAN LUIS OBISPO, CA 93401 • (805) 545-9838 • FAX (805) 545-0107

RESTAURANT SINK

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15460
Order: 06279
Received: 11/30/07
Printed: 12/18/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Restaurant Sink	Kenneth Tab	11/30/07@08:30	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Total Coliform Bacteria	Absent	---	NA		SM 9223	11/30/07		2037

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

CREEK ENVIRONMENTAL LABORATORIES

Lab Director, Michael Ng

CREEK ENVIRONMENTAL LABORATORIES, INC.
A Minority-owned Business Enterprise
141 SUBURBAN ROAD, SUITE C-5 • SAN LUIS OBISPO, CA 93401 • (805) 545-9838 • FAX (805) 545-0107

RESTAURANT RESTROOM

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15461
Order: 06279
Received: 11/30/07
Printed: 12/18/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Restaurant Rest Room	Kenneth Tab	11/30/07@08:30	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Total Coliform Bacteria	Absent	---	NA		SM 9223	11/30/07		2037

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

CREEK ENVIRONMENTAL LABORATORIES

Lab Director, Michael Ng

CREEK ENVIRONMENTAL LABORATORIES, INC.
A Minority-owned Business Enterprise
141 SUBURBAN ROAD, SUITE C-5 • SAN LUIS OBISPO, CA 93401 • (805) 545-9838 • FAX (805) 545-0107

STORE SINK

Kenneth Tab
California Serengetti
P.O. Box 3058
Santa Margarita, CA 93453

Log Number: 07-C15462
Order: 06279
Received: 11/30/07
Printed: 12/18/07

REPORT OF ANALYTICAL RESULTS

Sample Description	Sampled By	Sampled Date @ Time	Matrix
Store Sink	Kenneth Tab	11/30/07@08:30	Drinking Water

Analyte	Result	DLR	Dilution Factor	Units	Method	Date Analyzed	Date Prepared	Batch
Total Coliform Bacteria	Absent	---	NA		SM 9223	11/30/07		2037

DLR = Detection Limit for Reporting. Results of "Not Detected" are below DLR.

CREEK ENVIRONMENTAL LABORATORIES

Lab Director, Michael Ng

Filipponi &
Thompson
Drilling Inc.

STATE LICENSE NO. C57 432680
P.O. Box 845 • ATASCADERO, CA 93423 • PHONE 466-1271

December 4, 2007

Kenny Tab
P.O. Box 3058
Santa Margarita, CA 93453

Re: 13531 Soda Lake Road - CA Valley - APN - 072-201-008 - Glade Trail Site
4.0 Hour Test Pump + 1.0 Hour Recovery

Date	Time	Flow Rate	Water Level
11/28/07	10:40 a.m.		11.9
	10:42	30	23.5
	10:45	30	24.7
	10:50	30	25.2
	11:00	30	25.6
	11:15	30	25.7
	12:40 p.m.	30	26.2
	1:00	30	26.2
	2:00	30	26.7
	2:40	30	26.8

RECOVERY DATA

Date	Time	Water Level
11/28/07	2:40 p.m.	26.8
	2:42	13.3
	2:45	12.9
	2:50	12.8
	3:00	12.6
	3:10	12.4
	3:20	12.3
	3:30	12.3
	3:40	12.2

Please contact our office at (805) 466-1271 with any questions regarding the information provided in this letter.

Thank you,

Ned M. Thompson

Ned M. Thompson
NMT/kf

Filipponi &
Thompson
Drilling Inc.

STATE LICENSE NO. C57 432680
P.O. Box 845 • ATASCADERO, CA 93423 • PHONE 466-1271

December 4, 2007

Kenny Tab
P.O. Box 3058
Santa Margarita, CA 93453

Re: 13531 Soda Lake Road - CA Valley - APN - 072-201-008 - Gaviota Trail Site
4.0 Hour Test Pump + 1.0 Hour Recovery

Date	Time	Flow Rate	Water Level
11/28/07	12:45 p.m.		20.8
	12:47	30	34.6
	12:50	30	35.5
	12:55	30	35.9
	1:05	30	36.1
	1:15	30	36.3
	1:45	30	36.9
	2:15	30	37.3
	3:15	30	37.9
	3:45	30	38.1
	4:45	30	38.3

RECOVERY DATA

Date	Time	Water Level
11/28/07	4:45 p.m.	38.3
	4:47	22.9
	4:50	22.4
	4:55	22.0
	5:05	21.7
	5:15	21.5
	5:25	21.4
	5:35	21.3
	5:45	21.2

Please contact our office at (805) 466-1271 with any questions regarding the information provided in this letter.

Thank you,

Ned M. Thompson
NMT/kf

Filipponi &
Thompson
Drilling Inc.

STATE LICENSE NO. C57 432680
P.O. Box 845 • ATASCADERO, CA 93423 • PHONE 466-1271

December 4, 2007

Margaret Camara
P.O. Box 1072
Seaside, CA 93955

Re: Devil's Den Trail - CA Valley - APN - 082-131-057
4.0 Hour Test Pump + 1.0 Hour Recovery

Date	Time	Flow Rate	Water Level
11/29/07	8:55 a.m.		09.9
	8:57	30	24.7
	9:00	30	29.2
	9:05	30	30.1
	9:10	30	31.8
	9:15	30	32.9
	9:25	30	34.1
	10:25	30	36.7
	10:55	30	37.0
	11:55	30	37.5
	12:55 p.m.	30	37.9

RECOVERY DATA

Date	Time	Water Level
11/29/07	12:55 p.m.	37.9
	12:57	21.4
	1:00	17.2
	1:05	15.2
	1:10	14.4
	1:15	13.7
	1:25	12.8
	1:35	12.3
	1:45	11.9
	1:55	11.6

Please contact our office at (805) 466-1271 with any questions regarding the information provided in this letter.

Thank you,

Ned M. Thompson
NMT/kf

Filipponi &
Thompson
Drilling Inc.

STATE LICENSE NO. C57 432680
P.O. Box 845 • ATASCADERO, CA 93423 • PHONE 466-1271

December 4, 2007

Margaret Camara
P.O. Box 1072
Seaside, CA 93955

Re: Ginger Road - CA Valley - APN - 082-212-015
4.0 Hour Test Pump + 1.0 Hour Recovery

Date	Time	Flow Rate	Water Level
11/29/07	12:15 p.m.		10.2
	12:17	30	23.2
	12:20	30	24.5
	12:25	30	25.9
	12:30	30	26.5
	12:35	30	27.0
	12:45	30	27.4
	1:15	30	27.9
	2:15	30	29.1
	3:15	30	29.3
	4:15	30	29.4

RECOVERY DATA

Date	Time	Water Level
11/29/07	4:15 p.m.	29.4
	4:17	16.5
	4:20	13.7
	4:25	12.8
	4:30	12.3
	4:35	12.1
	4:45	11.5
	4:55	11.2
	5:05	11.0
	5:15	10.9

Please contact our office at (805) 466-1271 with any questions regarding the information provided in this letter.

Thank you,

Ned M. Thompson
NMT/kf

Filipponi &
Thompson
Drilling Inc.

STATE LICENSE NO. C57 432680
P.O. Box 845 • ATASCADERO, CA 93423 • PHONE 466-1271

December 4, 2007

Margaret Camara
P.O. Box 1072
Seaside, CA 93955

Re: Dos Palos Road - CA Valley - APN - 082-131-019
4.0 Hour Test Pump + 1.0 Hour Recovery

Date	Time	Flow Rate	Water Level
11/29/07	6:50 a.m.		9.9
	6:52	30	18.9
	6:55	30	19.4
	7:00	30	19.7
	7:10	30	20.5
	7:20	30	20.9
	7:35	30	21.4
	7:50	30	21.7
	8:50	30	22.3
	9:50	30	22.7
	10:50	30	23.0

RECOVERY DATA

Date	Time	Water Level
11/29/07	10:50 a.m.	23.0
	10:52	14.3
	10:55	13.5
	11:00	13.0
	11:05	12.6
	11:10	12.3
	11:20	12.0
	11:30	11.8
	11:40	11.6
	11:50	11.4

Please contact our office at (805) 466-1271 with any questions regarding the information provided in this letter.

Thank you,

Ned M. Thompson
NMT/kf

ORIGINAL
File with DWR
Page 1 of 1

STATE OF CALIFORNIA
_LL COMPLETION REPORT
Refer to Instruction Pamphlet
No. **E057368**

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. Devil's Den
Date Work Began 11/7/2007, **Ended** 11/7/2007
Local Permit Agency San Luis Obispo County
Permit No. 2007-328 **Permit Date** 9/12/2007

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain, size, color, etc.
0	3	TOP SOIL
3	30	SANDY BROWN CLAY WITH THIN GRAVEL
		STRINGERS
30	38	SAND & GRAVEL
38	50	SANDY BROWN CLAY & GRAVEL
50	62	SAND & GRAVEL
62	80	SANDY BROWN CLAY & GRAVEL
80	85	SAND & GRAVEL
85	96	BROWN CLAY
96	100	SAND & GRAVEL
100	108	BROWN CLAY
108	115	SAND & GRAVEL
115	120	GREEN CLAY
		The Air Lift Test is only approximate. A Test Pump
		is recommended for an accurate account. (WP)

TOTAL DEPTH OF BORING 120 (Feet)
TOTAL DEPTH OF COMPLETED WELL 120 (Feet)

WELL OWNER

Name Margaret Camara
Mailing Address P.O. Box 1072
Seaside CA 93955
CITY STATE ZIP

WELL LOCATION

Address Devil's Den Trail Site
City California Valley CA
County San Luis Obispo
APN Book 082 Page 131 Parcel 057
Township 30 S Range 18 E Section 24
Latitude 35 18 030 N (DEG. MIN. SEC.) Longitude 119 59 120 W (DEG. MIN. SEC.)

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 10 (Ft.) & DATE MEASURED 11/7/2007
ESTIMATED YIELD * 50+ (GPM) & TEST TYPE Air Lift
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	30	10	✓				F-480 PVC	5	SDR 21	
30	120	10	PERF				F-480 PVC	5	SDR 21	.040

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	30	✓			
30	120			✓	Monterey Mix

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME FILIPPONI & THOMPSON DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS P.O. BOX 845 CITY ATASCADERO STATE CA ZIP 93423
Signed [signature] WELL DRILLER/AUTHORIZED REPRESENTATIVE
DATE SIGNED 11/12/07
C-57 LICENSE NUMBER 432680

DWR 188 REV. 11-97
IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. E057367

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. Dos Palos
Date Work Began 11/7/2007, Ended 11/7/2007
Local Permit Agency San Luis Obispo County
Permit No. 2007-329 Permit Date 9/12/2007

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	3	TOP SOIL
3	30	SANDY GREY CLAY
30	38	SAND & GRAVEL
38	50	BROWN CLAY
50	58	SAND & GRAVEL
58	115	BROWN CLAY W/ THIN GRAVEL STRINGERS
115	123	SAND & GRAVEL
123	130	GREEN CLAY
		The Air Lift Test is only approximate. A Test Pump is recommended for an accurate account. (WP)

TOTAL DEPTH OF BORING 130 (Feet)
TOTAL DEPTH OF COMPLETED WELL 120 (Feet)

WELL OWNER

Name Margaret Camara
Mailing Address P.O. Box 1072
Seaside CA 93955
CITY STATE ZIP

WELL LOCATION

Address Dos Palos Road Site
City California Valley CA
County San Luis Obispo
APN Book 082 Page 131 Parcel 019
Township 30 S Range 18 E Section 24
Latitude 35 18 159 N 119 59 119 W
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH
WEST
EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 10 (Ft.) & DATE MEASURED 11/7/2007
ESTIMATED YIELD * 75 (GPM) & TEST TYPE Air Lift
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	30	10	✓				F-480 PVC	5	SDR 21	
30	120	10		PERF			F-480 PVC	5	SDR 21	.040

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	30	✓			
30	120			✓	Monterey Mix

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME FILIPPONI & THOMPSON DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS P.O. BOX 845 ATASCADERO CA 93423
CITY STATE ZIP
Signed [signature] 11/12/07 432680
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR
Page 1 of 1
Owner's Well No. #1
Date Work Began 8/30/02, Ended 8/30/02
Local Permit Agency San Luis Obispo
Permit No. 2002-315 Permit Date 8/15/02

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 782652

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft	to Ft	DESCRIPTION Describe material, grain, size, color, etc.
0	3	TOP SOIL
3	8	VERY SANDY CLAY
8	25	SAND & GRAVEL
285	31	BROWN CLAY
31	37	SAND & GRAVEL
37	51	BROWN SANDY CLAY
51	55	SAND & GRAVEL
55	124	BROWN CLAY
124	130	SAND & GRAVEL
130	164	BROWN CLAY
164	176	BROWN SAND
176	190	BROWN SANDY CLAY
190	206	BROWN CLAY/SAND STRINGERS/SM GRAVEL
206	240	BROWN SANDY CLAY W/SAND LAYERS
		Air Lift Test is only approximate. A Test Pump is recommended for an accurate account. (WP)

TOTAL DEPTH OF BORING 240 (Feet)
TOTAL DEPTH OF COMPLETED WELL 240 (Feet)

WELL OWNER

Name Kenny Tab
Mailing Address 12900 Soda Lake Road
California Valley CA 93453
CITY STATE ZIP

WELL LOCATION

Address 12900 Soda Lake Road
City California Valley CA
County San Luis Obispo
APN Book 072 Page 141 Parcel 021
Township 30 S Range 18 E Section 12
Latitude 35 19 27 N (DEG. MIN. SEC.) Longitude 120 00 16 W (DEG. MIN. SEC.)

LOCATION SKETCH

NORTH
WEST
EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 7 (Ft.) & DATE MEASURED 8/30/02
ESTIMATED YIELD * 53 (GPM) & TEST TYPE Air Lift
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft	to Ft	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	120	10	✓				PVC	5	SDR 21	
120	240	10	Perf				PVC	5	SDR 21	.040

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft	to Ft	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	53	✓			
53	240			✓	Monterey Mix

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief
NAME FILIPPONI & THOMPSON DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. BOX 845 ATASCADERO CA 93423
ADDRESS CITY STATE ZIP
Signed [signature] 09/10/02 432680
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV 11-97
IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR
Page 1 of 1

STATE OF CALIFORNIA
_LL COMPLETION REPORT
Refer to Instruction Pamphlet
No. **E057368**

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. Devil's Den
Date Work Began 11/7/2007, Ended 11/7/2007
Local Permit Agency San Luis Obispo County
Permit No. 2007-328 Permit Date 9/12/2007

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain, size, color, etc.
0	3	TOP SOIL
3	30	SANDY BROWN CLAY WITH THIN GRAVEL STRINGERS
30	38	SAND & GRAVEL
38	50	SANDY BROWN CLAY & GRAVEL
50	62	SAND & GRAVEL
62	80	SANDY BROWN CLAY & GRAVEL
80	85	SAND & GRAVEL
85	96	BROWN CLAY
96	100	SAND & GRAVEL
100	108	BROWN CLAY
108	115	SAND & GRAVEL
115	120	GREEN CLAY
		The Air Lift Test is only approximate. A Test Pump is recommended for an accurate account. (WP)

TOTAL DEPTH OF BORING 120 (Feet)
TOTAL DEPTH OF COMPLETED WELL 120 (Feet)

WELL OWNER

Name Margaret Camara
Mailing Address P.O. Box 1072
Seaside CA 93955
CITY STATE ZIP

WELL LOCATION

Address Devil's Den Trail Site
City California Valley CA
County San Luis Obispo
APN Book 082 Page 131 Parcel 057
Township 30 S Range 18 E Section 24
Latitude 35 18 030 N DEG. MIN. SEC. Longitude 119 59 120 W DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

1

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 10 (Ft.) & DATE MEASURED 11/7/2007
ESTIMATED YIELD * 50+ (GPM) & TEST TYPE Air Lift
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	30	10	✓				F-480 PVC	5	SDR 21	
30	120	10	PERF				F-480 PVC	5	SDR 21	.040

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	30	✓			
30	120			✓	Monterey Mix

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME FILIPPONI & THOMPSON DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS P.O. BOX 845 CITY ATASCADERO STATE CA ZIP 93423
Signed [signature] WELL DRILLER/AUTHORIZED REPRESENTATIVE
DATE SIGNED 11/12/07 C-57 LICENSE NUMBER 432680

DWR 188 REV. 11-97
IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

STATE OF CALIFORNIA

LL COMPLETION REPORT

Refer to Instruction Pamphlet

No. E063575

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

Owner's Well No. Glade

Date Work Began 11/9/2007, Ended 11/9/2007

Local Permit Agency San Luis Obispo County

Permit No. 2007-311 Permit Date 9/7/2007

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	3	TOP SOIL
3	30	SANDY BROWN CLAY
30	36	SAND & GRAVEL
36	54	SANDY BROWN CLAY W/ GRAVEL STRINGERS
54	60	SAND & GRAVEL
60	104	SANDY BROWN CLAY W/ GRAVEL STRINGERS
104	112	SAND & GRAVEL
112	120	GREEN CLAY

The Air Lift Test is only approximate. A Test Pump is recommended for an accurate account. (WP)

TOTAL DEPTH OF BORING 120 (Feet)

TOTAL DEPTH OF COMPLETED WELL 120 (Feet)

WELL OWNER

Name Kenny Tab

Mailing Address P.O. Box 3058

Santa Margarita CA 93453

CITY STATE ZIP

WELL LOCATION

Address 13531 Soda Lake Road - Glade Trail Site

City California Valley CA

County San Luis Obispo

APN Book 072 Page 201 Parcel 008

Township 30 S Range 18 E Section 24

Latitude 35 17 560 N 119 59 215 W

DEG. MIN. SEC. DEG. MIN SEC.

LOCATION SKETCH

NORTH

WEST EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

1

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 10 (Ft.) & DATE MEASURED 11/9/2007

ESTIMATED YIELD * 50 (GPM) & TEST TYPE Air Lift

TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)

May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	30	10	✓				F-480 PVC	5	SDR 21	
30	120	10		PERF			F-480 PVC	5	SDR 21	.040

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	30	✓			
30	120			✓	Monterey Mix

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FILIPPONI & THOMPSON DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS P.O. BOX 845 ATASCADERO CA 93423
CITY STATE ZIP

Signed [signature] 11/12/07 432680
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

ORIGINAL
File with DWR

STATE OF CALIFORNIA
.LL COMPLETION REPORT
Refer to Instruction Pamphlet
No. **E063576**

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. Gaviota
Date Work Began 11/8/2007, Ended 11/8/2007
Local Permit Agency San Luis Obispo County
Permit No. 2007-312 Permit Date 9/7/2007

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	3	TOP SOIL
3	30	SANDY BROWN CLAY
30	34	SAND & GRAVEL
34	110	SANDY BROWN CLAY W/ THIN GRAVEL LAYERS
110	135	RED ROCK
		The Air Lift Test is only approximate. A Test Pump is recommended for an accurate account. (WP)

TOTAL DEPTH OF BORING 135 (Feet)
TOTAL DEPTH OF COMPLETED WELL 135 (Feet)

WELL OWNER

Name Kenny Tab
Mailing Address P.O. Box 3058
Santa Margarita CA 93453
CITY STATE ZIP

WELL LOCATION

Address 13531 Soda Lake Road - Gaviota Trail Site
City California Valley CA
County San Luis Obispo
APN Book 072 Page 201 Parcel 008
Township 30 S Range 18 E Section 25
Latitude 35 17 385 N (DEG. MIN. SEC.) Longitude 119 59 205 W (DEG. MIN. SEC.)

LOCATION SKETCH

NORTH
WEST
EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
— Deepen
— Other (Specify)
— DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 10 (Ft.) & DATE MEASURED 11/8/2007
ESTIMATED YIELD * 50 (GPM) & TEST TYPE Air Lift
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE: BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	35	10	✓				F-480 PVC	5	SDR 21	
35	135	10	PERF				F-480 PVC	5	SDR 21	.040

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	30	✓			
30	135			✓	Monterey Mix

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME FILIPPONI & THOMPSON DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. BOX 845 ATASCADERO CA 93423
ADDRESS CITY STATE ZIP
Signed [signature] 11/12/07 432680
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

TRITON
Environmental Group

CALIFORNIA SPRINGS LODGE & RESORT

GROUNDWATER RESOURCES EVALUATION CALIFORNIA VALLEY

July 3, 2002

Triton Environmental Group, Inc.
4450 California Avenue, Suite K-299
Bakersfield, California 93309
(661) 588-2448

TABLE OF CONTENTS

FIGURES

CALIFORNIA SPRINGS LODGE & RESORT

GROUNDWATER RESOURCES EVALUATION
CALIFORNIA VALLEY

San Luis Obispo County, California
July 3, 2002
Project No. 004

1.0 INTRODUCTION

Mr. Kenneth Tab of California Springs Lodge & Resort (CSLR) authorized Triton Environmental Group, Inc. (Triton) to prepare this Groundwater Resources Evaluation (Evaluation) for Section 12 and part of Section 24, Township 30 South, Range 18 East, Mount Diablo Base and Meridian (MDBM), located in the Carrizo Plain and shown on Figure 1 and 2 (Site). In accordance with a discussion between Mr. Jon Cooper of Triton and Mr. Tab on June 7, 2002, Triton understands that CSLR is planning to develop groundwater resources on the Site by drilling exploratory and production water supply wells for both drinking water and recreational use. The purpose of the Evaluation is to investigate the hydrogeology of the Site vicinity and to provide recommendations for well location and design using data previously generated by others. A summary of the background, records review, findings, conclusions, and recommendations follows.

2.0 BACKGROUND

Formerly part of a grain and cattle ranch, the Site vicinity is included in a subdivision that was approved by San Luis Obispo County in the late 1950s or early 1960s. A group of structures formerly operated as a service station, motel, store, and restaurant is located on the Site near the southwest corner of Section 12 (Figure 2). The purpose of anticipated groundwater resource development is to supply drinking water for use in the structures and for a planned recreational lake in the northward half of Section 12.

3.0 SITE SETTING

The Site consists of two non-contiguous parcels. The northern parcel, Section 12, occupies approximately 640 acres. The southern parcel occupies approximately 114 acres along the eastward side of Section 24. A northwest to southeast-trending intermittent stream channel transects Section 12. Soda Lake Road, a paved county road, also transects Section 12, trending north-northwest to south-southeast from the northwest corner of Section 12. Section 12 slopes toward the intermittent stream channel at an approximate rate of 30 feet per mile, and the southern parcel slopes eastward at the same approximate rate. Site elevation ranges from 1,980 feet above mean sea level (MSL) to 1,950 feet MSL.

4.0 CLIMATIC CONDITIONS

Local rainfall records in the Carrizo Plain for the ten-year average from 1960 to 1970 show annual rainfall of approximately 9.5 inches. In his Rainfall and Temperature Analysis of the Carrizo Plain, Joseph Lima states that:

> Rainfall amounts typically are less in the southern portion of the Carrizo Plain than in the northern portion. The summer days are hot and the nights are cool. A cool wind chill, both night and day, is not uncommon during the summer. The humidity stays fairly low most of the summer and winter. Breezes in the afternoon, from five to ten miles per hour, are also common during the summer months. Fog is very rare and frosts are quite common for at least six to eight months of the year (Lima, 1975).

5.0 HYDROGEOLOGY

The Carrizo Plain is an internally drained basin approximately 56 miles long and eight miles wide, bounded by the Temblor Range to the northeast and the Caliente Range to the southwest. The San Andreas Fault Rift Zone (SAF) is aligned with the southwestward foot of the Temblor range. Northeast of the SAF, Cretaceous to recent sediments rest on Franciscan basement rocks of Jurassic and Cretaceous age. Southwest of the SAF, Cretaceous to Recent sediments overlie Santa Lucia Granodiorite of Late Cretaceous age (Galehouse, 1967). Surface flow within the basin is toward Soda Lake; a desert playa located approximately six miles southwest of the Site that is a sag pond associated with the SAF.

The Site is located on Quaternary-aged alluvium containing alkaline, fine-grained soils that flank the intermittent stream channel conducting stormwater surface flow to Soda Lake (Figure 2). The channel conducts flow to Soda Lake from the northward portion of the Carrizo Plain drainage basin where annual rainfall is greatest.

A review of paired stereoscopic aerial photographs of the Site revealed a soil color pattern suggesting that an ancient channel conducting storm flow to Soda Lake was located approximately 0.4 miles southwest of the current channel and passed near the southwest corner of Section 12.

Most of the fresh groundwater in the Carrizo Plain is found in non-marine formations of post-Pliocene age located southwestward of the SAF. They consist mostly of loosely to well-consolidated sands, gravels, silts and clays, which overlay unconformably older folded and faulted marine and continental deposits. The post-Pliocene formation is wedge-shaped, thinning from approximately 3,000 feet in thickness along the west side of the SAF to zero along the Caliente Range and San Juan Hills that form the westward boundary of the Carrizo Plain.

Groundwater quality generally improves with increasing distance northward and westward from Soda Lake, and is generally poor between Soda Lake and the SAF (Cooper, 1990). Water samples from selected wells have varied in concentration of total dissolved solids (TDS) from 545 parts per million (ppm) in Section 13, T29S, R17E MDBM to 28,740 ppm near Soda Lake in Section 34, T30S, R18E, MDBM (Kemnitzer, 1967).

6.0 WELL DATABASE REVIEW

No local well measurement data were located upon review of the United States Geological Survey's Groundwater Site Information for California. Similarly, no local data were available on the California Department of Water Resources well database website.

A review of Triton's proprietary database yielded a summary of information as discussed below for the wells and test holes located on Figure 2. The summaries provided are Triton's interpretation of data reviewed in Water Well Drillers Reports.

Location 1. Location 1 was drilled to a total depth of 111 feet below ground surface (bgs). Although the water table was measured at a static level of 63.5 feet bgs, the formation encountered was described as yellow clay with very little sand. The well was screened from 63 feet to 111 feet bgs.

Location 2. Location 2 was drilled to a total depth of 50 feet bgs. The formation encountered was described as clay. The water table was measured at a static level of 22.5 feet bgs.

Location 3. Location 3 was drilled to a total depth of 480 feet bgs. The formation was analyzed using geophysical logging techniques. Formation sands encountered were described as poor in porosity and permeability, and the depth interval between 160 and 480 feet bgs is described as clay.

Location 4. Location 4 was drilled to a total depth of 580 feet bgs. The formation was analyzed using geophysical logging techniques. The total formation sand encountered at location 4 was estimated at 205 linear feet.

The sand intervals described as the best aquifer material were 103 feet to 140 feet bgs and 185 feet to 237 feet bgs.

Location 5. Location 5 is the current supply well. The well was constructed using a 10.75-inch diameter casing placed inside a 24-inch diameter boring drilled to a total depth of 520 feet bgs. The 10.75-inch diameter casing is screened from 100 feet to 520 feet bgs. A geophysical log was not available for the well. The total formation sand encountered at location 5 was estimated at 52 linear feet. The well's output capacity was estimated at 500 gallons per minute (Kemnitzer, 1967).

Location 6. Location 6 was drilled to a total depth of 275 feet bgs. The cumulative thickness of sand and gravel encountered at location 6 was estimated at 123 feet and the well was screened from 95 feet to 275 feet bgs. The water table was measured at a static level of 18 feet bgs. The well reportedly yielded 100 gallons per minute (gpm) during preliminary testing.

Location 7. Location 7 was drilled to a total depth of 160 feet bgs. The cumulative thickness of sand and gravel encountered at location 7 was estimated at 48 feet and the well was screened from 80 feet to 145 feet bgs. The depth interval between 145 feet and 160 feet bgs was described as clay. The water table was measured at a static level of 35 feet bgs.

Location 8. Location 8 was drilled to a total depth of 160 feet bgs. The cumulative thickness of sand and gravel encountered at location 8 was estimated at 105 feet and the well was screened from 60 feet to 160 feet bgs. The depth interval between 140 feet and 160 feet bgs was described as the best aquifer material. The water table was measured at a static level of 30 feet bgs.

Location 9. Location 9 was drilled to a total depth of 100 feet bgs. The cumulative thickness of sand, gravel and clay encountered at location 9 was estimated at 45 feet and the well was screened from 50 feet to 100 feet bgs. The water table was measured at a static level of 35 feet bgs.

7.0 FINDINGS

Based on Triton's document review, our findings and the relevance of the findings to the value of groundwater resources at the Site are summarized below.

7.1 Groundwater Well Yields

Well yields vary widely, depending on the details of well construction and design, pump specifications, and aquifer characteristics. Additionally, well yield is controlled by such factors as aquifer porosity, permeability, transmissivity and recharge.

The data relating to groundwater well yields obtained from Triton's record review is limited; however, the data from Locations 5 and 6 suggest that well pumping rates of 100 gpm to 500 gpm can be reasonably expected at selected locations in the Site vicinity.

Locations 1, 2, and 3 are associated with a large fraction of clay and clayey gravel in the subsurface formation, suggesting that well yields would be low beneath the northward portion of the Site. Locations 4, 5, and 6 are associated with formations containing greater fractions of sand and gravel, from which greater groundwater yields are likely.

Locations 7, 8, and 9 also have large fractions of sand and gravel. None of the wells was completed below a depth of 160 feet bgs; therefore, the estimated yield of deeper wells in this area is less certain.

7.2 Groundwater Quality

Well water from location 5 has been analyzed to identify chemical characteristics related to groundwater quality. In 1966, analyses indicated the water was excellent for drinking water uses, with TDS of 404 ppm. Results for nitrate concentration were not available (Kemnitzer, 1967). Detailed chemical data was not available for wells at the other locations listed; however, Triton personnel have previously completed field tests on groundwater from a well in the vicinity of Location 7 and determined the electrical conductivity to be within drinking water limits.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information presented above, Triton concludes that there are three groundwater resources available on the Site for development by CSLR:

- Rehabilitation of the existing well;
- Completion of a new well in Section 12; and
- Completion of a new well in Section 24.

A brief discussion of each alternative, with recommendations, follows.

8.1 Rehabilitation of Existing Well

A pumping test of the existing well should be conducted for a minimum duration of 24 hours. A detailed record of drawdown with pumping time should be completed under the direction of a Certified Hydrogeologist (C HG). Following the pumping test, the pump should be removed and the well casing logged with a video logger to evaluate casing condition. Based on the results of the pumping test and the video log, a well rehabilitation plan, if appropriate, should be prepared by a qualified hydrogeologist in consultation with a qualified well rehabilitation contractor.

8.2 Section 12 Exploratory Boring

An exploratory boring should be drilled in or near the portion of Section 12 west of Soda Lake Road and south of the former motel. Triton is available to assist CSLR and its drilling contractor in the selection of a specific drilling site. A test boring should be completed to a minimum depth of 600 feet bgs using mud rotary techniques. A lithologic log should be completed during completion of the test boring. A C HG or a geologist working under the direct supervision of a C HG should complete the log in the field. The geologist will observe and describe samples of cuttings returned by the drill rig and will record related data on the lithologic log such as drill penetration rates and drilling fluid circulation problems. The test boring should then be analyzed using a geophysical electric logging tool (E-log) to determine the appropriate screening interval and to evaluate the quantity and quality of water available in the water-bearing portions of the formation.

Well design, if appropriate, will be based on an analysis of the lithologic log and the E-log by a C HG. All work should be completed under the direction of a C HG.

8.3 Section 24 Exploratory Boring

An exploratory boring should be drilled in the northern half of Section 24 to assess the deeper aquifer in that vicinity. The test boring should be completed to a minimum depth of 600 feet bgs using mud rotary techniques. Protocol for monitoring and logging the exploratory boring should be the same as discussed in Section 8.2. Triton is available to assist CSLR and its drilling contractor in the selection of a specific drilling site.

Well design, if appropriate, will be based on an analysis of the lithologic log and the E-log by a C HG. All work should be completed under the direction of a C HG.

9.0 REFERENCES

Arrowsmith, J.R., 1995, The San Andreas Fault Zone in the Carrizo Plain, California: Review of Quaternary Geologic Investigations, Landforms, and Fault Activity.

Cooper, Jon W., 1990, A Geophysical Study of the Hydrogeology of the Carrizo Plain Area, San Luis Obispo County, California.

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United States Geological Survey (USGS), 1982, Simmler, Calif. 7 ½-minute topographic map.

10.0 LIMITATIONS

This Evaluation represents Triton's professional opinion and judgement, which are dependent upon information obtained during the Evaluation. Conclusions or recommendations are based in part on information supplied by others; the accuracy or sufficiency of which was not independently reviewed.

11.0 SIGNATURE PAGE

This Groundwater Resources Evaluation for California Springs Lodge & Resort, dated July 3, 2002, was prepared by Triton Environmental Group, Inc. under the responsible charge of the following professionals:

REPORT PREPARED BY:

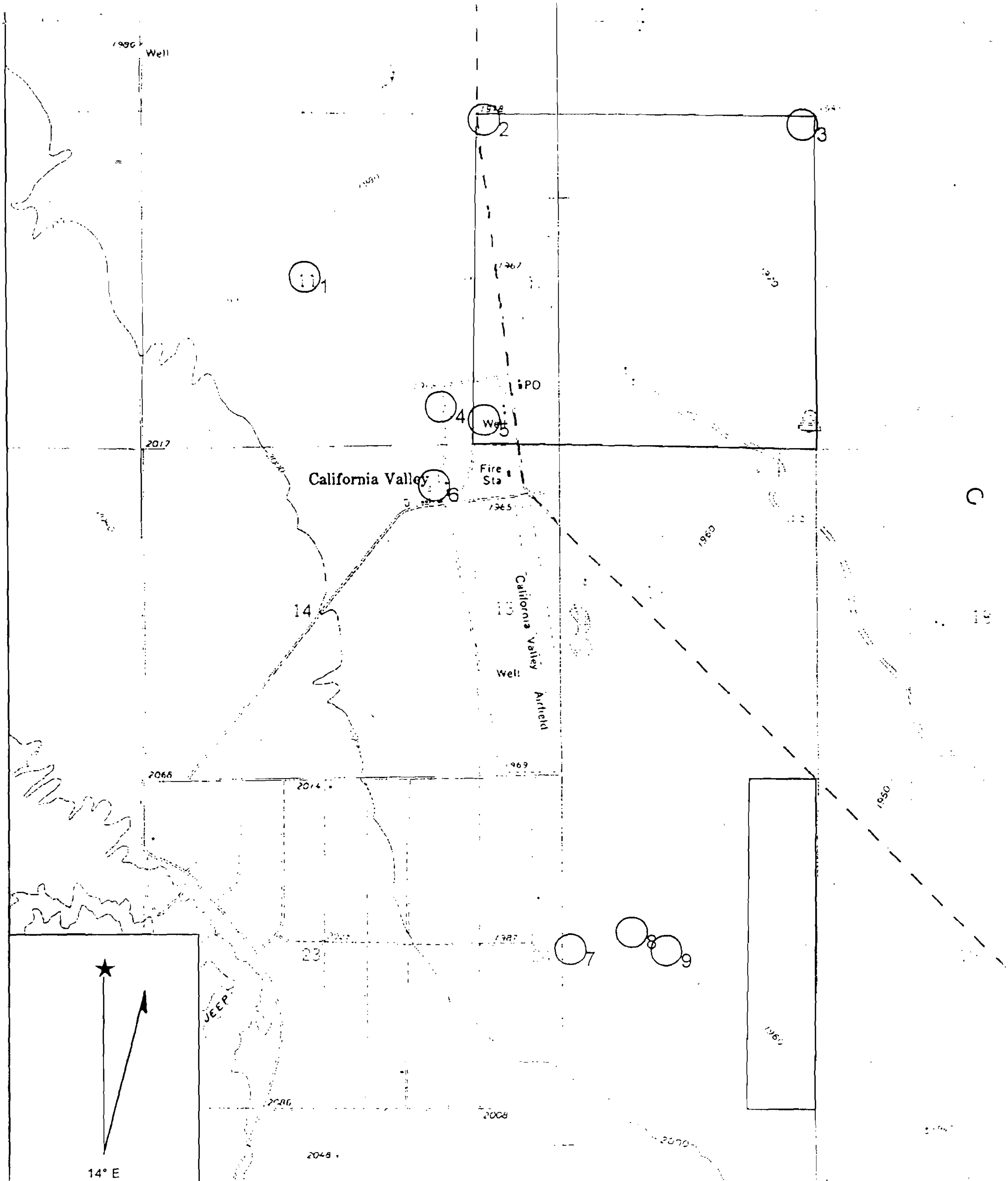
CERTIFIED HYDROGEOLOGIST ★ JON W. COOPER NO. 685 STATE OF CALIFORNIA

Jon W. Cooper, CHG
Certified Hydrogeologist

REPORT REVIEWED BY:

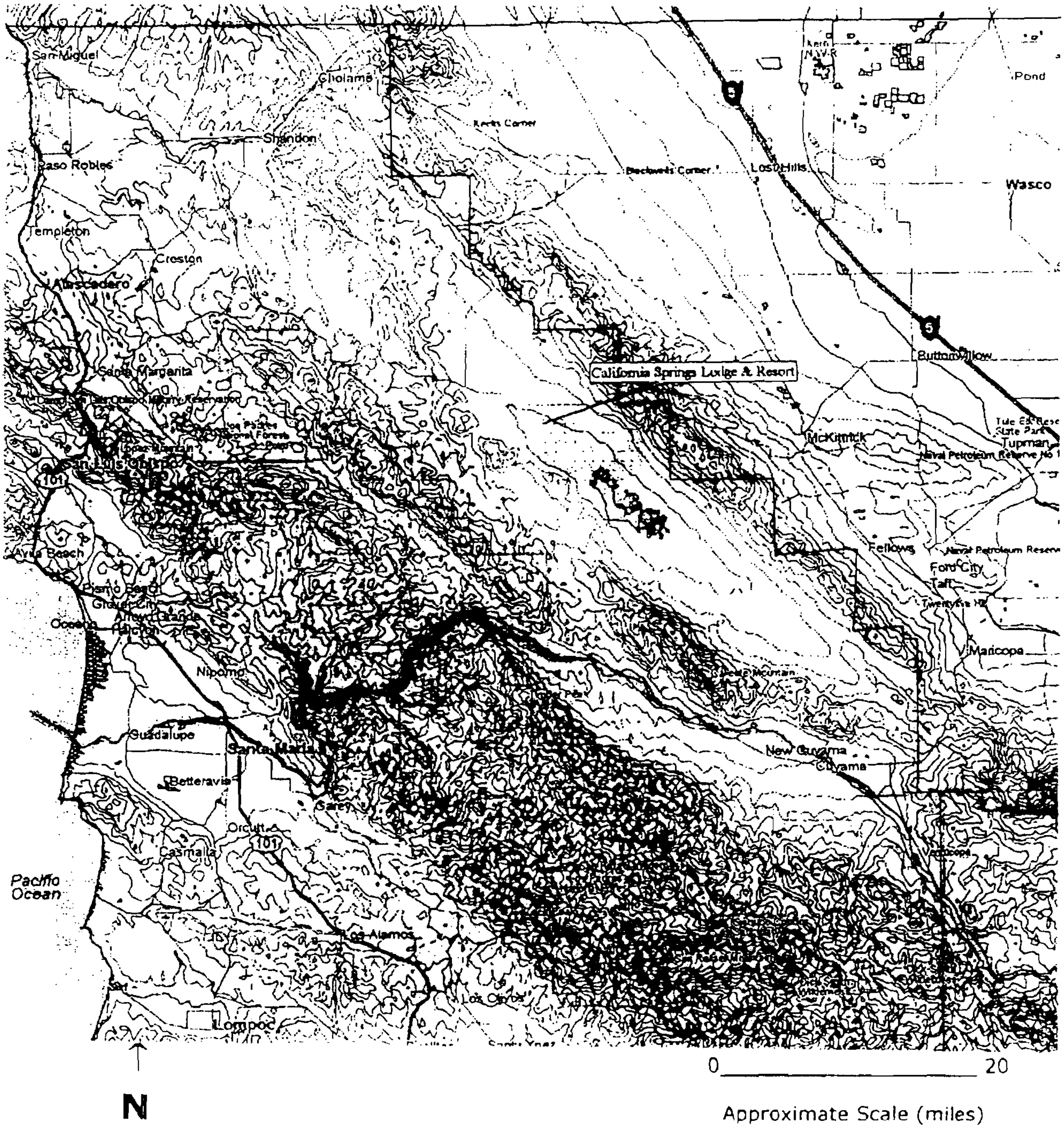
Jon Cooper for

Mark J. Pishinsky, REA
Environmental Engineer



Name: CALIFORNIA VALLEY
Date: 7/2/2002
Scale: 1 inch equals 2000 feet

Location: 035° 18' 58.3" N 120° 00' 09.6" W
Caption: FIGURE 2



PROJECT NO. 004	**SITE LOCATION MAP**	**Triton Environmental Group, Inc.**
California Springs Lodge & Resort **California Valley, California**	**FIGURE 1**	**4450 California Avenue,** **Suite K-299** **Bakersfield, CA 93309**

CARRIZO PLAIN STRATIGRAPHIC UNITS CHART

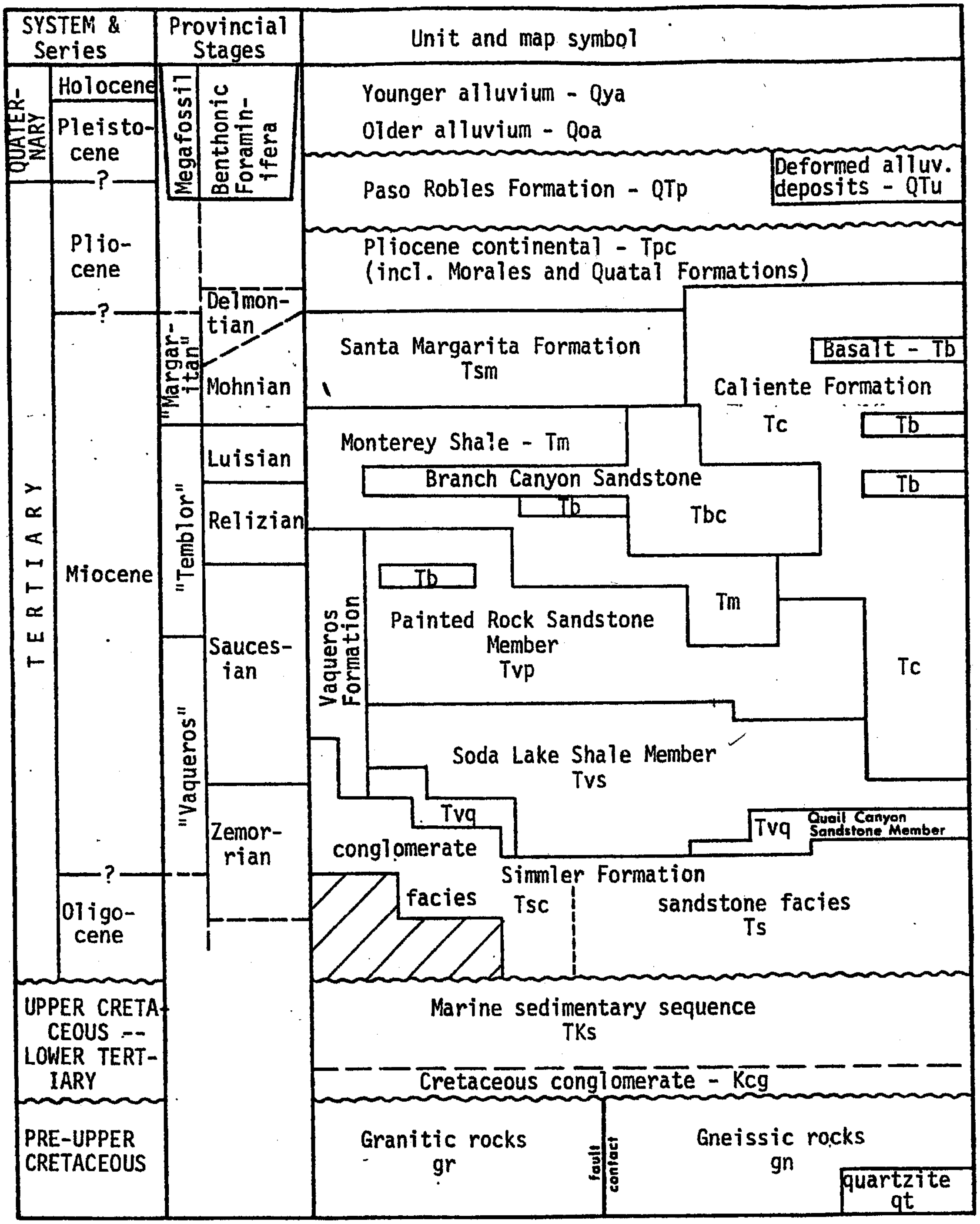


Figure 1.--Generalized chart of stratigraphic units in Caliente Range-Carrizo Plain area. Correlation of provincial megafaunal and foraminiferal stages after Addicott (1972) and Vedder (1973). Letter symbols same as symbols on plate 1 (geologic map). From Bartow, 1974.

EXISTING CESF PROJECT SITE GROUNDWATER WELL DRILLER'S REPORT

QUADRUPLICATE
RETAIN THIS COPY

WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

5

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 (Louie ? / Rob't Stere)
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.	Formation
0	4	soil & sandy clay
4	10	clay
10	40	sandy clay
40	55	fine sand
55	63	clay
63	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

07649 8-63 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.

C R Farrell

C. R. Farrell

CRF:as
Attachment

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 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

BECHTEL

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	6/13/84	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 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)

CALCULATION SHEET

0510 (11-74)

BECHTEL

DESIGN BY J. C. Isham DATE 5/10/84 CHECKED BY CRFarrell DATE 6/10/84 SHEET NO. 2 of ~~8~~ 9/10

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.

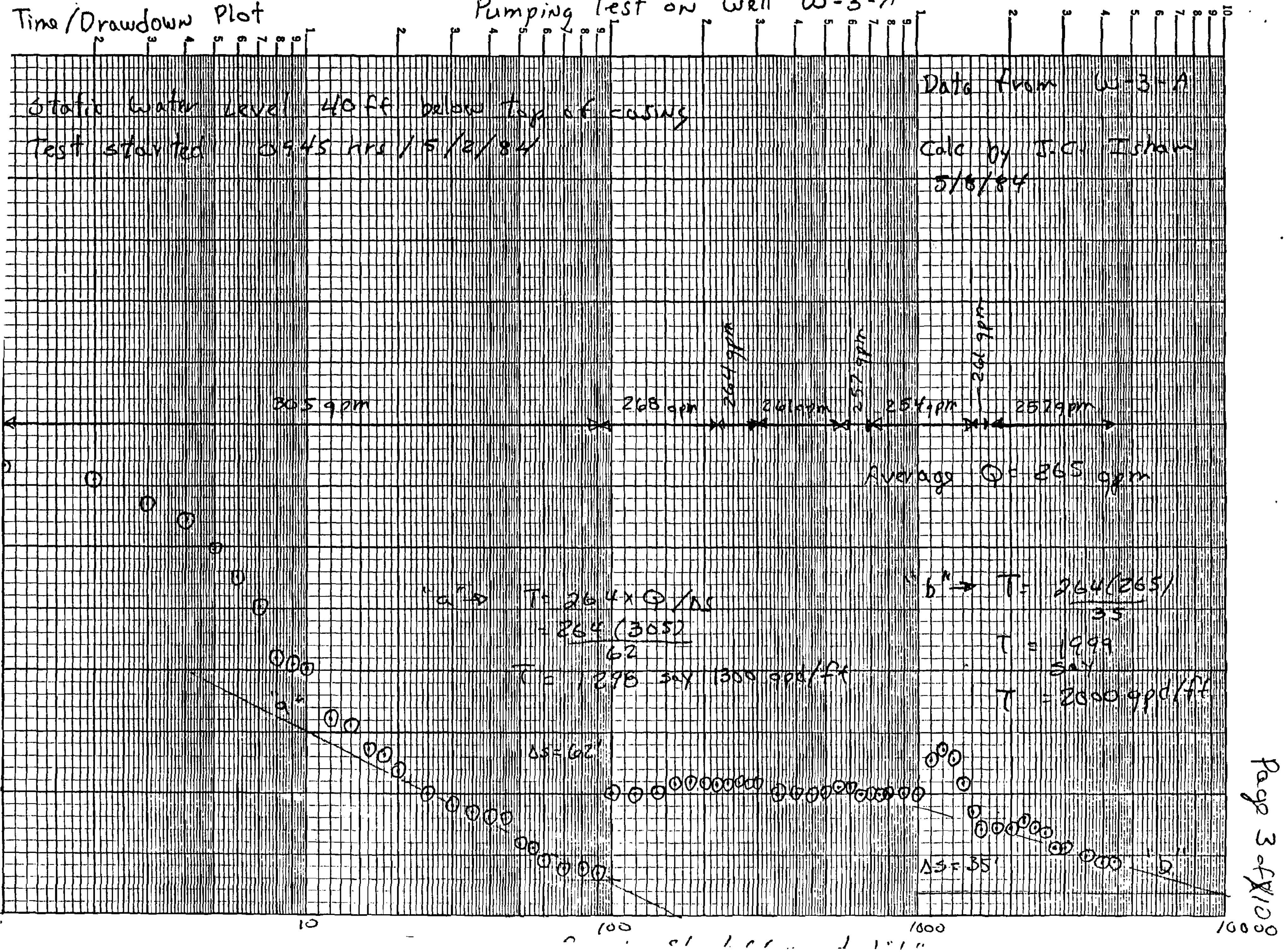
The analysis of the later data 1550 - 4335 mins. indicates a T of 2000 gpd/ft (curve "b")

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

Job # 16413

Pumping Test on Well W-3-A

Time/Drawdown Plot



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.

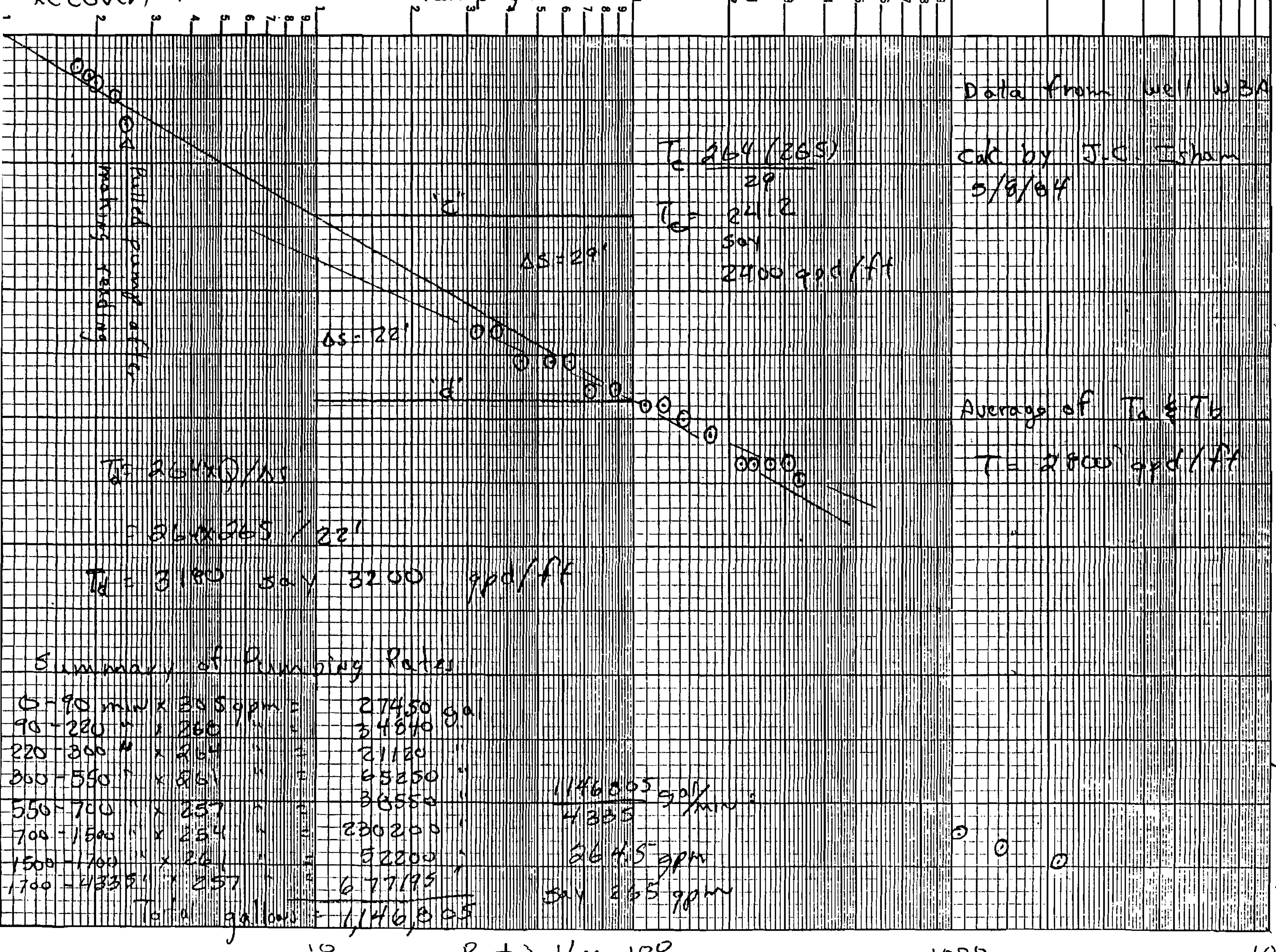
An average T from the recovery data is 2800 gpd/ft

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

Carrisa ...
Job # 1643

Recovery Plot

Pumping test in well W-3-A



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. 164B

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

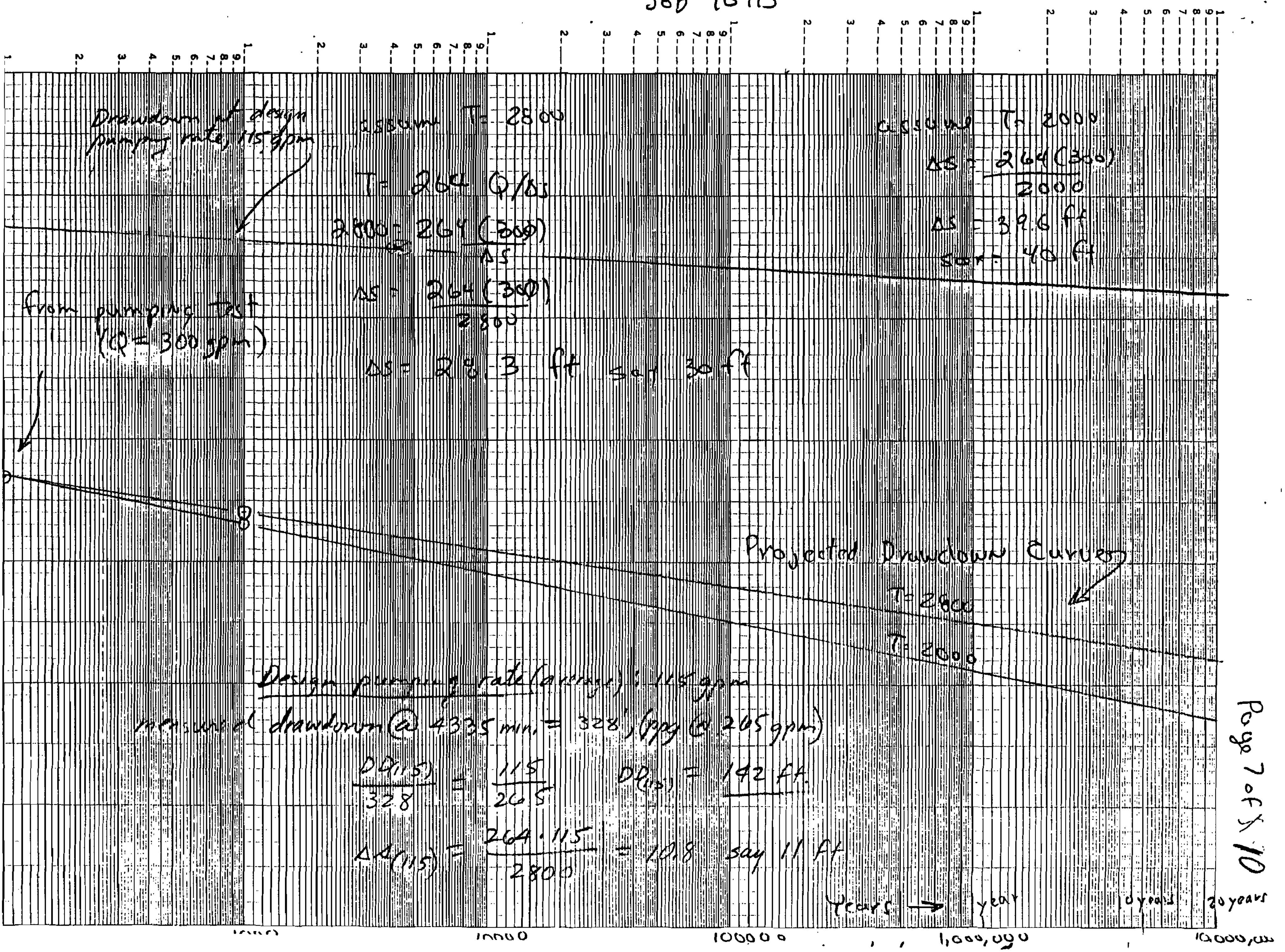
Using the data from the pumping test ie: 330' of drawdown after 90 mins. & a T of 2000 gpd/ft The projected drawdown after 20 years of pumping is shown on page 7

Assu...

1)

2) Coeffici...
(...)

Job # 16413


Drawdown at design pumping rate, 115 gpm
assume T = 2800
T = 264 Q/Δs
2800 = 264 (300) / Δs
Δs = 264 (300) / 2800
Δs = 28.3 ft say 30 ft
assume T = 2000
Δs = 264 (300) / 2000
Δs = 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', (pp) @ 265 gpm)
DD(115) / 328 = 115 / 265 DD(115) = 142 ft.
ΔA(115) = 264 · 115 / 2800 = 10.8 say 11 ft
Years →
1 year
10 years
20 years
1000
10000
100000
1,000,000
10,000,000

Carrisa Plain Project
Job # 1643 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 @ a 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)

0510 (11-74)

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CALCULATION SHEET

DATE

DESIGN BY [illegible] DATE 6/20/74 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:

$$s = \frac{Q}{0.60\, 4\pi T} \ln\left(\frac{2.25\, Tt}{r^2 S}\right)$$

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.

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

$S = 0.001$

$r = 0.5'$

$t = 4\ months = 120\ days$

$Q = 190 - 115 = 75\ gpm$

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

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

$= \underline{112\ ft}$

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 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 & Isham

STATIC W.L. 15.16 FT PH 5.51 COND'T 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	12:05PM	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 5	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 12:40AM	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	12:20PM	1600	354'	314'	261

BECHTEL 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

BECHTEL

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

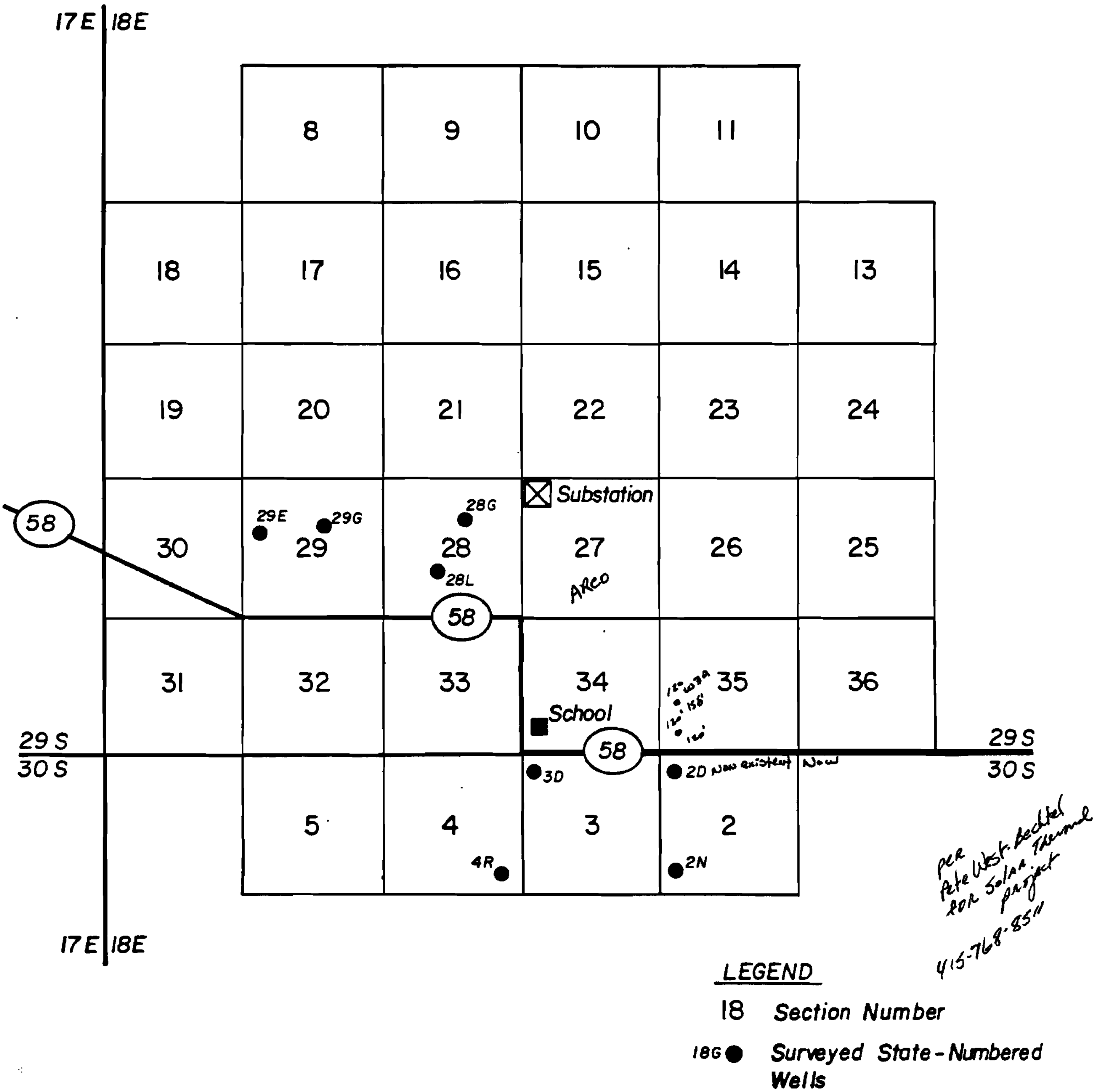
PUMPING PERIOD 4335 mins

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 off ( )	DEPTH TO WATER (ft)	DRAW DOWN (ft)	DISCHARGE t/t' ( )	TIME (24 HR) DAY	TIME-AFTER PUMP off ( )	DEPTH TO WATER (ft)	DRAW DOWN (ft)	DISCHARGE 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.						



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 and 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).

<u>Carrizo Plain Basin</u>

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.

<u>Cuyama Valley Basin</u>

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 CaCO3, 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 CaCO3, 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

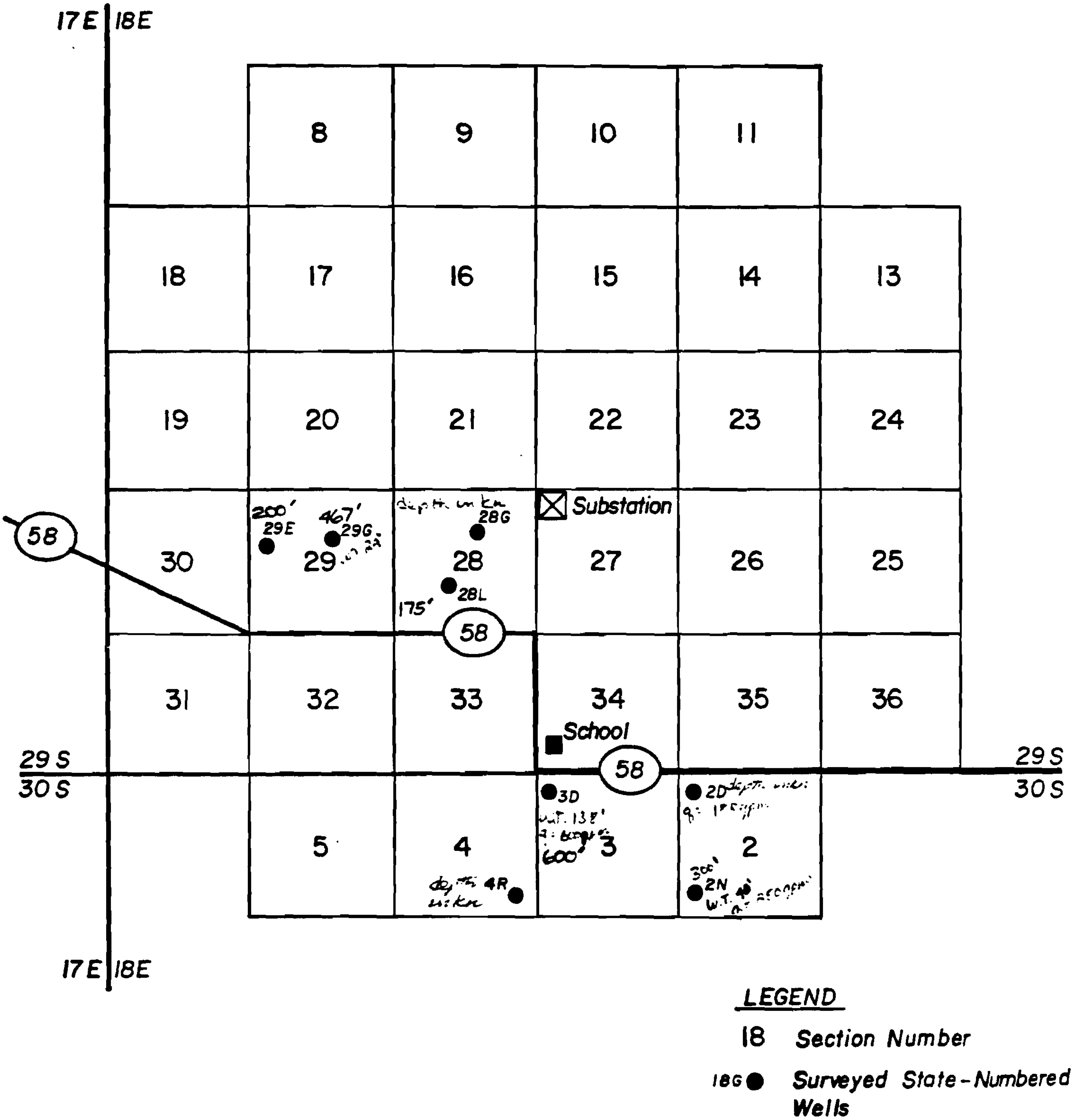
Table 1 - contd.

	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 CaCO3, 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)

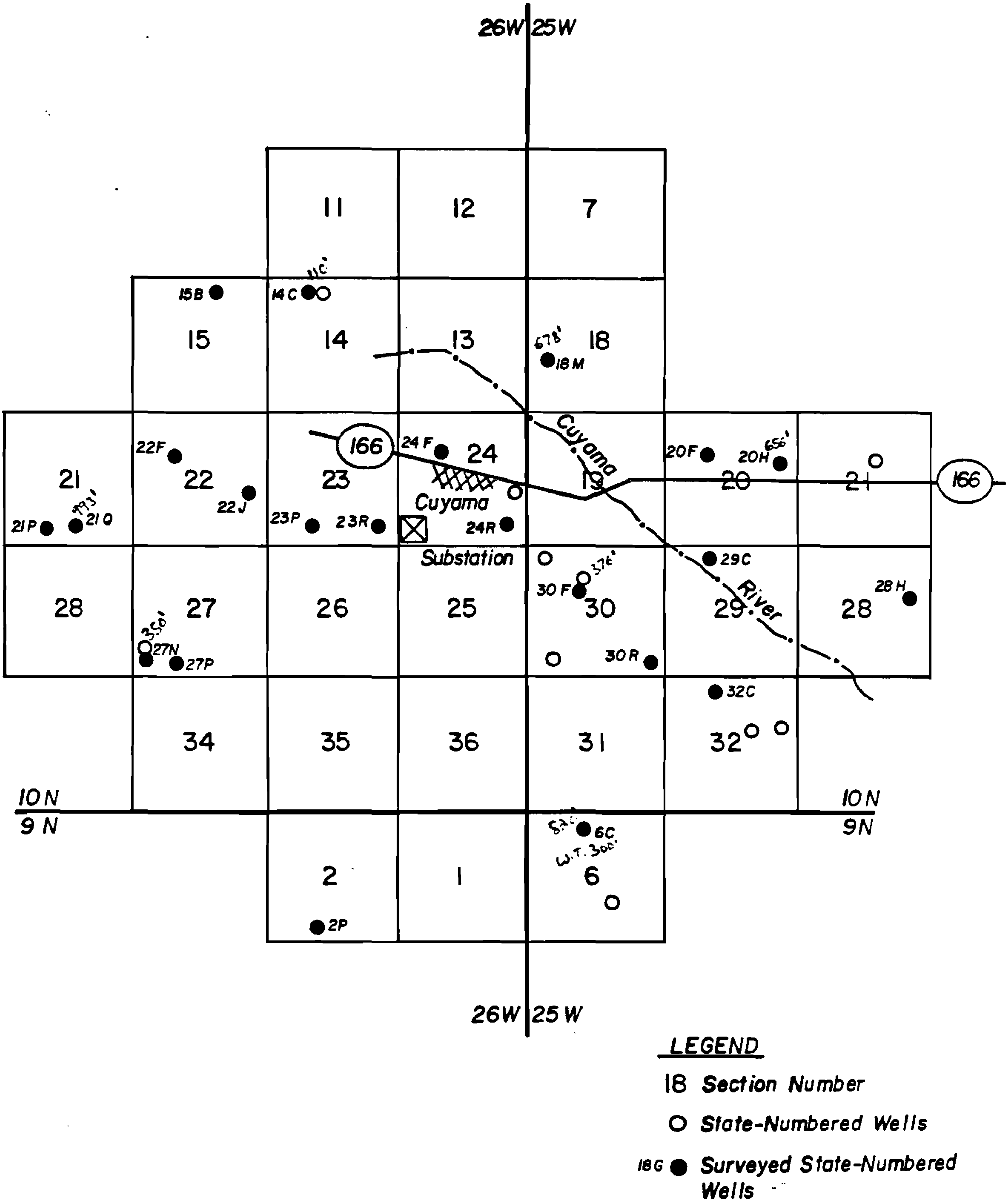
	Section Summary Well Location (Township/Range-Section)					Total
	29S/18E-28	29S/18E-29	30S/18E-02	30S/18E-03	30S/18E-04	Area Summary
No. of Wells Surveyed	2	2	2	1	1	8
Dates Sampled	10/65-10/77	10/53-10/72	3/54-10/77	11/72	10/68	10/53-10/77
Temperature, °F	62	-	65	68	-	65
pH	8.0	8.2	7.8	7.9	7.9	8.0
Electrical 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 CaCO3, 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



CARRIZO PLAIN

LOCATIONS OF SURVEYED WELLS

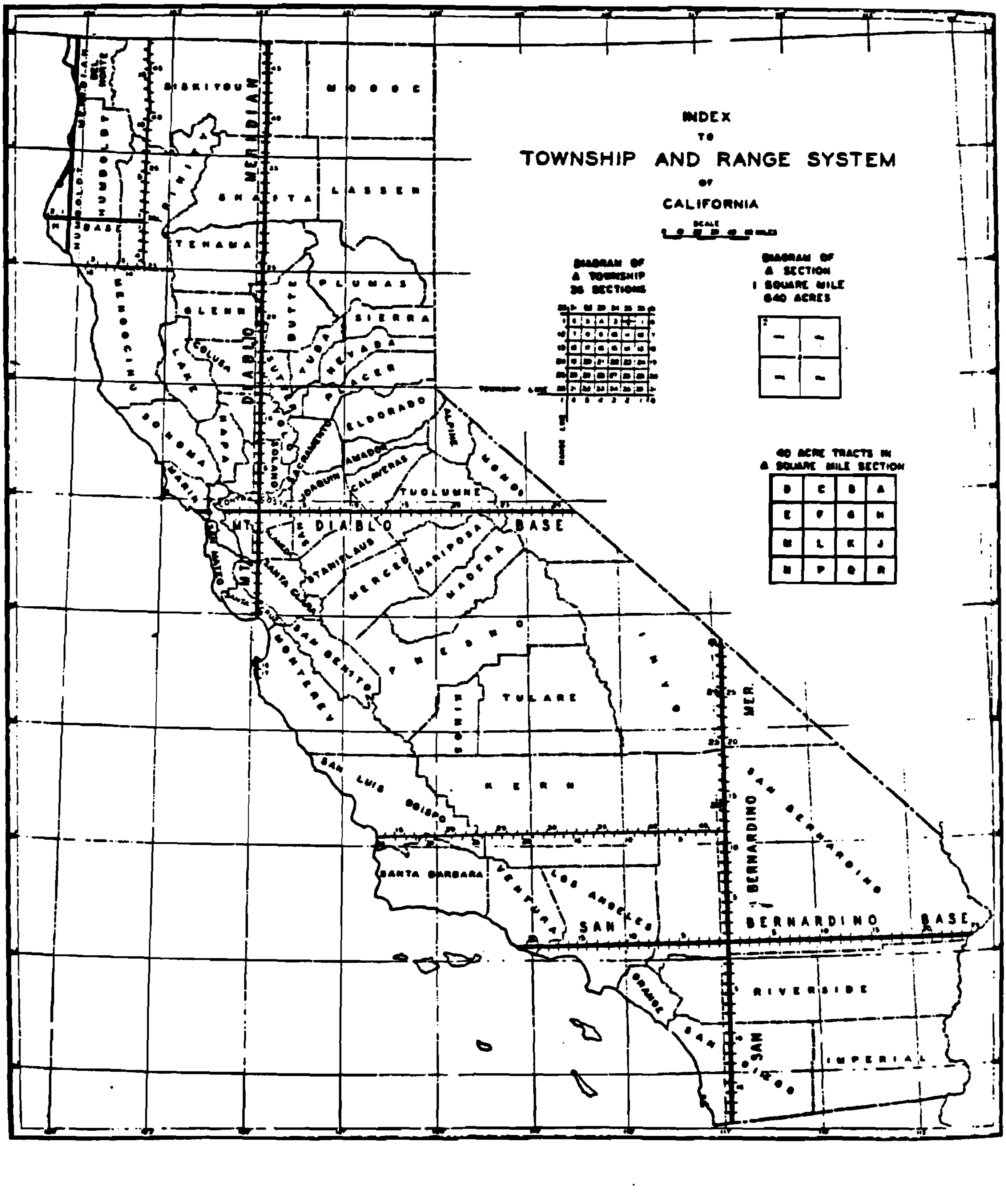
1" = 1 mile



CUYAMA VALLEY

LOCATIONS OF SURVEYED WELLS

1" = 1 mile


INDEX
TO
TOWNSHIP AND RANGE SYSTEM
OF
CALIFORNIA
DIAGRAM OF
A TOWNSHIP
36 SECTIONS
DIAGRAM OF
A SECTION
1 SQUARE MILE
640 ACRES
40 ACRE TRACTS IN
A SQUARE MILE SECTION
D C B A
E F G H
M L K J
N P Q R
HUMBOLDT MERIDIAN
HUMBOLDT BASE
MT. DIABLO MERIDIAN
MT. DIABLO BASE
SAN BERNARDINO MER.
SAN BERNARDINO BASE
SISKIYOU
MODOC
SHASTA
LASSEN
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
PLACER
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MENDOCINO
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NAPA
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ALPINE
AMADOR
CALAVERAS
TUOLUMNE
MONO
STANISLAUS
MERCED
MARIPOSA
MADERA
FRESNO
SAN BENITO
MONTEREY
TULARE
INYO
KINGS
KERN
SAN LUIS OBISPO
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
ORANGE
SAN DIEGO
IMPERIAL
SANTA CLARA

Figure 4

Street, Room 1310, Sacramento, 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 (SP = SPRING, W = WELL)	FLOW, LITERS PER MINUTE	TOTAL DISSOLVED SOLIDS, MILLIGRAMS PER LITER	DEPTH, METERS
IN- 8	UNNAMED SPRINGS	X36 20.70	117 53.80	30°	57	2150*	—
IN- 9	DIRTY SOCKS HOT SPRING (WELL)	36 19.75	117 56.90	34°	380	5630	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.

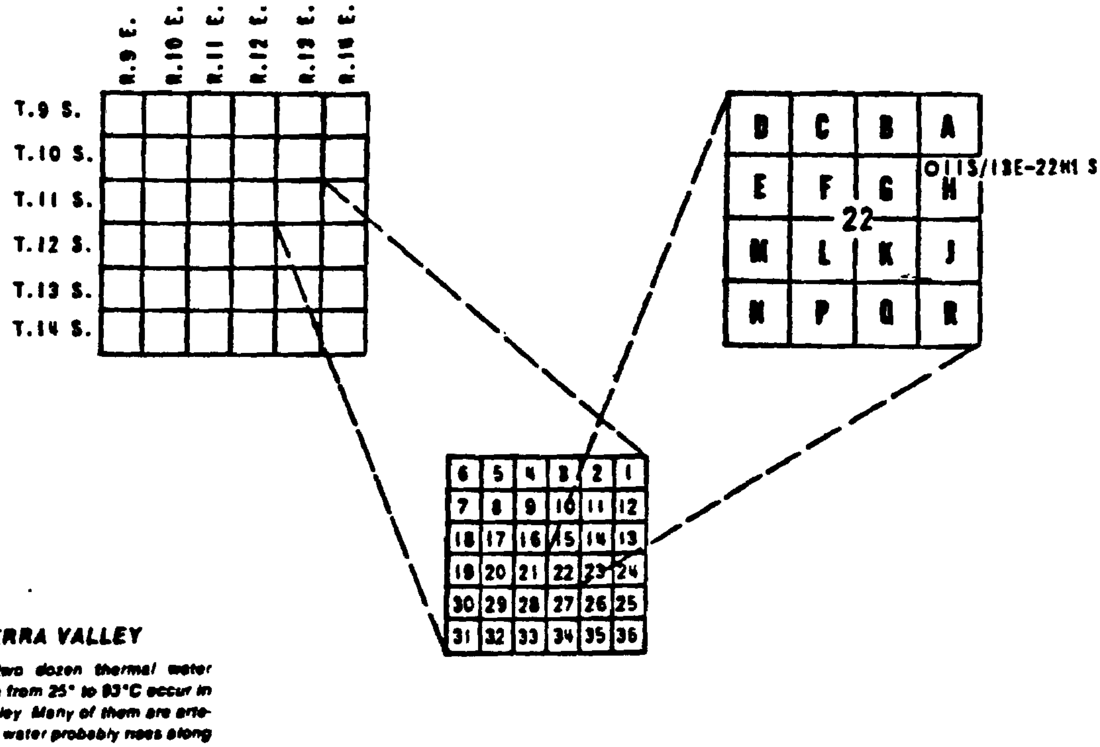

Figure 5

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 pro-

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

APPENDIX E

Laboratory Report and Chain-of-Custody Form - Proposed Pumping Well

Calscience Environmental Laboratories, Inc.

March 10, 2008

Bob Scott
URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Subject: **Calscience Work Order No.: 08-02-1151**
Client Reference: Ausra / 2239472.01701

Dear Client:

Enclosed is an analytical report for the above-referenced project. The samples included in this report were received 2/15/2008 and analyzed in accordance with the attached chain-of-custody.

Unless otherwise noted, all analytical testing was accomplished in accordance with the guidelines established in our Quality Systems Manual, applicable standard operating procedures, and other related documentation. The original report of subcontracted analysis, if any, is provided herein, and follows the standard Calscience data package. The results in this analytical report are limited to the samples tested and any reproduction thereof must be made in its entirety.

If you have any questions regarding this report, please do not hesitate to contact the undersigned.

Sincerely,

Vikas Patel

Calscience Environmental
Laboratories, Inc.
Vikas Patel
Project Manager

Calscience Environmental Laboratories, Inc.

Analytical Report

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received: 02/15/08
Work Order No: 08-02-1151
Preparation: EPA 3005A Filt.
Method: EPA 6010B
Units: mg/L

Project: Ausra / 2239472.01701

Page 1 of 2

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
IRW-1	**08-02-1151-1-F**	**02/14/08 14:10**	**Aqueous**	**ICP 5300**	**02/15/08**	**02/15/08 17:38**	**080215L05**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Antimony	0.0262	0.0150	1		Barium	0.0190	0.0100	1	
Beryllium	ND	0.00100	1		Selenium	ND	0.0150	1	
Thallium	0.0278	0.0150	1		Aluminum	ND	0.0500	1	
Iron	ND	0.100	1		Manganese	0.00776	0.00500	1	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

URS Corporation	Date Received: 02/15/08
1615 Murray Canyon Road, Suite 1000	Work Order No: 08-02-1151
San Diego, CA 92108-4319	Preparation: EPA 3010A Total / EPA 7470A Total
	Method: EPA 6010B / EPA 7470A
	Units: mg/L
Project: Ausra / 2239472.01701	Page 2 of 2

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
IRW-1	**08-02-1151-1-E**	**02/14/08 14:10**	**Aqueous**	**ICP 5300**	**02/15/08**	**02/15/08 17:30**	**080215L05**

Comment(s): -Mercury was analyzed on 2/15/2008 5:39:06 PM with batch 080215L04

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Arsenic	ND	0.0100	1		Manganese	0.0616	0.00500	1	
Cadmium	ND	0.00500	1		Potassium	0.900	0.500	1	
Chromium	0.0181	0.00500	1		Sodium	183	0.500	1	
Copper	ND	0.00500	1		Silicon	19.8	0.0500	1	
Lead	ND	0.0100	1		Zinc	0.0194	0.0100	1	
Mercury	ND	0.000500	1		Nickel	ND	0.00500	1	
Aluminum	ND	0.0500	1		Calcium	107	0.100	1	
Iron	0.733	0.100	1		Magnesium	23.7	0.100	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**099-04-008-3,364**	**N/A**	**Aqueous**	**Mercury**	**02/15/08**	**02/15/08 17:07**	**080215L04**

Parameter	Result	RL	DF	Qual
Mercury	ND	0.000500	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**097-01-003-8,022**	**N/A**	**Aqueous**	**ICP 5300**	**02/15/08**	**02/15/08 17:22**	**080215L05**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Arsenic	ND	0.0100	1		Iron	ND	0.100	1	
Cadmium	ND	0.00500	1		Magnesium	ND	0.100	1	
Chromium	ND	0.00500	1		Manganese	ND	0.00500	1	
Copper	ND	0.00500	1		Potassium	ND	0.500	1	
Lead	ND	0.0100	1		Sodium	ND	0.500	1	
Nickel	ND	0.00500	1		Silicon	ND	0.0500	1	
Aluminum	ND	0.0500	1		Zinc	ND	0.0100	1	
Calcium	ND	0.100	1						

7440 Lincoln Way, Garden Grove, CA 92841-1427 · TEL:(714) 895-5494 · FAX: (714) 894-7501

Calscience Environmental Laboratories, Inc.

ACCREDITED IN ACCORDANCE WITH nelac

ANALYTICAL REPORT

URS Corporation		Date Sampled:	02/14/08
1615 Murray Canyon Road, Suite 1000		Date Received:	02/15/08
San Diego, CA 92108-4319		Date Analyzed:	02/15/08
		Work Order No.:	08-02-1151
Attn: Bob Scott		Method:	EPA 6010B
RE: Ausra / 2239472.01701			Page 1 of 1

All concentrations are reported in mg/L (ppm).

Sample Number	SiO_2 Concentration	Reporting Limit
IRW-1	42.4	0.107
Method Blank	ND	0.107

Calscience Environmental Laboratories, Inc.

Analytical Report

URS Corporation		Date Received:	02/15/08
1615 Murray Canyon Road, Suite 1000		Work Order No:	08-02-1151
San Diego, CA 92108-4319		Preparation:	EPA 3510B
		Method:	EPA 8270C
		Units:	ug/L

Project: Ausra / 2239472.01701 | Page 1 of 2

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
IRW-1	**08-02-1151-1-G**	**02/14/08 14:10**	**Aqueous**	**GC/MS MM**	**02/18/08**	**02/21/08 23:08**	**080218L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
N-Nitrosodimethylamine	ND	10	1		4-Nitrophenol	ND	10	1	
Aniline	ND	10	1		Dibenzofuran	ND	10	1	
Phenol	ND	10	1		2,4-Dinitrotoluene	ND	10	1	
Bis(2-Chloroethyl) Ether	ND	25	1		2,6-Dinitrotoluene	ND	10	1	
2-Chlorophenol	ND	10	1		Diethyl Phthalate	ND	10	1	
1,3-Dichlorobenzene	ND	10	1		4-Chlorophenyl-Phenyl Ether	ND	10	1	
1,4-Dichlorobenzene	ND	10	1		Fluorene	ND	10	1	
Benzyl Alcohol	ND	10	1		4-Nitroaniline	ND	10	1	
1,2-Dichlorobenzene	ND	10	1		Azobenzene	ND	10	1	
2-Methylphenol	ND	10	1		4,6-Dinitro-2-Methylphenol	ND	50	1	
Bis(2-Chloroisopropyl) Ether	ND	10	1		N-Nitrosodiphenylamine	ND	10	1	
3/4-Methylphenol	ND	10	1		4-Bromophenyl-Phenyl Ether	ND	10	1	
N-Nitroso-di-n-propylamine	ND	10	1		Hexachlorobenzene	ND	10	1	
Hexachloroethane	ND	10	1		Pentachlorophenol	ND	10	1	
Nitrobenzene	ND	25	1		Phenanthrene	ND	10	1	
Isophorone	ND	10	1		Anthracene	ND	10	1	
2-Nitrophenol	ND	10	1		Di-n-Butyl Phthalate	ND	10	1	
2,4-Dimethylphenol	ND	10	1		Fluoranthene	ND	10	1	
Benzoic Acid	ND	50	1		Benzidine	ND	50	1	
Bis(2-Chloroethoxy) Methane	ND	10	1		Pyrene	ND	10	1	
2,4-Dichlorophenol	ND	10	1		Pyridine	ND	10	1	
Naphthalene	ND	10	1		Butyl Benzyl Phthalate	ND	10	1	
4-Chloroaniline	ND	10	1		3,3'-Dichlorobenzidine	ND	25	1	
Hexachloro-1,3-Butadiene	ND	10	1		Benzo (a) Anthracene	ND	10	1	
4-Chloro-3-Methylphenol	ND	10	1		Bis(2-Ethylhexyl) Phthalate	ND	10	1	
2-Methylnaphthalene	ND	10	1		Chrysene	ND	10	1	
Hexachlorocyclopentadiene	ND	25	1		Di-n-Octyl Phthalate	ND	10	1	
2,4,6-Trichlorophenol	ND	10	1		Benzo (k) Fluoranthene	ND	10	1	
2,4,5-Trichlorophenol	ND	10	1		Benzo (b) Fluoranthene	ND	10	1	
2-Chloronaphthalene	ND	10	1		Benzo (a) Pyrene	ND	10	1	
2-Nitroaniline	ND	10	1		Benzo (g,h,i) Perylene	ND	10	1	
Dimethyl Phthalate	ND	10	1		Indeno (1,2,3-c,d) Pyrene	ND	10	1	
Acenaphthylene	ND	10	1		Dibenz (a,h) Anthracene	ND	10	1	
3-Nitroaniline	ND	10	1		1-Methylnaphthalene	ND	10	1	
Acenaphthene	ND	10	1		1,2,4-Trichlorobenzene	ND	10	1	
2,4-Dinitrophenol	ND	50	1						

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
2-Fluorophenol	54	7-121		Phenol-d6	35	1-127	
Nitrobenzene-d5	90	50-146		2-Fluorobiphenyl	98	42-138	
2,4,6-Tribromophenol	92	41-137		p-Terphenyl-d14	127	47-173	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

URS Corporation	Date Received: 02/15/08
1615 Murray Canyon Road, Suite 1000	Work Order No: 08-02-1151
San Diego, CA 92108-4319	Preparation: EPA 3510B
	Method: EPA 8270C
	Units: ug/L

Project: Ausra / 2239472.01701

Page 2 of 2

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**095-01-003-2,344**	**N/A**	**Aqueous**	**GC/MS MM**	**02/18/08**	**02/19/08 13:46**	**080218L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
N-Nitrosodimethylamine	ND	10	1		4-Nitrophenol	ND	10	1	
Aniline	ND	10	1		Dibenzofuran	ND	10	1	
Phenol	ND	10	1		2,4-Dinitrotoluene	ND	10	1	
Bis(2-Chloroethyl) Ether	ND	25	1		2,6-Dinitrotoluene	ND	10	1	
2-Chlorophenol	ND	10	1		Diethyl Phthalate	ND	10	1	
1,3-Dichlorobenzene	ND	10	1		4-Chlorophenyl-Phenyl Ether	ND	10	1	
1,4-Dichlorobenzene	ND	10	1		Fluorene	ND	10	1	
Benzyl Alcohol	ND	10	1		4-Nitroaniline	ND	10	1	
1,2-Dichlorobenzene	ND	10	1		Azobenzene	ND	10	1	
2-Methylphenol	ND	10	1		4,6-Dinitro-2-Methylphenol	ND	50	1	
Bis(2-Chloroisopropyl) Ether	ND	10	1		N-Nitrosodiphenylamine	ND	10	1	
3/4-Methylphenol	ND	10	1		4-Bromophenyl-Phenyl Ether	ND	10	1	
N-Nitroso-di-n-propylamine	ND	10	1		Hexachlorobenzene	ND	10	1	
Hexachloroethane	ND	10	1		Pentachlorophenol	ND	10	1	
Nitrobenzene	ND	25	1		Phenanthrene	ND	10	1	
Isophorone	ND	10	1		Anthracene	ND	10	1	
2-Nitrophenol	ND	10	1		Di-n-Butyl Phthalate	ND	10	1	
2,4-Dimethylphenol	ND	10	1		Fluoranthene	ND	10	1	
Benzoic Acid	ND	50	1		Benzidine	ND	50	1	
Bis(2-Chloroethoxy) Methane	ND	10	1		Pyrene	ND	10	1	
2,4-Dichlorophenol	ND	10	1		Pyridine	ND	10	1	
Naphthalene	ND	10	1		Butyl Benzyl Phthalate	ND	10	1	
4-Chloroaniline	ND	10	1		3,3'-Dichlorobenzidine	ND	25	1	
Hexachloro-1,3-Butadiene	ND	10	1		Benzo (a) Anthracene	ND	10	1	
4-Chloro-3-Methylphenol	ND	10	1		Bis(2-Ethylhexyl) Phthalate	ND	10	1	
2-Methylnaphthalene	ND	10	1		Chrysene	ND	10	1	
Hexachlorocyclopentadiene	ND	25	1		Di-n-Octyl Phthalate	ND	10	1	
2,4,6-Trichlorophenol	ND	10	1		Benzo (k) Fluoranthene	ND	10	1	
2,4,5-Trichlorophenol	ND	10	1		Benzo (b) Fluoranthene	ND	10	1	
2-Chloronaphthalene	ND	10	1		Benzo (a) Pyrene	ND	10	1	
2-Nitroaniline	ND	10	1		Benzo (g,h,i) Perylene	ND	10	1	
Dimethyl Phthalate	ND	10	1		Indeno (1,2,3-c,d) Pyrene	ND	10	1	
Acenaphthylene	ND	10	1		Dibenz (a,h) Anthracene	ND	10	1	
3-Nitroaniline	ND	10	1		1-Methylnaphthalene	ND	10	1	
Acenaphthene	ND	10	1		1,2,4-Trichlorobenzene	ND	10	1	
2,4-Dinitrophenol	ND	50	1						
Surrogates:	REC (%)	Control Limits		Qual	Surrogates:	REC (%)	Control Limits		Qual
2-Fluorophenol	64	7-121			Phenol-d6	44	1-127		
Nitrobenzene-d5	93	50-146			2-Fluorobiphenyl	77	42-138		
2,4,6-Tribromophenol	103	41-137			p-Terphenyl-d14	140	47-173		

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

URS Corporation	Date Received:	02/15/08
1615 Murray Canyon Road, Suite 1000	Work Order No:	08-02-1151
San Diego, CA 92108-4319	Preparation:	EPA 5030B
	Method:	EPA 8260B
	Units:	ug/L

Project: Ausra / 2239472.01701 — Page 1 of 2

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
IRW-1	**08-02-1151-1-K**	**02/14/08 14:10**	**Aqueous**	**GC/MS CC**	**02/21/08**	**02/21/08 17:51**	**080221L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Acetone	ND	50	1		c-1,3-Dichloropropene	ND	0.50	1	
Benzene	ND	0.50	1		t-1,3-Dichloropropene	ND	0.50	1	
Bromobenzene	ND	1.0	1		Ethylbenzene	ND	1.0	1	
Bromochloromethane	ND	1.0	1		2-Hexanone	ND	10	1	
Bromodichloromethane	ND	1.0	1		Isopropylbenzene	ND	1.0	1	
Bromoform	ND	1.0	1		p-Isopropyltoluene	ND	1.0	1	
Bromomethane	ND	10	1		Methylene Chloride	ND	10	1	
2-Butanone	ND	10	1		4-Methyl-2-Pentanone	ND	10	1	
n-Butylbenzene	ND	1.0	1		Naphthalene	ND	10	1	
sec-Butylbenzene	ND	1.0	1		n-Propylbenzene	ND	1.0	1	
tert-Butylbenzene	ND	1.0	1		Styrene	ND	1.0	1	
Carbon Disulfide	ND	10	1		1,1,1,2-Tetrachloroethane	ND	1.0	1	
Carbon Tetrachloride	ND	0.50	1		1,1,2,2-Tetrachloroethane	ND	1.0	1	
Chlorobenzene	ND	1.0	1		Tetrachloroethene	ND	1.0	1	
Chloroethane	ND	1.0	1		Toluene	ND	1.0	1	
Chloroform	ND	1.0	1		1,2,3-Trichlorobenzene	ND	1.0	1	
Chloromethane	ND	10	1		1,2,4-Trichlorobenzene	ND	1.0	1	
2-Chlorotoluene	ND	1.0	1		1,1,1-Trichloroethane	ND	1.0	1	
4-Chlorotoluene	ND	1.0	1		1,1,2-Trichloro-1,2,2-Trifluoroethane	ND	10	1	
Dibromochloromethane	ND	1.0	1		1,1,2-Trichloroethane	ND	1.0	1	
1,2-Dibromo-3-Chloropropane	ND	5.0	1		Trichloroethene	ND	1.0	1	
1,2-Dibromoethane	ND	1.0	1		Trichlorofluoromethane	ND	10	1	
Dibromomethane	ND	1.0	1		1,2,3-Trichloropropane	ND	5.0	1	
1,2-Dichlorobenzene	ND	1.0	1		1,2,4-Trimethylbenzene	ND	1.0	1	
1,3-Dichlorobenzene	ND	1.0	1		1,3,5-Trimethylbenzene	ND	1.0	1	
1,4-Dichlorobenzene	ND	1.0	1		Vinyl Acetate	ND	10	1	
Dichlorodifluoromethane	ND	1.0	1		Vinyl Chloride	ND	0.50	1	
1,1-Dichloroethane	ND	1.0	1		p/m-Xylene	ND	1.0	1	
1,2-Dichloroethane	ND	0.50	1		o-Xylene	ND	1.0	1	
1,1-Dichloroethene	ND	1.0	1		Methyl-t-Butyl Ether (MTBE)	ND	1.0	1	
c-1,2-Dichloroethene	ND	1.0	1		Tert-Butyl Alcohol (TBA)	ND	10	1	
t-1,2-Dichloroethene	ND	1.0	1		Diisopropyl Ether (DIPE)	ND	2.0	1	
1,2-Dichloropropane	ND	1.0	1		Ethyl-t-Butyl Ether (ETBE)	ND	2.0	1	
1,3-Dichloropropane	ND	1.0	1		Tert-Amyl-Methyl Ether (TAME)	ND	2.0	1	
2,2-Dichloropropane	ND	1.0	1		Ethanol	ND	100	1	
1,1-Dichloropropene	ND	1.0	1						

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
Dibromofluoromethane	115	74-140		1,2-Dichloroethane-d4	127	74-146	
Toluene-d8	101	88-112		1,4-Bromofluorobenzene	88	74-110	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

URS Corporation	Date Received: 02/15/08
1615 Murray Canyon Road, Suite 1000	Work Order No: 08-02-1151
San Diego, CA 92108-4319	Preparation: EPA 5030B
	Method: EPA 8260B
	Units: ug/L

Project: Ausra / 2239472.01701

Client Sample Number	Lab Sample Number	Date/Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**099-10-006-24,504**	**N/A**	**Aqueous**	**GC/MS CC**	**02/21/08**	**02/21/08 12:36**	**080221L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Acetone	ND	50	1		c-1,3-Dichloropropene	ND	0.50	1	
Benzene	ND	0.50	1		t-1,3-Dichloropropene	ND	0.50	1	
Bromobenzene	ND	1.0	1		Ethylbenzene	ND	1.0	1	
Bromochloromethane	ND	1.0	1		2-Hexanone	ND	10	1	
Bromodichloromethane	ND	1.0	1		Isopropylbenzene	ND	1.0	1	
Bromoform	ND	1.0	1		p-Isopropyltoluene	ND	1.0	1	
Bromomethane	ND	10	1		Methylene Chloride	ND	10	1	
2-Butanone	ND	10	1		4-Methyl-2-Pentanone	ND	10	1	
n-Butylbenzene	ND	1.0	1		Naphthalene	ND	10	1	
sec-Butylbenzene	ND	1.0	1		n-Propylbenzene	ND	1.0	1	
tert-Butylbenzene	ND	1.0	1		Styrene	ND	1.0	1	
Carbon Disulfide	ND	10	1		1,1,1,2-Tetrachloroethane	ND	1.0	1	
Carbon Tetrachloride	ND	0.50	1		1,1,2,2-Tetrachloroethane	ND	1.0	1	
Chlorobenzene	ND	1.0	1		Tetrachloroethene	ND	1.0	1	
Chloroethane	ND	1.0	1		Toluene	ND	1.0	1	
Chloroform	ND	1.0	1		1,2,3-Trichlorobenzene	ND	1.0	1	
Chloromethane	ND	10	1		1,2,4-Trichlorobenzene	ND	1.0	1	
2-Chlorotoluene	ND	1.0	1		1,1,1-Trichloroethane	ND	1.0	1	
4-Chlorotoluene	ND	1.0	1		1,1,2-Trichloro-1,2,2-Trifluoroethane	ND	10	1	
Dibromochloromethane	ND	1.0	1		1,1,2-Trichloroethane	ND	1.0	1	
1,2-Dibromo-3-Chloropropane	ND	5.0	1		Trichloroethene	ND	1.0	1	
1,2-Dibromoethane	ND	1.0	1		Trichlorofluoromethane	ND	10	1	
Dibromomethane	ND	1.0	1		1,2,3-Trichloropropane	ND	5.0	1	
1,2-Dichlorobenzene	ND	1.0	1		1,2,4-Trimethylbenzene	ND	1.0	1	
1,3-Dichlorobenzene	ND	1.0	1		1,3,5-Trimethylbenzene	ND	1.0	1	
1,4-Dichlorobenzene	ND	1.0	1		Vinyl Acetate	ND	10	1	
Dichlorodifluoromethane	ND	1.0	1		Vinyl Chloride	ND	0.50	1	
1,1-Dichloroethane	ND	1.0	1		p/m-Xylene	ND	1.0	1	
1,2-Dichloroethane	ND	0.50	1		o-Xylene	ND	1.0	1	
1,1-Dichloroethene	ND	1.0	1		Methyl-t-Butyl Ether (MTBE)	ND	1.0	1	
c-1,2-Dichloroethene	ND	1.0	1		Tert-Butyl Alcohol (TBA)	ND	10	1	
t-1,2-Dichloroethene	ND	1.0	1		Diisopropyl Ether (DIPE)	ND	2.0	1	
1,2-Dichloropropane	ND	1.0	1		Ethyl-t-Butyl Ether (ETBE)	ND	2.0	1	
1,3-Dichloropropane	ND	1.0	1		Tert-Amyl-Methyl Ether (TAME)	ND	2.0	1	
2,2-Dichloropropane	ND	1.0	1		Ethanol	ND	100	1	
1,1-Dichloropropene	ND	1.0	1						

Surrogates:	REC (%)	Control Limits	Qual	Surrogates:	REC (%)	Control Limits	Qual
Dibromofluoromethane	114	74-140		1,2-Dichloroethane-d4	123	74-146	
Toluene-d8	103	88-112		1,4-Bromofluorobenzene	88	74-110	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

URS Corporation	Date Received:	02/15/08
1615 Murray Canyon Road, Suite 1000	Work Order No:	08-02-1151
San Diego, CA 92108-4319		

Project: Ausra / 2239472.01701 — Page 1 of 1

Client Sample Number	Lab Sample Number	Date Collected	Matrix
IRW-1	**08-02-1151-1**	**02/14/08**	**Aqueous**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Fluoride	1.4	0.10	1		mg/L	N/A	02/15/08	EPA 300.0
Chloride	66	10	10		mg/L	N/A	02/15/08	EPA 300.0
Nitrate (as N)	13	1.0	10		mg/L	N/A	02/15/08	EPA 300.0
o-Phosphate (as P)	ND	0.10	1		mg/L	N/A	02/15/08	EPA 300.0
Sulfate	560	100	100		mg/L	N/A	02/15/08	EPA 300.0
Turbidity	3.1	0.10	1		NTU	N/A	02/16/08	SM 2130 B
Alkalinity, Total (as CaCO3)	114	5.0	1		mg/L	N/A	02/15/08	SM 2320B
Bicarbonate (as CaCO3)	114	5.0	1		mg/L	N/A	02/15/08	SM 2320B
Carbonate (as CaCO3)	ND	1.0	1		mg/L	N/A	02/15/08	SM 2320B
Hydroxide (as CaCO3)	ND	1.0	1		mg/L	N/A	02/15/08	SM 2320B
Specific Conductance	1600	10	1		umhos/cm	N/A	02/15/08	SM 2510 B
Solids, Total Dissolved	1140	10	1		mg/L	N/A	02/15/08	SM 2540 C
Solids, Total Suspended	1.5	1.0	1		mg/L	N/A	02/15/08	SM 2540 D
pH	6.88	0.01	1		pH units	N/A	02/15/08	SM 4500 H+ B
Phosphorus, Total	0.40	0.10	1		mg/L	02/18/08	02/18/08	SM 4500 P B/E
Cyanide, Total	ND	0.050	1		mg/L	02/15/08	02/15/08	SM 4500-CN E
Carbon Dioxide	6.3	1.0	1		mg/L	N/A	02/15/08	SM4500-CO2D

Client Sample Number	Lab Sample Number	Date Collected	Matrix
Method Blank		**N/A**	**Aqueous**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Fluoride	ND	0.10	1		mg/L	N/A	02/15/08	EPA 300.0
Chloride	ND	1.0	1		mg/L	N/A	02/15/08	EPA 300.0
Nitrate (as N)	ND	0.10	1		mg/L	N/A	02/15/08	EPA 300.0
o-Phosphate (as P)	ND	0.10	1		mg/L	N/A	02/15/08	EPA 300.0
Sulfate	ND	1.0	1		mg/L	N/A	02/15/08	EPA 300.0
Alkalinity, Total (as CaCO3)	ND	1.0	1		mg/L	N/A	02/15/08	SM 2320B
Bicarbonate (as CaCO3)	ND	1.0	1		mg/L	N/A	02/15/08	SM 2320B
Carbonate (as CaCO3)	ND	1.0	1		mg/L	N/A	02/15/08	SM 2320B
Hydroxide (as CaCO3)	ND	1.0	1		mg/L	N/A	02/15/08	SM 2320B
Solids, Total Dissolved	ND	1.0	1		mg/L	N/A	02/15/08	SM 2540 C
Solids, Total Suspended	ND	1.0	1		mg/L	N/A	02/15/08	SM 2540 D
Phosphorus, Total	ND	0.10	1		mg/L	02/18/08	02/18/08	SM 4500 P B/E
Cyanide, Total	ND	0.050	1		mg/L	02/15/08	02/15/08	SM 4500-CN E

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

7440 Lincoln Way, Garden Grove, CA 92841-1427 · TEL:(714) 895-5494 · FAX: (714) 894-7501

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received: 02/15/08
Work Order No: 08-02-1151
Preparation: EPA 3010A Total
Method: EPA 6010B

Project Ausra / 2239472.01701

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
IRW-1	**Aqueous**	**ICP 5300**	**02/15/08**	**02/15/08**	**080215S05**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Antimony	99	102	72-132	2	0-10	
Arsenic	102	102	80-140	0	0-11	
Barium	101	102	87-123	1	0-6	
Beryllium	105	104	89-119	1	0-8	
Cadmium	102	101	82-124	1	0-7	
Chromium	104	105	86-122	1	0-8	
Copper	97	99	78-126	2	0-7	
Lead	91	90	84-120	1	0-7	
Nickel	103	103	84-120	1	0-7	
Selenium	91	92	79-127	0	0-9	
Thallium	96	95	79-121	1	0-8	
Aluminum	116	117	73-145	1	0-16	
Calcium	4X	4X	77-113	4X	0-11	Q
Iron	91	93	65-149	1	0-21	
Magnesium	4X	4X	56-140	4X	0-11	Q
Manganese	96	97	86-116	1	0-7	
Potassium	101	103	83-131	2	0-7	
Sodium	4X	4X	73-127	4X	0-9	Q
Silicon	4X	4X	24-180	4X	0-15	Q
Zinc	109	110	89-131	1	0-8	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received:	02/15/08
Work Order No:	08-02-1151
Preparation:	EPA 7470A Total
Method:	EPA 7470A

Project Ausra / 2239472.01701

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
08-02-1135-1	**Aqueous**	**Mercury**	**02/15/08**	**02/15/08**	**080215S04**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Mercury	96	97	66-126	1	0-7	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received: 02/15/08
Work Order No: 08-02-1151
Preparation: EPA 5030B
Method: EPA 8260B

Project Ausra / 2239472.01701

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
08-02-1028-1	**Aqueous**	**GC/MS CC**	**02/21/08**	**02/21/08**	**080221S01**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Benzene	101	100	88-118	1	0-7	
Carbon Tetrachloride	104	100	67-145	4	0-11	
Chlorobenzene	104	102	88-118	2	0-7	
1,2-Dibromoethane	106	103	70-130	2	0-30	
1,2-Dichlorobenzene	107	105	86-116	2	0-8	
1,1-Dichloroethene	95	93	70-130	3	0-25	
Ethylbenzene	108	106	70-130	2	0-30	
Toluene	110	107	87-123	3	0-8	
Trichloroethene	102	100	79-127	2	0-10	
Vinyl Chloride	112	111	69-129	1	0-13	
Methyl-t-Butyl Ether (MTBE)	102	101	71-131	2	0-13	
Tert-Butyl Alcohol (TBA)	110	104	36-168	6	0-45	
Diisopropyl Ether (DIPE)	95	94	81-123	0	0-9	
Ethyl-t-Butyl Ether (ETBE)	100	101	72-126	1	0-12	
Tert-Amyl-Methyl Ether (TAME)	101	101	72-126	0	0-12	
Ethanol	109	100	53-149	8	0-31	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received: N/A
Work Order No: 08-02-1151

Project: Ausra / 2239472.01701

Matrix: Aqueous

Parameter	Method	Quality Control Sample ID	Date Analyzed	Date Extracted	MS% REC	MSD % REC	%REC CL	RPD	RPD CL	Qualifiers
Phosphorus, Total	SM 4500 P B/E	IRW-1	02/18/08	2/18/08	106	102	70-130	2	0-25	
Fluoride	EPA 300.0	IRW-1	02/15/08	N/A	102	101	64-142	0	0-9	
Chloride	EPA 300.0	IRW-1	02/15/08	N/A	99	100	56-134	0	0-3	
Nitrate (as N)	EPA 300.0	IRW-1	02/15/08	N/A	104	104	58-142	0	0-6	
o-Phosphate (as P)	EPA 300.0	IRW-1	02/15/08	N/A	108	109	63-141	1	0-12	
Sulfate	EPA 300.0	IRW-1	02/15/08	N/A	111	113	49-133	1	0-3	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received: N/A
Work Order No: 08-02-1151

Project: Ausra / 2239472.01701

Matrix: Aqueous

Parameter	Method	QC Sample ID	Date Analyzed	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
pH	SM 4500 H+ B	IRW-1	02/15/08	6.88	6.91	0	0-25	
Specific Conductance	SM 2510 B	IRW-1	02/15/08	1600	1600	0	0-25	
Turbidity	SM 2130 B	IRW-1	02/16/08	3.1	3.1	0	0-25	
Carbon Dioxide	SM4500-CO2D	IRW-1	02/15/08	6.3	6.1	3	0-25	
Alkalinity, Total (as CaCO3)	SM 2320B	IRW-1	02/15/08	114	114	0	0-25	
Bicarbonate (as CaCO3)	SM 2320B	IRW-1	02/15/08	114	114	0	0-25	
Carbonate (as CaCO3)	SM 2320B	IRW-1	02/15/08	ND	ND	NA	0-25	
Hydroxide (as CaCO3)	SM 2320B	IRW-1	02/15/08	ND	ND	NA	0-25	
Solids, Total Suspended	SM 2540 D	08-02-1082-5	02/15/08	6100	6060	1	0-20	
Solids, Total Dissolved	SM 2540 C	08-02-0943-9	02/15/08	1710	1520	12	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received: N/A
Work Order No: 08-02-1151
Preparation: EPA 3010A Total
Method: EPA 6010B

Project: Ausra / 2239472.01701

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
097-01-003-8,022	**Aqueous**	**ICP 5300**	**02/15/08**	**02/15/08**	**080215L05**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Antimony	82	95	80-120	15	0-20	
Arsenic	82	96	80-120	15	0-20	
Barium	100	101	80-120	2	0-20	
Beryllium	95	98	80-120	4	0-20	
Cadmium	102	102	80-120	0	0-20	
Chromium	99	104	80-120	4	0-20	
Copper	100	96	80-120	4	0-20	
Lead	98	100	80-120	2	0-20	
Nickel	105	105	80-120	0	0-20	
Selenium	91	91	80-120	0	0-20	
Thallium	98	98	80-120	0	0-20	
Aluminum	94	101	80-120	8	0-20	
Calcium	95	109	80-120	14	0-20	
Iron	102	104	80-120	2	0-20	
Magnesium	98	99	80-120	1	0-20	
Manganese	94	99	80-120	5	0-20	
Potassium	90	95	80-120	6	0-20	
Sodium	92	98	80-120	7	0-20	
Silicon	107	107	80-120	0	0-20	
Zinc	102	105	80-120	2	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

URS Corporation		Date Received:	N/A
1615 Murray Canyon Road, Suite 1000		Work Order No:	08-02-1151
San Diego, CA 92108-4319		Preparation:	EPA 7470A Total
		Method:	EPA 7470A

Project: Ausra / 2239472.01701

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-04-008-3,364	**Aqueous**	**Mercury**	**02/15/08**	**02/15/08**	**080215L04**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Mercury	96	97	85-121	1	0-4	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received: N/A
Work Order No: 08-02-1151
Preparation: EPA 3510B
Method: EPA 8270C

Project: Ausra / 2239472.01701

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
095-01-003-2,344	**Aqueous**	**GC/MS MM**	**02/18/08**	**02/19/08**	**080218L01**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Phenol	35	35	4-142	0	0-24	
2-Chlorophenol	80	80	53-113	0	0-17	
1,4-Dichlorobenzene	70	70	50-122	0	0-19	
N-Nitroso-di-n-propylamine	78	78	56-146	0	0-22	
4-Chloro-3-Methylphenol	78	78	55-121	0	0-18	
Acenaphthene	85	86	55-139	1	0-17	
4-Nitrophenol	30	30	1-145	2	0-29	
2,4-Dinitrotoluene	76	77	41-161	1	0-22	
Pentachlorophenol	61	63	34-130	4	0-23	
Pyrene	106	106	38-170	1	0-27	
1,2,4-Trichlorobenzene	73	73	49-121	0	0-19	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

URS Corporation		Date Received:	N/A
1615 Murray Canyon Road, Suite 1000		Work Order No:	08-02-1151
San Diego, CA 92108-4319		Preparation:	EPA 5030B
		Method:	EPA 8260B

Project: Ausra / 2239472.01701

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-10-006-24,504	**Aqueous**	**GC/MS CC**	**02/21/08**	**02/21/08**	**080221L01**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Benzene	102	101	84-120	1	0-8	
Carbon Tetrachloride	99	102	63-147	3	0-10	
Chlorobenzene	102	103	89-119	1	0-7	
1,2-Dibromoethane	101	105	80-120	4	0-20	
1,2-Dichlorobenzene	104	106	89-119	1	0-9	
1,1-Dichloroethene	93	94	77-125	1	0-16	
Ethylbenzene	108	107	80-120	1	0-20	
Toluene	109	108	83-125	1	0-9	
Trichloroethene	102	100	89-119	2	0-8	
Vinyl Chloride	111	112	63-135	2	0-13	
Methyl-t-Butyl Ether (MTBE)	97	102	82-118	5	0-13	
Tert-Butyl Alcohol (TBA)	102	107	46-154	5	0-32	
Diisopropyl Ether (DIPE)	92	95	81-123	3	0-11	
Ethyl-t-Butyl Ether (ETBE)	98	101	74-122	3	0-12	
Tert-Amyl-Methyl Ether (TAME)	98	100	76-124	2	0-10	
Ethanol	93	103	60-138	10	0-32	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received: N/A
Work Order No: 08-02-1151

Project: Ausra / 2239472.01701

Matrix: Aqueous

Parameter	Method	Quality Control Sample ID	Date Extracted	Date Analyzed	LCS % REC	LCSD % REC	%REC CL	RPD	RPD CL	Qual
Fluoride	EPA 300.0	099-05-118-4,347	N/A	02/15/08	100	101	80-122	1	0-7	
Chloride	EPA 300.0	099-05-118-4,347	N/A	02/15/08	97	97	81-111	0	0-5	
Nitrate (as N)	EPA 300.0	099-05-118-4,347	N/A	02/15/08	102	102	87-111	0	0-12	
o-Phosphate (as P)	EPA 300.0	099-05-118-4,347	N/A	02/15/08	101	101	78-126	0	0-22	
Sulfate	EPA 300.0	099-05-118-4,347	N/A	02/15/08	104	104	89-107	0	0-13	
Cyanide, Total	SM 4500-CN E	099-05-061-2,225	02/15/08	02/15/08	84	84	80-120	1	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Laboratory Control Sample

URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108-4319

Date Received: N/A
Work Order No: 08-02-1151

Project: Ausra / 2239472.01701

Matrix : Aqueous

Parameter	Method	Quality Control Sample ID	Date Analyzed	Date Extracted	Conc Added	Conc Recovered	LCS %Rec	%Rec CL	Qualifiers
Phosphorus, Total	SM 4500 P B/E	099-05-098-1,897	02/18/08	02/18/08	0.400	0.411	103	80-120	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Glossary of Terms and Qualifiers

Work Order Number: 08-02-1151

Qualifier	Definition
*	See applicable analysis comment.
1	Surrogate compound recovery was out of control due to a required sample dilution, therefore, the sample data was reported without further clarification.
2	Surrogate compound recovery was out of control due to matrix interference. The associated method blank surrogate spike compound was in control and, therefore, the sample data was reported without further clarification.
3	Recovery of the Matrix Spike (MS) or Matrix Spike Duplicate (MSD) compound was out of control due to matrix interference. The associated LCS and/or LCSD was in control and, therefore, the sample data was reported without further clarification.
4	The MS/MSD RPD was out of control due to matrix interference. The LCS/LCSD RPD was in control and, therefore, the sample data was reported without further clarification.
5	The PDS/PDSD associated with this batch of samples was out of control due to a matrix interference effect. The associated batch LCS/LCSD was in control and, hence, the associated sample data was reported with no further corrective action required.
A	Result is the average of all dilutions, as defined by the method.
B	Analyte was present in the associated method blank.
C	Analyte presence was not confirmed on primary column.
E	Concentration exceeds the calibration range.
H	Sample received and/or analyzed past the recommended holding time.
J	Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated.
N	Nontarget Analyte.
ND	Parameter not detected at the indicated reporting limit.
Q	Spike recovery and RPD control limits do not apply resulting from the parameter concentration in the sample exceeding the spike concentration by a factor of four or greater.
U	Undetected at the laboratory method detection limit.
X	% Recovery and/or RPD out-of-range.
Z	Analyte presence was not confirmed by second column or GC/MS analysis.

Calscience Environmental Laboratories, Inc.

CHAIN OF CUSTODY RECORD

☐ SoCal Laboratory
7440 Lincoln Way
Garden Grove, CA 92841-1427
(714) 895-5494

☐ NorCal Service Center
5063 Commercial Circle, Suite H
Concord, CA 94520-8577
(925) 689-9022

Date 2/14/08

Page 1 of 1

LABORATORY CLIENT: URS Corp.	CLIENT PROJECT NAME / NUMBER: 22239472.01701
ADDRESS: 2020 E. First St. Suite 400	P.O. NO.:
CITY: Santa Ana STATE: CA ZIP: 92705	PROJECT CONTACT: robert_scott@urscorp.com Bob Scott 619-294-9400
TEL: 714-835-6886 E-MAIL: robert.scott@urscorp.com	LAB USE ONLY: 02-11151
	SAMPLER(S): (PRINT) Stavro Pilafas
	COELT LOG CODE: ☐☐☐☐
	COOLER RECEIPT TEMP= 0.9 °C

TURNAROUND TIME: ☐ SAME DAY ☐ 24 HR ☐ 48 HR ☐ 72 HR ☐ 5 DAYS ☐ 10 DAYS

SPECIAL REQUIREMENTS (ADDITIONAL COSTS MAY APPLY)
☐ RWQCB REPORTING FORMS ☐ COELT EDF ☐ ____

SPECIAL INSTRUCTIONS:
24-Hr TAT: All remaining analyses.
Standard TAT: CN, VOCs, SVOCs, radioactivity analyses.

REQUESTED ANALYSES

LAB USE ONLY	SAMPLE ID	FIELD POINT NAME (FOR COELT EDF)	SAMPLING DATE	SAMPLING TIME	MATRIX	NO. OF CONT.	EPA 3000.0 Anions - including Fluoride	EPA 6010B Diss. Metals - A including Sb, Ba, Be, Se, Tl	EPA 6010B/7470A Total Metals	SM 2130 B - Turbidity	SM 2320 B - Alkalinity	SM 2510 B - Specific Conductance	SM 2540 C - TDS	SM 2540 D - TSS	SM 4500 H+B - pH	SM 4500 P B/E - Total Phosphorus	SM 4500 - CO2 D CO2	Total CN	Radium 226 and 228	Tritium	Strontium 90 & Uranium	Gross Alpha and Gross Beta	EPA 8260B - VOCs	EPA 8270 - SVOCs	Asbestos
	IRW-1		2/14/08	1410	W	20	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Relinquished by: (Signature)	Received by: (Signature/Affiliation)	Date:	Time:
[signature] 2/15/08 0930	[signature] CEL	2/15/08	930
Relinquished by: (Signature)	Received by: (Signature/Affiliation)	Date:	Time:
Relinquished by: (Signature)	Received by: (Signature/Affiliation)	Date:	Time:

DISTRIBUTION: White with final report, Green and Yellow to Client.
Please note that pages 1 and 2 of 2 of our T/Cs are printed on the reverse side of the green and Yellow copies respectively.

05/01/07 Revision

Q&Q Graphic 714-898-9702

Calscience Environmental Laboratories, Inc.

WORK ORDER #: 08 - 0 2 - 1 1 5 1

Cooler 1 of 2

SAMPLE RECEIPT FORM

CLIENT: URS

DATE: 2/15/08

TEMPERATURE – SAMPLES RECEIVED BY:

CALSCIENCE COURIER:

_______ Chilled, cooler with temperature blank provided.
_______ Chilled, cooler without temperature blank.
_______ Chilled and placed in cooler with wet ice.
_______ Ambient and placed in cooler with wet ice.
_______ Ambient temperature.
_______ °C Temperature blank.

LABORATORY (Other than Calscience Courier):

0.9 °C Temperature blank.
_______ °C IR thermometer.
_______ Ambient temperature.

Initial: HT

CUSTODY SEAL INTACT:

Sample(s): _______ Cooler: _______ No (Not Intact) : _______ Not Present: ✓

Initial: HT

SAMPLE CONDITION:

	Yes	No	N/A
Chain-Of-Custody document(s) received with samples	✓		
Sampler's name indicated on COC	✓		
Sample container label(s) consistent with custody papers	✓		
Sample container(s) intact and good condition	✓		
Correct containers and volume for analyses requested	✓		
Proper preservation noted on sample label(s)	✓		
VOA vial(s) free of headspace	✓		
Tedlar bag(s) free of condensation			✓

Initial: HT

COMMENTS:

Calscience Environmental Laboratories, Inc.

WORK ORDER #: 08 - 0 2 - 1 1 5 1

Cooler 2 **of** 2

SAMPLE RECEIPT FORM

CLIENT: URS **DATE:** 2/15/08

TEMPERATURE – SAMPLES RECEIVED BY:

CALSCIENCE COURIER:

_______ Chilled, cooler with temperature blank provided.
_______ Chilled, cooler without temperature blank.
_______ Chilled and placed in cooler with wet ice.
_______ Ambient and placed in cooler with wet ice.
_______ Ambient temperature.
_______ °C Temperature blank.

LABORATORY (Other than Calscience Courier):

0.9 °C Temperature blank.
_______ °C IR thermometer.
_______ Ambient temperature.

Initial: HT

CUSTODY SEAL INTACT:

Sample(s): _______ Cooler: _______ No (Not Intact) : _______ Not Present: ✓

Initial: HT

SAMPLE CONDITION:

	Yes	No	N/A
Chain-Of-Custody document(s) received with samples	✓		
Sampler's name indicated on COC	✓		
Sample container label(s) consistent with custody papers	✓		
Sample container(s) intact and good condition	✓		
Correct containers and volume for analyses requested	✓		
Proper preservation noted on sample label(s)	✓		
VOA vial(s) free of headspace	✓		
Tedlar bag(s) free of condensation			✓

Initial: HT

COMMENTS:

LA Testing
159 Pasadena Avenue, South Pasadena, CA 91030
Phone: (323) 254-9960 Fax: (323) 254-9982 Email: pasadenalab@latesting.com

Attn: **Vik Patel**
Calscience Environmental Labs, Inc.
7440 Lincoln Way
Garden Grove, CA 92841-1432

Fax: (714) 894-7501 Phone: (714) 895-5494
Project: **08-02-1151**

Customer ID: 32CALS51
Customer PO: 08-02-1151
Received: 02/15/08 12:40 PM
LA Testing Order: 320801961

LA Testing Proj:
Analysis Date: 2/21/2008
Report Date: 2/21/2008

Determination of Asbestos Structures over 10um in Length in Waste Water Performed by the EPA 100.2 Method

Sample ID	Sample Prep Date	# Fibers Asbestos	# Fibers Non-Asbestos	Type(s) Of Asbestos	Analytical Sensitivity (MFL)	Confidence Limits	Concentration Of Asbestos Fibers (MFL)	Comments
IRW-1 *320801961-0001*	2/21/2008	0	0		0.19	0.00-0.69	<0.19	Total area of filter examined = 0.23 mm2

Effective filtration area = 1288 mm2. Sample prepped past 48 hour hold time. UV ozonated.

Analyst(s)
Sherrie Ahmad (1)

Derrick Tanner, Laboratory Manager
or other approved signatory

THIS IS THE LAST PAGE OF THE REPORT.

ENVIRONMENTAL

ANALYTICAL CHEMISTS

March 7, 2008

Lab ID : SP 801769
Customer : 2017756

Calscience Environmental Laboratories
7440 Lincoln Way
Garden Grove, CA 92841-1432

Laboratory Report

Introduction: This report package contains total of 5 pages divided into three sections:

Case Narrative (2 Pages) : An overview of the work performed at FGL.
Chemical Results (1 Page) : Results for each sample submitted.
Quality Control (2 Pages) : Supporting Quality Control (QC) results.

This report package pertains to the following sample:

Sample Description	Date Sampled	Date Received	FGL Lab Sample ID #	Matrix
IRW-1	02/14/2008	02/15/2008	SP 801769-01	DW

Sampling and Receipt Information: The sample was received, prepared and analyzed within the method specified holding times. All samples arrived at 3 °C. All samples were checked for pH if acid or base preservation required (except for VOAs). For details of sample receipt information, please see the attached Chain of Custody and Condition Upon Receipt Forms.

Quality Control: All samples were prepared and analyzed according to the following tables:

Radio Chemistry QC

900.0	02/22/2008:A207 All preparation quality controls are within established criteria.
	02/28/2008:B - GP218 All analysis quality controls are within established criteria.
903.0	02/20/2008:A215 All preparation quality controls are within established criteria.
	02/20/2008:A - GP215 All analysis quality controls are within established criteria.
905.0	02/26/2008:B - GP217 All analysis quality controls are within established criteria.
906.0	02/25/2008:A217 All preparation quality controls are within established criteria.
	02/26/2008:A - LS201 All analysis quality controls are within established criteria.
908.0	02/27/2008:A218 All preparation quality controls are within established criteria, except: The following note applies to Uranium: 325 QC not within Acceptance Range (AR). Data could not be confirmed by reanalysis. Use results with discretion. The following note applies to Uranium: 410 Relative Percent Difference (RPD) not within Maximum Allowable Value

~~Table continued on next page...~~

Corporate Offices & Laboratory
P.O. Box 272 / 853 Corporation Street
Santa Paula, CA 93061-0272
TEL: (805) 392-2000
FAX: (805) 525-4172
CA NELAP Certification No. 01110CA

Office & Laboratory
2500 Stagecoach Road
Stockton, CA 95215
TEL: (209) 942-0182
FAX: (209) 942-0423
CA ELAP Certification No. 1563

Office & Laboratory
563 East Lindo Avenue
Chico, CA 95926
TEL: (530) 343-5818
FAX: (530) 343-3807

Field Office
Visalia, California
TEL: (559) 734-9473
FAX: (559) 734-8435
Mobile: (559) 737-2399

March 7, 2008

Lab ID : SP 801769
Customer : 2017756

Calscience Environmental Laboratories

Quality Control:

Radio Chemistry QC

908.0	02/27/2008:A218 Continued... (MAV). Data was accepted based on the LCS or CCV recovery.
	02/29/2008:A - GP214 All analysis quality controls are within established criteria.
Ra-05	02/21/2008:A212 All preparation quality controls are within established criteria.
	02/27/2008:A - GP218 All analysis quality controls are within established criteria.

Certification: I certify that this data package is in compliance with NELAC Standards, both technically and for completeness, except for any conditions listed above. Release of the data contained in this data package is authorized by the Laboratory Director or his designee, as verified by the following signature.

FGL ENVIRONMENTAL

KAD:kdm

Kelly A. Dunnahoo, B.S.
Laboratory Director

FGL ENVIRONMENTAL

NELAC ACCREDITED

ANALYTICAL CHEMISTS

March 7, 2008

Calscience Environmental Laboratories
7440 Lincoln Way
Garden Grove, CA 92841-1432

Description : IRW-1
Project : 08-02-1151

Lab ID : SP 801769-01
Customer ID: 2-17756

Sampled On : February 14, 2008-14:10
Sampled By : Not Available
Received On: February 15, 2008-10:16
Matrix : Drinking Water

Sample Results - Radio

Constituents	Result ± Error	MDA	Units	MCL	Preparation Method	Preparation Date/ID	Analysis Method	Analysis Date/ID
Radio Chemistry P:1,5								
Gross Alpha	9.36 ± 3.16	3.9	pCi/L	15*	900.0	02/22/08:A207	900.0	02/29/2008:B01
Gross Beta	0.000 ± 2.11	3.7	pCi/L	50	900.0	02/22/08:A207	900.0	02/29/2008:B01
Strontium 90	1.03 ± 0.467	0.74	pCi/L	8	905.0	02/25/08:A214	905.0	02/27/2008:B01
Alpha Radium(226)	0.237 ± 0.184	0.18	pCi/L	5	903.0	02/20/08:A215	903.0	02/21/2008:A01
Tritium	0.000 ± 198	400	pCi/L	20,000	906.0	02/25/08:A217	906.0	02/26/2008:A01
Uranium	6.00 ± 1.16	0.76	pCi/L	20	908.0	02/27/08:A218	908.0	03/03/2008:A01
Ra-228	0.241 ± 0.651	0.55	pCi/L	2	Ra-05	02/21/08:A212	Ra-05	02/27/2008:A01

MDA = Minimum Detectable Activity; Data utilized by the DHS to determine matrix interference. MCL = Maximium Contaminat Level.
Containers: (P) Plastic Preservatives: (1) Cool 4°C, (5) HNO3 pH < 2
* Including Radium but excluding Uranium. (Ref. Title 22 sec. 64442.)
CCR Section 64442: Compliance Note: If Gross Alpha (Result + (0.84 x error)) exceeds 5 pCi/L run Uranium. If Gross Alpha minus Uranium exceeds 5 pCi/L run Radium 226. Samples that exceed 5 pCi/L are held for 6 months at FGL.

Compliance:
Gross Alpha - Uranium ≤ 15 pCi/L
Uranium ≤ 20 pCi/L
Radium 226 + Radium 228 ≤ 5 pCi/L

Corporate Offices & Laboratory
P.O. Box 272 / 853 Corporation Street
Santa Paula, CA 93061-0272
TEL: (805) 392-2000
FAX: (805) 525-4172
CA NELAP Certification No. 01110CA

Office & Laboratory
2500 Stagecoach Road
Stockton, CA 95215
TEL: (209) 942-0182
FAX: (209) 942-0423
CA ELAP Certification No. 1563

Office & Laboratory
563 East Lindo Avenue
Chico, CA 95926
TEL: (530) 343-5818
FAX: (530) 343-3807

Field Office
Visalia, California
TEL: (559) 734-9473
FAX: (559) 734-8435
Mobile: (559) 737-2399

March 07, 2008
Calscience Environmental Laboratories

Lab ID : SP 801769
Customer : 2-17756

Quality Control - Radio

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Alpha Radium(226)	903.0	02/20/2008:A215	RgBlk	pCi/L		-0.03	2	
			LCS	pCi/L	18.85	83.4%	52- 89	
			BS	pCi/L	18.85	83.8%	43- 92	
			BSD	pCi/L	18.85	91.7%	43- 92	
			BSRPD	pCi/L		8.9%	≤35.5	
Alpha-α	903.0	02/20/2008:A	00-CCB	cpm		0.10	.084±.05	
			00-CCV	cpm	19760	45.9%	41.0±10	
Gross Alpha	900.0	02/22/2008:A207	Blank	pCi/L		ND	<1	
			LCS	pCi/L	114.2	101%	75-125	
			MS	pCi/L	114.2	86.7%	60-140	
		(SP 801910-01)	MSD	pCi/L	114.2	87.2%	60-140	
			MSRPD	pCi/L		0.5%	≤30	
Alpha-α	900.0	02/28/2008:B	00-CCB	cpm		0.12	.0775±.054	
			00-CCV	cpm	11700	42.0%	41.0±5.0	
Gross Beta	900.0	02/22/2008:A207	Blank	pCi/L		ND	<4	
			LCS	pCi/L	105.7	101%	75-125	
			MS	pCi/L	105.7	94.2%	80-130	
		(SP 801910-01)	MSD	pCi/L	105.7	84.0%	80-130	
			MSRPD	pCi/L		11.2%	≤30	
Beta-ß	900.0	02/28/2008:B	00-CCB	cpm		0.46	.373±.11	
			00-CCV	cpm	11700	91.3%	88.9±5.0	
Ra-228	Ra-05	02/21/2008:A212	RgBlk	pCi/L		0.01	3	
			LRS	pCi/L	101.2	40.0%	35- 50	
			BS	pCi/L	101.2	98.5%	75-125	
			BSD	pCi/L	101.2	96.5%	75-125	
			BSRPD	pCi/L		2.0%	≤25	
Beta-ß	Ra-05	02/27/2008:A	00-CCB	cpm		0.44	.373±.11	
			00-CCV	cpm	11700	91.2%	88.9±5.0	
	905.0	02/26/2008:B	00-CCB	cpm		0.44	.376±.097	
			00-CCV	cpm	11700	92.5%	88.6±5.0	
Tritium	906.0	02/25/2008:A217	Blank	pCi/L		ND	<518	
			LCS	pCi/L	2409	103%	75-125	
			BS	pCi/L	2409	103%	75-125	
			BSD	pCi/L	2409	107%	75-125	
			BSRPD	pCi/L		4.0%	≤25	
	906.0	02/26/2008:A	00-CCB	cpm		11	12±1.7	
			00-CCV	cpm	372.1	23.6%	25.5±4.5	
Uranium	908.0	02/27/2008:A218	RgBlk	pCi/L		0.23	1	
			LRS	pCi/L	20.27	85.4%	46-100	
			BS	pCi/L	20.27	95.5%	75-125	
			BSD	pCi/L	20.27	64.3%	75-125	325
			BSRPD	pCi/L		39.0%	≤20	410
Alpha-α	908.0	02/29/2008:A	00-CCB	cpm		0.10	.046±.08	

Report continued on next page...

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March 07, 2008

Calscience Environmental Laboratories

Lab ID : SP 801769
Customer : 2-17756

Quality Control - Radio

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Alpha-α	908.0	02/29/2008:A	00-CCV	cpm	19760	46.7%	42.0±10	

Explanations

325 QC not within Acceptance Range (AR). Data could not be confirmed by reanalysis. Use results with discretion.

410 Relative Percent Difference (RPD) not within Maximum Allowable Value (MAV). Data was accepted based on the LCS or CCV recovery.

Definitions

Blank : Method Blank - Prepared to verify that the preparation process is not contributing contamination to the samples.
RgBlk : Method Reagent Blank - Prepared to correct for any reagent contributions to sample result.
LCS : Laboratory Control Standard/Sample - Prepared to verify that the preparation process is not affecting analyte recovery.
LRS : Laboratory Recovery Standard
MS/MSD : Matrix Spikes - A random sample is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.
BS/BSD : Blank Spikes - A blank is spiked with a known amount of analyte. It is prepared to verify that the preparation process is not affecting analyte recovery.
CCB : Continuing Calibration Blank - Analyzed to verify the instrument baseline is within criteria.
CCV : Continuing Calibration Verification - Analyzed to verify the instrument calibration is within criteria.
ND : Non-detect - Result was below the DQO listed for the analyte.
DQO : Data Quality Objective - This is the criteria against which the quality control data is compared.

Calscience Environmental Laboratories, Inc.
7440 LINCOLN WAY
GARDEN GROVE, CA 92841-1432
TEL: (714) 895-5494 . FAX: (714) 894-7501

TO: FGL LABS

CHAIN OF CUSTODY RECORD

DATE: 02/15/08

PAGE: 1 OF 1

801769

LABORATORY CLIENT: Calscience Environmental Laboratories, Inc.	CLIENT PROJECT NAME / NUMBER: 08-02-1151
ADDRESS: 7440 Lincoln Way	P.O. NO.:
CITY: Garden Grove, CA 92841-1427	PROJECT CONTACT: Vik Patel
TEL: 714/895-5494 FAX: 714/894-7501 E-MAIL: vipatel@calscience.com	QUOTE NO.:
	SAMPLER(S): (SIGNATURE)
	LAB USE ONLY

TURNAROUND TIME
☐ SAME DAY ☐ 24 HR ☐ 48HR ☐ 72 HR ☐ 5 DAYS ☐ 10 DAYS

SPECIAL REQUIREMENTS (ADDITIONAL COSTS MAY APPLY)
☐ RWQCB REPORTING ☐ ARCHIVE SAMPLES UNTIL ___/___/___

SPECIAL INSTRUCTIONS

Standard TAT

REQUESTED ANALYSIS

LAB USE ONLY	SAMPLE ID	LOCATION/ DESCRIPTION	SAMPLING DATE	SAMPLING TIME	Matrix	#Cont	Radium 226	Radium 228	Gross Alpha & Beta	Tritium	Strontium 90	Uranium
	IRW-1		02/14/08	1410	W	7	X	X	X	X	X	X

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
[signature] CEL	GSO AB# 508949584	2/15/08	1600
Goldenstate overnight	JS	2/16/08	1014

FGL Environmental
Revision Date: 10/18/07

Doc ID: F2REC005.011
Page: 1 of 1

Santa Paula - Condition Upon Receipt (Attach to COC)

Sample Receipt:

1. Number of ice chests/packages received: 1
   Note as OTC if received over the counter unpackaged.
2. Were samples received in a chilled condition? Temps: 3 / ___ / ___ / ___
   Acceptable is 2° to 6° C. Also acceptable is received on ice (ROI) for the same day of sampling or received at room temperature (RRT) if sampled within one hour of receipt. Client contact for temperature failures must be documented below. If many packages are received at one time check for tests/H.T.'s/rushes/Bacti's to prioritize further review. Please notify Microbiology personnel immediately of bacti samples received.
3. Do the number of bottles received agree with the COC? Yes No N/A
4. Were samples received intact? (i.e. no broken bottles, leaks etc.) Yes No
5. Were sample custody seals intact? N/A Yes No

Sign and date the COC, obtain LIMS sample numbers, select methods/tests and print labels.

Sample Verification, Labeling and Distribution:

1. Were all requested analyses understood and acceptable? Yes No
2. Did bottle labels correspond with the client's ID's? Yes No
3. Were all bottles requiring sample preservation properly preserved? Yes No N/A FGL
4. VOAs checked for Headspace? Yes No N/A
5. Were all analyses within holding times at time of receipt? Yes No
6. Have rush or project due dates been checked and accepted? N/A Yes No

Attach labels to the containers and include a copy of the COC for lab delivery.

Sample Receipt, Login and Verification completed by (initials): ele

Discrepancy Documentation:

Any items above which are "No" or do not meet specifications (i.e. temps) must be resolved.

1. Person Contacted: ______________ Phone Number: ______________
   Initiated By: ______________ Date: ______________
   Problem:

   Resolution:

2. Person Contacted: ______________ Phone Number: ______________
   Initiated By: ______________ Date: ______________
   Problem:

   Resolution:

(2-17756)
Calscience Environmental Laboratories
SP 0801769
IV-02/18/2008-09:14:35

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA

APPLICATION FOR CERTIFICATION *For the CARRIZO ENERGY SOLAR FARM* PROJECT	Docket No. 07-AFC-8 PROOF OF SERVICE (Revised 5/15/2008)

INSTRUCTIONS: All parties shall either (1) send an original signed document plus 12 copies or (2) mail one original signed copy AND e-mail the document to the address for the Docket as shown below, AND (3) all parties shall also send a printed or electronic copy of the document, which includes a proof of service declaration to each of the individuals on the proof of service list shown below:

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. 07-AFC-8
1516 Ninth Street, MS-14
Sacramento, CA 95814-5512
docket@energy.state.ca.us

APPLICANT

Perry H. Fontana, QEP
Vice President-Projects
Ausra, Inc.
2585 East Bayshore Road
Palo Alto, California 94303
perry@ausra.com

APPLICANT CONSULTANT

Angela Leiba, GISP
Senior Project Manager
GIS Manager/Visual Resource Specialist
URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, CA 92108
angela_leiba@urscorp.com

Kristen E. Walker, J.D.
URS Corporation
1615 Murray Canyon Road, Suite 1000
San Diego, California 92108
kristen_e_walker@urscorp.com

COUNSEL FOR APPLICANT

Jane Luckhardt, Esq.
Downey Brand Law Firm
555 Capitol Mall, 10th Floor
Sacramento, CA 95814
jluckhardt@downeybrand.com

INTERESTED AGENCIES

Larry Tobias
CA Independent System Operator
151 Blue Ravine Road
Folsom, CA 95630
ltobias@caiso.com

Electricity Oversight Board
770 L Street, Suite 1250
Sacramento, CA 95814
esaltmarsh@eob.ca.gov

INTERVENORS

* California Unions for Reliable Energy (CURE)
c/o Tanya Gulesserian
Adams Broadwell Joseph & Cardozo
601 Gateway Boulevard, Suite 1000
South San Francisco, CA 94080
tgulesserian@adamsbroadwell.com

ENERGY COMMISSION

Jackalyne Pfannenstiel
Chairman and Presiding Member
jpfannen@energy.state.ca.us

Jeffrey D. Byron
Commissioner and Associate Member
jbyron@energy.state.ca.us

Gary Fay
Hearing Officer
gfay@energy.state.ca.us

John S. Kessler
Project Manager
jkessler@energy.state.ca.us

Mary Dyas
Project Manager
mdyas@energy.state.ca.us

Caryn Holmes
Staff Counsel
cholmes@energy.state.ca.us

Michael Doughton
Staff Counsel
mdoughto@energy.state.ca.us

Public Adviser's Office
pao@energy.state.ca.us

DECLARATION OF SERVICE

I, Kristen E. Walker, declare that on June 27, 2008, I deposited copies of the attached Hydrology and Hydrogeology Report for the Vicinity of the Proposed Carrizo Energy Solar Farm (CESF) San Luis Obispo County, California (Carrizo Energy Solar Farm 07-AFC-8) in the United States mail (FedEx) with first-class postage thereon fully prepaid and addressed to those identified on the Proof of Service list above.

OR

Transmission via electronic mail was consistent with the requirements of California Code of Regulations, title 20, sections 1209, 1209.5, and 1210. All electronic copies were sent to all those identified on the Proof of Service list above.

I declare under penalty of perjury that the foregoing is true and correct.