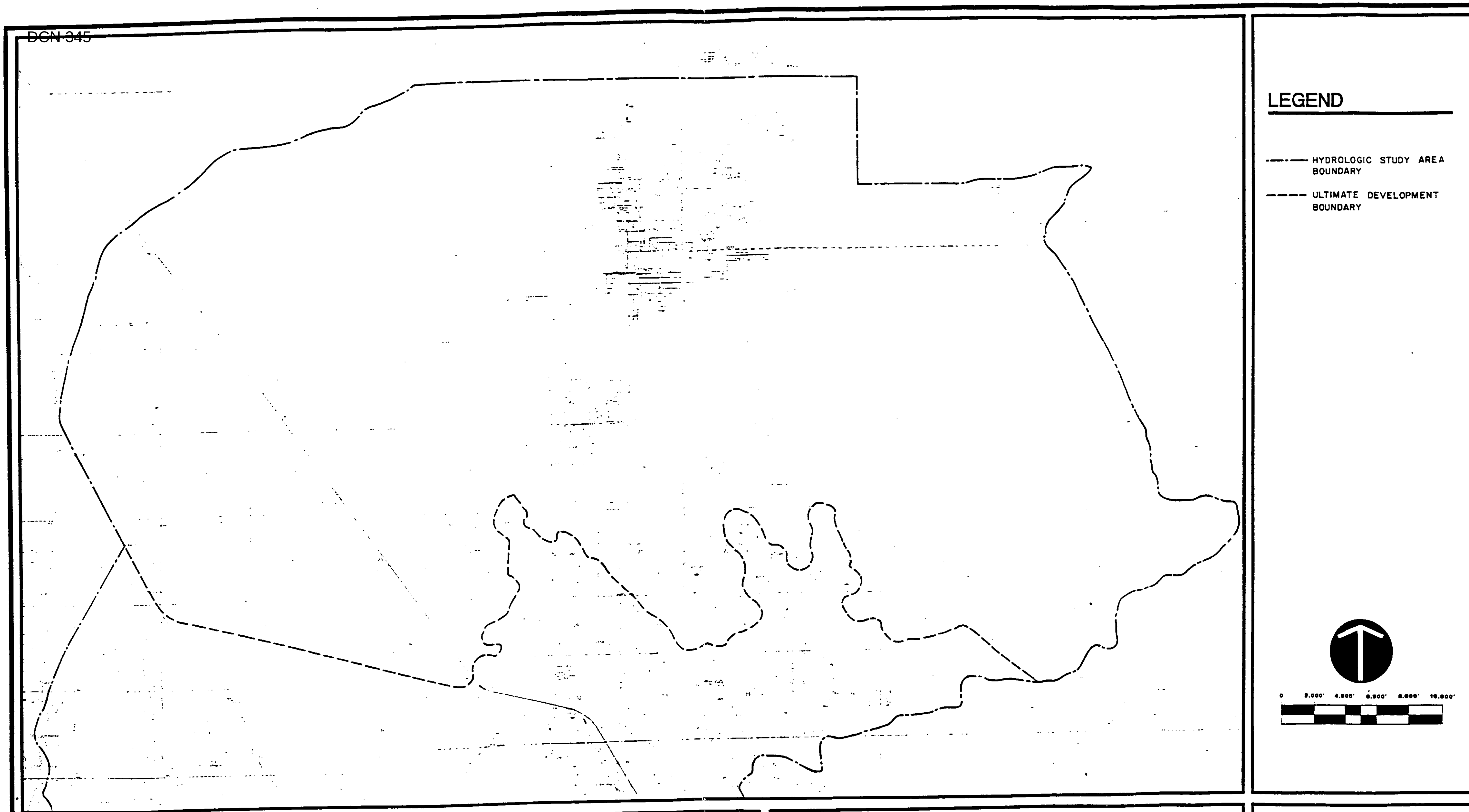
DCN 345



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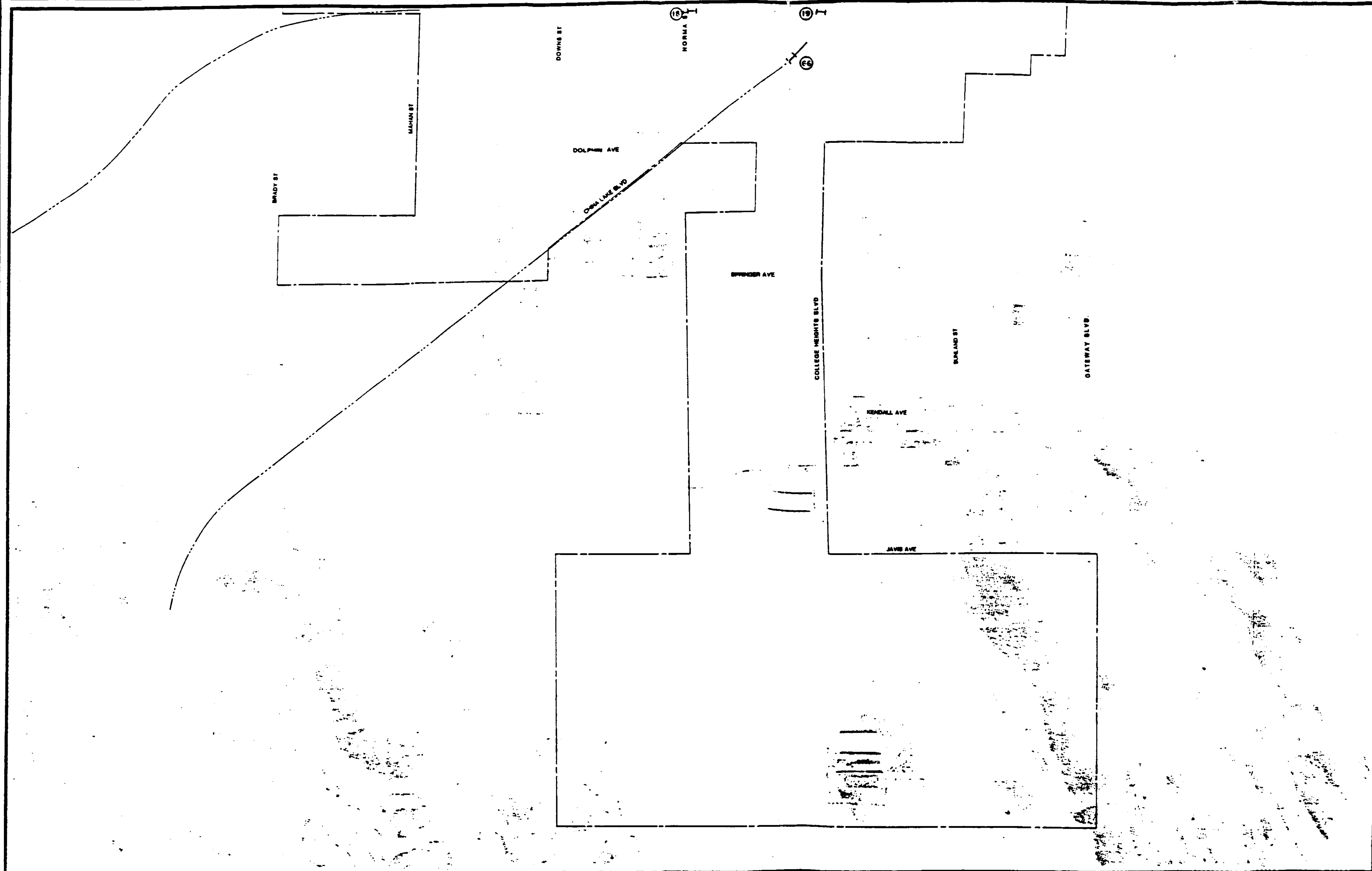
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

STUDY AREA
AND
ULTIMATE DEVELOPMENT BOUNDARY

FIGURE 3-1

FIGURE 15-1



LEGEND

- CULVERT
- STORM DRAIN
- IMPROVED CHANNEL
- CATCH BASIN / LEACH LINE
- NATURAL WASH OR SWALE
- (13) FACILITY ID NUMBER

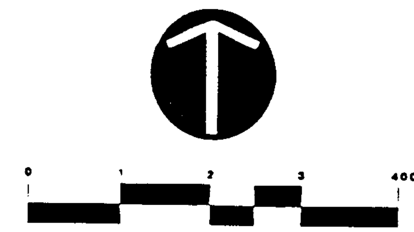


PHOTO DATE: 12-03-87

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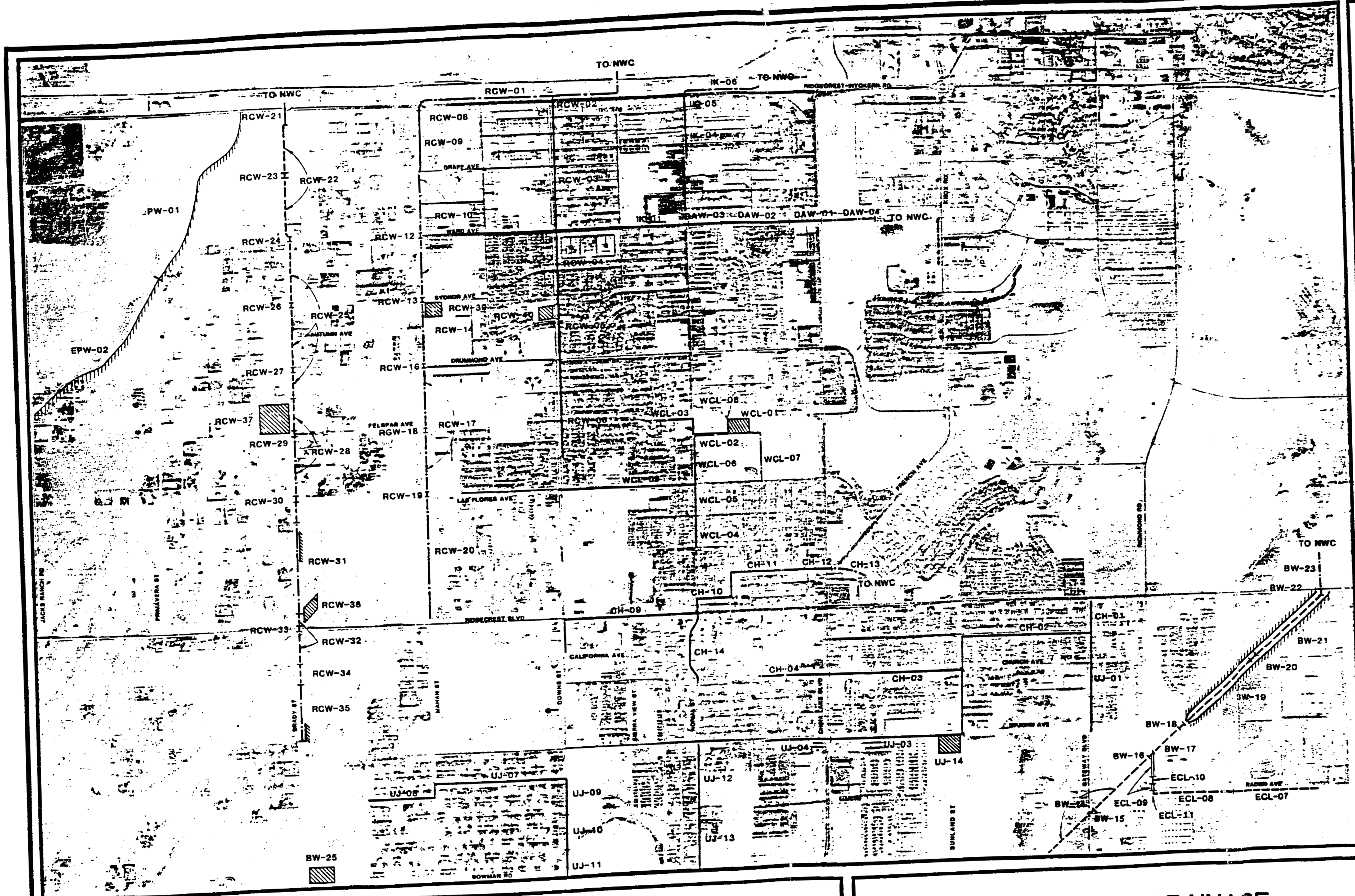
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

EXISTING DRAINAGE FACILITIES

FIGURE 4-1B

FIGURE 15-2A.



LEGEND

———	BURIED CONDUIT (PIPE/BOX)
———	UNLINED CHANNEL
- - - -	RIP RAP LINED CHANNEL
═══	CONCRETE LINED CHANNEL
/////	DIKE/LEVEE
▨	DETENTION/RETENTION BASIN
▣	DEBRIS BASIN
⊢	CULVERT/BRIDGE
BW-06	FACILITY NUMBER

0 1 2 3 4000'

PHOTO DATE: 12-03-87

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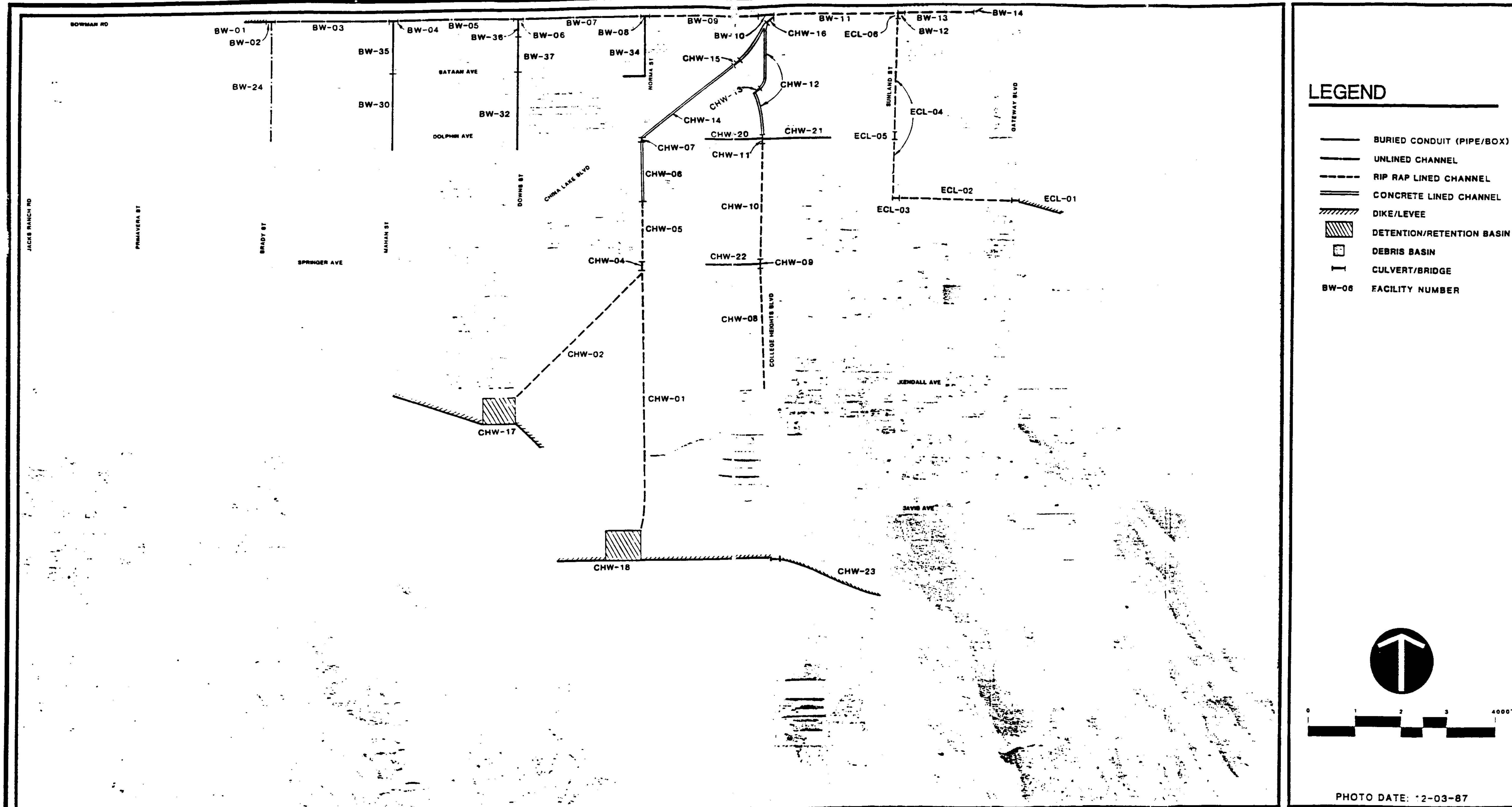
CITY OF RIDGECREST
MASTER DRAINAGE PLAN

RECOMMENDED DRAINAGE
IMPROVEMENTS

FIGURE 1-1A

FIGURE 15-3A



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CITY OF RIDGECREST
MASTER DRAINAGE PLAN

RECOMMENDED DRAINAGE
IMPROVEMENTS

FIGURE 1-1B

FIGURE 15-3B

SECTION II

Chapter 16.0

WATER SUPPLY

This analysis was prepared by the Community Development Department and hereby incorporates the "Indian Wells Valley Water District Domestic Water System 1990 Water General Plan" adopted October 15, 1990 (copies of this plan are available at the office of the IWVWD).

16.1 SETTING

16.1.1 Introduction

The following section provides an introduction to general concepts utilized in this report to evaluate potential impacts to water resources.

Water supplies are usually measured in acre-feet per year (AFY). An acre-foot (AF) is the amount of water needed to cover one (1) acre to a depth of one (1) foot and is equivalent to 325,851 gallons.

Because water supplies are constantly being used and replenished, water sources are defined in terms of their "safe yield." When used in reference to water from groundwater storage, the term safe yield refers to the maximum rate of net extractions from the groundwater basin which, if continued over an indefinitely long period of years, results in the maintenance of certain desirable fixed conditions. Groundwater safe yield is determined by a variety of means. One or more of the following criteria are usually utilized:

- o Mean seasonal extraction of water from groundwater basin does not exceed mean seasonal replenishment.
- o Water levels are not so lowered as to cause harmful impairment of the quality of the groundwater by intrusion of other water of undesirable quality or by accumulation of mineral degraders or pollutants.

- o Water levels are not lowered to such a degree as to cause excessive costs of pumping from the basin or to exclude the user from the supply by virtue of inadequate depth of pumping facilities.

Safe yield is also affected by pumping patterns, the magnitude of groundwater basin utilization by others and other factors. It is possible to withdraw from a basin more than the safe yield. This is called overdrafting. Continued overdrafting resulting in lowered water levels, may result in the degradation of water quality due to concentration of degraders in a reduced volume of water and by intrusion of lesser quality waters.

16.1.2 District Boundaries of Regional Purveyor and City Service Area

The City of Ridgecrest is located within the boundaries of the Indian Wells Valley Water District (IWVWD), the sole purveyor of water for the City. The IWVWD utilizes the groundwater basin to supply the users within its service area. There are some private well owners within the City limits, the majority of which are used for landscape irrigation (Heritage Village and City).

The IWVWD presently provides water to urban, commercial and rural customers as illustrated in Figure 16-1. This service area's general boundaries includes China Lake Acres to the west, Inyokern Road (Highway 178) as the approximate northern edge, one mile east of San Bernardino County Road as the approximate eastern boundary, one mile south of Javis Avenue as the southern boundary and Jack's Ranch Road as a western boundary to Drummond Avenue where it would continue west to Victor Street in the China Lake Acres area. The IWVWD service area covers approximately 38 square miles within the Indian Wells Valley and provides water to an estimated population of 36,000 persons.

The Indian Wells Valley Groundwater Basin also provides water to the NAWS, North American Chemical Company (NACC), the Community of Trona, the Community of Inyokern, private agreement water purveyors, private well owners, and agricultural interests.

16.1.3 Sources of City Water Supply

Groundwater is the only source for water presently utilized by the Indian Wells Valley (Valley). Groundwater in the Valley is usually identified as belonging to either the shallow or deep aquifer. The two aquifers appear to be separated by some type of structural control. The deep aquifer is the most utilized by the Valley. The deep aquifer is further divided into subareas or well fields, of which the IWVWD presently pumps all of its supply from the Intermediate Zone. The well fields being utilized by Valley users are presented in Table 16-1. (The City of Ridgecrest is utilizing treated sewer effluent for agricultural purposes. For the purpose of this report, this will not be considered a water supply.)

a. Shallow Aquifer. The unconfined shallow aquifer, located for the most part in the northeastern part of the Valley centered around the China Lake Playa, is of poor quality and is unfit for potable public uses due to its high Total Dissolved Solids (TDS) and chemical constituents. (USGS, Ground Water Quality, 1975). The shallow aquifer is found in the younger lacustrine deposits of the Valley. The thickness of the shallow aquifer is 300 feet based on an assumed aquifer bottom elevation of 1900 feet. It is not found in the recharge areas at the periphery of the basin.

TABLE 16-1

SUMMARY OF GROUND WATER EXTRACTION IN INDIAN WELLS VALLEY (1985)

	acre-feet/year
Ridgecrest Well Field	4,460
Intermediate Well Field	6,768
Inyokern Well Field	2,969
Other Areas	447
Northwest Agricultural Areas	6,882
TOTAL	21,526

b. Deep Aquifer. The confined deep aquifer is the main aquifer underlying the Valley. It consists of younger alluvium, the younger and older lacustrine deposits and the older alluvium. In the central portion of the Valley, the deep aquifer is separated from the shallow aquifer by the intervening low permeability lacustrine deposits which cause the deeper aquifer to become confined. It has been conservatively estimated that the annual recharge to the deep aquifer is approximately 9,850 acre feet (AF) annually.

In an average year between 400,000 AF and 500,000 AF of precipitation (rain and snow) falls on the mountains, hills and catchment basin that furnishes water to the groundwater supply of the Indian Wells Valley. Of this annual precipitation, groundwater replenishment is only about 11,000 AFY due to the high evaporation rates for the area (St. Amand, 1986). In the draft EIR for the Southwest Well Field (a copy of this plan is available at the IWVWD's offices), it is noted that "about 200,000 AF of precipitation falls on the mountains and hills within the Indian Wells Valley and about 100,000 AF of precipitation falls on the Valley floor. Of about 300,000 AF of annual precipitation, annual groundwater replenishment is only about 11,000 AF with replenishment of only about 7,000 AF/Yr where most production occurs (Ridgecrest, Intermediate, and Inyokern areas).(IWVWD, 1990 General Plan) Tables 16-2A and B show the deep aquifer recharge distribution. (Estimates of recharge vary, although they consistently indicate that the amount of recharge is less than the quantity of water being pumped)

When groundwater is pumped at a rate greater than water recharge to the basin, an overdraft situation is created. Tables 16-1 and 16-2 demonstrate that more water is being used than is being recharged to the aquifer.

16.1.4 Current Supply and Demand

The IWVWD water production records show the highest recent annual total water demand was 8,727.4 AFY for the year 1989. New connections have historically increased by 5% per year, but are currently increasing at a rate of one and one-half percent per year. Due to aggressive conservation, steel line replacement and meter installation programs, and a tiered rate structure for consumption and perhaps a decline in the population, the total annual water consumption has dropped 1.6% in 1990, 10.4% in 1991 and 1.6% to a total of 7644.60 AF in 1992. Due to the continuance of these programs, and to new construction efficiency standards, new water demand is expected to increase during the next few years by an estimated zero to one percent for residential and commercial connections.

To accurately assess the water demand for the Valley groundwater, one must realize that the Valley supplies water to other agencies and users than just the customers of the IWVWD. Table 16-3 lists these agencies and the water usage by each.

For planning purposes, the IWVWD's records show that most of the water produced by that agency is used by single family (SFR) and multifamily (MFR) residential services. SFR connections average 3.4 residents with 144 gallons per person per day (GPCD) use. MFR connections average 2.8 residents per unit and seven units per connections, with 95 GPCD. In 1989 the IWVWD records indicated that 0.89 AFY per connections was used, while the records for 1992 indicate that water usage has dropped to 0.72 AFY per connection. It is believed that this is a direct result of the aggressive water conservation programs and steel line replacement that the IWVWD has instituted over the past several years. Table 16-4 summarizes the IWVWD usage by type. For the projection purposes of this document the IWVWD provided record data indicating that usage by the City residents for the year 1991 was 6,033 AFY (Oral communication, Roy Tucker, Assistant General Manager, IWVWD).

TABLE 16-2A

AQUIFER RECHARGE DISTRIBUTION

AREA PER Bloyd and Robson, 1971	RECHARGE (AFY)
Coso Wash	1,000
Petroglyph Canyon	590
Renegade Canyon	230
Mountain Springs Canyon	930
Unnamed Canyon (near NE Valley end)	60
Wilson Canyon	350
Burro Canyon	8
El Paso Drainage	400
Little Lake	43
Freeman Gulch	2,040
Freeman Canyon	430
Indian Wells Canyon	400
Grapevine Canyon	1,620
Sand Canyon	495
Nine-mile and Noname Canyons	775
Five-mile and Deadfoot Canyons	475
TOTAL	9,850

TABLE 16-2B

AQUIFER RECHARGE DISTRIBUTION

AREA PER Bean, 1989	RECHARGE (AFY)
Recharge from Sierran Streams	6,3000
Coso Basin Runoff	2,000
Argus Mountains Runoff	1,000
El Paso Range Runoff	400
LADWP	900
Geothermal Leakage	100
Recharge from Sierran Granite	2,500
Recharge from Rose Valley	400
Recharge from Human Activity	1,500
TOTAL	15,100

TABLE 16-3

WATER USAGE BY AGENCY

AGENCY	USAGE
IWVWD	7,645 AF (1992)
NAWS	3,409 AF (1992)
North American Chemical Company*	2,521 AF (1992)
Inyokern Community Service District	140 AF (1992)
Agricultural	7,064 AF (1989)
Private Users**	3,000 AF (1992)
City of Ridgecrest (Non-potable)	19.4 AF (1992)
ASSUMED ANNUAL TOTAL FOR 1992	**23,844.4 AF**

* Includes the Community of Trona

** Estimate supplied by Peggy Breeden, President, Well Owner's Association based on 2,200 connections (includes small agricultural users)

TABLE 16-4

CUSTOMER TYPES

Customer Type	1991 Services	1991% of Services
Single Family	9,740	92.1%
Multifamily	238	2.0%
Commercial	447	4.0%
Industrial	0	0.0%
Public	84	0.8%
Construction	31	0.3%
Fire	27	0.3%
Flat Rate	50	0.5%
TOTAL	**10,567**	**100.0%**

Groundwater quantity and quality vary significantly within the basin. Groundwater availability has been and continues to be the subject of great concern within the Valley. Numerous investigations have contributed to differing opinions which can generally be subdivided into two groups, one group professing a "closed basin" concept with recharge resulting from infiltration and percolation and discharge through groundwater extraction and some evapotranspiration. The other group espouses an "open basin" concept with a regional flow system that has groundwater moving under the basin at depth from the Sierra Nevada Mountains and continuing under the Argus and El Paso Mountains. Regardless of these differing opinions, groundwater levels have been and continue to decline. "Since 1959, annual groundwater pumpage has exceeded annual natural recharge (9,850 AFY) (Berenbrock, 1989) Groundwater replenishment appears to have been insufficient to maintain groundwater levels.

Table 16-5 gives the estimated pumpage by the users of the Valley groundwater basin.

16.1.5 Potential Future Water Sources

a. The IWVWD is currently exploring alternative water sources that could be imported to this Valley. Readers are referred to the IWVWD for further exploration of this source of future water.

b. Reclaimed Sewer Effluent has been brought forward as a valuable asset to the community. The City of Ridgecrest is presently exploring the reuse of this water source. The Sewer Master Plan identifies that this effluent could be developed as a water source for landscape, agricultural, golf course, and industrial waters as proscribed by Title 22 Health Standards. The IWVWD has also advised the City it is ready to make use of treated sewage effluent provided such use is economically feasible.

c. Further test and evaluation of possible blending of potable waters with non-potable waters is being done by the IWVWD. Initial results from those wells drilled at Neal Ranch indicate high levels of TDS. It would be acceptable to blend low TDS waters with the high TDS waters for drinking water purposes.

16.1.6 Water Supply System Components

a. The reader is referred to the IWVWD Master Plan in respect to the components of its domestic water system that includes waterlines, reservoirs, pressure zones and booster pump stations.

b. Wells. The Valley has five potential well fields. The Intermediate Area, the Southwest Well Field (draft EIR for Southwest Well Field was never adopted), the Inyokern Area,

TABLE 16-5

AGENCY WATER PRODUCTION/PUMPAGE IN AFY
FOR THE YEARS 1983-1992

YEAR	ICSD	IWVWD	NAWS	NACC	AG	PVT	COR
1992	140	7644.7	3409.8	2521.8	*	*	19.4
1991	159	7716.6	3365.9	2406.2	*	3000	*
1990	164	8663.3	3715.8	2504.4	*	*	*
1989	171	8167.5	4237.6	2318.6	7,064[a]	*	*
1988	174	7220.9	4236.6	2330.1	6,450[b]	*	*
1987	139	6465.3	4584.3	2511.3	5,588	*	*
1986	178**	5901.0	4616.5	2427.2	9,342	*	*
1985	178**	4980.2	4002.0	2399.9	14,150	*	*
1984	178**	4949.8	4694.0	2485.7	13,480	*	*
1983	178**	4316.1	4402.0	2615.8	13,438	*	*
1982		3963.5	4450.0	2887.0	13,402		*
1981		4223.1	4804.0	3065.0	13,638		
1980		3819.2	4995.0	2887.0	11,156		
1979		3401.9	5154.0	3081.0	6,857		

ICSD	Inyokern Community Service District
IWVWD	Indian Wells Valley Water District
NAWS	Naval Air Weapons Station
NACC	North American Chemical Company
AG	Agricultural Users
PVT	Well Owners Association and other Private Wells
COR	City of Ridgecrest
*	Data not available for this year
**	Average production figure
N/A	Not Available
a	Neal Ranch Closed
b	Spike Leroy Ranch closed

(The figures for the IWVWD may not reflect their acquisition of smaller water purveyors in this time period) the Northwest Area, the Southeast Area (NAWS well fields are not listed). See Table 16-7 for the capacity and status of the production wells that are online as well as the reservoir capacity of the system.

16.1.7 Current System Deficiencies

The IWVWD is the sole commercial purveyor of water for the City of Ridgecrest, it is a public agency separate from the City. The IWVWD as of 1992 had undertaken the following measures to address supply deficiencies.

- Development of additional wells to augment existing capacity during peak demand periods.
- Construction of two additional production wells.
- Completion of the "Ridgecrest Heights" assessment district improvements that replaced substandard and leaking water lines and lifted the building moratorium for this area.
- Completion of the Ridgecrest Heights Water Storage Reservoir that increased storage capacity for this elevation.
- Completion of the "Bowman Road" water storage reservoir that brings the reservoir capacity of the IWVWD to fifteen (15) million gallons.
- Interconnection agreements with the NAWS and NACC so that adequate supply is available should they suffer equipment failure.
- Replacement of water line on State Route 178, that allows for more efficient distribution from wells 17, 30, and 31.
- Continued testing and evaluation of the Valley water aquifer.
- Research and evaluation of the feasibility of importing water to the Valley.

16.1.8 Long Term Assessment

As the City and the surrounding area continue to develop and buildout, the IWVWD will, by necessity and good practice, review their General Plan to address the changing needs of the community. It will be the IWVWD's responsibility to ensure that their customers are adequately serviced by potable water. It can be reasonably foreseen that they will review their plan in order to accommodate anticipated growth with the following options in mind:

- o Rotation of the use of wells in order to "rest the area" and to lessen the pumping depression.
- o Coordinate the timing of well pumping, to employ energy efficiency techniques.
- o Continue to research and explore the importation of potable waters to the customers of the Indian Wells Valley.
- o Water fees increases due to the rising demand for potable water in a "closed basin"

16.2 Impact Analysis

16.2.1 Significance Thresholds

In evaluating the impact of the development alternatives on the water system, each alternative is reviewed in terms of available sources of supply, and the ability of the major system components to deliver that supply to the area of demand.

a. System Supply. The water demand for each of the alternatives is compared against current available sources of supply. If demand for an alternative exceeds available sources of supply, a significant impact would occur.

Determining a threshold of significance for groundwater extraction is difficult, given the unknown character of the Valley groundwater basin. Due to the two theories (open or closed basin) being contradictory regarding the nature of the groundwater basin (See Section 16.1.4), the City for the purpose of this report will utilize the closed basin theory, as a more conservative approach.

The U.S. Bureau of Reclamation's study of the Valley groundwater basin is expected in early 1994 and may clarify the discussion between the "open" and "closed" basin camps. It is anticipated that this study will further reiterate a very conservative view of the groundwater situation of the Valley.

In St. Amand's paper "Water Supply of Indian Wells Valley, California", April 1986, there is an estimate of the water supply available to Valley users. "About 2,200,000 AF of useful water is stored in the basin. Of this, only about 600,000 AF are available under the present pumping pattern before the aquifer is contaminated with saline water from the playa." In the text, he describes three separate storage units and indicates surface area, saturated volume, specific yield, and storage quantity. The combined storage units contain 600,000 AF of useable groundwater (Unit 1 = 131,000 AF; Unit 2 = 161,000 AF; and Unit 3 = 295,000 AF) within the upper 200 feet of the saturated aquifer.

It is further stated "The safe perennial yield of the Indian Wells Valley is 10,000 AFY, provided that evapotranspiration in the playa area can be reduced to 1,000 AFY or less. If more water is used it must come from the naturally stored underground water." St. Amand recommends in his paper that water use in the Valley should be limited to 10,000 AFY.

Ignoring potential contamination of the groundwater supply by migration of saline water from the China Lake Playa, 3,200,000 AF of available groundwater in storage would provide 200 years of water supply with groundwater overdraft at 16,000 AFY and about 120 years of available groundwater supply with groundwater overdraft at 26,500 AFY

The IWVWD in their "Urban Water Management Plan", January 1991" were and still are concerned regarding the major pumping depressions in the Intermediate and Ridgecrest Area and the overdraft of the valley aquifer. In an effort to better manage the basin, the IWVWD is studying the development of well fields in the northwest and southwest, that will serve to disperse groundwater extractions more evenly throughout the Valley. Berenbrock (USGS 89-4191) provides water quality and level models based upon a wider distribution of the wells fields. It is believed that through this effort, contamination from the China Lake Playa will be reduced or delayed. The IWVWD using their past user records and extrapolating those numbers using a moderate growth rate state, "the available groundwater supply will last at least 20 years under existing pumping conditions and with appropriate management will last about 70 years". It is estimated that the present groundwater supply can sustain a population of 75,000 for 100 years.

b. Major System Components. The IWVWD is responsible for identifying what system components are incapable of delivering the expected demand with the four alternatives proposed in the General Plan. Their evaluation could include the need to expand major pump stations, reservoir storage, and/or add pipeline capacity. (It is the responsibility of the developer to assure that the lines serving their developments have adequate carrying capacity without deteriorating the service to adjoining areas.)

16.2.2 Water Demand of Buildout Under Each Alternative

In order to evaluate the increase in total water supply to meet the needs of the four development alternatives, average per capita water consumption was utilized. For planning purposes, the IWVWD records show that unit production has ranged from 0.76 to 0.87 AF per connection per year since the late 1970's.

Table 16-6 shows current and projected water demands under each of the four alternatives and the expected amount of water supply needed. It should also be noted that the estimates do not account for reductions in water use due to implementation of water conservation measures in addition to what is presently in use over the entire planning period. Table 16-7 lists the well supply sources and their possible production rate.

TABLE 16-6

Current and Projected Water Demands (City Only)

	Population	Water Demand on Record (AFY)	Typical Water Demand (AFY)
Present(1991)	28,241	6,033	7,060
Alternative 1	50,000	10,628*	12,500*
Alternative 2	75,000	16,048*	18,750*
Alternative 3	100,000	21,357*	25,000*
Alternative 4**	62,000	13,245*	15,499*

* Estimates based on extrapolation from 1991 record
** No Project Alternative
Water Demand Records from the IWVWD indicates 0.214 AFY per person.
Typical Water Demand indicates 0.25 AFY per person

Although the availability and use of reclaimed water is anticipated to occur during the planning period, the resulting reduction in the use of other available water sources has been excluded from this assessment.

The IWVWD Master Plan indicated that as a purveyor, it currently has sufficient supplies and delivery capabilities to accommodate current demand and the water demand of buildout of Alternatives 1 (50,000 pop.), 2 (75,000 pop.), and 4 (62,000 pop.).

The Plan does indicate that there is insufficient storage to meet the demands of Alternatives 2 (75,000 pop.), 3(100,000 pop.), and 4 (62,000 pop.). Although available supplies in 1990 could meet the bulk of demand under Alternative 2, water demand would exceed storage capacity of the IWVWD. The anticipated shortfall for Alternative 3 could be met through increased well production and storage capability, although this would shorten the life of the groundwater basin considerably. New sources of water supply should be studied for Alternatives 3.

TABLE 16-7

IWVWD Supply And Storage Facilities

Wells:

Well #	CAPACITY (GPM)	STATUS
2	200	Standby
3	200	Standby
5	200	Standby
6	200	Standby
7	150	Standby
8	1,200	Standby
9	1,000	Operating
10	1,100	Operating
11	1,200	Operating
12	840	Operating
13	1,100	Operating
14	250	Standby
16	450	Standby
17	1,200	Operating
18	---	Not Equipped
19	400	Standby
30	1,200	Operating
31	1,200	Operating
Capacities:	8,840	Operating
	3,250	Standby

Reservoirs:

NAME	CAPACITY (MG)
Bowman No. 1	2.0
Bowman No. 2	5.0
Kendall	2.0
Ridgecrest Heights	3.0
Well Field	1.0
Gateway	0.6
C-Zone	0.4
D-Zone	0.1
College	0.6
China Lake Acres	0.1
Lane Acres	0.2
TOTAL	15.0

(This data was taken from correspondence dated November 23, 1993)

Because of the pumping depressions in the Ridgecrest and Intermediate areas, the buildout expected under Alternatives 2 and 3 would necessitate the further development of the Southwest and Northwest Well Fields. Of concern to researchers is that high usage of the groundwater basin could lead to a lateral migration of water from area of possibly poor water quality, hence degrading waters where deep pumping depressions occur. Of special concern is the possible migration of sodium-chloride waters into the Ridgecrest well field from the southern and southeastern parts of the City. This concern is not presently substantiated by the 1989 study prepared by Whelan and Baskin, in which they state that except for some isolated wells in the Valley, they believe that the "quality of water in the Valley is changing little, if any, at most wells".

Changes in permeability associated with urbanization under each of the development alternatives would not significantly reduce the recharge occurring from Valley floor rainfall. Studies indicate that the majority of the recharge to the groundwater basin occurs at the basin margin near the Sierras.

It should be noted that urban development may potentially pollute local water resources from point and non-point sources such as oil spills, parking lot runoff and dumping of chemicals. These potential pollution sources are typically regulated in the development review process or by local, state and/or federal requirements, and are not anticipated to result in a significant impact.

16.2.3 Impact on Major System Components for Each Alternative

As the sole purveyor of potable waters to the City of Ridgecrest, it is the ultimate responsibility of the IWVWD to review the ability of its water system to deliver the increased water demand necessitated by growth under each of the alternatives. Although the IWVWD will prepare any study of their system, criteria that will likely be addressed includes supply facilities, storage volumes, and the distribution systems.

The City will cooperate to its fullest capability with the IWVWD, as the sole water purveyor, in performing a review of its water system upon the adoption of the revised General Plan for the City of Ridgecrest. This review should address average annual water demands, maximum daily demands and peak hour demands utilized wherever possible to review the system components. Additionally, reservoir storage, fire demand and a distribution system to meet the demands of an increased population without appreciable pressure loss, should be studied with particular attention to the pressure zones.

16.3 MITIGATION MEASURES

16.3.1 Water System and Supply Deficiencies

a. Alternative 1 (50,000 population). Development to levels indicated under this alternative will require the IWVWD to address existing system deficiencies as outlined in the IWVWD 1990 Water General Plan. The development of water conservation guidelines that further encourage wise water usage, and more evenly distributing water pumpage throughout the valley. No other improvements would be required. These deficiencies are not considered significant. The City of Ridgecrest will assist and co-operate in the implementation of these mitigations to the extent allowed.

Residual Impact. Implementation of these mitigation measures would reduce the impacts of Alternatives 1 on the existing distribution system to less than significant levels.

b. Alternative 2 (75,000 population) and 4 (No Project Alternative) 62,000 population). These alternatives would require, in addition to those improvements required for Alternative 1, the following improvements to be made to the existing water system:

- o Additional pumping capacity
- o Additional well development
- o New well field development
- o Additional reservoir storage
- o Completion of recommended improvements as noted by IWVWD
- o Expanded distribution zone

Residual Impact. The above improvements would reduce the impacts of Alternative 2 and 3 buildout on the City water system to less than significant levels. The City of Ridgecrest will assist and co-operate in the implementation of these mitigations to the extent allowed.

The provision of a sufficient water supply to serve full buildout under Alternatives 2 and 4 would result in potentially significant secondary impacts. As discussed in Section 16.2.2 additional extractions from the Valley groundwater basin would contribute to the existing overdraft as well as cause poorer quality waters from the China Lake Playa to enter the Intermediate Well Field.

c. Alternative 3 (100,000 population). Alternative 3 would require, in addition to those improvements described above for Alternative 2, the following improvements to the existing water system.

- o Development of outside sources of water would be necessary.
- o Development of treated wastewater effluent as a water resource
- o Additional reservoir storage
- o Increased well capacities
- o Blending/mixing of the high and low quality waters

Residual Impact. If these measures are implemented, the impacts of Alternative 3 buildout on the existing water system is anticipated to be reduced to less than significant.

The provision of a sufficient water supply to serve full buildout of Alternative 3 could necessitate the development of an outside source of water. Another option could be the blending of the poorer quality water with the high quality water.

Should Alternatives 2 or 3 be adopted, it is recommended that the IWVWD complete a detailed review of the water system for the City. Only in this way can the City be assured of a balanced water distribution and supply system capable of serving the increased growth. The City of Ridgecrest will assist and co-operate in the implementation of these mitigations to the extent allowed.

16.3.2 Water Conservation Measures

Because of the Valley groundwater basin being in an overdraft situation, conservation measures are applicable regardless of the development alternative adopted by the City. As part of this effort in 1992, the City adopted Ordinance 92-18 (December 2, 1993), which is a water conservation ordinance mandated by Assembly Bill 325. Further the IWVWD has adopted a Water Management Plan that address water conservation measures. The City of Ridgecrest will gladly work with the IWVWD in examining these issues and developing any requried guidelines for thier implmentation. The following measures incorporate, augment, and reinforce the requirements of the City ordinance and the IWVWD's plan:

- o Public Awareness
- o In-School Education
- o Water Audits

- o Landscaping
- o Leak Detection
- o System Management and Maintenance
- o Demonstration Garden
- o Wastewater Reclamation
- o Commercial Landscape Measures
- o ULF Toilet and Fixture Requirements for New and Existing Customers
- o Low Water Consumption Requirements
- o Annual water use/conservation report to study and track usage by new and existing developments to monitor effectiveness of mitiagions

Each of these elements have a series of components which are currently being implemented or are proposed as future measures. At this time, the program emphasizes educational/informational services intended to increase public awareness and provide useful information regarding conservation techniques.

The following are other recommended conservation measures which would help reduce per capita water consumption:

- o Complete and implement the Landscape Guidelines currently under preparation.

- o Develop incentive program encouraging the retrofit of existing structures with low flow fixtures. Program should target owners of multi-unit residential or commercial facilities.

- o Use mulch extensively in all landscaped areas. (Mulch applied on top of soil will improve the water-holding capacity of the soil by reducing evaporation and soil compaction.)

- o Install efficient irrigation systems that minimize runoff and evaporation, and maximize the water which will reach the plant roots. Drip irrigation, "leaky pipe", soil moisture sensors and automatic irrigation systems are a few methods of increasing irrigation efficiency.

- o Prepare and protect existing trees and shrubs. Established plants are often adapted to low water condition.

- o Implement new water reduction and wastewater treatment technology in institutional, industrial, commercial, and certain residential uses.

- Continue to support the IWVWD in its conservation oriented rate structures.

- Review the present water waste Ordinance to determine its strength.

- Protect the fire hydrants from waste usage.

- Research with the IWVWD and the Kern County Fire Department on reducing water pressure to new developments from 80 psi.

- Adopt an ordinance strengthening local building code standards and support state and federal legislation improving new construction standards for water efficiency.

- Continue to encourage the IWVWD to offer water-use audits in regards to landscaping, residential, and commercial usages.

- Encourage the Cerro Coso Community College to offer a training program for the landscape professional that addresses wise water usage.

- Develop water conservation landscaping demonstration projects throughout the City.

- Investigate offering free water conservation devices to the public.

- Investigate the usage of "gray water" for irrigation purposes and if feasible developing code amendments permitting the use of graywater.

- Investigate the procedures, restriction, etc. and construction of an infrastructure for the delivery of treated wastewater effluent.

- Encourage the IWVWD to continue to be the leader in providing water conservation information.

- Investigate financial incentives to promote water reclamation

- Support the IWVWD in their investigations to provide an alternative (non-local) water source for the Valley

- Encourage the IWVWD to continue in their development of conservation staff to initiate, monitor, and implement water conservation programs targeted to reduce the water use per connection.

- o Adopt ultra low flow and water conservation appliances for all new construction.
- o Require approval of water conservation landscape prior to final occupancy of new structures.
- o Continue to require all new construction and development to obtain a "will serve" letter from the IWVWD.

INDIAN WELLS VALLEY WATER DISTRICT
MAIN WATER LINE MAP

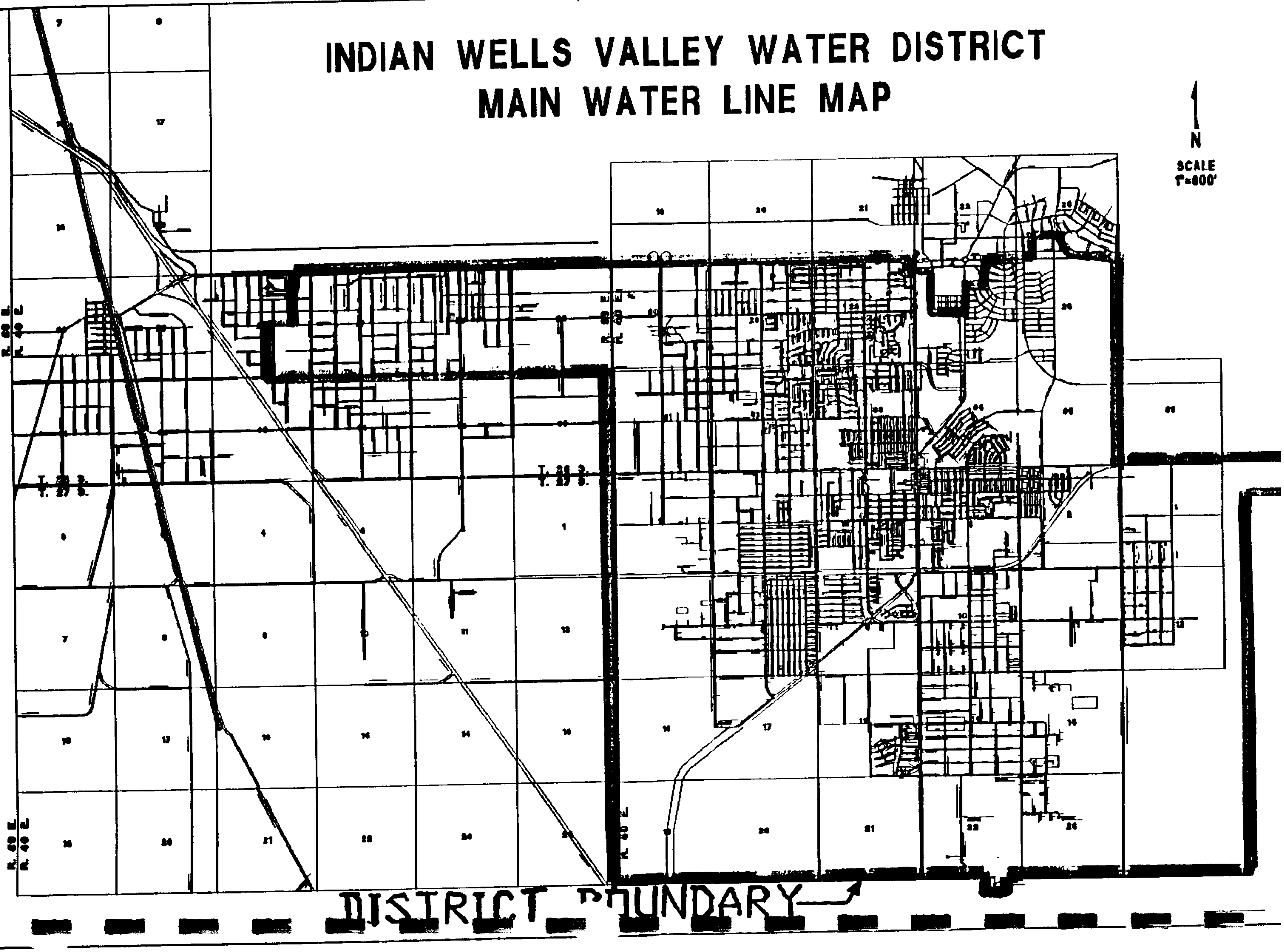


FIGURE 16-1

SECTION II

Chapter 17
WASTEWATER

17.1 WASTEWATER

This report utilizes and relies on information contained in the following reports: A) "Master Plan for Wastewater Treatment Facilities" prepared by Montgomery Watson; and B) "Master Sewer Plan for the City of Ridgecrest", prepared by Wildan & Associates in 1981, which addresses the flow capacity of the sewer lines as well as other system deficiencies.

The Montgomery Watson study, upon its completion and expected adoption by the Ridgecrest City Council, will be used as the basis for future actions by the City in regards to Wastewater Treatment Plant (WWTP) improvements.

17.1.1 History

Prior to the formation of the Ridgecrest Sanitation District in 1952, sewer service was provided by septic tanks, cesspools and leach fields. The Ridgecrest Sanitation District merged with the City of Ridgecrest in 1972. At that time, the treatment plant located in the southeastern part of the city was rapidly reaching its service capacity. It was originally designed to serve an ultimate population of 12,500 people. The average daily flow level used to determine the facilities size was low, 75 gallons per capita (Actual planning factor is 100 Gallons per Day [GPD]), yielding a plant capacity of 930,000 GPD. The actual demand in 1972 ranged from an average daily flow of 800,000 GPD to peak flows as high as 1,200,000 GPD. In addition to the immediate need for plant expansion to meet existing demand, further development was planned for the area adjacent to the plant. The sewer system was not able to operate entirely on gravity flow, due to local topography, which necessitated pump stations and, therefore, increased energy costs and a less efficient system overall.

In 1972, the Naval Air Weapons Stations (NAWS) was operating its own wastewater treatment plant that had been constructed in the 1940's. This plant was designed to accommodate a peak flow capacity of 2.8 million gallons per day (MGD). The NAWS plant was serving a population of 11,000 people and discharging 1,700,000 GPD. The NAWS population was beginning to shift to the City planning area resulting in the underuse of the NAWS plant and simultaneously overburdening the City plant.

In 1972 the Lahontan Regional Water Quality Control Board (LRWQCB) in its Water Quality Control Plan, ordered the consolidation of the NAWS and the City systems. As a result the NAWS treatment plant was expanded for this purpose and the City abandoned its plant at San Bernardino County Line Road.

The City was named as the responsible party for the operation of the consolidated facility. Through a construction grant and financial assistance from the EPA and allocated through the LRWQCB, the City was granted easement of the original NAWS plant and enlarged it to meet the needs of its users. The peak flow capacity of the plant was increased to 3.1 MGD. In August of 1987, the LRWQCB approved a revised design flow that upgraded the peak flow capacity to 4.4 MGD. The State of California through the Clean Water Act specifies that when the plant reaches 75% of its operating capacity, the operator must initiate planning programs to address expansion.

17.2. SETTING

17.2.1 Introduction

The following discussion provides an introduction to general concepts utilized in this report to evaluate potential wastewater system impacts.

Sanitary sewer systems are ideally gravity flow to treatment or disposal points and are confined in natural drainage basins. The major drainage basins are further divided by natural land forms into minor drainage areas. The capacity of the system serving each drainage basin and drainage area must be sufficient to accommodate the quantity of wastewater resulting from all uses located within the drainage area that is tributary to the system. The basic factors considered in the design of the system include: 1) the volume of wastewater discharge by various land uses; 2) peak flow characteristics of the system, and 3) the sewer system characteristics based upon topography of the drainage area. The amount of wastewater discharged is determined by the amount of residential, commercial, and industrial land uses within a community. With such demand factors established, it is possible to determine the general design requirements of the sewer system based on projected land use mix and patterns. The City of Ridgecrest currently (1991) estimates for design purposes that the total average flow through the system is 3.3 MGD (million gallons per day), of which 1.985 is contributed by the City and the remainder being attributed to NAWS, with a one day maximum of 3.656 MGD. (A one day maximum of 8.3 MGD was due to the August 1984 floods which allowed large inflows into the system.)

Sanitary sewer systems are designed to accommodate the maximum instantaneous flow over some design time period. This peak can be computed by establishing a ratio of average daily flow (the average day over a 1 year period) to an instantaneous peak flow. This ratio is derived from reliable engineering data and from the existing sewer system wherever possible.

Generally, the size of wastewater lines depends upon the amount of flow expected, which is dependent upon the ultimate area to be served and the slope of the wastewater line which is dependent upon the topography of the drainage basin. For the most part the main lines (collection system) increase in size and capacity near the downstream treatment, disposal, or accumulation point. The gravity sewer grade is variable depending upon size and capacity to provide sufficient velocity to transport solid materials. Where topographic conditions require, sharp upward vertical changes are generally overcome by lift stations. Where pumping is required over a distance, a force main is used to pump the flow under pressure against existing topography until gravity flow can again be accomplished.

The Sanitation Department of the City of Ridgecrest maintains actual flow measurements for the wastewater treatment system. The equation $Q\ PEAK = 1.75\ (Q\ AVE)^{0.93}$, is used to calculate peak flows for a system.

17.2.2 Existing Sanitary Wastewater Systems Serving the Planning Area

The City's planning area and the NAWS's mainsite and Michelson Lab are served by separate sewer collection systems. However, these two systems terminate in the at the consolidated regional wastewater treatment plant where primary treatment consists of the removal of settleable solids. Additional treatment is provided by a series of eleven oxidation/evaporation ponds on approximately 240 acres, where much of the effluent is evaporated. An average of 375,000 GPD (upon use of 20" line this amount will increase to 500,000 GPD) of effluent is transported through a 6" line to the site of the old wastewater treatment facility at San Bernardino Road for agricultural purposes. Up to 1.0 MGD (Average of 0.6 MGD) of effluent from the ponds on base are used for irrigation of the NAWS golf course. An average of 1.4 MGD evaporates from the surface of the ponds. The service area and location of the treatment plant is shown on Figure 17-1. Some lots within the planning area also use septic systems. It is the City's policy that no unincorporated areas are to receive service from the City's wastewater treatment plant.

a. <u>Ridgecrest Sanitation District</u>. The city sanitary sewer system is a gravity system. The system is totally separated from the storm drainage system.

The City's Wastewater Treatment Plant serves almost the entire city with a tributary area of over 13,000 acres. The plant consists of four components: influent and effluent flow measurement, preliminary treatment, primary treatment (including sludge handling facilities) and a series of oxidation ponds. A generalized flow schematic is shown in Figure 17-2.

A total of 3 Parshall flumes are used to monitor influent and effluent flows from the treatment plant. Preliminary treatment consists of a bar screen with a grit removal chamber, and two comminutors. Screenings collected from the bar screen are deposited in a dumpster for hauling to the landfill. Grit is currently removed from the grit chamber via a vacuum truck and deposited on a dedicated sludge drying bed. Primary treatment consists of four primary settling tanks. Sludge and scum collected in the primary settling tanks are pumped to a two-stage anaerobic digester system where they are stabilized prior to drying on sludge drying beds for dewatering and then placed in dumpster for disposal.

Secondary treatment consists of eleven ponds, some of which can be classified as primarily facultative oxidation ponds and other as primarily evaporation ponds. The distinction is somewhat arbitrary since all the ponds serve both functions to some degree.

Ancillary facilities at the treatment plant include: an operations building, electrical control panels, small maintenance shop, and storage yard.

TABLE 17-1

CITY OF RIDGECREST HISTORICAL AND PROJECTED WASTEWATER FLOW FOR THE RIDGECREST WASTEWATER TREATMENT PLANT FOR ALTERNATIVE 2

YEAR	POPULATION	AVG FLOW (MGD) [2]	GPCD[1]
1980	15,929	1.35	85
1985	18,000	1.61	87
1990	27,725	2.08	75
1991	28,700	1.99	69
2010	75,000	6.00	80

1 For flow projections purposes, the gallons per capita per day (gpcd) wastewater flow for 1995 to 2010 is set at a value near the average of the range between the historic values for 1980, 1990, and 1991.

2 These flows do not indicate the NAWS contribution to the influent flow

As of 1992, 11,029 single family dwelling units and 3,834 multi-family dwelling units (City Wastewater Department) were serviced by the treatment plant. This represents an equivalent population of approximately 29,313 persons. Table 17-1, gives a history of the flow data for the plant. Although the plant has received a capacity rating of 4.4 MGD from LRWQCB, estimates by Montgomery Watson suggest that the actual operating capacity is less than that. Table 17-2 relates the seasonal variations in flow and evaporation experienced at the plant.

TABLE 17-2

SEASONAL VARIATIONS IN FLOW AND EVAPORATION

	Percent of Annual Influent Flow (1)	Average Rainfall (inches)(2)	Average Pan Evaporation (inches)(2)
January	8.6	0.71	3.1
February	7.0	0.70	4.48
March	8.3	0.59	8.06
April	7.7	0.15	9.90
May	8.3	0.12	13.02
June	8.4	0.05	15.00
July	8.7	0.23	15.19
August	9.2	0.31	13.95
September	8.9	0.25	9.90
October	8.6	0.17	6.82
November	7.5	0.50	4.50
December	8.8	0.50	2.48
TOTAL:	**100.0**	**4.28**	**106.4**
Total Including 1990 and 1991 Data		**4.34**	**106.1**

(1) Based on 1991 plant records

(2) Taken from Lloyd Corbett's The Weather at NWC, 1990. Rainfall data is averaged from 1960 to 1989 and pan evaporation from 1986 to 1989

b. Septic Tanks. A few island areas within the planning area are currently on individual septic tanks for sanitary wastewater disposal. These areas have been annexed to the city since 1963, were not a part of the original Ridgecrest Sanitation District or were more than 300' from the nearest sewer line. It is City policy that new construction within 300' of an existing sewer line connect to the city system. Annexation 11, which is agricultural lands, is the largest area that still exclusively uses septic tanks. The Leroy Jackson Park (former Kern Regional Park) utilizes septic tanks in its design. The island areas have been slowly connecting to the city's sewer as failures of the private septic tank systems occur.

TABLE 17-3

Trunk Sewer System Deficiencies Based on Existing Land Use**

Trunk Sewer Area	Line Size	Above Design Capacity	Correction Measure
1. Alley West of CLB btwn Ward/Graaf	12"	0.47 MGD*	Add parallel 10" line length = 1461.0'
2. Graaf btwn Mahan and Sierra View	8"	0.11 MGD	Add parallel 8" line length = 1263.0'
3. Graaf btwn Sierra View and Norma	8"	0.15 MGD	Add parallel 8" line length = 1302.0'
4. Perdew to 753' East of Norma	8"	0.03 MGD	Add parallel 8" line length = 753'
5. Perdew from 753' east of Norma to Wayne	8"	0.12 MGD	Add parallel 8" line length = 340'
6. Perdew from Wayne to Alene south to Graaf	8"	0.06 MGD	Add parallel 8" line length = 1321.0'
7. Ward btwn Griffith and Wayne	10"	0.39 MGD*	Add parallel 12" line length = 1747.0'
8. Ward from Wayne to Mesquite	8"	0.38 MGD*	Add parallel 10" line length = 373.5'
9. Ward from Sierra View to Griffith	10"	0.14 MGD	No correction required, Parallel lines exist on Joyner and Weiman Avenue
10. Gold Canyon from Carricart to Richmond	10"	0.33 MGD	Add parallel 10" line length = 4068.0'

TABLE 17-3 (continued)

Trunk Sewer Area	Line Size	Above Design Capacity	Correction Measure	
11. China Lake from Ridgecrest to 650' south	15"	1.08 MGD*	Add parallel 8" line	length = 650.1'
12. Ridgecrest from Helena to Fairview	8"	0.01 MGD	Add parallel 8" line	length = 690.0'
13. Ridgecrest from Sanders to China Lake	8"	0.15 MGD	Add parallel 8" line	length = 701.2'
14. From Sanders/Argus intersection east to China Lake then south 990'	15"	0.67 MGD	Add parallel 8" line	length = 1954.9'
15. Fairview from Las Flores to Argus	15"	0.46 MGD	Add parallel 8" line	length = 1652.4"
16. Peg from Kevin to 110.9' south	10"	0.03 MGD	Add parallel 8" line	length = 110.9'
17. Peg from Mary Ann to Las Flores	10"	0.13 MGD	Add parallel 10" line	length = 315.0'

* Surcharge will occur at peak flow

** This table is derived from Tables 6 and 16 in "The Master Sewer Plan for the City of Ridgecrest", Wildan Associates, 1981

17.2.3 Major Collection System Components

The city's collection system is comprised of a minimum of 150 miles of sewerage collection piping consisting of mostly of vitreous clay pipe (VCP) and poly vinyl chloride pipe (PVC). The sewer system lines range in diameter from 6 to 27 inches. The entire system is gravity conveyed to the treatment plant located north of the City on the NAWS by two separate trunk systems that have a common junction at the plant site.

a. Main Collector System. The two independent trunk systems have no interconnections and are referred to as the East Trunk Sewer and the West Trunk Sewer. The East Trunk consisting of 24" and 27" VCP flowing from a southeasterly, direction joins the West Trunk Sewer at the wastewater treatment plant. The West Trunk consists of 15" and 18" VCP that flows from a southwesterly direction. At their junction, the flow is carried through a 24" VCP pipe and into a 12" throat Parshall flume at the plant headworks. Table 17-3 addresses the deficiencies of the present collection system based on the existing land use of 1981.

The West Trunk Sewer area system covers the Ridgecrest planning area generally to the north of Drummond Avenue, with some areas east of Downs Street also being served by this trunk.

The East Trunk Sewer area system covers the Ridgecrest Planning area to the south of Drummond Avenue. This trunk services the majority of the planning area of the City.

The majority of the collection system is relatively new due to the City's growth in the 1960's and 1970's. This combined with the desert climate, average annual precipitation of 4.75", and soils of relatively low vertical transmissivity limit inflow/ infiltration to the system to very low levels.

The 1981, "Master Sewer Plan for the City of Ridgecrest", prepared by Wildan Associates identifies improvement projects for the City's trunk sewer system. This document is hereby incorporated by reference.

b. Summary of Plant Condition and Capacity (Master Plan for Wastewater Treatment Facility, Montgomery Watson, 1992)

The following improvement projects are recommended for the existing plant. The ultimate result of these projects will lead to improvement in the preliminary and primary treatment processes. These projects address various factors including lack of proper equipment, poor design, and/or limited capacity. Problem areas are not limited to any single process, but are most severe in the grit removal, scum pumping, and sludge handling processes. The condition of various treatment plant components below:.

1. Calibrate the flow metering system (Parshall flumes with ultrasonic sensor and auto-recorders) performed annually.

2. Correctly size the grit removal system to prevent grit buildup in the digesters.

3. Eliminate the comminutors which are not required in this plant.

4. For two stage operation given existing flow rates, Digester Nos. 1 and 2 are sized adequately. Improvements to the mixing and heating capacity for Digester No. 1 are required, due to the heat exchanger appearing to be marginally sized for current flows. Replacement or repair of the mixing/recirculation pump should improve digester mixing and heating. Need larger or extra heat exchanger or new plant.

5. The sludge drying beds do not appear to be overtaxed. (It should be noted that WWTP staff do not find these beds adequate.)

6. Continue data collection throughout the year for TSS (total suspended solids) or BOD (Biological Oxygen Demand) removal in primary treatment or VSS (Volatile Suspended Solids). It appears that reduction in the digesters are effective during the summer months, reducing 67% of VSS in the primary sludge, however winter data is not available.

7. The facultative ponds provide adequate treatment, current reuse does not require disinfection. Although coliforms are periodically high (>1600 MPN (most probable number)) as measured in the flow to the City-owned pasture land, the BOD generally remains within the acceptable limit (30 mg/L). The average effluent BOD concentration in Pond 3 for 1991 was 29.7 mg/L. The average 1992 BOD and TSS concentrations, respectively for Pond 3 were 28.6 mg/L and 27.7 mg/L. The BOD and TSS concentrations for Pond 9 were 35.4 mg/L and 34.7 mg/L.

c. <u>Plant Capacity</u>

The following plant capacities (Table 17-4) are based on both hydraulic and influent characteristics. An assessment of actual capacity based totally on performance has been based on limited data concerning influent and various effluent characteristics. Figure 17-3 summarizes the existing plant capacity by unit process. This figure shows that available effluent storage limits the capacity of the existing Regional Plant to 3.25 MGD (Montgomery Watson).

d. Immediate Short-Term Improvements Needed At the Plant If the plant is expected to perform at an acceptable level in the near term (1 to 2 years), the primary treatment facility needs several immediate improvements. These include replacement and upgrading of various mechanical equipment, but no changes to the structures. It should be noted that these are short term improvements intended to keep the plant operating but are not expected to solve the main plant problem of undersized unit processes.

1. Place the grit screw in-line and make operational.

2. Bring the scum collection and pumping system on-line and make fully operational. The existing pumps should be replaced by a chopper pump.

3. The primary digester sludge recirculation pump should be replaced with a properly sized chopper pump in accordance with the City's already budgeted plan.

4. Although both digesters should be cleaned, the secondary digester is of special concern. Currently, this digester appears to be nearly inoperable. This cleaning should be followed by installation of fixed covers and gas storage system.

5. The worn sludge collection system parts in settling tank No. 3 should be replaced and this tank should be put on-line in accordance with the City's already budgeted improvement plan. **(This corrective action was completed in 1992-1993 Fiscal Year.)**

6. Plant personnel should continue to perform periodic and systematic sampling of the various plant processes. Data collection was begun in the summer of 1992 and should be expanded to provide a record of plant operations and performance which will assist in making decisions concerning future alternatives.

WWTP staff notes that certain of these repairs could become unnecessary depending upon the alternative selected from the Montgomery Watson study and implementation schedule.

TABLE 17-4

PLANT COMPONENT OPERATING CAPACITY

Unit Process	Capacity	Reason/Comments
Flumes	6.0 MGD average 10.4 MGD peak	Site of City influent flume; can be upgraded with minimal structural alteration
Bar Screen	6.0 MGD average 10 MGD peak	Channel and downstream hydraulics; channel freeboard
Grit Chamber	1.0 MGD average	Detention Time/Capacity
Comminutors	(not required)	
Primary Settling Tanks	3.0 to 3.5 MGD ave.	Based on performance data
Ponds	3.9 MGD average	Organic loading
Digesters	3.2 to 3.7 MGD ave.	Heat exchanger capacity; requires winter primary sludge temperature data to refine capacity figure
Sludge Drying Beds	3.5 to 4.5 MGD ave.	High evaporation rate is ideal for sludge drying beds
Effluent Seasonal Storage	3.25 MGD	Higher flows may result in pond freeboard less than two (2) feet
Effluent Disposal	3.4 MGD	Limited by existing 6" line capacity; using 1991 built 20-inch line and recently acquired 40 acres of irrigation site, the capacity increases from 3.5 to 3.6 MGD

17.3 IMPACT ANALYSIS

17.3.1 Significance Thresholds

In evaluating the impact of each of the four alternatives on the sewer systems within the planning area, the following will be considered as a significant threshold of service.

a. Trunk Line Capacity Reached or Exceeded Caused by Increased Growth Within the Service Area. This will be addressed in terms of the increased length of the existing trunk system exceeding its capacity, caused by increased flows for each alternative. Design capacity and the full flow capacity of the trunk lines will be indicated. An exceedance of design capacity is significant because, with the unstable nature of wastewater generation and reduced hydraulic capacity of aging lines, excess capacity in the line is no longer available as a safety factor. This is most important in smaller lines where variation in wastewater flow is most noticeable. Exceeding full flow is significant because of the high probability of wastewater spills. Sewer lines begin operating under pressure (surcharged). With the unstable nature of sewer systems, minor increases in flow, or restriction to flow, can cause surcharging in the sewer line to the point where wastewater is allowed to escape from manholes, or backups occur within private property.

b. Treatment Plant Capacity Reached or Exceeded. Knowing when the capacity of the treatment plant will be exceeded is extremely important in terms of ability to continue to maintain and adequately treat the wastewater generated within the service area. Of lesser importance would be that point when average daily flows at the treatment plant reach 75 percent of the treatment plant capacity.

17.3.2 Wastewater Generation from Buildout Under Each Alternative

In order to determine the increase in total wastewater generated from each of the four alternatives, WEF (Water Environment Federation) generation rates were utilized for the City of Ridgecrest. For residential development, 100 gallons/person/day will be used as the average daily flow generated on a per person basis. (National Clay Pipe Institute for typical usage, EPA guidelines require average per capita daily flow to be accurately determined per community.) Since, there is limited usage by commercial, industrial and institutional development, their usage was not calculated into the tables. (Records for these usages demonstrate minimal flow) These numbers are slightly greater than current average flows for this land use group. In utilizing actual flow data per user group rather than flows equal to "design" criteria defined by the sewer agency, it is assumed that wastewater generation from incremental growth will be proportional to that which is currently being experienced.

Generation rates established above were then equated to the growth anticipated under each alternative. These average generation flows were then "peaked," using City design criteria, to evaluate the wastewater collection system. The impact on the City treatment plant is evaluated using average daily flows. Table 17-5 provides a tabulation of the expected average daily flows reaching the City treatment plant for each of the four alternatives. Also shown is the percentage of utilization of the existing treatment plant capacity.

Table 17-5

**ESTIMATED WASTEWATER GENERATION
AT
CITY OF RIDGECREST WASTEWATER TREATMENT PLANT**

	Estimated Increase Over Existing From City Planning Area	Total Demand	Percent Utilization of Capacity
Existing Flows	N/A	3.2 MGD	98%
Alternative 1	2.60 MGD	6.0 MGD	182%
Alternative 2	5.630 MGD	9.0 MGD	273%
Alternative 3	8.60 MGD	12.0 MGD	364%
Alternative 4	1.10 MGD	4.3 MGD	134%

The WEF standard of 100 GPCD was used utilized for these estimations

17.3.3 Impacts of Future Sewer Generation on Available Sewer System Facilities

a. Alternative 1, 2, 3, and 4. Buildout under these alternatives would result in the following impacts:

o The effects on the sewer collection system are considered significant but mitigable. The Wildan study names deficiencies for the ultimate land use within the City Planning area. This study recommends a system of parallel lines be put in place to serve the impacted areas.

- The effects on the treatment plant capacity are indicated on Table 17-5. Existing (1991) average daily flows at the plant are 3.3 MGD. Planning for any future expansion of the treatment plant should commence upon completion and adoption of the "Master Plan for Wastewater Treatment Facilities" by Montgomery Watson.

17.4 MITIGATION MEASURES

17.4.1 Alternatives 1 and 4

These alternatives would require the following improvements to be made to the existing sewer system:

- Increase the limitation on the amount of effluent transported through the 20" pipeline from 0.5 MGD to accommodate growth. (Approval for use of the 20" pipeline was received in 1993.) This improvement will require NEPA compliance in regards to allowing the NAWS to maintain the Mohave Tui Chub habitat.

- Adoption of Master Plan for the Wastewater Treatment Plant This plan is currently being reviewed for technical correctness by City staff. It will be placed before the City Council in early 1994 for adoption and implementation instructions for staff.

- Implement an annual review of the sewer user's fee. Revenues for the WWTP should be reviewed annually in order to adjust for inflation and needed equipment replacement. These fees should be applied equitably to all users.

- Implement and annually review a sewer connection fee. Revenues for connection fees should be reviewed annually in order to adjust for inflation. These fees should be applied equitably to all users.

- Repairs noted in section 17.2.3.d. These recommended repairs will allow the plant to function at its capacity of 3.6 MGD but will not remedy storage and effluent disposal capacity limitations.

- o City plan and implement a capital improvement program to correct identified sewer deficiencies. Such a program would eliminate the maintenance and nuisance problems and provide a margin of safety which would preclude degeneration.

- o City should continue to monitor wastewater flows in its trunk system as new land development occurs. By undertaking a periodic monitoring program, the City staff will be able to compare the projected wastewater flow quantities against those occurring as a result of the change in land use.

- o City should maintain and periodically update a land use data base for a computer model of the City sewer system. This model would reflect the construction of new relief facilities and/or the construction of new trunk lines.

- o Reevaluate the list of deficiencies noted in the Wildan Report and take appropriate action. The Wildan Report (1981) noted trunk line deficiencies and maintenance and nuisance problems that have not been implemented or corrected.

- o Implementation of water conservation measures. Through the use of water conservation measures the Wastewater Treatment Plant should see a reduction in the gallons per capita treated which would extend the life of the present facility.

- o Initiate regular inspections of the sewer facilities of commercial and industrial users. This would insure that these users are complying with all restrictions placed upon them and that there is an accurate record of their number of connections in order to correctly assess their user fees.

- o Further examination into reuse alternatives for sewer effluent.

- o The City treatment plant would require expansion at some point during the planning period. A review of current policies regarding connection fees should be made to insure sufficient funding is available for plant expansion as well as trunk line construction.

Residual Impact. The above improvements would reduce the impact of buildout under Alternative 1 on the existing sewer system to less than significant.

17.4.2 Alternative 2

Alternative 2 would require, in addition to those improvements shown for Alternative 1, the following improvements to be made to the existing sewer systems.

- o Implementation of the recommended alternative in the "Master Plan for Wastewater Treatment Facilities" prepared by Montgomery Watson. This recommended alternative will allow the City to have the treatment capacity to handle a population of 75,000.

Residual Impact. The above improvements would reduce the impact of buildout under Alternative 2 on the existing sewer system to less than significant.

17.4.3 Alternative 3

Buildout under this alternative would require the following improvements to be made to the existing sewer system, in addition to those already discussed under prior alternatives:

- o Amend the Montgomery Watson Master Plan to address a population of 100,000. The City presently does not have the sewer capacity for this alternative. Solutions and improvements would need to be implemented as noted in this study.

Residual Impact. The above improvements would reduce the impact of buildout under Alternative 3 to less than significant.

17.4.4 Water Conservation Measures

Because a reduced water usage directly affects wastewater flows, management and conservation of local water resources is essential to ensuring the availability of adequate sewer system capacity to existing and future users. Conservation measures are applicable regardless of the development alternative adopted by the City.

- o Work cooperatively with the Indian Wells Valley Water District to address water conservation issues.

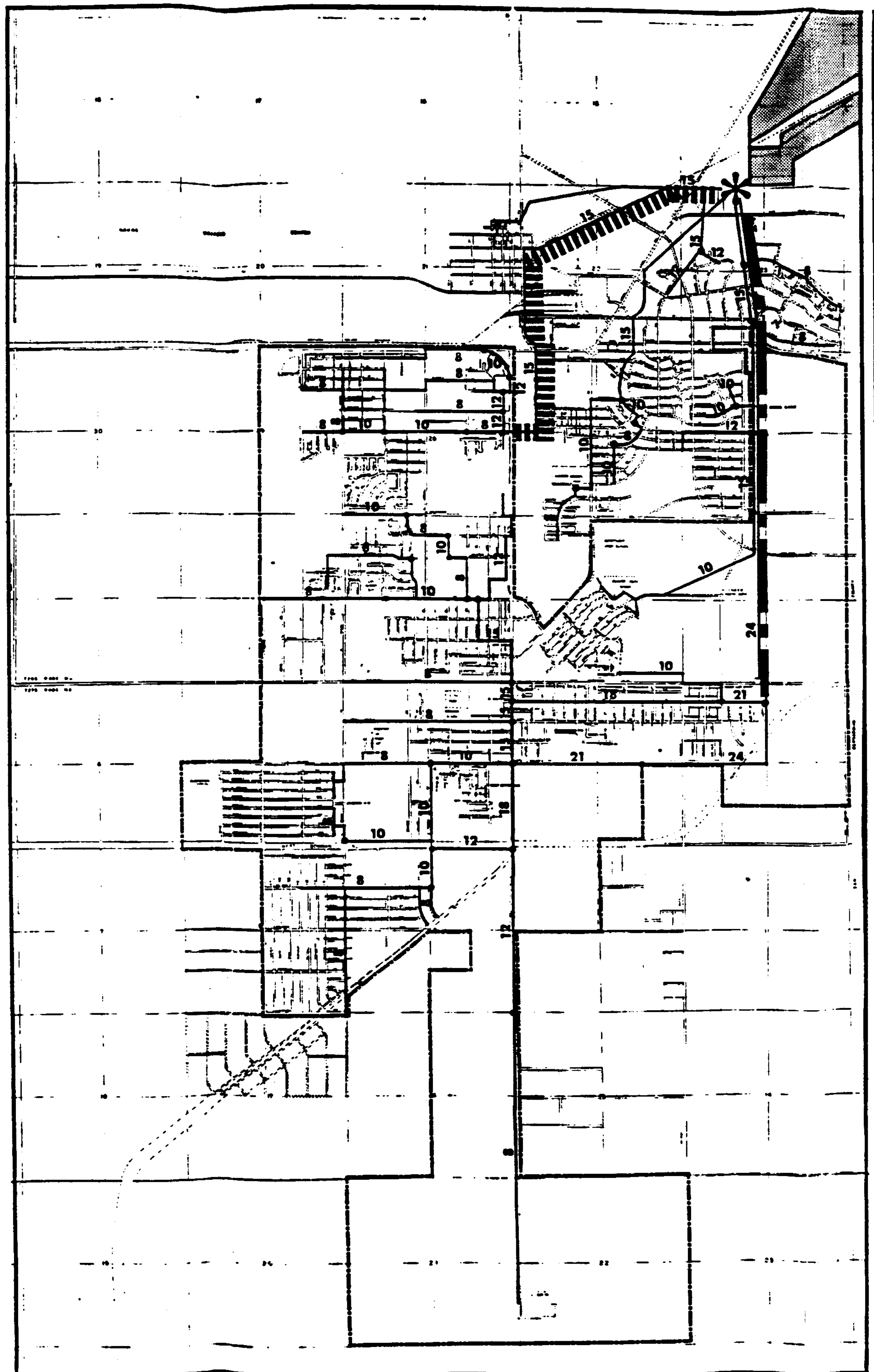


FIGURE 17-1

RIDGECREST GENERAL PLAN

Ridgecrest, California

SEWER SYSTEM

Legend

8 10 Trunk Line With Size In Inches

* Treatment Plant

Treatment Pond

WEST TRUNK

EAST TRUNK

Source:

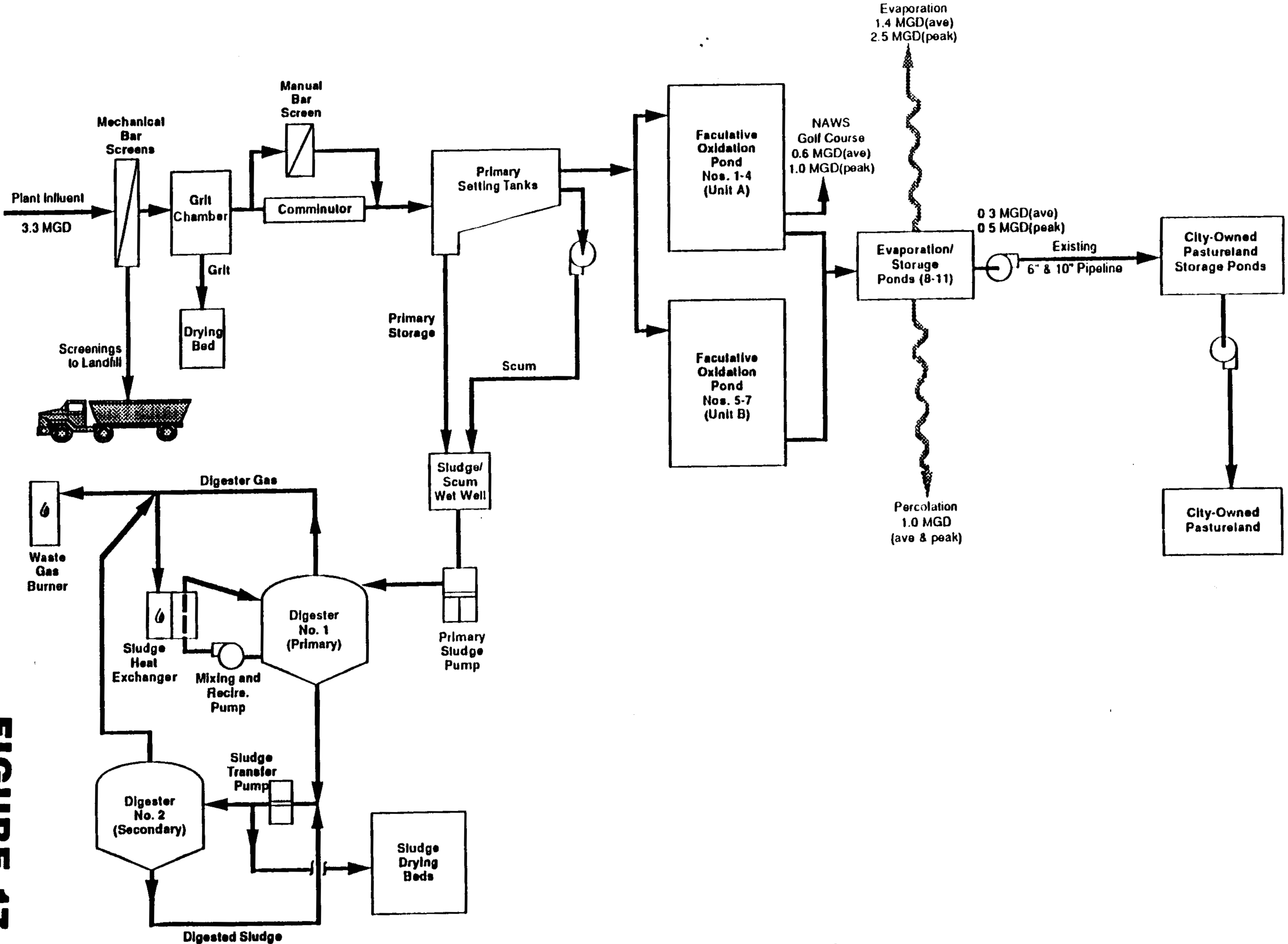
City of Ridgecrest

NWC, Public Works

prepared by EDAW Inc.

1981

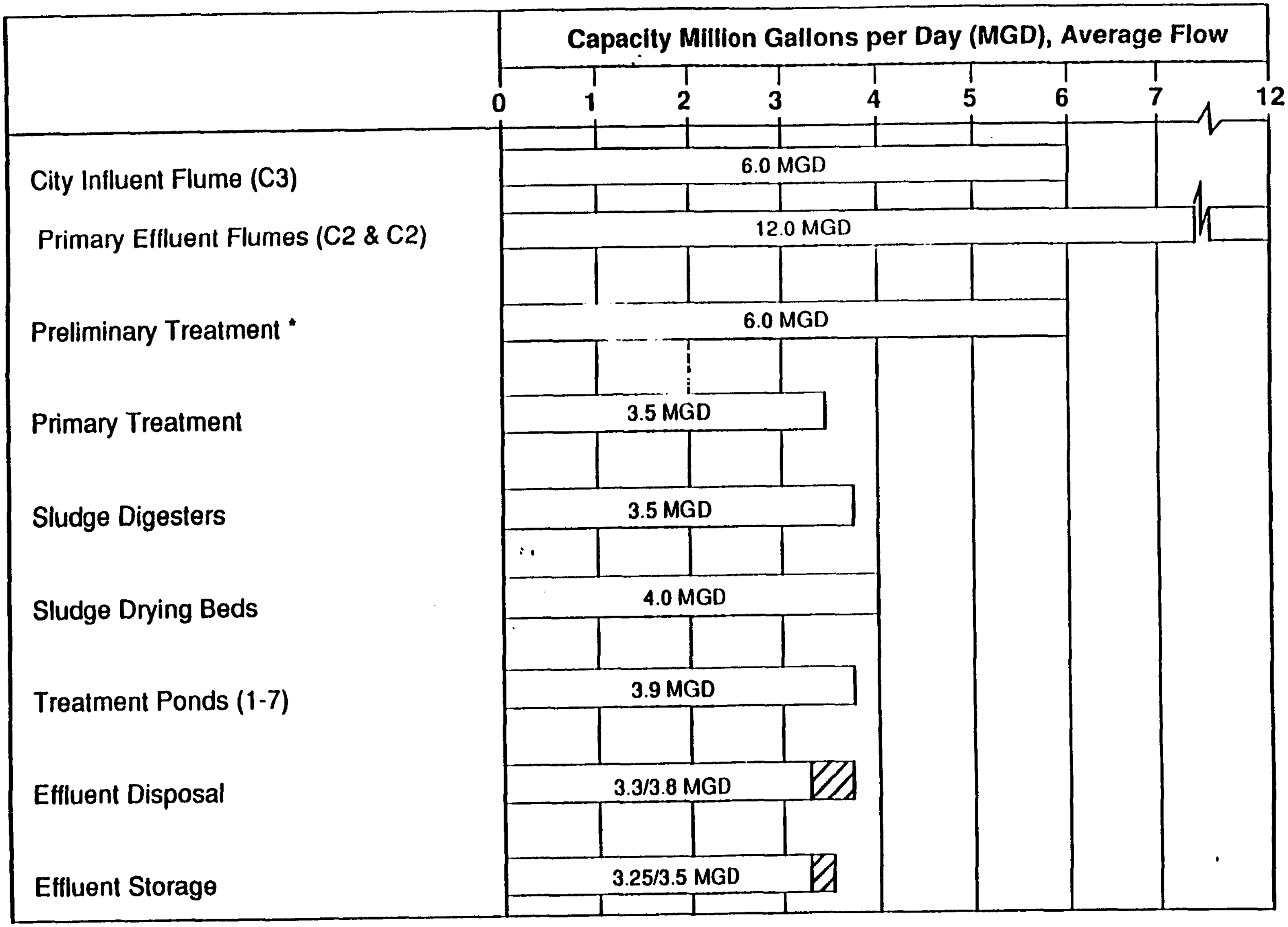
FIGURE 17-1



Existing Plant Process Flow Schematic
Figure 3-2

FIGURE 17-2

FIGURE 17-3



* Excluding Limitation Due to Grit Chamber

Legend

- Capacity with no major construction
- Incremental capacity with construction of Pond 12 and Additional 40 Acre Pastureland

Existing Plant Capacity Summary
Figure 3-6

SECTION II

Chapter 18.0

BIOLOGICAL RESOURCES

18.1 SETTING

The locations of the major biological resources within the planning area are shown in Figures 18-1 (Desert Tortoise), 18-2 (Mohave Tui Chub) and 18-3 (Mohave Ground Squirrel). In addition to the natural communities to be described below, there are several general classifications that have been created by human activities: urban, agricultural, and barren. The urban community consists of those plant species found within a developed residential, business or industrial area, either as landscape plantings or invading weeds. The agricultural areas that existed in Ridgecrest are fallow or have been overcoverd by structures, as such they will not be discussed here (See Chapter 1 for discussion of Agriculture). Barren lots have typically been graded, or are similarly disturbed and are currently devoid of vegetation.

18.2 PLANT COMMUNITIES

Plant communities are associations/aggregations of plant species adapted to a particular environment. An individual species' distribution may overlap from one community to another. "The term Plant Community for each regional element of the vegetation that is characterized by the presence of certain dominant species. In other words, the community is floristically determined. A vegetation type may consist of one to several communities" (Munz, 1968). Even so, description by community provides an excellent way to identify the general vegetation of a particular area.

The great majority of California plant Communities have a climatic rather than a purely edaphic basis. In California's diversified topography and its exceedingly complex distribution of climates, the communities naturally must often be geographically discontinuous, with parts of one occurring as islands within another. Many species of widespread distribution occupy a number of climatic zones and correspondingly a number of climatic races or ecotypes.

The following plant community names have been described in the NWC Preliminary Master Plan, the General Plan 1981-1995, City of Ridgecrest, Volume 2, Technical Appendix, the "Sensitive Plant Survey of Sewage Ponds and Effluent Pipeline Route For City of Ridgecrest, Kern County, California". A California Flora by Munz uses broader categorizations that result in fewer plant communities that encompasses a more widely based ecotype. These sources have referenced the Natural Diversity Data Base maintained by the California Department of Fish and Game. (Table 18-1 identifies the species by its scientific and common name.)

TABLE 18-1

Native Plant Species Common Names

Acamptopappus sphaerocephalus	goldenhead
Allenrolfea occidentalis	pickleweed
Ambrosia dumosa	burro bush
Lycium andersoni	Anderson thornbush
Atriplex polycarpa	all scale
Atriplex confertifolia	shadscale
Chilopsis spp.	desert willow
Distichlis spicata	saltgrass
Haplopappus acradenius	Alkali goldenbush
Hymenoclea salsola	cheesebush
Kochia californica	Mojave red sage
Larrea tridentata	creosote bush
Lepidium fremontii	desert alyssum
Nitrophylla occidentalis	alkali pink
Psorothamnus arborescens var arborescens	Mojave indigo bush
Scirpus robustus	alkali bulrush
Stanleya pinnata	Prince's Plume
Suaeda moquinii	inkweed/sea-blite
Tetradymia glabrata	desert horsebrush

The following are the plant communities as described by Munz:

a. Creosote Bush Scrub. *Larrea divaricata, Franseria Dumosa, Fouquieria splendens, Dalea californica, D. Schottii, D. spinosa, Lycium brevipes, L. Andersonii, Hymenoclea Salsola, Encilia farinosa, E. frutescens, Sphaeralcea ambigua, Bacharis sergiloides, Echincereus*

Engelmannii, Opuntia Bigelovii, O. echinocarpa, O. basilaris; Prosopis juliflora var. glandulosa, Olneya Tesota, Pluchea sericea, and Chilopsis linearis along the watercourses.

Well drained soil of slopes, fans, and valleys, usually below 3500 feet, in desert from southern end of Owens Valley to Mexico.

Average rainfall mostly 2 to 8 inches, some as summer showers; frost free days 180 to 345; highly variable seasonal and diurnal temperatures, mean summer maxima 100° - 110°, mean winter minima 30° -42°F.

b. Alkali Sink. *Atriplex polycarpa, A. lentiformis, A. breweri, A. spinifera, A. Parryi, Sarcobatus vermisculatus, Allenrolfea occidentalis, Suaeda Torreyana var. ramosissima, Salicornia virginica, Frankenia grandiflora var. capestris.*

Poorly drained alkaline flats and playas in floor of Great Central Valley and of arid regions east of the Sierra Nevada, and in such sinks as Panamint and Death Valleys, mostly at less than 4000 feet elevation.

Average rainfall mostly 1.5 to 7 inches, frost free days 200 to 335; highly variable seasonal and diurnal temperatures, mean summer maxima 106° - 116°, mean winter minima 28° - 37°F.

Low scattered gray or fleshy halophytes where there is poor or no drainage, as about dry lakes; under this community are grouped several associations that are perhaps more distinct and cover larger areas in the desert of Nevada and Utah.

The following is a composite description from the other three resources cited above:

a. Desert Saltbush Scrub or Alkali Sink. The desert saltbush scrub surrounds the sewer ponds located on the NAWS facility and is additionally located at Mirror and Satellite Lake playas. The dominant and common plant species are usually low growing (1 to 3 feet tall), small leafed and often succulent, including several species of saltbush and sea-blite. These are usually widely spaced with bare ground between and are often distributed in zonal patterns around the lake beds reflecting the alkalinity conditions.

This community is composed of *Atriplex polycarpa, Atriplex confertifolia,* with occasional *Larrea tridentata , Ambrosia dumosa, Suaeda moquinii, Haplopappus acradenius and Stanleya pinnata.*

b. Desert sink scrub. The desert sink scrub community was also found on the perimeter of the sewer ponds located on the NAWS facility and is additionally located at Mirror and

Satellite Lake playas. This community is found in poorly drained alkaline flats and playas at mostly less than 4000 feet elevation.

This community is dominated by *Distichlis spicata, Allenrolfea occidentalis, Atriplex confertifolia* and *Kochia californica* with occasional *Lepidium fremontii, Notrophylla occidentalis, Tetradymia glabrata, Haplopappus acradenius* and *Stanleya pinnata.* It is typified by low scattered gray halophytes where there is poor or no drainage, as about dry lakes.

c. Alkali marsh. This community was found in a few areas along the north side of the ponds and near the old railroad grade on the northeast side of the sewer ponds. This community is dominated by *Scirpus.*

d. Alkali meadow. This community was found intermixed with the alkali marsh community near the old railroad grade. This community was dominated by *Distichlis spicata.* The alkali marsh and the alkali meadow appeared to be dry at the time of the survey (June 4, 1991) with the plants appearing to be dead. It appears that these communities are dependent upon seepage from the pond for their water.

e. Creosote Bush Scrub Community. The Creosote bush scrub community is by far the largest plant community in the planning area. It is typified by well-drained soils of slopes, fans and valleys usually below 4500 feet in the desert. Local variations in the dominant species and overall species composition do occur in response to localized soil conditions through out the study area. Despite the harsh conditions of the desert, the Creosote Bush Scrub Community supports a surprising diversity and abundance of wildlife.

The dominant species of this community are the *Larrea tridentata, Ambrosia dumosa, Hymenoclea salsola, Acamptopappus sphaerocephalus*, and *Lycium andersoni.* These shrubs are 1-6' feet tall and are widely spaced being largely dormant between rainy seasons. This community is capable of supporting a wide variety of ephemeral herbs and wildflowers in early spring following winter rainfall and sometimes after late summer/fall rains. Germination and growth of these annuals is rapid followed by a short flowering period. Plants then die and persist as seeds throughout the remainder of the year until conditions are once again favorable for their germination.

18.3 WILDLIFE HABITAT

The potential variety and abundance of animal species in an area is determined by physical parameters (i.e., soils, slope, exposure, precipitation, evapotranspiration) and vegetation which can also reflect physical parameters. All botanic areas serve as wildlife habitats, with some encompassing the prime habitat of several rare and endangered animal species. Despite the harsh conditions of the desert, the creosote bush scrub supports a wide variety and abundance of wildlife.

In addition, to the many resident species of wildlife inhabiting the area, there are many migrants and winter visitors which use these habitats on a seasonal basis. Of particular importance to these species are habitats used for feeding, nesting and watering during migration and overwintering. The City sewer ponds, and the two dry lakes, Mirror and Satellite, when inundated following winter rainfall, are found to serve as important habitat to a wide variety of waterfowl, shorebirds and other birds traveling along the Eastern Sierra Flyway.

The NAWS has noted that it provides habitat for at least 80 species of mammals, 225 species of birds, and over 30 species of reptiles and amphibians. Those species known to abide within the planning area have been included in Tables 18-3 and 18-4 found at the end of this chapter. A complete listing of invertebrates for the planning area is not known to exist at this time, however Table 18-5, attempts to fill this gap. Table 18-6 was supplied by the Desert Tortoise Council and lists the sensitive species and their state or federal status.

18.4 RARE AND ENDANGERED SPECIES

The Federal Endangered Species Act (Act) was passed by Congress in 1973 and is amended periodically. The basic policy of the Act is that all federal agencies must seek to conserve threatened and endangered species through their actions. The Act has a prohibition against "take" of listed wildlife species with the exception of "take" being allowed under the procedure for obtaining a Section 7 or Section 10(A) permit. There are civil and criminal penalties for unauthorized take.

The Act contains a very broad definition of take, including "harass" (such as significant disruption of behavior) harm (includes significant habitat modification), pursue, hurt, shoot, wound, kill, trap, capture, collect or attempt to engage in any such conduct. The "take" prohibition applies to individuals, business entities, local and state governments, and federal agencies alike.

In recognition that take could occur incidental to the conduct of otherwise legal activities, the Act contains a provision to acquire a Section 10(a) incidental take permit. This permit allows a private individual, business, or local government to take listed species if the take is incidental to, and not the purpose of, carrying out otherwise lawful activities. To acquire the permit, an applicant must prepare a Habitat Conservation Plan (HCP) and Implementing Agreement which describes the method in which the applicant will minimize the impacts to the species. A permit can be granted if a number of stringent conditions are met, including a finding of non-jeopardy (an action that is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat).

The Act regularly defines a species status as follows:

> Endangered Species means any species which is in danger of extinction throughout all or a significant portion of its range, other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man.
>
> Threatened Species means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

In 1984, the state passed the California Endangered Species Act (CESA). The basic policy of CESA is to conserve and enhance endangered species and their habitats. As such, agencies should not approve private or public projects under their jurisdiction that would jeopardize threatened or endangered species or destroy habitat essential to their continued existence if reasonable and prudent alternatives are available.

The CESA requires that all state lead agencies must conduct an endangered species consultation with California Department of Fish and Game (CDFG) if their actions could affect a state listed species. The lead agency must provide information on the project and its impacts to CDFG, which in turn will prepare written findings on whether the proposed action would jeopardize the listed species or destroy essential habitat. If necessary, the CDFG will recommend reasonable and prudent alternatives to avoid "jeopardy" (to engage in an action that reasonably would be expected to, directly or indirectly, reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species), unless there are overriding considerations.

Although the CESA does not require local lead agencies to consult with CDFG for projects involving state listed species, the agency must still ensure that their actions would not result in "take" of a state listed species, an action prohibited by the CESA and subject to civil and criminal violations.

The CESA prohibits the "take", without a permit to "take", of listed wildlife species. Take is more narrowly defined compared to the federal law. The state definition includes hunt, pursue, capture, or kill, or attempting this conduct. As such, the CESA does not specifically include the disturbance of habitat or disruption of behavior as take, activities which are defined as take in the federal law.

The CESA contains a provision (Section 2081) for the CDFG to issue permits or memorandums of understanding to individuals, public agencies, and private entities to take listed species for specific purposes. This provisions is used in the same manner as the federal Section 10(a) incidental take permit in that the CDFG will issue a Section 2081 permit of management agreement for public and private projects that cause incidental take, provided that there is sufficient mitigation and that jeopardy would not occur. These incidental take authorizations have been issued to various local governments and private parties.

The California Fish and Game Code (§2062 and § 2067) defines a species status as:

endangered species means when a native species or subspecies of a bird, mammal, fish, amphibian, reptile. or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, over exploitation, predation, competition, or disease.

threatened species means a native species or subspecies of a bird, mammal, fish, amphibian. reptile. or plant that although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by this chapter.

There are six sensitive plant species (Table 18-2) that have potential habitat in the planning area. No federal or state listed or proposed rare, threatened or endangered plant species are known to exist in the study area. Only one species, *Calochortus striatus* (alkali Mariposa lily) is a Federal candidate species and has been found in the vicinity of China Lake and the NAWS magazine area. The remainder are listed by the California Native Plant Society (CNPS) as California Natural Diversity Data Base (CDDB) special plants.

Legislation at both the state and federal levels have designated several species of animals that may inhabit or visit the planning area as either endangered, rare, or threatened. These are the Desert tortoise and Mohave tui chub. Other sensitive species have been catalogued on the lands comprising the NAWS, however, these species have not been identified within the City of Ridgecrest and its sphere of influence (planning area as acknowledged by LAFCO) recognized in this document. (The tables found at the end of this chapter provide a list of bird, mammal, reptile, and plant species identified in the Indian Wells Valley)

The following species have been of the most concern to the City of Ridgecrest in addressing CEQA issues for new growth and development:

a. Desert tortoise (*Gopherus xerobates agassizii*

State Classification:	Threatened
Federal Classification:	Threatened

TABLE 18-2

SENSITIVE PLANT SPECIES

Scientific Name	Common Name	Habitat	Rank or Status*
Calorchortus striatus	alkali mariposa lily	Alkaline meadows and springy places	CNPS - 1B NDDB - S2.2 USFWS - C2
Camissonia kernensis ssp *kernensis*	Kern County evening primrose	Sandy gravelly granitic slopes and flats, desert washes and canyons	CNPS - 4 NDDB - S?
Chorizanthe spinosa	Mojave spineflower	Sandy washes and flats. occasionally on gravelly slopes	CNPS - 4 NDDB - S?
Linanthus arenicola	Sand linanthus	Loose sandy, sometimes gypsum rich soils; sandy dunes or edges of washes	CNPS - 2 NDDB - S?
Loeflingia squarrosa	sage-like loeflingia	Dunes and sandy flats often among sagebrush	CNPS - 3 NDDB - S?
Sparina gracilis	alkali cord grass	Alkaline meadow	CNPS - 4 NDDB - S?

* Rank or status abbreviations

CNPS ranks are: 1A-plant presumed extinct in California; 1B -plants rare and endangered in California and elsewhere; 2 -plants rare, threatened, or endangered in California, but more common elsewhere; 3 -plants about which more information is needed- a review list; and 4 -plants of limited distribution-a watch list.

NDDB (Natural Diversity Data Base a section within the CDFG) ranks are: S1 - extremely endangered; S2 -endangered; S3 -restricted range, rare; S4 -apparently secure. A more precise degree of threat to the element is sometimes expressed by a decimal followed by a number.

CDFG (California Department of Fish & Game) listing are: E - endangered, R - rare under the California Native Protection Act and CESA

USFWS (U.S. Fish & Wildlife Service) listings under the Endangered Species Act: C1 - Candidate List; C2 - Candidate List; and C3c - Non-candidate plant

The Desert tortoise is the largest North American desert reptile. It ranges across the Mojave and Colorado Deserts of California, northern Arizona, southern Nevada and southwest Utah in the southwestern United States south into the Sonoran desert and Sinaloa thornscrub of Mexico. Tortoises survive and reproduce in the desert environment by using a variety of adaptive strategies.

Tortoises spend 98% of their time in burrows that are often located under perennial plants, such as creosote. These burrows are crescent shaped and vary in size, depth and shape by geographic location and by size of tortoise. During the spring the tortoises emerge from their burrows to feed on the water-rich annuals and grasses that grow after spring rains. They remain active into the summer taking refuge in their burrows, pallets (sites in the shade of bushes that tortoises clear of debris), and also short "pallet" burrows when temperatures are high. When water shortages, rising temperatures and dwindling forage become to severe, desert tortoises become inactive and stay in their burrows to await late summer rains when they can emerge and replenish water stores and feed on new annual and perennial plant growth and dried grasses. After this brief period of activity, they spend the rest of the year in their burrows to avoid cold temperatures and food shortages.

b. Mohave tui chub (*Gila bicolor mohavensis*)

State Classification:	Endangered
Federal Classification:	Endangered

The Mohave tui chub (chub) was introduced onto NAWS in 1971 and is listed by both the U.S. Fish and Wildlife Service and the California Department of Fish and Game (CDFG) as an endangered species.

According to the NWC Master Plan, the chub were transplanted to the Center's Lark Seep Lagoon by the CDFG when it was realized that the last remaining population of the fish, living in a spring near Baker, California, were in jeopardy. In an effort to save the species from extinction, CDFG biologists organized a transplantation program with the Center serving as one of fourteen transplant/refuge sites. In 1971, approximately 400 chub were introduced into Lark Seep Lagoon on NAWS. This transplantation effort was highly successful. The population of chub is now estimated to be more than 18,500, in Lark Seep and G-1 Seep and the interconnecting channel . As none of the other transplant sites were successful, this species is considered to be one of the high priority management species on NAWS.

A study conducted in 1982 found the determining factors for the successful transplantation of the chub to be: water temperature and water quality, including the oxygen.

c. Mohave ground squirrel (*Spermophilus mohavensis*)

State Classification: Threatened*
Federal Classification: Candidate

* (The California Fish & Game Commission has recently decided to delist this species. The final delisting vote was held August 27, 1993. Legal actions regarding this action are still pending. These action may amend this section)

The Mohave ground squirrel (MGS) is one of several species of desert ground squirrels which inhabit the western Mojave Desert region of California. The MGS is a member of a large mammal family that includes ground squirrels, marmots, chipmunks, and tree squirrels. The MGS is cinnamon gray in color with white underparts. The species lives in underground burrows in which it spends approximately seven months of the year (August to February) in estivation (underground hibernation). The skin is darkly melanistic to assist in thermoregulation.

The MGS eats the fruits and seeds of desert plants. It is also known to feed on crops associated with farming activities. The species is known to occur in an area that includes southwestern Inyo County, eastern Kern County, northwestern San Bernardino County, and northeastern Los Angeles County. This range encompasses as area in excess of 7,000 square miles. The MGS inhabits the creosote bush, Joshua tree woodland, and shadscale scrub plant communities.

18.5 IMPACT ANALYSIS

18.5.1 Significance Thresholds

The significance of impacts on biological resources varies with the recognized habitat/community value of that resource, its geographical distribution and abundance, the extent of impact, the isolation of the habitat from urban influences, its recovery potential, and the overall size of habitat(s) available. The following criteria attempt to take into account these values in determining the significance threshold.

An impact would be considered significant if, without mitigation, it is expected to cause a measurable change in species composition, abundance, or function of a major portion of a habitat of recognized importance. A habitat of such importance is the alkali desert marsh of the

Mohave tui chub and the habitats of sensitive plants and animals (i.e., organisms not yet classified as rare, threatened, or endangered by state and federal agencies, but which are on lists that could result in such classification).

18.5.2 General Impacts

The increasing urbanization of a community results in the gradual alteration of natural biological resources to man-made structures and maintained landscapes. Increased community growth results in the direct reduction of habitat and indirect effects on adjacent habitats. Habitats at the edge of urban areas have reduced diversity of plants and wildlife due to the recreational use of such areas, invasion of exotic plants, and wildlife depredation by domestic cats and dogs. The significance of these impacts is dependent on the value and sensitivity of the adjacent natural habitat. Impacts of the individual alternatives are discussed relative to location in the following sections.

Increased population growth within the planning area will also cause increased water use, greater sewage outflow, and increased air pollutant emissions. These could potentially have significant impacts on biological systems. The level of significance of these increases is dependent on community design relative to actual population growth and these impacts are discussed in the appropriate portions of this document.

No direct impacts on rare and endangered plants or animals are expected due to any of the four alternatives. The Mohave tui chub is located in an area that is being managed by the NAWS and would be maintained under all alternatives in their existing condition. Indirect impacts that include loss of habitat may be significant.

It should additionally be recognized that some 90% of the lands in the Mojave Desert are under the jurisdiction of different Federal agencies. As such, lands held under private ownership should not be acquired for mitigation, but, instead developers should have mitigation options that include but are not limited to habitat restoration on public lands, buying mineral and grazing rights on public lands and other creative measures.

18.5.3 Alternatives 1 and 4 (No Project Alternative)

These alternatives would cause continued development in areas currently adjacent to existing development. These alternatives are not expected to cause any significant biological impacts since they will not disturb any sensitive biological habitats, nor increase impacts to threatened or endangered species. The City has entered into an interim Section 2081 permit with the CDFG that addresses appropriate mitigation for the loss of habitat for the Mohave ground squirrel. (Although this animal has been technically delisted, the CDFG will likely be brought to suit by various environmental groups over the legality of this decision.) The City as a participant in the BLM

Western Mohave Coordinated Management Plan fully intends to mitigate for the loss of any habitat for the species addressed in this plan. As such all development is viewed as being mitigable for loss of habitat.

The no project alternative would see restricted development to the lands within the planning area. As such it would be limited to infill development on lands that have limited or no habitat value.

18.5.4 Alternatives 2 and 3

These alternatives would likely cause the expansion of the present city limits. Development would occur on lands that are within the sphere of influence of the City and as such have experienced human and domestic animal impacts. As a participant in the BLM Western Mohave Coordinated Management Plan, the City will require the developers to mitigate adequately for any loss of habitat.

18.6 MITIGATION MEASURES

The following measures are recommended to reduce potentially significant impacts caused by additional urban growth.

* Support the NAWS in their continued management and maintenance of the Mohave tui chub on their lands.

* The City should develop landscaping guidelines to recommend native and/or desert adaptive plants and plants of high value to wildlife for use throughout the City and require that such species be used to the extent feasible at all interfaces with natural areas. Native plants require less care than cultivated species and maintenance cost can be reduced. In addition, native plants or adaptive landscape plants may encourage the return of animals more tolerant of human activity, thereby providing habitat for some of the species displaced by these alternatives.

* The City should continue to make available a list of suggested plant material that focuses on natural and desert adaptive vegetation.

* Participate in the cooperative development of the Western Mohave Desert Coordinated Habitat Management Plan (by the Bureau of Land Management acting as lead agency) in order to obtain a new Section 2081 permit from CDFG (replacement of current 2081) and a Section 10(a) permit from USFWS for the lands within the City's planning area.

- Upon the issuance of a new Section 2081 permit (CDFG) and/or a Section 10(a) permit (USFWS), the City will notify the public of the procedure to comply with the conditions of approval for the permit.

- As part of the CEQA process, the City will consult with USFWS during the environmental review of public and private projects that may affect federal endangered or threatened species prior to the final certification of a CEQA document.

- As part of the CEQA process, the City will consult with CDFG during the environmental review of public and private projects that may affect state endangered or threatened species prior to the final certification of a CEQA document.

- The City should continue to work cooperatively with all agencies involved in conservation and environmental planning.

- The City should continue to enforce off-road vehicle restrictions within the city limits and assist other agencies at boundary areas.

- The City should participate in desert education programs.

- In the event that the City does not participate in the BLM Habitat Management Plan, it shall continue to require biota surveys where applicable and shall require the developer and/or agency to consult with the appropriate state or federal wildlife management agency.

- All development shall be subject to the requirements of the Endangered Species Act in regards to development limitations or mitigation for land being proposed for development.

Residual Impacts. Continued growth in the City will result in the alteration of native habitats and open area to landscaping. This would result in a decline in the abundance of animals and plants not tolerant of urban conditions. These impacts are considered insignificant for Alternatives 1, 2, 3 and 4 (No Project Alternative) when properly mitigated as indicated above.

TABLE 18-3

BIRDS OF THE RIDGECREST AREA
Kern and San Bernardino Counties, California
Compiled by Dave Blue and Don Moore)
October 1992

This checklist includes the species that have been observed, either as residents or seasonal visitors, in the vicinity of the City of Ridgecrest, including adjoining desert habitat areas and the city-operated wastewater treatment facilities on the Naval Air Weapons Center, China Lake.

Taxonomy and nomenclature conform to the American Ornithologists' Union *Check-List of North American Birds*, through the Thirty-seventh Supplement, 1989. Definitions for status and abundance codes are from *Distributional Checklist of North American Birds* by David DeSante and Peter Pyle. Extensions to that standard include the fall transient (FT) and spring transient (ST) status codes, and the introduced *(i)* status code prefix.

Status Codes:

P -	Permanent resident and confirmed breeder
P* -	Non-breeding permanent breeder
S -	Summer resident and confirmed breeder
S* -	Non-breeding summer resident
T -	Transient (occurring within its established range during migration)
ST -	Spring Transient
FT -	Fall Transient
a -	Vagrant (occurring outside its established range during migration)
W -	Winter resident or visitant (January-February occurrences only)
i -	Introduced (used as prefix in conjunction with above codes)

Abundance Codes:

	A Few Individuals Encountered on:	Many Individuals Encountered on:
c - common or abundant	> 90% of Days	> 50% of Days
f - fairly common	50-90% of Days	10-50% of Days
u - uncommon	10-50% of Days	< 10% of Days
r - rare	< 10% of Days	------
x - extremely rare	(10 or fewer records for that season)	

Abundance Modifiers

i - irregular (of cyclic or sporadic occurrence)
l - limited (to a geographic area that comprises 10% or less of the area

TABLE 18-3 (continued)

LOONS
Common Loon...........xST, Rft

GREBES
Pied-billed Grebe............uS,rW
Horned Grebe...................xFT
Eared Grebe..................cS,fW
Western Grebe..............xST,uFT
Clark's Grebe...................rT

PELICANS
American White Pelican..........fT

CORMORANTS
Double-crested Cormorant.....uT

BITTERNS & HERONS
American Bittern...............xFT
Least Bittern..................xFT
Great Blue Heron..........uS*,fT,xW
Great Egret.....................fT
Snowy Egret.....................fT
Cattle Egret....................uT
Green-backed Heron..............rT
Black-crowned Night-heron.uS*,fT,rW

IBISES & SPOONBILLS
White-faced Ibis...............fs*

SWANS, GEESE & DUCKS
Tundra Swan...................xFT
Greater White-fronted Goose.rFT,xW
Snow Goose.....................cW
Ross' Goose.................rT,xW
Canada Goose...................fW
Wood Duck...................xT,xW
Green-winged Teal..............fW
Mallard........................cP
Northern Pintail...............fW
Blue-winged Teal..............rST
Cinnamon Teal...............fS,cT
Northern Shoveler..............cW
Gadwall.....................uS,fW
American Wigeon................cW
Canvasback.....................uW
Redhead........................fW
Ring-necked Duck...............uW
Lesser Scaup...................uW
Common Goldeneye..............rFT
Bufflehead.....................cW
Common Merganser..............rFT
Red-breasted Merganser........rFT
Ruddy Duck.....................cP

AMERICAN VULTURES
Osprey.........................xT
Black-shouldered Kite..........xT
Bald Eagle.....................xT
Northern Harrier..............cP*
Sharp-shinned Hawk.............uW
Cooper's Hawk..................uW
Red-shouldered Hawk............rT
Red-tailed Hawk.............uS,cW
Ferroginous Hawk...............rW
Rough-legged Hawk..............rW
Golden Eagle..................uP*

FALCONS
American Kestrel...........uS,fT,uW
Merlin.........................rT
Prairie Falcon................uP*

PARTRIDGES & QUAIL
Chukar........................*I*-uP
California Quail...............uP

RAILS, GALLINULES & COOTS
Virginia Rail...............uT,xW
Sora...........................uT
Common Moorhen.................xW
American Coot..................cP

PLOVERS
Black-bellied Plover...........uT

TABLE 18-3 (continued)

PLOVERS *(cont.)*
Snowy Plover......................uT
Semipalmated Plover...............uT
Killdeer..........................fP

STILTS & AVOCETS
Black-necked Stilt................cS
American Avocet...................cS

SANDPIPERS & PHALAROPES
Greater Yellowleg.............fT,rW
Lesser Yellowlegs.................uT
Solitary Sandpiper................uT
Willet............................uT
Spotted Sandpiper.................cT
Whimbrel..........................rT
Long-billed Curlew................rT
Marbled Godwit....................uT
Sanderling........................rT
Western Sandpiper.................fT
Least Sandpiper...................fT
Baird's Sandpiper................rFT
Pectoral Sandpiper...............rFT
Dunlin............................rT
Short-billed Dowitcher............uT
Long-billed Dowitcher.............fT
Common Snipe...................uT,xW
Wilson's Phalarope,,..,,,,,,,,,,,cT
Red-necked Phalar- ....cT

SKUAS, GULLS & TERNS
Franklin's Gull...................rT
Bonaparte's Gull..................uT
Ring-billed Gull...............fT,uW
California Gull................fT,uW
Caspian Tern......................uT
Forster's Tern....................uT
Black Tern........................fT

PIGEONS & DOVES
Rock Dove.......................*I*-cP
White-Winged Dove.................xV
Mourning Dove..................cS,fW
Band-Tailed Pigeon..............irST

CUCKOOS & ROADRUNNERS
Greater Roadrunner................uP

BARN OWLS
Barn Owl..........................rP

TYPICAL OWLS
Great Horned Owl..................uP
Burrowing Owl..................uS,rW
Long-eared Owl....................rW
Short-eared Owl...................rT

GOATSUCKERS
Lesser Nighthawk..................fS
Common Poorwill................rS,xW

SWIFTS
Vaux's Swift.....................rST
White-Throated Swift.............rST

HUMMINGBIRDS
Black-chinned Hummingbird.........fs
Anna's Hummingbird.............fT,rW
Costa's Hummingbird............uS,xW
Calliope Hummingbird.............xST
Rufous Hummingbird................fT

KINGFISHERS
Belted Kingfisher.................rT

WOODPECKERS
Lewis' Woodpecker...............irFT
Red-naped Sapsucker..............uFT
Red-breasted Sapsucker...........rFT
Ladder-backed Woodpecker..........uP
Nuttall's Woodpecker.............rFT
Downy Woodpecker..................rT
Hairy Woodpecker.................rFT

TABLE 18-3 (continued)

WOODPECKERS *(cont)*
Northern Flicker................fW

TYRANT FLYCATCHERS
Olive-sided Flycatcher..........rT
Western Wood-Pewee..............uT
Willow Flycatcher...............fT
Hammond's Flycatcher...........rST
Dusky Flycatcher...............rST
Gray Flycatcher................rST
Pacific-slope Flycatcher........uT
Black Phoebe....................fP
Say's Phoebe....................cP
Vermillion Flycatcher...........rV
Ash-throated Flycatcher.........uT
Western Kingbird................cS

LARKS
Horned Lark....................cP

SWALLOWS
Tree Swallow......................cT
Violet-green Swallow.............uT
N. Rough-winged Swallow...........fT
Bank Swallow......................fT
Cliff Swallow.....................uT
Barn Swallow......................cT

JAYS, MAGPIES & CROWS
Stellar's Jay....................irT
Scrub Jay.......................rT,xW
Pinyon Jay.......................xFT
Common Raven......................cP

TITMICE
Mountain Chickadee................rT
Plain Titmouse....................rT

VERDINS
Verdin...........................uP

BUSHTITS
Bushtit..........................rT

NUTHATCHES
Red-breasted Nuthatch.............rT
White-breasted Nuthatch...........rW

CREEPERS
Brown Creeper....................xFT

WRENS
Cactus Wren.......................uP
Rock Wren.........................fP
Canyon Wren.......................uP
Bewick's Wren.....................uW
House Wren........................uT
Marsh Wren........................cW

MUSCICAPIDS,
Kinglets & Gnatcatchers
Golden-crowned Kinglet.........rT,xW
Ruby-crowned Kinglet...........fT,rW
Blue-Gray Gnatcatcher............uT

Solitaires & Thrushes
Western Bluebird.................uW
Mountain Bluebird................uW
Townsend's Solitaire...........xW,rT
Swainson's Thrush............rST,xFT
Hermit Thrush.....................uT
American Robin....................fW
Varied Thrush...................irFT

MOCKINGBIRD & THRASHERS
Northern Mockingbird..............cP
Sage Thrasher................rST,uFT
California Thrasher...............xT
Le Conte's Thrasher...............uP

PIPITS
American Pipit....................fW

TABLE 18-3 (continued)

WAXWINGS
Bohemian Waxwing................xW
Cedar Waxwing..................ifW

SILKY FLYCATCHERS
Phainopepla.....................uT

SHRIKES
Loggerhead Shrike...............fP

STARLINGS
European STarling............*i*-cP

VIREOS
Solitary Vireo..................rT
Warbling Vireo..................uT

EMBERIZIDS
Wood-Warblers
Orange-crowned Warbler..........fT
Nashville Warbler...............rT
Virginia's Warbler.............rV
Yellow Warbler..................fT
Black-throated Blue Warbler.....xV
Yellow-rumped Warbler........cT,fW
Black-throated Gray Warbler.....uT
Townsend's Warbler..............rT
Black-and-white Warbler.........xV
MacGillivray's Warbler..........uT
Common Yellowthroat.............cS
Wilson's Warbler................fT
Yellow-breasted Chat...........rT

Tanagers
Western Tanager.................uT

Grosbeaks & Buntings
Rose-breasted Grosbeak..........xV
Black-headed Grosbeak...........fT
Blue Grosbeak...................rT
Lazuli Bunting..................rT

Towhees & Sparrows
Green-tailed Towhee............rST
Rufus-sided Towhee.............uW
Chipping Sparrow................uT
Brewar's Sparrow................rT
Black-chinned Sparrow..........lrS
Vesper Sparrow.................uFT
Lark Sparrow...................uFT
Sage Sparrow....................cP
Savannah Sparrow.............cT,uW
Fox Sparrow.....................rW
Song Sparrow....................fW
Lincoln's Sparrow..............uT
Golden-crowned Sparrow.......rT,xW
White-crowned Sparrow...........cW
Harris's Sparrow................xW
Dark-eyed Junco.................fW

Blackbirds & Orioles
Red-winged Blackbird............cS
Western Meadowlark.............uS,fW
Yellow-headed Blackbird...........cS
Brewer's Blackbird................cP
Great-tailed Grackle..............rT
Brown-headed Cowbird..............fS
Hooded Oriole.....................rS
Northern Oriole...................uS

Old World FInches
Purple Finch......................xW
Cassin's Finch...................xFT
House Finch.......................cP
Red Crossbill..................xT,xW
Pine Siskin......................irT
Lesser Goldfinch.................fT
Lawrence's Goldfinch.............xT
Evening Grosbeak.................irT

Old World Sparrows
House Sparrow.................*I*-cP

TABLE 18-4

CHECKLIST
OF THE
AMPHIBIANS, REPTILES,AND MAMMALS
OF INDIAN WELLS VALLEY
AND
SURROUNDING AREAS

These lists are based on field observations of the compilers and museum records. The areas covered in the lists include Indian Wells Valley, adjacent canyons, and mountain ranges to the level of the piñon-juniper belt.

HABITAT TYPES
FOR
AMPHIBIANS, REPTILES AND MAMMALS
OF THE INDIAN WELLS VALLEY
AND
SURROUNDING AREAS

1. Urban developments
2. Rural developments, cultivated areas
3. Sewage ponds, marshes, drainage ditches
4. Alkali sink associations
5. Creosote Bush Scrub
6. Shadscale Scrub
7. Joshua Tree woodland
8. Sagebrush scrub
9. Piñon-juniper woodland
10. Wet canyons: a) Sierran, b) desert
11. Rock canyons

TABLE 18-4 (continued)

AMPHIBIANS AND REPTILES OF THE INDIAN WELLS VALLEY AND SURROUNDING AREAS
By Kristen Berry
Maturango Museum Press

	Habitat Type
Order Amphibia	
Family Ambystoamtidae Mole Salamanders	
Tiger Salamander *(Ambystoma tigrinum)*	exotic: 1, 3, 10a
Family Hylidae Tree Frogs	
Pacific Treefrog *(Hyla regilla)*	1, 2, 3, 10a
Family Bufonidae True Toads	
Western Toad *(Bufo boreas)*	1, 2, 3, 10a
Red-spotted Toad *(Bufo punctatus)*	10b
Order Reptilia	
Family Testudinidae, subfamily Testudininae, Gopher Tortoises	
Desert Tortoise *(Gopherus agassizii)*	(captive) 4-7, 11
Family Gekkonidae Geckos	
Banded Gecko *(Coleonyx variegatus)*	4-9, 10, 11
Family Iguanidae Iguanid Lizards	
Desert Iguana *(Dipsosaurua dorsalis)*	4-7, 11
Chuckwalla *(Sauromalus obesus)*	5(11), 7(11)
Zebra-tailed Lizard (Callisarus draconoides)	4-7, 8
Collared Lizard *(Crotaphytus collaris)*	11:5,7,8,9
Leopard Lizard *(Crotaphytus wislizenii)*	4-7,8
Desert Spiny Lizard *(Sceloporus magistar)*	5,6,7,11
Western Fence Lizard *(Sceloporus occidentalis)*	9
Side-blotched Lizard *(Uta stansburiana)*	4-11
Desert Horned Lizard *(Phrynosoma platyrhinos)*	4-11
Family Xantusiidae Night Lizards	
Desert Night Lizard *(Xantusia visilis)*	4(unc),5,7
Family Scinidae Skinks	
Gilbert's Skink *(Eumeces gilberti)*	10a,10b
Family Teiidae	
Western Whiptail *(Cnemidophorus tigris)*	4-11
Family Anguidae Alligator Lizards	
Southern Alligator Lizard *(Gerrhonotus multicarinatus)*	Exotic: 1,10a
Family Anniellidae Legless lizards	
California Legless Lizard *(Anniella pulchra)*	7-10 (Sierras only at Walker Pass

TABLE 18-4 (continued)

Family Leptotyphlopidae Slender Blind Snakes	
Western Blind Snake *(Leptotyphlops humilis)*	4-9.11
Family Boidae Boas	
Rosy Boa *(Lichanura trivirgata)*	4-7,10,10
Family Colubridae	
Spotted Leaf Snake *(Phyllorohynchus decurtatus)*	4-7, 11
Red Racer *(Masticophis flagellum)*	2,3,4-11
Western Patch-nose Snake *(Salvadora hexalephis)*	4-9,10,11
Glossy Snake *(Arizona elegans)*	4-9,10,11
Gopher Snake *(Pituophis melanoleucus)*	2.3.4-11
Common Kingsnake *(Lampropeltis getulus)*	4-11
Western Ground Snake *(Sonora sesmiannulata)*	4-7.10-11
Western Shovel-nosed Snake *(Chiconactis occipitalis)*	*4-7,10-11*
Utah Black-headed Snake *(Tantilla planiceps utahensis)*	4-11
Desert Night Snake *(Hypsigiena torquata deserticola)*	4-11
Family Viperidae, subfamily Crotalinae	
Northern Pacific Rattlesnake *(Crotalus viridis oreganus)*	8,9 (Sierran, 10a)
Mojave Desert Sidewinder *(Crotalus certastes certastes)*	4-7,10,11
Panamint Rattlesnake *(Crotalus mitchelli stephensi)*	11,5,7-9,10
Mojave Rattlesnake *(Crotalus scutulatus scutulatus)*	5-7

TABLE 18-4 (continued)

MAMMALS OF THE INDIAN WELLS VALLEY AND SURROUNDING AREAS by Kristin Berry

	Habitat Type
Order Marsupialia	
Family Didelphidae	
Opossum *(Didelphis maruspialis virginiana)*	Sierran affinities
Order Insectovora	
Family Soricidae Shrews	
Ornate Shrews *(Sorax onratus ornatus)*	Little Lake
Crawford's Desert Shrew *Notisorex crawford)*	5,7+
Order Chiroptera	
Family Vespertilionidae	
Little Brown Mytosis *(Mytosis lucifugus carissima)*	
California Mytosis *(M. californicus stephansi, M.c. californicus)*	
Yuma Mytosis *(M. yumanensis sociabilis, M. y. yumanensis)*	
Long Eared Mytosis *(M. evotis evotis)*	
Fringed Mytosis *(M. thysanodes)*	
Long-legged Mytosis *(M. volans interior)*	
Western Pipistrelle *(Pipistrellush. hesperus)*	11:5+
Big Brown Bat *(Eptesicus fuscus pallidus, E. f. bernardinus)*	
Red Bat*(Lasiurus borealis teliotus)*	
Hoary Bat *(Lasiurusiurus* Cinereus cinereus)	
Spotted Bat *(Euderma maculatum)*	
Townsend's Big-eared Bat *(Plecotus/Corynorhinus tonwsendii pallescens)*	
Pallid Bat *(Antrozous pallidus pallidus)*	
Family Molossidae	
Brazilian Free-tailed Bat *(Tadarida brasiliensis mexicana)*	
Order Lagomorpha	
Family Leporidae	
Black tailed Hare *(Lepus californicus deserticola)*	2-11
Audubon Cottontail *(Sylvilagus auduboni arizonae)*	2,3,5,7-11
Order Rodentia	
Family Sciuridae	
Beechey or Califonria Ground Squirrel *(Otospermophilus beecheyi)*	7-10a

TABLE 18-4 (continued)

Panamint Chipmunk *(Eutamias panmintinus)*	9
Antelope Ground Squirrel *(Ammospermophilus leucurus)*	3-9,10,11
Mojave Ground Squirrel (Citellus mojavensis)	5
Family Geomyidae	
Botta Pocket Gopher *(Thomomys bottae)*	5,7+
Family Heteromyidae	
Little Pocket Mouse *(Perognathus longimembris)*	4-9,11
Long-tailed Pocket Mouse *(Perognathus formosa)*	4-9,11
Great Basin Pocket Mouse *(Perognathus parvus)*	8,9+(Argus Mtn)
Yellow-eared Pocket Mouse *(Perognathus* xanthanotus)	7-9 Walker Pass only
Panamint Kangaroo Rat *(Dipodomys panamintinus)*	5-8+
Great Basin Kangaroo Rat *(Dipodomys microps)*	4
Merriam Kangaroo Rat *(Dipodomys* merriami)	4-8+
Desert Kangaroo Rat *(Dipodomys deserti)*	4-5
Family Cricetidae	
Western Harvest Mouse *(Reithrodontomys megalotis metalotis)*	10
Family Cricetidae (continued)	
Canyon Mouse *(Peromyscus crinitus stephansi)*	11:5,6,7+
Cactus Mouse *(Peromyscus* eremicus eremicus)	8,9
Deer Mouse *(Peromyscus maniculatus sonoriensis)*	4-11
Brush Mouse *(Peromyscus* boylii boylii)	9,10a
Piñon Mouse *(Peromyscus truei montipinoris, P.t. truei)*	8,9,10 ab
Southern Grasshopper Mouse *(Onychomys torridus pulcher)*	4-9
Desert Woodrat *(Neotoma lepida lepida)*	11:5-9;7 without 11
Family Erethizontidae	
Porcupine (*Erethizon dorsatum)*	10a
Family Canidae	
Kit Fox *(Vulpes macrotis arsipus)*	4-9,10,11
Gray Fox *(Urocyon cineroargenteus)*	10a
Coyote *(canis latrans)*	1-11
Family Procyonidae	
Ringtailed Cat *(Bassariscus astutus willetti)*	5,7+,10 ab
Racoon *(Procyon lotor psora)*	10a
Family Mustelidae	
Long-tailed Weasel *(Mustela frenata pulchra)*	4,7-10
Badger *(Taxida taxus berlandieri)*	1-11
Spotted Skunk *(Spilogale putorius)*	4-9
Striped Skunk *(Mephitis mephitis)*	10a
Family Felidae	
Bobcat *(Lynx rufus baileyi, L.r. californicus)*	2-11

TABLE 18-4 (continued)

Order Artiodactyla		
Family Bovidae		
Bighorn Sheep *(Ovis canadensis)*	Desert Mts.	8,9,10b
Order Perissodactyla		
Family Equiidae		
Burro		4-11

TABLE 18-5

INVERTEBRATES OF THE INDIAN WELLS VALLEY AND THE SURROUNDING AREA BY KEN PRINGLE

SPIDERS

(There are many spiders in the valley. Many are indigenous, some have come in with new resident, but there is no way at this point in time to tell the difference. Almost all families are represented.)

Sub-order Orthognatha

Hairy Mygalomorphs
1. *Aphonopelma eutylenum*

Trapdoor Spiders
1. *Bothriocyrtum californicum*
2. Another one here not named (Possibly Antrodiaetus)

Sub-order Labidognatha (True Spiders)

Brown Spiders (Loyoscelidae)
1. *Loyosceles deserta*

Diguetids (Diguetidae)
1. *Diguetia canities*

Daddy-Long-Legs (Pholcidae)
1. *Pholcus sp.*

Cobweb weavers (Theridiidae)
1. *Steatoda sp.*

Widows (Black)
1. *Latrodectus mactans*
2. Possibly others

Sheetweb Weavers (Linyphiinae)
1. Not named

Pirate Spiders (Mimetidae)
1. *Mimetus sp.*

Orb-Weavers (Araneidae)
1. *Argioge trifasciata* (Banded argiope)
2. *Argiope argentata*
3. Others have been observed, but not identified

Funnel Weavers (Agelenidae)
1. Here, but not identified

Nursery Web Spiders (Pisauridae)
1. *Pisaura sp.*

Wolf Spiders (Lycosidae)
1. *Lycosa sp.*
2. *Pardosa sp.*

Gnaphosids (Gnaphosidae)
1. *Haplodrassus sp.*

Sac Spiders (Clubionidae)
1. Several unidentified species

Crab Spiders (Thomisidae)
1. *Misumena sp.*
2. Several others

Jumping Spiders (Salticidae)
1. *Phidippus johnsoni*
2. *Phidippus apacheanus*
3. At least 6 unidentified ones

Filistatids (Filistatidae)
1. *Filistata sp.*

Uloborids (Uloboridae)
1. *Uloborids glomosus*

Many other spiders occur in the Indian Wells Valley, but there has not been enough work done in this area to make positive identifications.

TABLE 18-5 (continued)

OTHER ARTHROPODS OF INDIAN WELLS VALLEY

Winscorpions
1. *Eremobatius durangonus* (Sun Spider)

Scorpions
1. *Hadrurus hirsutus* (Giant Hairy Hadrurus)
2. One or Two others

Harvestmen
1. At least two species

Mites
1. *Trombidium sp.*
2. Others

Ticks
1. Unknown Species

Centipedes
1. At least two Species

Millipedes
1. One or Two Species

INSECTS OF INDIAN WELLS VALLEY

Order Apterygota

Protura

Probably one species from here

Order Diplura

Collembola

Probably one species of these

Thysanura

Lepismatidae (Common Silverfish)
1. *Lepisma saccharina*

Machilidae

Probably one species from here

Order Pterygota

Ephemeroptera

Some species in this classification

Odonata (Damselflies and Dragonflies)

Several species from here

TABLE 18-5 (continued)

Order Pterygota (continued)
- Plecoptera (Stoneflies)
  - At least one species from here
- Blattodea (Cockroaches)
  1. *Blattella germanica*
  2. *Supella supellectilium*
  3. *Eremoblatta subdiaphana*

Order Isoptera (Termites)
- One species from here

Order Grylloblattodea (Rock Crawlers)

Order Orthoptera (Crickets, Crasshoppers, Katydids)
- Acrididae
  - Several Species from here
- Tettigoniidae
  - At least one species from here
- Gryllacrididae
  - At least one species from here
- Mantodea (Mantids)
  1. *Stagmomantis californica* (Praying Mantis)
  2. One other species from here
- Phasmatodea (Walking Sticks)
  - Two different species from here
- Dermaptera (Earwigs)
  - At least two species from here
- Embioptera (Webspinners)
  - Unknown
- Psocoptera (Black Lice)
  - Unknown
- Mallophaga (Biting Lice)
  - Probably two Species
- Anoplura (Sucking Lice)
  - Probably four Species
- Hemiptera (True Bugs)
  - Pentatomidae (Stink Bugs)
    - At least Two Species
  - Corimelaenidae
    - Unknown

Order Orthoptera (continued)

Hemiptera (continued)

Scutelleridae (Shield Bugs)

Probably one species

Coreidae (Leaf-footed Bugs)

Rhopalidae

1. *Leptocoris rubrolineatus* (Western Box-Elder)

Lygaeidae (Milk Weed Bug)

Probably one species from here

Tingidae (Lace Bugs)

At least one species from here

Reduviidae (Assassin Bugs, Kissing Bugs)

Four or more species from here

Cimicidae (Bed Bugs)

Probably one species from here

Miridae (Plant Bugs)

Several Species from here

Nabidae (Damsel Bugs)

1. *Nabis ferus*

Gerridae (Water Striders)

1. *Gerris remigis*

Homoptera (Cicadas, Hoppers, Aphids)

Cicadidae

One or two species from here

Cicadellidae (Leafhoppers)

Several species from here

Aphididae (Aphids)

Several species from here

Coccoidea

Several species from here

Neuroptera (Dobsonflies and Alderflies)

Corydalidae

At least one species from here

Chrysopidae (Green Lacewings)

One species form here

Myrmeleontidae

1. *Brachynemurus sp.*

Mecoptera (Scorpionflies)

One or more species from here

TABLE 18-5 (continued)

Order Orthoptera (continued)

Diptera (Flies, Gnats, Midges)

Tipulidae (Crane Flies)

1. *Tipula sp.*

Ceratopogonidae

A few species found here

Culicidae

A couple of species from here

Chironomidae (Water Midges)

Probably a species from here

Bibionidae (March Fly)

Probably a species found here

Stratiomyidae (Soldier Flies)

At least one species from here

Tabanidae (Horse and Deer Flies)

1. *Tabanus punctifer* (Big Black Horse Fly)
2. *Chrysops sp.*

Asilidae (Robber Flies)

Several Species from here

Bombyliidae (Bee Flies)

Several species from here

Syrphidae (Hover Flies)

Some species from here

Empididae (Dance Flies)

1. Rhamphomyia sp.

Tephritidae (Fruit Flies)

Several species from here

Drosophilidae (Vinegar Flies)

1. *Drosophila spp.*

Muscidae (Muscid Flies)

1. *Musca domestica* (House Fly)
2. *Stomoxys calcitrans* (Stable Fly)

Calliphorioae (Blow Flies)

Several Species from here

Order Siphonaptera (Fleas)

Probably several species

Order Trichoptera (Caddisflies)

Probably several species

TABLE 18-5 (continued)

Order Lepidoptera (Moths and Butterflies)

Incurrariidae
1. *Tegeticula spp.*

Psychidae
1. *Thyridopteryx meadi* (Creosote Bush Bagworm)

Tineidae
1. *Tineola bisselliella* (Clothes Moth)

Gracillariidae
Some species found here

Lyonetiidae
Probably a species found here

Plutellidae
At least one species found here

Sesiidae
Probably one species found here

Oecophoridae
One or more species found here

Cossidae (Goat Moths)
1. *Prionoxystus robiniae* (Carpenterworm)

Pyralidae
1. *Plodia interpunctella* (Indian Meal Moth)
2. *Pyralis farinalis* (Meal Moth)

Lasiocampidae
1. *Malacosoma spp.* (Tent Caterpillars)

Noctuidae (Millers and Cutworms)
Several species are found here

Arctiidae
Several species are found here

Saturniidae (Silk Moths)
1. *Antheraea polyphemus* (Polyphemus Moth)
2. *Hemileuca nevadensis* (Nevada Buck Moth)
3. Probably other species

Sphingidae (Hawk Moths, Sphinx Moths)
1. *Smerinthus cerisyi* (Eyed Sphinx)
2. *Eumorpha achemon* (Achemon Sphinx)
3. *Pachysphinx occidentalis* (Western Poplar Sphinx)
4. *Hyles lineata* (White-Lined Sphinx)
5. *Manduca sexta* (Tomato Hornworm)

Hesperiidae (Skippers)
Probably some species found here

TABLE 18-5 (continued)

Order Lepidoptera (continued)

Lycaexidae

1. *Brephidium exilis* (Pigmy Blue)
2. *Plebejus acmon* (Acmon Blue)
3. *Celastrina argiolus* (Echo Blue)

Nymphalidae

1. Probably one species here
2. *Danaus plexippus* (Monarch)
3. *Euphydryas chalcedona* (Common Checkerspot)
4. *Nymphalis antiopa* (Mourning Cloak)
5. *Vanessa cardui* (Painted Lady)
6. *Vanessa atalanta* (Red Admiral)

Pieridae

1. *Colias cesonia* (Southern Dogface)
2. *Colias eurytheme* (Alfalfa Sulfur)

Order Coleoptera (Beetles)

Carabidae (Predaceous Ground Beetles)

1. *Holciophorus sp.*
2. *Pterostichus sp.*

Gyrinidae (Whirligig Beetle)

1. *Gyrinus sp.* (Common Whirligig)

Scarabaeidae (Scarabs)

1. *Phyllophaga sp.* (Common June Beetle)
2. *Cotinus texana* (Green Fruit Beetle)

Elateridae (Click beetle)

1. *Limonius sp.* (Common Click Beetle)
2. *Ctenicera sp.* (Common Click Beetle)

Phengodidae

1. *Zarhipis integripen* (Glowworms)

Dermestidae

1. *Dermestes marmoratus* (Common Carrion Beetle)

Cleridae (Checkered Beetles)

1. *Necrobius rufipes* (Red-Legged Ham Beetle)

Nitidulidae (Dried Fruit Beetles)

1. *Carpophilus pallipennis* (Cactus Flower Beetle)

Meloidae (Blister Beetles)

1. *Tegrodera sp.* (Soldier Blister Beetle)
2. *Cysteodemis armatus* (Desert Spider Beetle)

TABLE 18-5 (continued)

Order Coleoptera

Tenebrioxidae (Darkling Ground Beetles)

1. *Eleodes armata* (Armored Stink Beetle)

Coccinellidae (Ladybird Beetles)

1. *Hippodamia quinquesignata* (Five-spotted Ladybird)
2. Probably other species here also

Cerambycidae (Longhorn Beetles)

One or more species here

Chrysomelidae

1. *Diabrotica undecimpunctata* (Cucumber Beetle)
2. *Chrysochus cobaltinus* (Blue Milkweed Beetle)

Curculionidae (Weevils)

1. *Sitophilus granarius* (Granary Weevil)
2. *Scyphophoruc yuccae* (Yucca Weevil)

Scolytidae (Bark Beetles)

Probably some species are here

Order Strepsiptera (Stylops)

Possible but not noted

Order Hymenoptera (Ants, Wasps, Bees)

Tenthredinidae (Sawflies)

1. *Tenthredo sp.*

Braconidae

1. *Apanteles sp.* (Common Braconid)
2. *Aphidius sp.* (Aphid Parasites)

Ichneumonidae

1. *Option spp.* (Common Ichneumonids)

Cynipidae (Gall Wasps)

1. Probably one species found here

Chalcididae

1. *Brachymeria ovata* (Butterfly Chrysalis Chalcid)

Tiphiidae

1. *Myzinum sp.* (Tiger Tiphiids)
2. *Brachycistis sp.* (Nocturnal Tiphiids)

Mutillidae (Velvet Ants)

1. *Dasymutilla gloriosa* (Glorious Velvet Ant)
2. *Dasymutilla coccineohirta* (Red Velvet Ant)

Scoliidae

1. *Trielis alcione* (Kingfisher Wasp)

TABLE 18-5 (continued)

Order Hymenoptera (continued)

Formicidae

1. *Pogonomyrmex californicus* (Harvester Ant)
2. *Iridomyrmex humilis* (Argentine Ant)
3. *Formica sp.* (Red Mound Ant)
4. *Myrmecocystus sp.* (Honey Ant)

Pompilidae (Spider Wasps)

1. *Pepsis sp.* (Tarantula Hawk)

Vespidae (Paper Nest Wasps, Yellowjackets)

1. *Euodynerus annulatum* (Common Eumenid)
2. *Vespula sp.* (Yellowjackets)
3. *Polistes fuscatus* (Golden Paper Wasps)

Order Hymenoptera

Sphecidae (Digger Wasps)

1. *Sceliphron caementarium* (Mud Dauber)
2. *Sphex ichneumonia* (Golden Digger Wasp)
3. *Ammophila sp.* (Thread-waited Wasp)
4. *Sphecius convallis* (Western Cicada Killer)
5. *Bembix sp.* (Sand Wasp)
6. *Chlorion aerarium* (Green Cricket Hunter)

Andrenidae

1. *Andrena sp.* (Common Burrowing Bee)
2. *Andrena prunorum* (Orange-banded Andrena)

Megachilidae

1. *Anthidium sp.*
2. *Dianthidium*

Halictidae

1. *Nomia Melanderi* (Alkali Bee)
2. *Agapostemon sp.*

Anthophoridae

1. *Xylocopa sp.* (Carpenter Bee)

Apidae

1. *Bombus sp.* (Bumble Bee)
2. *Apis mellifera* (Honey Bee)

TABLE 18-6

FEDERAL AND STATE STATUS OF SENSITIVE SPECIES

Species Reported From Ridgecrest Area	State Status	Federal Status
Birds		
Cooper's Hawk	Species of Special Concern	None
Sharp-shinned hawk	Species of Special Concern	None
Golden Eagle	Species of Special Concern	None
Ferruginous Hawk	Species of Special Concern	Category 2
Northern harrier	Species of Special Concern	None
Black-shouldered kite	Special Animal	None
Merlin	Species of Special Concern	None
Prarie falcon	Species of Special Concern	None
Short-eared owl	Species of Special Concern	None
Long-eared owl	Species of Special Concern	None
Burrowing owl	Species of Special Concern	None
Vaux's swift	Species of Special Concern	None
Willow flycatcher	**State Endangered**	**None**
Vermillion flycatcher	Species of Special Concern	None
LeConte's thrasher	Species of Special Concern	None
Loggerhead shrike	Species of Special Concern	Category 2
Yellow warbler	Species of Special Concern	None
Yellow-breasted chat	Species of Special Concern	None
REPTILES		
Desert Tortoise	**State Threatened**	**Federal Threatened**
Chuckwalla	None	Category 2
MAMMALS		
Pallid bat	Species of Special Concern	None
Spotted bat	Species of Special Concern	Category 2
Townsend's big-eared bat	Species of Special Concern	Category 2
Mohave ground squirrel	**State Threatened**	**Category 2**
American badger	Species of Special Concern	None
Nelson's bighorn sheep	Special Animal	None

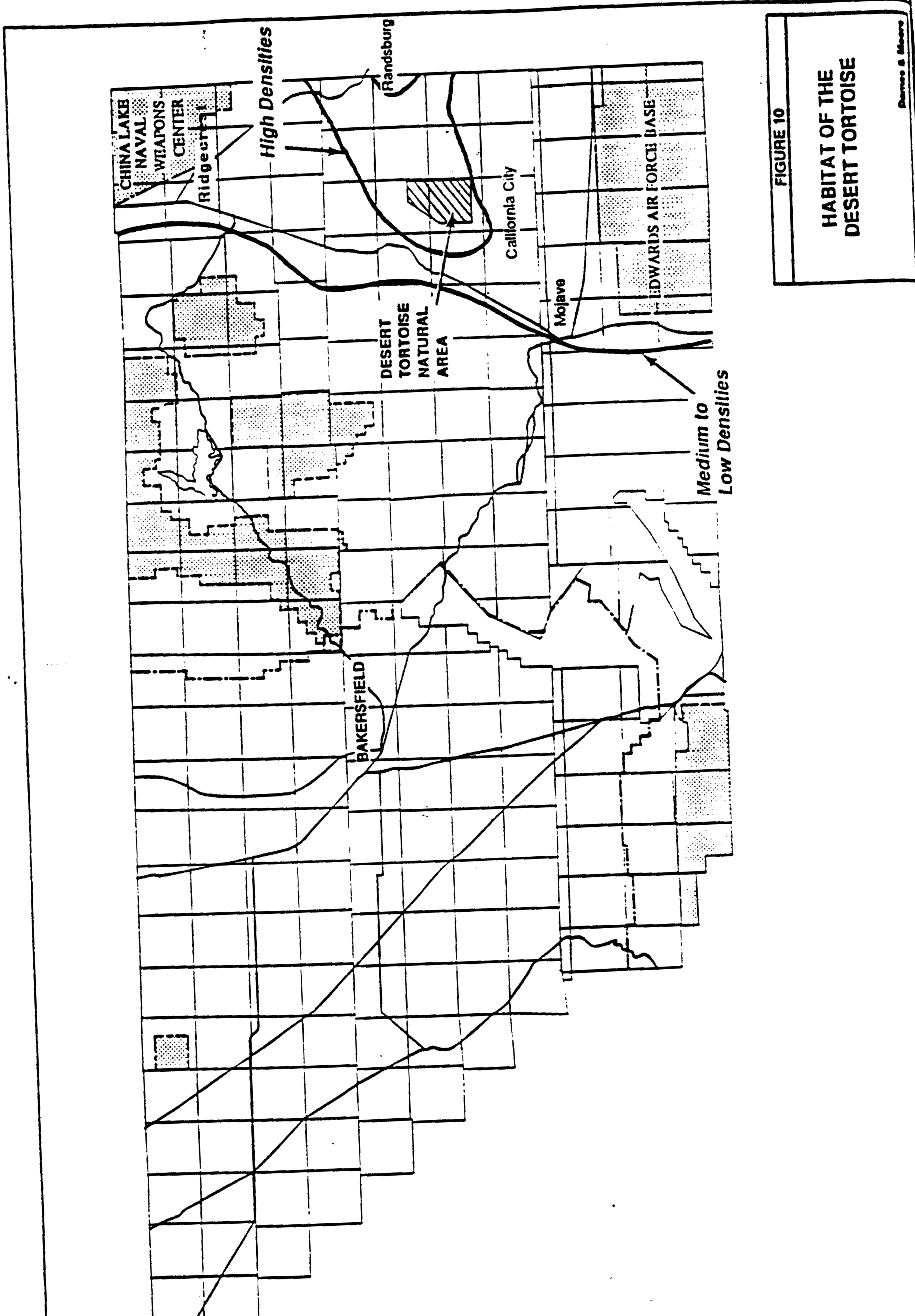
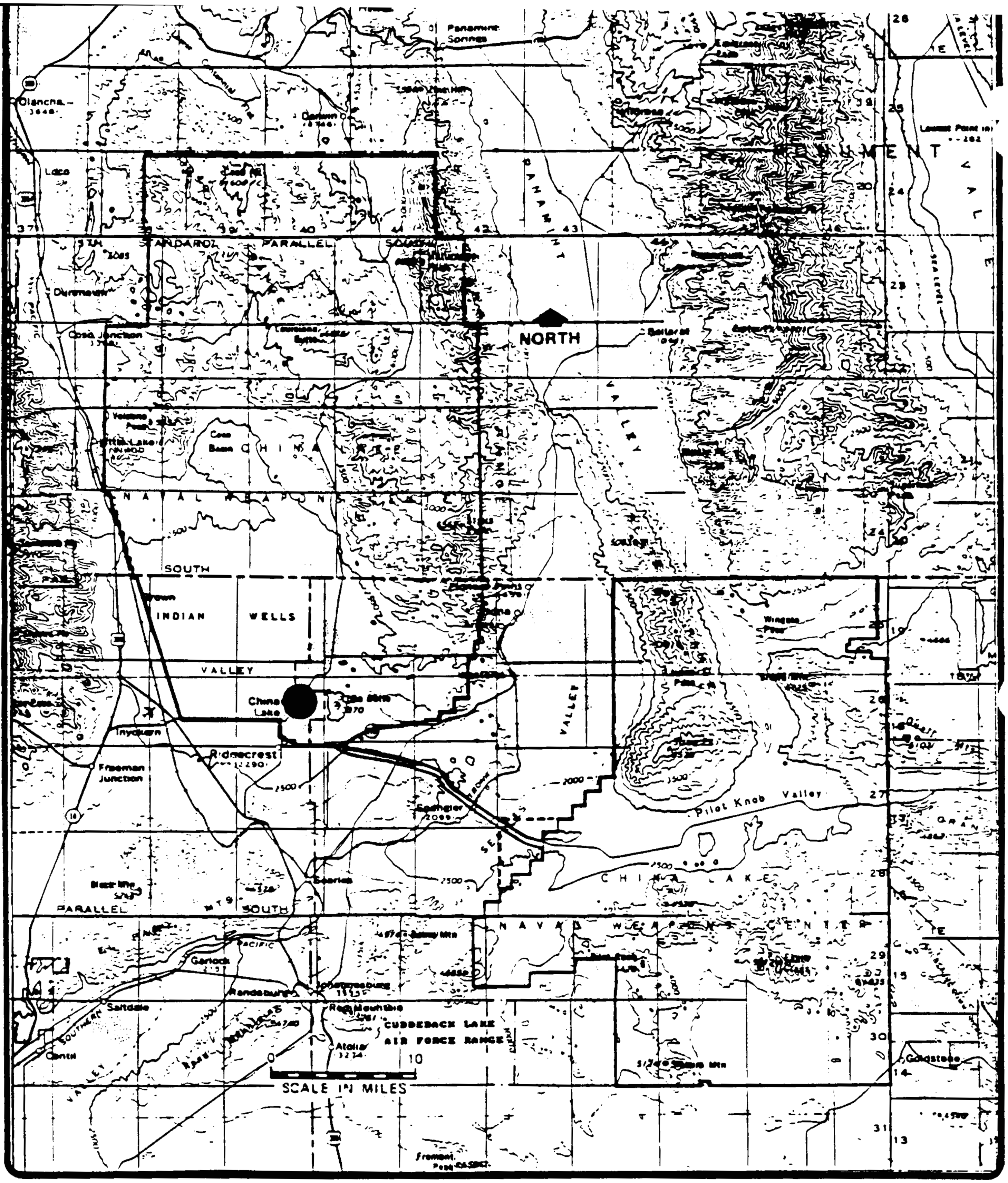


FIGURE 10
HABITAT OF THE DESERT TORTOISE
Dames & Moore
CHINA LAKE NAVAL WEAPONS CENTER
Ridgecrest
High Densities
Randsburg
California City
DESERT TORTOISE NATURAL AREA
Mojave
EDWARDS AIR FORCE BASE
Medium to Low Densities
BAKERSFIELD

FIGURE 18-1



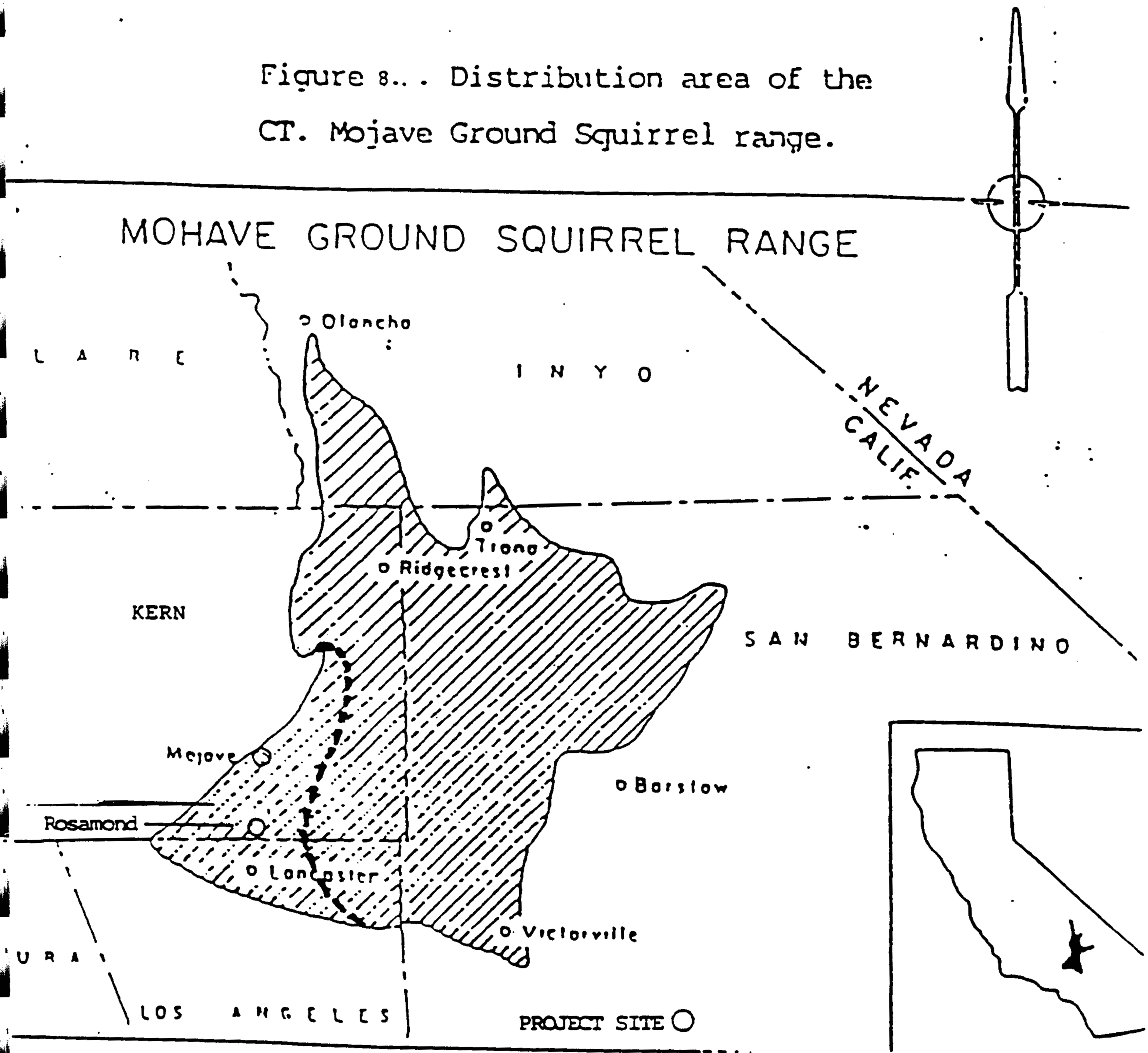
NAVAL WEAPONS CENTER CHINA LAKE MASTER PLAN

MOHAVE TUI CHUB HABITAT

FIGURE 5.4-3

FIGURE 18-2

Figure 8... Distribution area of the CT. Mojave Ground Squirrel range.



HABITAT REDUCTION IN RECENT KERN TRAPPING RECORDS.

FIGURE 18-3

SECTION III

SECTION III

Chapter 1.0

GROWTH INDUCING IMPACTS

The draft general Plan is specifically intended to provide for the orderly growth of the planning area, to ensure that infrastructure is sufficient to accommodate that growth and to define the ultimate limits of that growth. In the sense and to the extent that the General Plan defines, provides for and manages growth, then the entire plan may be regarded as a growth inducing document. The plan is intended to maintain and enhance the design and land uses of the traditional and existing community and to guide any future land uses in a manner that will maintain the goals and values of the community with consistency into the future. The premier "growth management" tool of a community is it's general plan.

Each of the four Alternatives of the general plan involve change and impacts on the environment. Alternatives 3 and 4, the population 100,000 and no project Alternatives respectively, involve the most impacts. Alternative 3 exceeds the existing infrastructure resources of the community and would require a redesign and displacement of the land uses in the existing community. The "no project" Alternative would allow the existing land uses of the community to develop without planning and would congest infrastructure. Similarly, Alternative 2, population 50,000 is less than the calculated entitlement that could result in a community of 62,000. Although growth inducing impacts are associated with Alternative 2, the General Plan preferred alternative, the impacts are planned for and contained.

The draft general plan will result in a buildout of portions of the planning area that are currently outside of the Sphere of Influence. These include properties to the south and west of the existing Sphere of Influence. The majority of the parcels proposed for urban development are located within the existing Sphere of Influence. Although the General Plan Update would necessitate that the sphere of influence be expanded to include those properties to the south and west, significant growth inducing impacts are not anticipated to occur because of:

1. the physical restraints on some of the properties (habitat and species restrictions),

2. ownership, a large portion of these lands are owned by the Bureau of Land Management for resource management and may contain sensitive biological and visual resources; and

3. with the exception of those lands directly adjacent to Highway 395 which will be developed with freeway interchanges and associated commercial land uses supporting the visitor service industry, the lands are proposed primarily for open space and very low density residential.

The draft General Plan proposes roadway improvements, but all of them are consistent with the existing adopted Circulation Plan of the City. Provision of the Bowman and Jack's Ranch Road Parkways to relieve traffic congestion would encourage and facilitate the development of properties in this area earlier than would be ordinarily expected but properties in the western part of the City will continue the established very low density development pattern. The construction of the freeway interchanges on Highway 395 will encourage growth and development in the south and west parts of the City, but this buildout is expected to occur, and therefore the circulation element is not expected to significantly induce additional growth in the area.

Buildout under the General Plan will necessitate the expansion of the City's wastewater treatment plant. Sewage flow currently exceeds 75% of plant capacity and the City has initiated a master sewer plan update to plan for future expansion of the plant consistent with State and Regional Water Quality Control Board Guidelines. The City has initiated planning for the expansion concurrent with completion of the General Plan Update. Expansion of the plant would accommodate only the growth that would occur under the General Plan and be consistent with population projections.

The draft General Plan would require that exploration and reclamation of new water sources and supplies be addressed. The growth supported by water sources would result in mitigable impacts on air quality, traffic, noise, urban services, biologic and scenic resources, and archeological resources.

The draft General Plan would create more employment opportunities in the planning area, which may result in pressure to develop additional housing in or around the planning area, or necessitate that employees live outside the planning area and commute to work. In either case, the additional employment opportunities may induce the development of additional housing. This demand and growth is anticipated and incorporated into the General Plan.

SECTION III

Chapter 2.0

SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

For environmental impact reports on public plans, ordinance, or policies, CEQA requires the EIR include a discussion of any irreversible environmental changes. This section addresses the use of nonrenewable resources, commitments of future generation to proposed uses, and irreversible damage from buildout under the General Plan update. Irretrievable commitments of resources should be evaluated to assure that current consumption is justified.

Construction of the uses proposed will involve substantial quantities of building materials and energy, many forms of which are non-renewable. The increase in water use would contribute to the existing overdraft of local aquifers. Consumption of building materials, energy and water are associated with any development, and these commitments of resources are not unique or unusual in Ridgecrest.

In a general sense, development in accordance with the update represents a long-term commitment to use of the planning area for a variety of urban uses outlined in the plan. Development of these uses would preclude returning the developed area to its previous open space or low intensity use state. In addition, the opportunity for intensification presented by the plan encourages a recycling of some existing urban uses which may affect the built environment.

The plan provides for an increase in population which would irretrievably increase the demand for finite energy resources such as petroleum and natural gas. It should be noted, however that increasingly efficient building designs and fixtures and automobile engines will temper demand.

The increased population and associated activity accommodated by the plan would cause an increase in traffic, resulting in the generation of additional air pollutants, potentially degrading air quality regionally, due to ozone levels, and locally, due to carbon monoxide at intersections. The increased traffic resulting from buildout of the general plan would result in a reduced LOS (Level of Service) capacity rating at many of the existing major intersections in the community, however, development of the circulation plan with alternative routing for commuters and other travelers will mitigate the impacts to acceptable levels.

Despite site-specific noise mitigation measures to shield sensitive uses from noise impact, ambient noise in the planning area would be perceptively increased.

Development in accordance with the proposed plan represents an irretrievable long term commitment to the conversion of open space lands to urban uses. The open space acreage contributes to the scenic quality of the planning area, and its urbanization will irreversibly change the character of this scenic resource.

Demand for water resources would irreversibly increase upon buildout of the plan. The conversion of lands to residential uses introduces water consumption for the first time to these areas. Infiltration characteristics of the aquifer basins may be irreversibly altered by diminishing penetrable surface area associated with urbanization.

The proposed plan creates the potential for irreversible environmental change of historical and archeological resources through an increased level of urban development. Though the precise impact is based on qualitative judgements, the potential to alter the intrinsic historic or archeological value of sites exists through development in the plan. This is especially true where historic resources are disturbed or covered by development activity. Though many of these impacts can be full or partially mitigated through special protection on a project by project basis, an irreversible impact to context may occur.

Irreversible change to biologic resources is minimal but likely if buildout occurs under the proposed plan. This is due to the existence of natural settings within the planning area which support the desert tortoise and other sensitive species. Although habitat loss and species will be mitigated in accordance with federal and state law and professional practice, there will be an irreversible affect.

SECTION III

Chapter 3.0

RELATIONSHIP BETWEEN LOCAL SHORT TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

For environmental impact reports on public plans, ordinances or policies, CEQA requires an EIR to include a discussion of cumulative and long-term effects of the project that adversely affect the state of the environment. Special attention is to be given to impacts that narrow the range of beneficial uses of the environment or pose long-term risks to health or safety. The reasons why the project is considered to be justified now, rather than reserving an option for future alternatives, should be explained.

Development in accordance with the draft General Plan (Alternative 2) would represent a long-term commitment of the planning area for urban uses to accommodate a population of 75,000. Advantages of urban use of the land include potentially greater short-term productivity from the land, increased social productivity for the surrounding community in terms of commercial convenience and increased employment opportunities, and an increase in tax revenues for the city. Urban use of the planning area would preclude returning the developed areas to their previous natural state or agricultural use. Development for one urban use in general precludes development for another use, except at substantially greater intensity, because of the cost of transforming or removing existing uses.

Buildout under Alternative 2 is not expected to result in the irreversible loss of significant habitat for the long-term beneficial use by any rare or endangered species. However, this loss substitutes short-term use of the land for urban land uses for the long-term biological productivity of the habitats.

Other long-term beneficial uses reduced or eliminated as a result of this alternative include the open space visual resources of the more rural southern areas.

Channelizing of natural drainages to improve flood control for the urban development may reduce but, potentially may improve the long-term benefits of these drainages as biological habitat, wildlife migration corridors, and scenic resources.

Potential alteration or destruction of recorded and unknown archaeologic and historic resources to accommodate urban development under Alternative 2 could eliminate the long-term benefits of preserving the resources for their research potential for gaining knowledge of early occupation of the area.

Buildout under the Draft Comprehensive Plan would result in long-term economic productivity due to a net increase in city operating revenues. The costs of providing capital improvements to accommodate the growth were not investigated within the scope of this EIR and may offset the increase in city operating revenues.

Significant incompatibilities arise between local short-term uses of the environment for urban development and long-term productivity of the land and its resources. The city decision makers may consider adoption of alternative 2 justified now, rather than reserving an option for future alternatives, because the plan allows the city to guide land use decisions to and beyond 2010 (beyond the year 1990 horizon of the adopted General Plan), based on land use designations selected through an intense and lengthy process of evaluation and compromise by reviewers and committees consisting of representatives from the business sector and civic and environmental groups.

Certainly the designation of long term land uses and the comprehensive statement of goals and policies to guide the community into the future constitute good reasons why the project is considered to be justified. The plan enables the community to define what is best about itself and to establish goals and policies that preserve intrinsic community values. Alternative 2 provides a planning structure that will enable the City to accommodate growth, transformation and development on terms that it defines and according to a balance that it creates.

SECTION III

Chapter 4.0

IMPACTS FOUND NOT TO BE SIGNIFICANT

An initial study for a potential maximum population of 75,000 (Alternative 2) in the planning area was prepared by the city in 1991. This initial study identified only those issues determined to be potentially significant, to be addressed in the EIR. Table 1-1 identifies those impacts that were determined to be less than significant. These impacts are further addressed under the applicable issue area.

SECTION III

Chapter 5.0

ENVIRONMENTALLY SUPERIOR ALTERNATIVE

Section 15126(d) of the State CEQA Guidelines requires that an EIR describe a range of reasonable alternatives to the project and evaluate the comparative merits of the alternatives. The analysis contained in this EIR provides a discussion of the impacts that would occur from buildout under three development alternatives in addition to a "no project" alternative. The assessment of impacts has been conducted for all of these alternatives. The Guidelines also require that the environmentally superior alternative be identified. In addition to the three alternatives assessed previously in this report, "No Development" and "No Project" alternatives can be considered development options. The discussion below assesses a "No Development" and a "No Project" alternative, and identifies the environmentally superior alternative from among alternatives considered in this report.

5.1 NO DEVELOPMENT (EXISTING CONDITIONS)

A no development alternative has been considered by some courts to be an appropriate "no project" alternative under CEQA for comparison purposes. The no development alternative includes existing land uses only, without allowing any additional development to take place in the planning area, through the year 2010. The "No Development" Alternative is quite different and distinct from the "No Project Alternative, alternative 4.

It should be noted that under this alternative, the current population may actually increase even though no new dwelling units would be added to the existing housing stock, because more individuals would occupy each unit. With new housing curtailed, existing housing would be at a premium. The cost of existing housing would escalate to the point that more individuals (either related or unrelated) would need to combine incomes in order to afford shelter, thereby increasing the number of people residing in each unit.

Assuming that the existing population and economy could remain stable (and assuming that "stability" is possible), this alternative may be considered environmentally superior to the alternatives addressed in Section II, Chapters 1 through 18 and the "No Project" alternative described below because it would pose no additional demands on local infrastructure, facilities, services, and water resources. This alternative would also result in the least disruption of the natural environment in the planning area, as no new development would be permitted, and result in the least exposure of people and property to natural hazards.

This alternative would be difficult to implement. This alternative would permit no urban use of land presently within a city sphere of influence for which urban development has been assumed to be the ultimate use for many years. Further, this alternative could also prohibit the completion of development projects that have already received City approval. Prohibition of the construction of approved projects could be likely to result in costly litigation against the City. Implementation of this alternative would require substantial acreage of land currently proposed in the City's existing General Plan and zoning ordinance to be redesignated and rezoned for open space or other low intensity uses, or to be condemned to prevent development at high cost to the City. This alternative could result in the conversion of vacant property previously planned for urban-development to very low density/open space/agricultural uses, if no greater economic gain can be made from the property. As a result, the amount of land in open space and agricultural designations within the planning area could increase under this scenario.

5.2 NO PROJECT (DEVELOPMENT UNDER THE 1980 GENERAL PLAN)

This alternative, Alternative 4, would result in no changes to the existing land uses or policies of the adopted General Plan. The total area proposed for urban uses would be less than proposed under the draft General Plan (Alternative 2). Potential growth-inducing impacts identified for buildout under the draft Plan would be eliminated and areas currently designated for open space & agricultural uses would be retained, thereby reducing impacts on open space and agricultural land.

Buildout of the adopted General Plan, would result in a total population of approximately 62,000 after the year 2010, approximately 13,000 less than the buildout to occur after the year 2010 under the draft General Plan. This lower population could result in less impacts on public services, available water supply, air quality, traffic and noise than those resulting from development under the draft General Plan. However, the adopted Plan does not recognize or plan for additional buildout that will occur after the year 1995, and does not provide sufficient transportation design, infrastructure facilities, housing units to meet the projected need of the future planning area.

The impacts of building out the existing land uses without changes to the circulation system and sewer treatment facilities, and without implementing the Master Storm Drainage Plan could result in traffic congestion, degradation of air quality, sanitary health problems and exposure of people and property to flooding. These items could be significant environmental impacts. Buildout under the draft General Plan would also not meet the need for affordable units that would be created by the resulting population. The draft Plan is anticipated to provide more affordable units in absolute numbers than the adopted Plan, merely because more units would be built, but the demand for affordable units could be greater.

5.3 ENVIRONMENTALLY SUPERIOR ALTERNATIVE

The "no development" alternative, alternative 4, is considered to be the environmentally superior alternative in general, because it represents no change to the existing conditions, and of the four (4) alternatives, would result in the least impact on public services, available water supplies, and the natural environment. However, this alternative would necessitate that a moratorium be immediately enacted to prohibit further residential and nonresidential development. As such, this alternative would be difficult to implement and would appear to be infeasible.

Alternative 1 (approximately 50,000 population after the year 2010) would appear to be environmentally superior to the remaining alternatives. However, buildout under this scenario includes projects which have received approved land use designations under the existing General Plan and Zoning Ordinance, and which will require approval by the City under existing land use policies before they can be constructed. The land use designations that have been applied to properties are regarded by the owners as "property and entitlement" and removing, altering or amending these entitlements can involve property rights defenses. As such, buildout under this alternative would occur under the existing General Plan, and whether or not the General Plan Update is adopted. This existing plan does not address any additional development after 1995, although there are land use entitlements in place (zoning designations) that could permit significant development to occur into the next century. Further, similar to the "no development" alternative, implementation of this buildout limitation could require that a moratorium be enacted following the construction of the pending development to guide and limit new buildout through the year 2010.

Alternative 2 (75,000 population) is considered to be an environmentally superior alternative to the remaining alternative. This alternative would allow additional buildout beyond what is already constructed ("no development") or (Alternative 1) to the year 2010. This alternative would result in substantially less impact on the natural environment and public service systems than buildout under Alternative 3, the population 100,000 alternative. Buildout under Alternative 2 would meet the objectives of the General Plan Update to provide for logical and planned growth within the planning area, to insure that adequate public services are available to serve City growth and to conserve the City's remaining natural resources. It should be noted that this alternative would result in and relies on a significant reduction in the City's existing and historical rate of growth between now and the year 2010 in that the City&'s growth rate would be more than halved to approximately 3% per annum, a low to moderate growth rate. This alternative, which would mature about the year 2025, converts more open space and agricultural land to urban uses but provides for master planning of the circulation system, sewer and storm drainage systems and mitigates and minimizes impacts on traffic, air quality, sanitary sewer, and exposure of people and property to flooding. Based on the analysis in the EIR alternatives 1 and 2 appear to be the preferred alternatives, with alternative 2 the most feasible in that the planned alternative plans for a level of balanced development and land uses that can be supported without involving "takings." The planned land uses appear to be sustainable and the infrastructure can be developed in stages to accommodate growth without significant impact to the community. It should be noted that the population scenarios are characterized as outside parameters, and that population may never reach the levels discussed in the plan text.

Alternative 3, the population 100,000 alternative, builds the community beyond the ability of existing and proposed infrastructure to sustain it. It would involve intense impacts on existing and proposed streets, and mitigation would require a significant redesign of internal land uses, circulation systems, and of the sewer collection and treatment and storm drainage systems. This redesign could involve the displacement of people and the disruption of existing patterns of development. Without the redesign this alternative would result in traffic congestion, air pollution, impacts on sewer and storm drainage, the loss of open space and scenic lands and impacts on support services and infrastructure.

APPENDICES

APPENDIX A

APPENDIX A

GLOSSARY

Closed Basin	A district draining to some depression or lake within its area, from which water escapes only by evaporation; a basin not connected to a larger body of water
diurnal	opening in the daytime and closing at night, said of flowers
edaphic	pertaining to the chemical and physical characteristics of the soil or water environment, without reference to climate
halophytes	plants that can grow in salty or alkaline soil
Hydraulic conductivity	capacity of a porous medium to transmit water; also known as the coefficient of permeability
Indirect Source	any facility, building, structure or installation, or combination thereof, which generates or attracts mobile source activity that results in emissions of any pollutant for which there is a state ambient air quality standard. (Includes single family developments)
RARCT	an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source
seiche	a periodic oscillation of a body of water whose period is determined by the resonant characteristics of the containing basin as controlled by its physical dimensions
splay	to spread out or apart; expand
sufficiently active	A fault is deemed sufficiently active if there is evidence of Holocene (the last 10,000-12,000 years) surface displacement along one or more of its segments or branches. Holocene surface displacement may be directly

	observable or inferred; it need not be present everywhere along a fault to qualify for zoning.
take	"to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" with regard to federally listed, endangered species of wildlife [Section 3(19) of the Act. Regulations have broadened this definition to include federally listed, threatened species of wildlife
transmissivity	the average of all horizontal hydraulic conductivities at various depths multiplied by the vertical saturated thickness of the aquifer; is used for calculating ground-water flow rates and recharge capacities
TCM	Transportation Control Measure, are strategies that reduce vehicle trips, vehicle use. vehicle miles travelled, vehicle idling or traffic congestion for the purpose of reducing vehicle emissions

APPENDIX B

APPENDIX B

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APPENDIX C

APPENDIX C

LIST OF PREPARERS

DOCUMENT PREPARATION AND PRODUCTION

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Ridgecrest, ca 93555

(619) 371-3721

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Air Quality
- Tom Paxson

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- Carol Beck
- Joe DiCarlo

APPENDIX D

APPENDIX E

RESOLUTION 94-07

A RESOLUTION OF THE RIDGECREST CITY COUNCIL ADOPTING AND CERTIFYING THE ENVIRONMENTAL IMPACT REPORT FOR THE CITY OF RIDGECREST GENERAL PLAN

THE CITY COUNCIL OF THE CITY OF RIDGECREST RESOLVES as follows:

FINDINGS

WHEREAS, at direction of the City Council the Planning Commission and staff have prepared an update of the City's General Plan pursuant to California Government Code 65300 et seq.; and,

WHEREAS, the draft General Plan is a project as defined by CEQA and the City of Ridgecrest Environmental Guidelines which require that the City Council and Planning Commission be aware of the environmental consequences of project related legislative and discretionary decisions; and,

WHEREAS, the Planning Commission, Planning and Zoning Committee, and city staff have prepared an environmental impact report (EIR) for the General Plan pursuant to the California Public Resources Code and the California Environmental Quality Act (CEQA); and,

WHEREAS, the draft EIR, in accordance with law, code and policy, was circulated to public agencies, made available to the public and was reviewed by the Planning Commission at public hearings in order to ensure public participation; and,

WHEREAS, the Planning Commission finds it has completed its work on the Environmental Document and have recommended it to the City Council for certification with the adoption of Planning Commission Resolution 94-08; and,

WHEREAS, the City Council of the City of Ridgecrest has held a public hearing to take comments in public hearing on the proposed project;

NOW, THEREFORE, BE IT RESOLVED and stated by the City Council of the City of Ridgecrest that it has publicly considered and reviewed the Final Environmental Impact Report prepared for the General Plan update, and adopt and certify it as an adequate document pursuant to CEQA and the City Environmental Guidelines.

APPROVED AND ADOPTED THIS 2nd day of March 1994, by the following vote:

Ayes: Mayor Corlett, Council Members Auld, Bitney, Bryan, and Parode.

Noes: None.

Abstain: None.

Absent: None.

Kevin S. Corlett, Mayor

ATTEST:

Pamela Snyder, City Clerk

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY PETE WILSON, *Governor*

DEPARTMENT OF TRANSPORTATION
SOUTH MAIN STREET
BISHOP, CA 93514

(619) 872-0689

Received 9/28/93 S.W.

September 27, 1993

File: Ker-178-Var

City of Ridgecrest
Community Development Department
100 West California Ave.
Ridgecrest, CA 93555

PROJECT TITLE: City of Ridgecrest General Plan Update
SCH #92012011

We have reviewed the above referenced document and have the following comment to offer: page II, 12-16, paragraph F, truck routes; fails to mention that RTE 178 is included in the SHELL (Subsystem of Highways for the Movement of Extra Legal Permit Loads) system and these trucks are allowed only on Inyokern Rd. to and from the NAWS.

ROBERT J. RUHNKE, Chief
Transportation Planning
Branch B

RJR:pd
cc: SCH
Sara Stremple

City of Ridgecrest

Community & Economic Development Department

City of Ridgecrest General Plan Environmental Impact Report
Response to Comments
120793

Response to Comments: California Dept of Transportation District 6

Thank you for taking the time to review the City of Ridgecrest General Plan Draft Environmental Impact Report. The District's participation in preparing information for, & in formulating the DEIR is recognized as being critical to it's success and accuracy as an "adequate document." The comments received by the City and the responses to these comments will be incorporated into the FEIR in accordance with CEQA Guidelines 15087, 15088 & 15089.

Comment Acknowledged. The City appreciates the assistance rendered by the CalTRans in preparing the DEIR and in providing the information that the DEIR contains. Text of Chapter II-12 amended to include discussion of SHELL System.

102693
-41.

STATE OF CALIFORNIA

PETE WILSON, *Governor*

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
'AHONTAN REGION
CTORVILLE BRANCH OFFICE
15428 CIVIC DRIVE, SUITE 100
VICTORVILLE, CA 92392-2359
(619) 241-6583
FAX No. (619) 241-7308

Michael Swigart
City of Ridgecrest
100 West California Street
Ridgecrest, CA 93555

October 21, 1993

Dear Mr. Swigart:

COMMENTS TO THE CITY OF RIDGECREST DRAFT GENERAL PLAN

Regional Board staff has received the Draft Environmental Impact Report for the City of Ridgecrest Draft General Plan. Upon review, staff has the following comments:

1. The estimated life of the Ridgecrest Landfill needs to take into account the new Subtitle D regulations. Plans for the City's waste after the Ridgecrest landfill reaches capacity needs to be better addressed.

2. With the safe yield of ground water being exceeded every year, measures being taken or planned for the reduction of the amount of water used by the City of Ridgecrest should be indicated. The measures which will be taken to maintain the current surface permeability for ground water recharge also need to be addressed.

3. The Draft General Plan often refers to the City of Ridgecrest Master Sewer Plan. The current status and the expected date of adoption of the Master Sewer Plan needs to be provided.

4. An earlier review of the Draft Master Sewer Plan, indicated a treatment plant design capacity of 9.0 mgd. Under some of the projected growth scenarios this treatment plant design capacity will be exceeded. The General Plan needs to better address what is planned in terms of treatment plant expansion under these scenarios.

5. The expected sewage flows on Page I-3-8 are listed as: Alternative 1 = 6.0 mgd, Alternative 2 = 9.0 mgd, Alternative 3 = 12.0 mgd. On Page II-17-13 the expected sewage flows are listed as: Alternative I = 5.0 mgd, Alternative 2 = 7.5 mgd, Alternative 3 = 10 mgd. The difference between these values needs to be explained.

If you have any questions regarding these comments, please call me at (619) 241-7391.

Sincerely,

Tina S. Hutchinson

Tina S. Hutchinson
Water Resource Control Engineer

lc-b/swigart.ltr

Draft CITY OF RIDGECREST

Community & Economic Development Department

City of Ridgecrest General Plan Environmental Impact Report
Response to Comments
120793

Response to Comments: California Regional Water Quality Control Board, Lahontan Region

Thank you for taking the time to review the City of Ridgecrest General Plan Draft Environmental Impact Report. Lahontan's participation in preparing information for, and in formulating the DEIR is recognized as being critical to it's success and accuracy as an "adequate document." The comments received by the City and the responses to these comments will be incorporated into the FEIR in accordance with CEQA Guidelines 15087, 15088 & 15089.

These numbered responses correlate to the numbered comments received.

1. The Ridgecrest Landfill operations is the sole responsibility of the Kern County Public Works Department. The City, in conjunction with the Naval Base and Kern County, has developed and adopted a Source Reduction and Recycling Element to reduce the amount of waste entering the landfill. The E.I.R. developed for the SRRE has been incorporated by reference into the Draft E.I.R. for the Ridgecrest General Plan update. The SRRE E.I.R. addresses landfill capacity. Copies of this document are available at City Hall. Kern County is currently developing an E.I.R. for continued permitting of the Ridgecrest Landfill. Subtitle D regulations have been referred to in that document. Please refer to the Kern County Public Works department regarding the E.I.R. for the Ridgecrest Landfill.

2. The City of Ridgecrest is not the sole agency responsible for the management of water in the Indian Wells Valley. The City, in cooperation with the Indian Wells Valley Water District (IWVWD), has taken steps to reduce the use of water. The IWVWD's records indicate

that many of the conservation measures taken over the past several years have "borne fruit" by indicating that water use per capita has been reduced. The City supports many water conservation programs and requires all new development in the City to deliver a "will serve" letter from the IWVWD. Section II-16.3.1 and II-16.3.2 in the FEIR address the mitigation and conservation measures that the City is willing to implement or assist the IWVWD in their implementation.

Presently, all reports regarding recharge to the Indian Wells Valley groundwater basin, refer to the recharge zone as being at the base of the Sierra and El Paso Mountains. As such any overcovering by structures in the City limits does not affect this area of recharge. The City does within its boundaries by zoning, limits the percentage of lands that may be overcovered by a structure dependent upon the zone. The City is continually reviewing its methods of maintaining the integrity of the water basin as well as being a participating member of the Ad Hoc Water Management Advisory Group, that is addressing the wise use of the basins's groundwater.

3. The City of Ridgecrest anticipates that the environmental review to determine if a EIR/EIS is required will be completed by early 1994. Based upon that determination, a final timeline for adoption and implementation of the Master Sewer Plan will be developed. The City is aware that its future is incumbent upon this plan. LRWQCB will be notified and kept apprised of the milestones of this project.

4. The City recognizes that future planning will need to address this issue, but is dependent upon the final development of the Master Sewer Plan. The direction to take on those issues will be addressed in that plan.

5. Acknowledged.

110293
-M.

THE
DESERT TORTOISE COUNCIL

P.O. Box 1738
47-900 Portola Avenue
Palm Desert, CA 92261

28 October 1993

Ms. Gina Marie Robinson, City Planner
City of Ridgecrest
Community Development Department
100 W. California Avenue
Ridgecrest, California 93555

RE: Comments to the Draft EIR for the City of Ridgecrest Draft General Plan, 1991 - 2010

Dear Ms. Robinson:

The Desert Tortoise Council appreciates this opportunity to review the Draft General Plan, and has the following concerns regarding the Plan:

1) Inappropriate mention of desert kit fox as a special-status species.
2) Failure to identify impacts to the desert tortoise, which will be impacted in areas where they occur.
3) Inappropriate reliance on the Western Mojave Coordinated Management Plan, which has not yet been drafted, reviewed by the public, or implemented.
4) Inappropriate statement that "lands held under private ownership should not be acquired for mitigation", and relying on the federal government, instead, to protect species on federal lands.
5) Failure to identify current, interim measures to protect tortoises (and Mohave ground squirrels) prior to the implementation of the West Mojave Coordinated Management Plan.
6) Failure to delineate meaningful open-space and conservation areas, which are two of the seven mandatory elements of any general plan. The draft plan also does not identify management prescriptions regulating development and other human activities in open-space and conservation areas.
7) Failure to include 24 reptiles, birds, and mammals as state and federally designated sensitive species in the Plan's discussion of impacts and mitigation measures.

For your convenience, we have first identified the portion of the Plan by section and page number, and where appropriate, restated the pertinent portions of the Plan. These comments have been reviewed by Marc Graff, Co-Chairperson, and several Board Members, and therefore represent the concerns of the Desert Tortoise Council, rather than my own opinions.

Matrix 1-1, page I-1-11: Impact #6 states that "Development will negatively affect the habitat of the desert tortoise, and possibly the desert kit fox." Desert kit fox should not be included in this matrix, as it is not considered a special-status species by either the state or federal governments. A few years ago it was considered a California Species of Special Concern, but as of December, 1992 (California Department of Fish and Game, Natural Diversity Data Base, Special Animals) it has no rare or endangered status. In California, the only kit fox having a special status is San Joaquin kit fox (*Vulpes macrotis mutica*), in the San Joaquin Valley.

Matrix 1-1, page I-1-11 and 18.5.2, page II-18-11: The matrix states that "Development will negatively affect the habitat of the desert tortoise..." yet section 18.5.2 states "No direct impacts on rare and endangered plants or animals are expected due to any of the four alternatives." The Council believes that there would be direct impacts to desert tortoises wherever tortoises occur. We know that tortoises occur throughout the areas south of the City Limits, and likely within the City Limits between Zones 4 and 5, including the two square miles of BLM land to the south (see Figure 8-1.1 of the draft EIR).

Even if direct impacts are mitigated by the Western Mojave Coordinated Management Plan, the mitigation does not discount the impact. The statement cited above (i.e., "No direct impacts on rare and endangered plants or animals are expected due to any of the four alternatives") is not correct. As with the Mohave tui chub on page II-18-11, there should be a sentence indicating that direct impacts will affect tortoises where they occur. Also, the draft plan should state here that impacts will continue to Mohave ground squirrel whether it remains listed or is delisted.

18.5.2, page II-18-11: The statement, "As such, lands held under private ownership should not be acquired for mitigation..." is just not true. It is true that many privately owned lands are not suitable for the conservation of tortoises, but there are many private parcels (e.g., around California City and the Desert Tortoise Natural Area) that would serve well for the conservation of tortoises. The Santa Fe Pacific Railroad, for example, has about 300 square miles of land - much of it within prime tortoise habitat and within CDFG-designated Crucial Tortoise Habitat - that could be effectively used to mitigate impacts to tortoises. Also, there is no guarantee that tortoises will be protected on federal lands. The Desert Tortoise Preserve Committee and The Nature Conservancy are responsible for acquiring and maintaining lands, including private lands, for the benefit of tortoises and other animals resident on those lands.

18.5.3, page II-18-11: The statement, "The City as a participant in the BLM Western Mojave Coordinated Management Plan fully intends to mitigate for the loss of any habitat for the species addressed in this plan [desert tortoise, Mohave ground squirrel, etc.]." does not provide current protection for tortoises. Our best understanding is that the Coordinated Management Plan will not likely be implemented within the next several years, maybe not until 1995 or 1996. The prior acceptance of the Coordinated Management Plan to implement the City's mitigation of impacts and conservation of tortoises relies on the BLM's plan to protect tortoises. The Coordinated Management Plan is a herculean effort, involving numerous towns, cities, counties, and other jurisdictional entities. Although the Desert Tortoise Council would fully support any plan that protects tortoises, we would not presume that any undrafted plan will effectively conserve tortoise habitat. Until the Coordinated Management Plan has been drafted, reviewed by the public, including the Desert Tortoise Council, and is implemented, no one should assume that the plan will protect tortoises. The Final General Plan should emphasize measures to protect tortoises and not rely on the undrafted Coordinated Management Plan to do so.

Section 18.4 of the draft plan provides a good explanation of current state and federal protection of tortoises. The Council believes that the City should continue to enforce these policies, and not shift the responsibility to the Western Mojave Coordinated Management Plan, which may never be implemented or effectively protect tortoises. The General Plan should be a stand alone document; the City should not shift its responsibilities onto other plans that may or may nor protect tortoises.

Section 18.6 states: "Upon the issuance of a section 2081 permit (CDFG) and/or a section 10(a) permit (USFWS), the City will notify the public of the procedure to comply with the conditions of approval for the permit.", meaning that these permits would be issued with the implementation of the Coordinated Management Plan. Again, there is no guarantee that the Coordinated Plan will ever be implemented, or in the interim prior to the Plan's implementation, that tortoises will be protected. The City should have alternatives in section 18.6 that will protect tortoises if the Coordinated Plan fails to be implemented. The City should continue to require that tortoise surveys be performed, that the results of those surveys be provided to the CDFG and USFWS, and that the CDFG and USFWS be contacted to discuss impacts and conservation efforts.

Open-space and conservation elements of the general plan Open-space is "any parcel or area of land or water which is essentially unimproved and devoted to an open-space use [including] open-space used for the preservation of natural resources including, but not limited to, areas required for the preservation of plant and animal life, including habitat for fish and wildlife species; areas required for ecologic and other scientific study purposes..." Furthermore, "the open-space plan shall contain an action program consisting of specific programs which the legislative body intends to pursue in implementing its open-space plan: no building permit may be issued, no subdivision map approved, and no open-space zoning ordinance adopted, unless the proposed construction, subdivision, or ordinance is consistent with the local open space plan" (Governor's Office of Planning and Research 1987).

The Executive Summary states that open-space and conservation elements are two of the seven mandatory elements of a general plan, however neither of these elements is discussed in this draft plan. The draft plan offers no opportunity to review the open-space and conservation elements, which are presumably in the original, 1981 Plan, but missing from the draft plan.

Open-space elements are shown on Figure 8-1.1 of the draft plan. These "open-space" areas include golf courses, Naval Weapons Center parks, several schools, and one college. Do any of these areas meet the criteria of open-space as defined by the Governor's Office of Planning and Research? Even if they did, open-space areas should be linked by natural travel corridors, and be sufficiently large and unaffected by human recreation and development to support animals and plants that would be benefited by open-space designation linked by travel corridors. Conceptual travel corridors should be delineated in the draft plan. Meaningful, functioning open-space areas should be connected in at least two places by travel corridors to other open-space areas.

If the City adopts alternatives that result in maximum build-out capacity and the annexation of adjacent areas, we strongly recommend that open space areas be delineated to the south in Zones 4 and 5 (Figure 8-1.1). The narrow block of land between South China Lake Boulevard and BLM lands would serve as appropriate open-space areas, as would the two square miles of BLM land to the south. If annexation occurs to the southwest, it would impact many tortoises, and those areas should also be designated as open-space. As drafted, the City's Draft General Plan does not have meaningful open-space or conservation elements that would benefit wildlife, particularly desert tortoises. If these elements were included in the 1981 General Plan, they should be reiterated in the current draft where they can be reviewed by people who do not have a copy of the 1981 document.

Miscellaneous comments:

Page II-18-2: The common name for *Hymenoclea salsola* is "cheesebush", not "goldenhead." The scientific species name for desert tortoise, "*agassizi*", is misspelled, it should be *agassizii*, with two "ii's".

Table 18-3: Page II-18-7 states: "Other sensitive species have been catalogued on the lands comprising the NAWS, however, these species have not been identified within the planning area identified in this document. (The tables found at the end of this chapter provide a list of bird, mammal, reptile, and plant species identified in the Indian Wells Valley)." These sentences are contradictory: the tables at the end of the chapter list "Birds of the Ridgecrest Area", many of which are considered sensitive by state and federal resource agencies. The following animals, which are listed in Table 18-3, are considered by state and/or federal resource agencies as "sensitive", likely occur within the planning area, and may be directly or indirectly impacted by expansion within and adjacent to the City Limits. We have provided status designations for each species as of December, 1992 (California Department of Fish and Game, Natural Diversity Data Base, Special Animals). Those species that are listed by the state and/or federal governments as threatened or endangered are highlighted.

Table 1. Sensitive species given in Table 18-3 of the Draft General Plan that have a state and/or federal protection status and may be impacted by development in the City of Ridgecrest.

Species reported from Ridgecrest Area	State Status	Federal Status
Birds		
Cooper's hawk	Species of Special Concern	None
Sharp-shinned hawk	Species of Special Concern	None
Golden eagle	Species of Special Concern	None
Ferruginous hawk	Species of Special Concern	Category 2
Northern harrier	Species of Special Concern	None
Black-shouldered kite	Special Animal	None
Merlin	Species of Special Concern	None
Prairie flacon	Species of Special Concern	None
Short-eared owl	Species of Special Concern	None
Long-eared owl	Species of Special Concern	None
Burrowing owl	Species of Special Concern	None
Vaux's swift	Species of Special Concern	None
Willow flycatcher	**State Endangered**	**None**
Vermilion flycatcher	Species of Special Concern	None
LeConte's thrasher	Species of Special Concern	None
Loggerhead shrike	Species of Special Concern	Category 2
Yellow warbler	Species of Special Concern	None
Yellow-breasted chat	Species of Special Concern	None
Reptiles		
Desert tortoise	**State Threatened**	**Federally Threatened**
Chuckwalla	None	Category 2
Mammals		
Pallid bat	Species of Special Concern	None
Spotted bat	Species of Special Concern	Category 2
Townsend's big-eared bat	Species of Special Concern	Category 2
Mohave ground squirrel	**State Threatened**	**Category 2**
American badger	Species of Special Concern	None
Nelson's bighorn sheep	Special Animal	None

Any biological surveys in the Ridgecrest area should consider impacts to these or other sensitive animals observed. The Final General Plan should make it clear that these animals have been reported from the Ridgecrest area, and that they may be impacted, depending on the size, location, and type of proposed development. Most of the birds, both reptiles, and most of the bats would benefit from "real" designations of open-space and conservation areas within and adjacent to the City. The failure to designate realistic open-space areas would result in cumulative significant impacts to sensitive species that live and forage in these areas.

The Council understands that the Ridgecrest Planning Department is severely understaffed, and relied on the best available knowledge to draft the EIR. We offer the comments in this letter as additional insights into the biological issues that should be included in the Final EIR and General Plan. We are not being antagonistic, and sincerely hope that we are helping your staff by providing these comments. Failure to implement realistic open-space and conservation elements in the Final General Plan may prove very costly, particularly if the plan does not meet the requirements of the California Environmental Quality Act and the guidelines given by the Governor's Office of Planning and Research.

We sincerely wish you the best of luck with your monumental task, and hope that our comments are useful.

Sincerely,

Edward L. LaRue Jr.

Desert Tortoise Council
Edward L. LaRue, Jr.
Board Member

CITY OF RIDGECREST

Community & Economic Development Department

City of Ridgecrest General Plan Environmental Impact Report
Response to Comments
120793

Response to Comments: Desert Tortoise Council (DTC)

Thank you for taking the time to review the City of Ridgecrest General Plan Draft Environmental Impact Report. The comments received by the City and the responses to these comments will be incorporated into the FEIR in accordance with CEQA Guidelines 15087, 15088 & 15089.

These numbered responses correlate to the numbered comments received.

1. Acknowledged

2. Surveys of lands within the City and its sphere of influence have typically shown that human and domestic animals have impacted them so as to no longer be suitable habitat for the Desert Tortoise. The City has consistency required mitigation for loss of habitat. It is the City's opinion, that when an impact is mitigatible, it is no longer significant.

3. The Bureau of Land Management is to be commended for taking the initiative in the coordination and drafting of the Western Mohave Coordinated Management Plan. The BLM plan will rely heavily on the USF&WS Recovery Plan for the Desert Tortoise, which after some three years remains unadopted and unimplemented as well. As the Desert Tortoise is a species with a much larger habitat than the City of Ridgecrest, the City believes that it's participation in and support of this effort is the first step towards the recovery of this species.

4. The City strongly supports alternatives to land mitigation and is simply stating an opinion. The City has and will continue to mitigate to the extent required by law.

5. The City presently holds a permit from the CDF&G for the mitigation of any loss of habitat for the Mohave Ground Squirrel and has complied with it since its issuance. The section that deals with mitigation measures shall be clarified and strengthened appropriately.

6. The DTC is referred to the City's Draft General Plan Update (1991-2010), where the elements described in your letter are contained. The document that the DTC reviewed was the Draft EIR for the General Plan Draft Update, which contained a summary, which is just that and is not intentended to be a comprehensive review of the City's planning programs. If the DTC wishes to review the Draft General Plan Update it is available at Ridgecrest City Hall and the Kern County Library (131 E. Las Flores). The Draft General Plan addresses the Desert Tortoise Council's concerns.

7. Acknowledged

112493 -M.

INDIAN WELLS VALLEY WATER DISTRICT

November 23, 1993

City of Ridgecrest
Community Development Department
100 West California Avenue
Ridgecrest, CA 93555

Subject: Draft Environmental Impact Report
for the City of Ridgecrest Draft General Plan, 1991-2010

Gentlemen:

Thank you for the opportunity to review the draft Environmental Impact Report (EIR) for the City's draft General Plan, which is to serve as a guideline for development of Ridgecrest through 2010. As the draft EIR notes, the Indian Wells Valley Water District is the area's primary purveyor of domestic water, and thus has a direct interest in any project which has the potential of affecting groundwater quality or quantity.

Planning for additional and expanded development of the Ridgecrest area has the potential of directly impacting both groundwater quantity and quality by causing increased extractions from the area's overdrawn aquifer, thus exacerbating the overdrafted condition of the aquifer and potentially resulting in groundwater gradient reversals which would draw non-potable water from the China Lake playa into the potable groundwater supplies underlying most of the Ridgecrest/Inyokern area.

The Board of Directors and staff of the District have reviewed subject draft EIR, and have a number of comments and concerns regarding same. To simplify the City's response to the District's comments and concerns, we have divided same into the following numbered sections:

1. The discussion regarding the supply of groundwater included in Section II-16.1 appears to be accurate and complete, and is generally in accordance with the District's findings regarding the condition of the aquifer and the amount of groundwater currently in storage and available for use. As is noted in said Section, overdraft of the aquifer is currently estimated to be occurring at a rate of approximately 14,000 acre feet per year. Overdraft at this rate, in combination with estimated reserves of high quality potable groundwater, indicates that the groundwater supply of the Valley is sufficient only for a maximum of 70 years at current and projected rates of consumption, and that an increase in population or businesses which will result in increased groundwater production will in the opinion of the District have a significant adverse impact upon the environment.

500 W. RIDGECREST BLVD. • MAILING ADDRESS: P.O. BOX 399 • RIDGECREST, CALIFORNIA 93556
(619) 375-5086 • FAX (619) 375-3969

2. The discussion of the District's existing system included in subject draft EIR is not completely accurate, as it largely reflects the state of the system as reported in the District's 1990 General Plan. Subsequent to the preparation of said General Plan, the District has constructed a number of significant improvements to its supply, storage, and conveyance systems. In addition, some facilities (particularly wells) have been taken out of service, thus making some of the information included in the draft EIR inaccurate and misleading. For instance, Table 16-7 includes a number of wells which are now out of service, and does not include the District's recently constructed Wells 30 and 31, which are two of the most productive wells in the District's existing supply system. Also, on Page II-16-8, the draft EIR states that the District's current storage capacity is 8 million gallons, whereas in actuality the District's current nominal storage capacity is 15 million gallons. In order to enable the City to include a more accurate description of the District's existing system in the final EIR, we have prepared a table (copy attached) which more accurately reflects the current supply and storage facilities operated and maintained by the District.

3. The draft EIR notes in some detail the current condition of groundwater supplies in the Indian Wells Valley, and that the District is expected to be able to secure sufficient imported water supplies to enable continued and expanded development of the City of Ridgecrest. The District has yet to secure a source for imported water supply, and is uncertain when it will be able to secure same. Any population or business growth that results in increased overdraft should be evaluated as a significant adverse impact.

   The City should make water supplies one of the primary considerations in deciding which of the four alternatives to adopt; for, while imported water supplies may become available, there is no way of ensuring same, or of ensuring that quantities of imported water will be equal to increases in water demands. In particular, Section III-5 includes only limited mention of the impacts on water supplies which are likely to result from adoption of Alternative 2 (75,000 ultimate population), which appears to be the City's preferred alternative. The discussion regarding the impacts of the various alternatives included on Pages II-16-11 through II-16-15 does not address actual solutions, instead concentrating on general comments regarding increased water demands.

4. The City should keep in mind when referring to the District's 1990 Water General Plan that said document is a planning document only, and is not an environmental evaluation. The Water General Plan does not include a detailed discussion of the environmental effects which might result from ongoing and increasing groundwater overdraft. The Water General Plan is intended to outline the facilities that the District must construct to provide safe and reliable water service to its service area. As evidenced by the significant improvements recently made to its water supply, transmission, storage, and distribution systems, the District is fully capable of constructing, operating, and maintaining all necessary facilities and supplying same with as much water as required; however, the question of securing water supplies sufficient to ensure the same level of service well into the future is yet to be resolved. In the interim, it is vital that the Indian Wells Valley's sole water source be protected from degradation that may result if the overdrafted condition of the aquifer is exacerbated by increased withdrawals from same.

5. Although the draft EIR, as well as a number of studies of the groundwater system in the Indian Wells Valley, discusses "safe yield", it is important to note that any discussion of the expected safe yield is based on estimates and is therefore suspect. In addition, it should be realized that the first of the three definitions of safe yield included on Page II-16-1 is considered most pertinent with regard to the Indian Wells Valley's groundwater system; said definition reads, "mean seasonal extraction of groundwater from groundwater basin does not exceed mean seasonal replenishment."

   The difficulty with the concept of safe yield is that it is unknown whether or not the safe yield of the aquifer is being exceeded until significant long-term declines in groundwater levels (i.e. not attributable to seasonal fluctuations) are experienced. The general consensus of the authors of various studies of the Indian Wells Valley's aquifer (e.g. Bean, St. Amand) is that it is in a state of overdraft (i.e. "unsafe" yield), and that increased extractions will magnify the problem. Furthermore, the City should treat predictions regarding the safe yield of the Indian Wells Valley aquifer with considerable suspicion and should not rely on estimates that show that continued and unmitigated overdraft can be sustained for 70 or more years. Rather, the District would prefer that the City be supportive of the pursuit of additional water supplies (e.g. reclaimed wastewater, imported water, treatment of brackish water) and actively pursue increased water conservation measures to reduce the problem of overdraft, and thus help to guarantee the continued availability of water to residents of the Indian Wells Valley.

6. Section II-15, Surface Water Hydrology, does not include a discussion of National Pollutant Discharge Elimination System (NPDES) Storm Water Discharge Permit requirements. The NPDES Storm Water Discharge Permit program is designed to limit or eliminate the impact of polluted storm water discharges on groundwater quality, and is applicable to populated areas throughout the country. However, the consensus of most authorities indicates that groundwater recharge does not occur in the Ridgecrest area, and the City's failure to develop an NPDES Storm Water Discharge Permit program is unlikely to result in significant adverse impacts upon groundwater quality. Nevertheless, City staff should address this issue in the final EIR, since it is a significant new regulatory requirement enforced by the State Water Resources Control Board through the California Regional Water Quality Control Boards.

7. Subject draft EIR appears to incorporate a number of documents by reference, including two District documents (the 1990 Water General Plan and the draft EIR for the Southwest Well Field), but does not include the location where copies of said documents can be accessed and referenced as required by CEQA Guidelines Section 15150(b). In addition, the City of Ridgecrest's draft EIR does not include a list of preparers of the document. Although the District does not have any particular concerns in regard to either of these omissions, City staff may find it advisable to include both elements in the final EIR. Also, it should be noted that the District's draft EIR for the Southwest Well Field was never adopted by the Board of Directors.

8. The District has a number of recommendations regarding both revisions to the document and mitigation measures that should be included in the final version of the EIR for the City of Ridgecrest Draft General Plan, 1991-2010. In addition, the District recommends that the City prepare a comprehensive Mitigation Monitoring Program (MMP) and circulate same to all

reviewers of the draft EIR for review and comment; although circulation of MMP's is not required by CEQA Section 21081.6, it is not prohibited either, and circulation of same would represent a good-faith effort on the part of the City in that it would allow comments upon a vital element of the CEQA/disclosure process.

a. In recognition of the fact that any further growth in the Indian Wells Valley will exacerbate the overdrafted condition of the aquifer underlying same, the City should acknowledge and cooperate with the District in the District's ongoing efforts to develop additional water sources, including, but not limited to, increased conservation, wastewater reclamation, desalting of water with excessive mineral concentrations, and import of water from sources outside the Valley. Furthermore, the City should advise the District of potential significant growth projects, as such projects are proposed to the City.

b. It is inappropriate for the City to rely upon the District to provide mitigation for a general plan and related draft EIR that it is preparing, and the mitigation measures included in Section II-16.3 should therefore be revised with regard to increased water demands resulting from population or business increases. Appropriate mitigation measures should be developed in conjunction with the District, and the City should make a strong commitment to same which will result in reduced water consumption in the Indian Wells Valley.

c. Section III-2, Significant Irreversible Environmental Changes Which Would Be Involved In The Proposed Action Should It Be Implemented, should be revised to emphasize the significant impacts upon groundwater resources that are likely to occur in the event that additional business development and population increases are allowed prior to the District's development of additional water supplies. In addition, the City will have to adopt a Statement of Overriding Considerations in the event that it proceeds with adoption of the 1991-2010 General Plan EIR unless the recommendations included in Sections 8.a and 8.b above are included therein.

d. An important mitigation measure which could be included in the MMP would consist of an annual water use/conservation report regarding development which occurs following certification of the final EIR and adoption of the 1991-2010 General Plan. Elements of said report might include the water conservation measures required in new developments, a comparison of average household water use in new developments with City-wide average water use, and related issues. The District would be willing to cooperate with the City in compiling data for such an annual report.

In conclusion, the District is concerned by the increases in groundwater overdraft that are likely to occur if the City of Ridgecrest is allowed to grow significantly in the absence of additional water supplies. Since groundwater is and will remain (at least in the near term) the sole water source for the Indian Wells Valley, it is of the utmost importance that all available measures be taken to protect the aquifer from the quantitative and qualitative degradation which would result from increased overdraft. Since the City has control over growth through the planning process, it is vital that the City participate

INDIAN WELLS VALLEY WATER DISTRICT

with the District in the protection of groundwater resources and in the implementation of appropriate conservation measures to be included in this document.

Again, we appreciate the opportunity to review and comment upon the draft EIR for the City of Ridgecrest draft General Plan, 1991-2010, and look forward to reviewing the final EIR prior to its certification.

Sincerely,

Warren F. McGowan
General Manager

RDF/dsm
28P3CRC1
(178-28.3)

cc: Board of Directors, Indian Wells Valley Water District
Ronn King, Indian Wells Valley Water District
Robert Hartsock, McMurtrey & Hartsock
Charles A. Krieger, Krieger & Stewart

TABLE I

INDIAN WELLS VALLEY WATER DISTRICT
SUPPLY AND STORAGE FACILITIES

WELLS

WELL NO.	CAPACITY (gpm)	STATUS
2	200	Standby
3	200	Standby
5	200	Standby
6	200	Standby
7	150	Standby
8	1200	Standby
9	1000	Operating
10	1100	Operating
11	1200	Operating
12	840	Operating
13	1100	Operating
14	250	Standby
16	450	Standby
17	1200	Operating
18	---	Not Equipped
19	400	Standby
30	1200	Operating
31	1200	Operating
Capacities:	8840	Operating
	3250	Standby

RESERVOIRS

NAME	CAPACITY (MG)
Bowman No. 1	2.0
Bowman No. 2	5.0
Kendall	2.0
Ridgecrest Heights	3.0
Well Field	1.0
Gateway	.6
C-Zone	.4
D-Zone	.1
College	.6
China Lake Acres	.1
Lane Acres	.2
Total:	15.0

Draft

CITY OF RIDGECREST

Community & Economic Development Department

City of Ridgecrest General Plan Environmental Impact Report
Response to Comments
120793

Response to Comments: Indian Wells Valley Water District

Thank you for taking the time to review the City of Ridgecrest General Plan Draft Environmental Impact Report. The District's participation in preparing information for, & in formulating the DEIR is recognized as being critical to it's success and accuracy as an "adequate document." The comments received by the City and the responses to these comments will be incorporated into the FEIR in accordance with CEQA Guidelines 15087, 15088 & 15089.

These numbered responses correlate to the numbered comments received.

1. Acknowledged. The City appreciates the assistance rendered by the District in preparing the DEIR and in providing the information that the DEIR contains.

2. Acknowledged, updated information incorporated into FEIR.

3. Acknowledged. The conservative approach taken by the City to the Valleys water supply and recharge capability is intentionally congruent with the Water District's general approach. If the resources of the ground water basin are seen as "capital," and recharge is seen as "revenue," then clearly the Valley, is "spending" (extracting) more water from the basin as a whole than "revenue" would allow. The Indian Wells Valley is subsidizing income with capital. Although the IWV has a significant amount of capital available in the ground water basins, living on Capital is not prudent over the long term, and we have characterized it as an "adverse impact." Increasing the population that will live on this "capital," increases the severity of the impact on the resource.

The City currently uses approximately 6,000+ acre feet of the IWVWD supply, the preferred alternative GPEIR scenario, increases city demand by an additional 10,000 AF after the year 2025 and the amount of valleywide overdraft to 20,000+ AF. The District has stated that with appropriate management, "the present groundwater supply can sustain a population of 75,000 for 100 years." At buildout post- 2025, assuming current rates of customer usage and without conservation, the City would use approximately 16,000 AF per annum. The ground water basin has been estimated to contain 2,200,000 AF of water, 600,000 AF of which may not necessitate any increased extraction or treatment costs. The size of the Groundwater Basin along with the conservation and conjunctive use measures delineated in section 16.3, Mitigations, coupled with a long lead 100 year time frame in which to identify, develop and import additional sources of water lead us to conclude that at this time there is sufficient reason to determine that the impacts of the preferred alternative can be mitigated to a point of non-significance. This conclusion will of course will be reexamined at each subsequent General Plan (Five Year) update and will respond to any new research or datum. The City is confident that the District will be able to identify new sources of water to recharge and supplement the Ground Water Basin. The City will cooperate with and support its purveyor in this area as needed.

4. Acknowledged. See mitigations.

5. Acknowledged, the City is supportive of pursuit of additional supplies of water, *exploration*, and of reducing water demand by the introduction of management techniques, *conservation*, see chapter 16, DEIR.

6. Acknowledged, please see II-15-3 for a brief discussion of NPDES permitting.

7. Acknowledged. Text Amended.

8. Mitigation Monitoring for the General Plan EIR will be done in compliance with CEQA and established professional practice. The City will coordinate the development and implementation of monitoring programs with appropriate agencies including the District.

    a. Chapter 16 states that the City and District will continue to cooperate in ongoing efforts for water resource development and conservation.

    Review of development applications are routinely sent to concerned agencies in order to solicit comments, especially those of environmental concern.

b. As the District implied in 8. a., it is entirely appropriate and incumbent on their public responsibilities for the City and the District to cooperate in the discovery of new sources of water and in implementing conservation programs...the mitigations for the General Plan. The City's General Plan and EIR make a firm commitment to effective water management in the Indian Wells Valley.

c. The recommendations of 8. a & b were incorporated in the DEIR but will be strengthened in the FEIR.

d. The City is appreciative of this offer of assistance and co-operation from the IWVWD and has included this recommended action as a conservation measure. Such a report could be very valuable as a means of tracking the effectiveness of mitigation programs, and subsequent review would promote the ability to fine tune conservation programs over the long term. The City would be pleased to work with the District on a report of this nature.

112493
—M.

DEPARTMENT OF THE NAVY
NAVAL AIR WEAPONS STATION
CHINA LAKE, CALIFORNIA 93555-6001

IN REPLY REFER TO:

5090
Ser C0803/ 2161
24 Nov 93

Mr. Michael R. Swigart
Community Development Director
City of Ridgecrest
100 West California Avenue
Ridgecrest, CA 93555-4054

Dear Mr. Swigart:

In response to your request for review of the Environmental Impact Report (for the City of Ridgecrest Draft General Plan 1991-2010), attached are the Naval Air Weapons Station, China Lake comments. Comments on pages 1 through 3 will need to be correlated with additional comments on pages 4 through 8.

If you have any questions regarding these comments, please contact a member of my staff, Barry Kenady, Head of the Facilities Planning Division, at phone number 939-9436.

C. A. STEVENSON
Captain, US Navy
Commanding Officer

NAWS, China Lake
Comments (November 1993)
City of Ridgecrest
Environmental Impact Report
Draft General Plan 1991-2010

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1. General - Many of the impacts identified in the "Geology" and "Hydrology" sections of the Environmental Impact Report (EIR) propose to mitigate identified impacts by "conforming to the City's Master Storm Drainage Plan". As noted previously by NAWS, China Lake (in letters to the City and the County dated 06 Mar 89, 26 Sep 89, 20 Mar 91, and 26 Apr 91) the Station has concerns with portions of the Master Storm Drainage Plan. Specific concerns were:

- the potential for the completed drainage channels (particularly the Bowman Road water diversion ditch) to cause an increasing amount and rate in the delivery of storm water to Station lands causing potential flooding of Station roadways, abandoned dump sites, sensitive wildlife species habitats, and structures.
- the fact that the Master Storm Drainage Plan was incomplete by stopping at the Station's boundary.
- the fact that no environmental documentation (a comprehensive environmental review) was prepared.

Although the City adopted the Master Storm Drainage Plan in May 91 the concerns identified above still need to be addressed with specific attention given to the need for environmental documentation. It is suggested that an appropriate environmental review/documentation be completed before there is any new development in relation to the Master Storm Drainage Plan. This review/document could be prepared as a follow-on (tiered) document based on the Programmatic EIR for the Draft General Plan.

2. General - Although the EIR indicates how the City plans to accommodate growth it does not clearly address how the City plans to support the local school district in obtaining proper facilities in conjunction with the projected population increases. This issue should be addressed.

3. General - The EIR references Resolution No. 92-604 as a City adopted plan to deal with source reduction, recycling, and household hazardous waste elements. Presently the City uses the Station's recycling center and does not have a similar facility. As recycling efforts and the populations increase so will the need for the City to provide recycling facilities (above and beyond existing NAWS, China Lake facilities). This issue has not been adequately addressed in the EIR.

4. General - Throughout the report the Station is referred to as the Naval Weapons Center and/or NWC. This needs to be changed to read the Naval Air Weapons Station and/or NAWS.

5. Page I-1-6, Second Tier Impact Analysis - The SEDAB looks as if it has been improperly classified. It should be classified as a non-attainment area.

6. Page I-1-8, para. 1.7. - It needs to be clarified as to what Chapter 20 of the Ridgecrest Municipal Code is (Implementation Section)? How does Residual/Second Impacts 1.7 pre-1966 Auto affect Chapter 20 of Code and Balanced homes and shopping? This relationship is unclear.

7. Page I-1-11, para. 6. - Residual and Secondary Impact is not "none" it should be "increased development costs".

8. Page I-1-12, para. 7. - Should be "NAWS" vs "NAWS/WPNS".

9. Page I-1-13, general - This report fails to recognize or make mention of alternate fuel vehicles legislation and actions to meet this legislation.

10. Page I-1-14, general - It is recommended that surface fracturing be addressed which is evident in this zone.

11. Page I-1-20, para. 3. - By restricting hours of development you increase development costs which causes a secondary impact.

12. Page I-1-23, para. 2.3. - Requiring development participation in unrelated program will result in a secondary impact of increased development costs.

13. Page I-1-24, para. 1. - It is unclear as to what the statement means "Consider implementation of safety and security fees as necessary to insure that demand can be accommodated." How is this to be implemented?

14. Page I-1-27, para. 7. and para 7.3. - Para. 7., when allowing only non-flammable roofs this eliminates the use of asphalt shingle, built-up composition roofs and similar normal construction practices materials. This would limit architectural design and increase construction and repair costs. A secondary impact. Para. 7.3, what is the City going to implement as soon as possible? This statement is unclear.

15. Page I-1-33, para. 1.1. - Acquisition of new sites ahead of time has not been addressed. An earlier school board bought some sites but subsequent boards sold the sites. Additional sites may be needed which has not been addressed. Maybe there are some state school lands in the district which could be acquired, then traded or sold (or other options available).

16. Page I-1-36, general - The Navy is on record as wanting the sewer plant off Navy property. This does not seem to have been addressed in this report. The existing plant is behind security fences and not readily accessible. The plant should be relocated for easy access to the workers and public dischargers such as septic tank trucks. This option would have to consider affects on the Mojave Chub fish. The City is relying only on fees and not exploring other means of financing the project. The impact of requiring reduced flow or low flow toilets (1.5+/- gal) has not been evaluated as to impact. Again developers costs are being heavily relied on to support the proposals with the attendant increased development costs.

17. Page I-4-1, para. 4.1.1. - Ridgecrest is northeast of Bakersfield rather than southeast.

18. Page I-4-1, para. 4.1.4. - Research and Development, as well as Test and Evaluation, are done aboard Naval Air Weapons Station, China Lake.

19. Page I-4-2, para. 4.2.1.3. - 115 acres cited here but only 93 page I-3-7. Coordinate.

20. Page I-4-4, 5th para. - There are at least 8 elementary schools in the SSUSD vs 6.

21. Page II-3-2, 2nd para. - There is only one DARE officer now (if recent newspaper accounts were correct).

22. Page II-3-8, 1st para. - Why would new structures (includes residential?) require a proprietary fire system and not major retrofits of existing facilities? Also, what constitutes a proprietary fire system (smoke alarms, fire sprinklers, etc. ?)?

23. Page II-5-3, last para. - SH 178 does not go to Death Valley but stops in the vicinity of Trona. It is a County road after that until you connect to SH 190

24. Page II-5-7 - Residual impacts are indicated but not identified in the matrix.

25. Page II-9-1, 3rd para. - We now have 8 elementary schools in the district where there were only 6 previously stated on page I-4-4, 5th para..

26. Page II-9-4, general - Higher educational opportunities are not limited to Cerro Coso Community College. Chico, Northridge and Bakersfield State U's provide courses at NAWS leading to higher degrees. No mention is made of them yet they are providing services in the planning area.

27. Page II-12-6, para. b. - Regional Access. You can't get to Bakersfield on SH14 or SH395. Connections must be made to SH58 providing east-west access to Barstow and Bakersfield.

28. Page II-12-11, 1st para. - Storage. CALTRANS provided the lot (storage) at Richmond Road and SH178 and the Navy provided the land. This is the only lot that we are aware of at the access gates. There have been discussions about expanding the lot or using other alternatives.

28. Page II-12-11, 4th para. - The last sentence is incomplete.

29. Page II-12-16, 2nd para. - At the next to last line George Air Force Base no longer uses this area (they have been closed).

30. Page II-17 and figure 17-1, general - See comment #16 above. The option of relocating the sewer plant off of Navy lands needs to be addressed. Also, Figure 17-1 references trunk lines on Navy land that are inactive. These lines should be removed from the drawing.

1. Pg I-1-7, under "Implementation" heading ? "signalization" -?. Where does it belong?

2. Reference to City's Master Storm Drainage Plan - pg. I-1-5 & I-1-18 - Note the concerns earlier expressed by NAWS re: additional water directed onto the Station's playa lakes and anticipated environmental impact. Drainage plan does not go far enough.

3. Does there need to be addressed the problem of oil spills & leaks onto the soil from construction equipment? (Noticeable in recent construction on "the hill".)

4. Pg I-1-21 - Any thought given to require developers to set aside acreage for parks in the development they are building in? Also, require developer to set aside land for schools?

5. Pg I-1-29 - Any thought given to maximum height of buildings in new project areas? OK. (See #3 pg I-1-31 "Mitigation Measures")

6. General - Be aware of cumulative impacts of paving over dirt when it comes to water run-off.

7. Pg I-4-2 para.. 4.2.1.3 & pg I-4-1 para.. 4.1.4 pg I-4-3 para. 4.2.2 . . . and throughout document - Need to refer to Naval Air Weapons Station.

8. Pg I-5-2 - 3rd para. 5.1.1.1 - 2nd line - which "Element" is referred to? Open Space Element? Both para.'s above it refer to other "Elements".

9. Pg I-5-5 - Close parenthesis at end of 5.2.1.1

10. Pg II-1-1 para. 1.1 reference "(C)" should be inserted between "service," and "California".

11. Pg II-1-2 para. 1.2 2nd line ... "area as a linear parks." ? Delete plural "s". Or "a".?

12. Pg II-2-2 End of 2nd full para. - need to insert an "a" after "continue" to read " continue as well, ..."

13. Pg II-3-2 4th para., 5th line - Change "expanding" to "expand".

14. Pg II-3-2 para. 3.1.2 - A new/updated Mutual Aid Agreement was drafted in 1993. Was it not signed?

15. Pg II-3-2 2nd para. - If stating "approximately" "699 calls for emergency" - Why not round up to 700 - Would still be "approximately"?

16. Pg II-3-3 para. 3.1.2(b) - 2nd para. - Question the 10 minute response time to Cerro Coso - with New Station #77 at the bottom of the hill!

17. Pg II-4-4 2nd line - "aresult" to " a result".

18. Pg II-5-6 para. 5.3 - be consistent with the end of each bullet ":" or ";".

19. Pg II-5-7 1st bullet, 2nd line - at the end delete the "a".

- Pg II-5-7 2nd, 5th & 6th bullet's end with a "."

  Delete "and" at end of 7th bullet.

20. Pg II-5-8 Delete "and" at end of first bullet.

21. Pg II-7-5 5th full para. - at the end - should this read "the first American Physics Nobel Laureate." vs. "... Laureate American."?

22. Pg II-8-6 para. 8.1.4(a) - What about the new sports facility at Cerro Coso College? Can it be used as an auditorium?

23. Pg II-8-8 para. 8.1.4(e) - What about the NAWS Museum under consideration?

24. Pg. II-8-11 2nd ., 3rd line from the bottom - Change "This," to "Thus,".

25. Pg. II-10-4 Line 19 from the top - remove the ";".

26. Pg. II-12-7 3rd para., 2nd sentence - Very confusing - Need to start the sentence differently.

27. Pg II-12-18 para. 12.5.2 - Should KernCog be Kern Cog - Also pg II-12-21 para. 12.7 (space) ?

28. Note: Throughout the document the City is sometimes capitalized and sometimes not. Need to be consistent! See: e.g. pg II-12-20 No. 19.

29. Pg II-12-21 para. 12.7 - 2nd para. - Delete "is" after KernCog.

30. Pg II-12-22 2nd full para. - 3rd line - Delete "is" after "As it".

31. Note: Page numbering system changes at Ch. 13. should all have "II" before letters pg. No.)

32. Pg 13-1 para 13.1.1(a), 3rd line - Close parenthesis after (0 sub 3).

33. Pg 13-4 - First full para., second sentence should start with "Section".

34. Pg 13-6 - First full para., - Under Table 13-3, CCAA, should use California Clean Air Act when used for the first time.

35. Pg 13-7 - 4th para. - What is "CAAQS"?

36. Pg 13-7 - 5th para. - What is "NAAQS"? (Identify terms when using for the first time.)

37. Pg 13-8 4th line - Replace "." after "many" with a ",".

38. Pg 13-8 1st para., 3rd sentence is too long and confusing. Should break into two sentences.

39. Pg 13-10 1st para. - Next to the last line. "December 1992". Was that date met, or should it read "1993"?

40. Pg 13-10 Para "b" - The Word Analysis has a capital "Y", should be lower case.

41. Pg 13-10 3rd para., 2nd line - The word "updated" is used before and after the word "standards". Only need to use it once.

42. Pg 13-11 2nd para. - "SED" should be "SEDAB".

43. Pg 13-14 para. 13.3.1 - Should start off the para. with "Transportation Control Measures" and put "TCMs" in parenthesis.

(Note: Kern COG - See earlier statement. Keep consistent. Is "COG" to be all capitalized?)

44. Pg 13-14 Last para. - Needs a "." at the end.

45. Pg 13-15 para. 13.3.2. - Identify "ARB".

46. Pg 13-18 para. 13.3.4, 2nd line - Space needed in "citedin" to read "cited in".

47. Pg 13-18 & 19 - Need "." at the end of each procedure.
Pg 19 last line needs ".".

48. Pg 13-20 - Add "." at end of lines.

49. Pg II-14-2 para. 14.1.1(a), 5th line at the end - Change "as" to "an".

50. Pg II-14-5 1st para., 7th line - The words "foremost city structures" are out of context. Delete.

51. Pg II-14-6 1st para., 9th line - Capitalize "I" at start of new sentence.

52. Pg II-14-6 2nd para. - Third sentence is confusing. Delete the word "this" and the "," preceding it.

53. Pg II-14-10 4th para., 2nd line from the bottom - Replace "." after the word "Avenue" with a ","

(Note: This project concerns NAWS from a standpoint of diverting storm water that could end up on the Base. See earlier comments.)

54. Pg II-14-12 3rd para., 3rd line - Redundant use of "is the channel". Delete one.

55. Pg II-14-14 Last para., 2nd sentence - Need to capitalize "it."

56. Pg II-14-15 4th para. - Need a "," after the word "soil" in the 4th line.

57. Pg II-14-23 para. 14.4.1 - Need a "." at the end of the last measure for project sites.

58. Pg II-14-25, 3rd bullet under para. "C." - Need a "." at the end.

59. Pg II-15-9 1st measure under 15.4.1, 3rd sentence - Needs to have a capital letter starting the word "However".

60. Pg II-16-5 Table 16-3 - Does not list the amount of water utilized from the Valley by the Community of Trona (See pg II-16-2, 3rd full para.)

61. Pg II-16-6 Full para. under Table 16-4, 4th line from the bottom - "groundwater" "ground-water" repeated. Delete one usage.

62. Pg II-16-6 - Comment: If the Basin is in "overdraft" why is North American Chemical Company allowed to transport water out of this Basin into a separate Basin?

63. Pg II-16-7 Table 16-5 - Also does not list the usage by the Community of Trona.

64. Pg II-16-8 para. 16.1.7 - Need "." at the end of each "measure".

65. Pg II-16-9 para. 16.1.8 - Need "." at the end of each "option".

66. Pg II-16-10 1st para. - Perhaps update this with: "The U.S. Bureau of Reclamation Study of the Vally groundwater basin is expected in early 1994)" . . .

67. Pg II-16-10 3rd & 4th para. - Uses two different methods of designating Acre Feet per year, i.e. AFY and AF/YR. Standardize.

68. Pg II-16-10 5th para., 5th line - After the words "the development of" - delete the "a".

69. Pg II-16-14 para. 16.3.1.(b) - Need "." at the end of each "improvement".

70. Pg II-16-14 para. 16.3.1(c) - Need a "." at the end of each "improvement".

71. Pg II-16-15 through Pgs. 11-16-7, para. 16.3.2 - Need a "." at the end of each "measure".

72. Pg II-16-17, Last measure, Last line - Should the word "provide" read "obtain"?

73. Pg II-17-6 4th full para. - States annual precipitation at 4.75" - Yet - earlier figures quoted 3.0", see pg I-4-1 at para. 4.1.3.

74. Pg II-17-19 - List item No. 7 needs a "." at the end instead of "1".

75. Pg II-17-13 para. 17.4.1 - Mitigation measures already being utilized. Also, this EIR has been prepared subsequent to the "Spring of 1993". Has the City Council adopted and implemented the Master Plan for the Wastewater Treatment Plant? Need a "." at the end of the 2nd bullet's underlined sentence.

76. Pg II-18-1 para. 18.2, 4th sentence - Move the "," from in front of "words" to after it.

77. Pg II-18-1 3rd para., 2nd line - Space in the word "thana" to read "than a".

78. Pg II-8-5 para. 18.4, 2nd para., 4th line - Insert a "," after the word "bill".

79. Pg II-18-6 1st full para., 10th line - Delete the word "to" after the word "indirectly" since it is redundant, already used in line 9. Also, need a "," after the word "to" at the end of line 9.

80. Pg II-18-7 para. beginning with "Legislation ..." - Includes the Mojave ground squirrel as a listed species. That has now been removed from the state's listing, but special interest groups are still fighting to have it included. See pg II-18-9 at the bottom.

81. Pg II-18-10 2nd para., 3rd line - following the words "... know to occur in", change "a" to read "an".

- 6th line - After the word "encompasses" change "as" to "an".

82. Pg II-18-11 para. 18.5.3 - May not have to mitigate for Mojave ground squirrel now.

Para. 18.5.4 - Same as 18.5.3.

83. Pg III-3-2 3rd full para., 3rd line from the end - Delete the word "a" at the end of that line.

End of Comments

Draft

CITY OF RIDGECREST

Community & Economic Development Department

City of Ridgecrest General Plan Environmental Impact Report
Response to Comments
120793

Response to Comments: China Lake Naval Air Weapons Station

Thank you for taking the time to review the City of Ridgecrest General Plan Draft Environmental Impact Report. The Comments received by the City and the responses to these comments will be incorporated into the FEIR in accordance with CEQA Guidelines 15087, 15088 & 15089.

These numbered responses correlate to the numbered comments received.

1. Acknowledged. The City of Ridgecrest Master Storm Drainage Plan (MSDP) was prepared for flood control purposes and as such and with proposed future infrastructure identifies, contains, mitigates, and conveys accelerated storm drainage. The plan identifies the numerous sub-watershed Ridgecrest related components of the approximately 140 square mile watershed within the Indian Wells Valley.

Taking a comprehensive approach to drainage in the Valley has been a recent phenomena that began subsequent to flooding in the late 1960's when the Corps of Engineers and the Navy proposed a series of bypass channels in the North and West of the City (then county) that would have directly diverted water from the El Paso Wash to China lake. The project was never initiated. In 1980 the National Flood Insurance Program mapped and identified "flood hazard" zones in Ridgecrest, and the City embarked on a series of projects that generally directed surface flow along City Streets and provided for channelization. A large portion of Ridgecrest/NAWS lies in the plain of the 100 year flood.

Ridgecrest and NAWS share a fundamental flaw in site location and design, both developed at the conveyance bottom (gravity well) of a watershed some 140 square miles in area. The Bowman Watershed alone is 51 square miles in area...ultimately, because of given topography, nearly all drainage in the valley arrives at China lake or the Satellite/Mirror lake area.

In 1989 the City adopted the Master Drainage Plan which identifies sources of stormwater and proposes a series of public works projects as solutions minimizing flooding...total cost in excess of $49 Million. The City welcomes cooperative efforts between the three agencies (city, county, navy) in seeking Solutions to storm drainage issues in the Indian Wells Valley.

Specifics:

Bowman Channel, a major component of the MSDP, is a historical watercourse that the plan expands to divert, focus, convey, and contain stormwater. Its ultimate design provides detention for increased runoff while accommodating historic flow and relies on its historic outlet, Satellite/Mirror lakes. City staff has provided the MSDP to the Naval Station, has had numerous meetings with Naval staff regarding potential downstream concerns and will respond to specific NAWS input. It is City understanding that the Bowman Channel minimizes (mitigated) both City/Navy flood risk due to detention storage. Storm/Floodwaters would reach their historic outfall at the dry lakes regardless of the mitigation channel.

It is our understanding that the MSDP was originally proposed as a joint city/navy project but the Navy declined to participate; as a consequence the resultant City study stops at Station boundary.

Environmental documents were not prepared for the MSDP. Any subsequent individual storm drainage projects will require environmental review. The City has placed MSDP environmental documentation on it's master Community Development projects list.

2. Support for the local school district is prescriptive and statutory: California Government Code sections 53080 and 65995 establish fees as mitigation. The Government Code not withstanding, the City (RRA) and the School District have cooperatively developed Gateway School and will pursue other projects as they are identified.

3. The Environmental Impact Report for the City of Ridgecrest Solid Waste and Household Hazardous Waste Elements adopted by Council Resolution 93-17 are incorporated by reference.

4. Acknowledged. Corrections made.

5. Acknowledged, the text was updated to conform to the Federal Clean Air Act amendments implemented in early 1991, changing the designation form unclassified to serious non-attainment.

6 Chapter 20 of the Ridgecrest Municipal Code is the Zoning Ordinance. Residual Impact 1.7, pre-1966 autos has been corrected to read 1.6.

7. Habitat is the subject. None refers to residual impact on habitat.

8. See 4.

9. Section I-1-13 is a summary, see discussion of conservation and alternative fuels in chapters II-4, Energy Resources, and II-13, Air Quality.

10. Section I-1-4 is a summary, see discussion of liquefaction in Geology and Soils in Chapter II-14-5.

11. Noise is the subject. None refers to residual impact on noise. Restrictions on construction hours are common and do not necessarily effect cost. We fail to see how this comment relates to the NAWS mission.

12. Text amended to indicate that Such fees may have a secondary affect on development cost. We fail to see how this comment relates to NAWS mission.

13. Section I-1-24 is a summary, see discussion of Police and Fire Services in Chapter II-3.

14. For clarification, "Non-flammable," amended in text to read "fire rated assembly." 7-3 refers to 7-2. We fail to see how these comments relate to the NAWS mission.

15. School District indicates sites will be identified and acquired as needed.

16. We are not aware of the Navy being "on record as wanting the sewer plant" removed from Navy property." Certainly, neither the City nor the Navy were pleased when, in the 1970's, the RWQCB ordered that the City and Navy sewer facilities be combined.

Since that time in the 1970's all of the gravity flow interceptor and trunk lines accompanying new development (doubling the size of the community) have been routed toward the Naval Station. The WWTP at the Naval Station is located at one of the lowest elevations in the Indian Wells Valley and currently 3.3 million gallons of sewage are processed by the plant daily. Any alternative plant location would, in all probability, be located some vertical 40' to 60' above the existing plant. The increased cost of developing, operating and maintaining (including energy costs) a pumping system that would lift 1200 million gallons of unprocessed sewage per annum to an alternative location some 40 feet to 60 feet higher is enormous. The Navy is the Wastewater Department's largest single customer and pays approximately 35% of the plants operational cost. An increase in these costs will require unnecessary expenditures that neither the citizen customers nor the navy need. As a consequence both the navy and the city have determined that alternative locations are infeasible from a financial standpoint. The Navy's concern (B. Kenady, correspondence) is that city operations not expand beyond the easement area currently utilized by the city. Alternatives which are explored in the Draft Master Plan Sewer Plant (1993), do not identify a need to utilize additional land beyond that in the easement.

City is aware and has had conversation with NAWS command regarding security and access limitations and of course will continue to cooperate with any security provisions required. City employees accessing the WWTP for work related purposes are cleared through the base security and screening process.

If security becomes problematic, private dischargers utilizing septic trucks and vacuum trucks can utilize private dump station points located within the community.

State Law requires that low flow toilets be utilized in all new construction. State documentation regarding the impact is available.

Federal and State guidelines require that sewer agencies develop revenues sources that make them self sufficient and non-reliant on outside funds. City "User Fee" policy is that new development shall pay its own way. Fees are collected to offset costs and are fairly apportioned. Replacement of the existing plant will be paid for by existing users. Costs associated with expansion of capacity to accommodate needs and impacts of new and future users will be paid for by new and future users. Without the revenue (fees) to expand the capacity of the plant, the city would be forced to enact a moratorium and there would be no development. Consequently, the development fee, although an increase in cost, is seen as beneficial to the development community.

17. Acknowledged.

18. Acknowledged.

19 115 acres of parks is correct. All other amounts have been change to reflect this.

20. There are 9 elementary schools in the Sierra Sands School District. Seven are located within city limits. Text has been amended to reflect this.

21. Acknowledged.

22. The Uniform Building and Fire Codes are updated by State Law every three years and the most current Code is applied at time of permitting and development. Prior construction is addressed in the Existing Building Code and others. Few of the codes require retrofitting of existing structures unless a defined threat to public health and safety is present. Definition of proprietary fire system added to page II-3-6.

23. Acknowledged.

24. Acknowledged- Matrix has been corrected to reflect residual impacts.

25. Refer to #20 above

26. Acknowledged. Text amended to reflect additional higher educational opportunities.

27. Acknowledged

First 28. Acknowledged

Second 28. Sentence on II-12-11 is continued on II-12-13

29. Acknowledged

30. See Response 16. The Navy maintains the trunk lines on their property,

The City provides the trunk map as an informational item. The Navy may supply a revised sketch that indicates the trunk lines that should be removed. City WWTP staff have visited several of these inactive lines and have found that some activity still exists in them.

Page 4, second set of responses

4-1 Acknowledged

4-2 See response to comment 1. Drainage plan goes to military boundary, not further, as with streets city does not presume to plan for Navy. We are available to discuss and coordinate this issue further.

4-3 Spills regulated by State Laws and Kern County Health Department.

4-4 Yes, Park dedications are discussed in Draft Open Space Element. We are precluded from most school site development dedications by State Law...which prescribes mitigation. City can reserve lands on land use map and address issue on request of School District.

4-5 Yes. Zoning Ordinance.

4-6 Acknowledged

4-7 See 4.

4-8 Acknowledged.

4-9 and numerous comments following: Acknowledged. Typographical errors corrected. Thank you for proofing.

4-14 MOU drafted, Mayor and NAWS Commander anticipated to sign January, 1994.

4-15 Acknowledged

4-16 Estimate was supplied by Kern County Fire, authorities on their response times.

4-17 Typographical error corrected.

4-22 Perhaps, the College could review this. Fail to see how this relates to NAWS mission.

4-23 Section 8.1.4's subject matter is Cultural Arts and Facilities.

4-39 The December 31, 1992 date was correct. A resolution of that study has not been completed to the City's knowledge.

4-60 This water usage number includes the Community of Trona. North American Chemical Company's system pumps and supplies (at a cost) the water to the Trona Water Company for distribution to its customers.

4-62 It is suggested that the NAWS consult with North American Chemical Company's water rights attorney, who will likely start with a discussion of the Indian Wells Valley water basin being non-adjudicated and therefore, water rights are determined on a "first in" basis. The City is not adjudicating the basin.

4-63 See 4-60

4-75 Mitigation Measure has been changed to read "Increase the limitation on the amount of effluent transported through the 20" pipeline from 0,5 mgd to accommodate growth. This improvement will require NEPA compliance in regards to allowing the NAWS to maintain the Mohave Tui Chub habitat. Has been changed to read "in mid 1994".

4-82 Appropriate language was added to the referenced paragraph.

Document Separator

INDIAN WELLS VALLEY WATER DISTRICT

May 19, 1995

Honorable Alan J. Dixon, Chairman
Defense Base Closure and Realignment Commission
1700 North Moore Street, Suite 1425
Arlington, Virginia 22209

Please refer to this number when responding 950523-25

Re: China Lake Water Supply

Dear Chairman Dixon:

We appreciate the commitment and service you and the Commission have given to the difficult subject of base closures and realignments, and the many complicated issues you face. We hope the following information will serve to clarify the issue of water availability in the Indian Wells Valley to support future growth of NAWC China Lake and the local communities.

Recent correspondence to the Commission raised a question of water availability at China Lake and the Indian Wells Valley based on a supposed new report, "Indian Wells Valley Groundwater Project" dated December, 1993. We were a sponsor and cooperator in the project and report, and have had access to both preliminary findings and the final report for quite some time. The following is intended to correct what we view as a misrepresentation of the water situation in the Indian Wells Valley, something that we have studied and managed for over twenty years.

Indian Wells Valley Water District (IWVWD), North American Chemical Company (NACC), and the Naval Air Weapons Center (NAWC) China Lake have been working together for nearly a decade in a cooperative effort to provide water to the Valley. Other large water producers have also been working with this group to develop a Cooperative Water Management Plan. These individuals comprise virtually all of the water providers and suppliers in the Valley.

IWVWD, NACC, and NAWC China Lake, in a cooperative effort with the Bureau of Reclamation, conducted a study of the ground water supply in the Valley. This study, however, made some conservative assumptions that may no longer be valid. Consequently, the aquifers life projections may improve drastically.

500 West Ridgecrest Boulevard - Mailing Address: P.O. Box 399, Ridgecrest, California 93556
(619) 375-5086 FAX (619) 375-3969

We have seen water levels start to increase since this study was conducted. We can now reasonably expect that a more optimistic forecast can be used. The following should be noted when considering the available water supplies in the Valley:

1. Virtually all major water providers (including the individual well owners association) have been working cooperatively to manage the water supply in the Valley.

2. With the most recent information (population projections and well data), we can consider projecting the useful resource life of the basin to 150-200 years. IWVWD and the City of Ridgecrest are working together to consider reuse and reinjection as further steps to extend resource life.

3. Presently, IWVWD is providing approximately 8200 AF/Yr., with the ability to provide up to 21,273 AF/Yr. Presently IWVWD has approximately 600 disconnected services. We also have the ability to add over 1200 services to the system which would give us the total ability to handle 1500 to 2000 new homes without new wells or transmission lines!

4. You should also know that our present water rates are lower than most others in this area, giving us financial flexibility to handle many alternative water sources.

5. All areas in the West have similar challenges of providing adequate water supplies. IWVWD is addressing the challenges in this area by reviewing alternatives and making preparations for action plans. Our options are too numerous to mention in this letter, but we would welcome the opportunity to personally brief you, should you think it necessary.

Indian Wells Valley Water District

I want to conclude by mentioning that this Valley has accomplished a very unique, cooperative approach with regard to water management. Virtually every major water provider, including the Navy, is working with each other to manage the water in the Valley. This unprecedented cooperation should be noted and should provide the confidence that we will meet the challenges of providing adequate water supplies to all users in the future.

Thank you again for your commitment to this arduous task. Please contact me at (619)375-5086 if we can be of additional assistance.

Sincerely,

Arden Wallum
General Manager

AW:le
cc: Board of Directors, Water District
Jack Connell, IWV 2000 Committee
Curt Bryant, Ridgecrest City Council
Ken Kelley, Ridgecrest City Administrator

Document Separator

CITY OF RIDGECREST
100 W. California Avenue
Ridgecrest, CA 93555-4054

CITY OF RIDGECR

May 19, 1995

Honorable Alan J. Dixon, Chairman
Defense Base Closure and Realignment Commission
1700 North Moore Street, Suite 1425
Arlington, VA 22209

Please refer to this number when responding 950525-1

Subject: China Lake Naval Air Weapons Station Water Resources

Dear Chairman Dixon:

The citizens of the City of Ridgecrest appreciate and thank you for the dedicated and important effort that you and the Base Realignment and Closure Commission are performing on behalf of the strategic defense of our nation. We are very aware of how difficult and yet how necessary your task is.

Due to the importance of the BRAC process to future national security, it is imperative that the information you receive be as factual and accurate as possible. We have reason to believe that you were recently supplied information that is inaccurate and potentially misleading. (Attached is information clarifying China Lake water resource issues).

From the BRAC library, we obtained a letter sent to you from Bob Lawrence and Associates stating that the China Lake Groundwater Basin is in a state of depletion. The letter misrepresents the very positive conclusions and recommendations of the Bureau of Reclamation Study, the objective of which was to "refine estimates of the life of the natural groundwater resource and identify management concepts to conserve and extend the useful life of this resource." This recent study along with dozens of other hydrological studies conclude that storage within the ground water basin is larger than previously identified, and additionally, that numerous sources of ground water basin recharge, as yet unquantified, exist. Copies of these studies being sent to your staff via separate cover should dispell the view of our alarmist friend who utilizes limited data, a 'do nothing' alternative, and presents it as a 'reasoned' future and inescapable condition.

The studies conclude that there is more than 2.2 million acre feet of water in the ground water basin. The Indian Wells Valley is utilizing 24,000 acre feet per year. Identified sources of ground water recharge conservatively indicate that recharge is occuring at a rate at least greater that 9,850 AF per year, other hydrological estimates are substantially higher. Utilizing a balanced view of the water resource, the China Lake Basin, at least, has 92 years of groundwater available. Management techniques can extend this life significantly. Each successive hydrological study in this vast, unexplored ground water basin discovered additional ground water resources to serve the present and future Ridgecrest and China Lake. Sources of ground water replenishment from the Sierra Nevada's are still being identified.

Last year, we concluded years of research and adopted the City of Ridgecrest General Plan and Master Environmental Impact Report. The plan concludes that impacts associated with the future development of our Community are mitigable; that our community can build schools, street systems, cultural facilities, and infrastructure to support a future Ridgecrest and China Lake of 75,000 persons.

Our studies included a review of all water datum for the Indian Wells Valley, the City, and China Lake. The City, in conjunction with the Water District, Bureau of Reclamation, Navy, prepared a summary of available resource. We conclude that Ridgecrest and the Indian Wells Valley have an abundance of water resources; the ground water basin alone, exclusive of recharge, rainfall, and supply, has water to support a community of 75,000 people for a period of 100 years. With our programs for water reclamation, water resource management, water exploration, conservation, and recognizing recharge, our community's resources may be extended hundreds of years. Our community of 30,000 can easily sustain and welcome the growth which the Commission may transfer here via the BRAC process.

As a defense city, dedicated to the support of China Lake and the nation, we thank you for your continued national service.

Sincerely,

Curt V. Bryan
Mayor

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BOB LAWRENCE & ASSOCIATES

Government Relations and Marketing

424 North Washington Street
Alexandria, Virginia 22314

(703) 836-3654
FAX: (703) 836-6086

May 5, 1995

Hon. Alan J. Dixon, Chairman
Defense Base Closure and Realignment Commission
1700 North Moore Street, Suite 1425
Arlington, VA 22209

Please refer to this number when responding 950508-10

Re: China Lake Water Supply: A Critical Consideration

Dear Chairman Dixon:

I thank you for serving your country by taking on the arduous and critically important task of Chairman and for carrying through the pressure filled process of closure and realignment.

My firm represents the 1500 member Irrigation Association and the international Geothermal Energy Association. We also are members of the Navy Industrial Alliance. In all of these capacities, we are extremely interested in the China Lake area, its functions, and the water situation there. In fact, in a prior life, I was the Air Force focal point for Propulsion, Power, and Energy Conversion R&D, and I used to visit China Lake on a regular basis. That was when I used my engineering Ph.D for something other than making lunch and dinner reservations.

From January 1991 through December 1993, a $1M study was conducted, headed by the Bureau of Reclamation and involving several Federal and private agencies, to delineate water use and availability in the Indian Wells Valley in which China Lake is situated. This study, entitled "Indian Wells Valley Ground Water Project", Final Report (December 1993, 2 Vols) is available through the Bureau of Reclamation, Department of the Interior. It only became available in April of this year, and the results do not appear to be widely known. In fact, they have been ignored during the BRAC process and they appear no-place in the overall evaluations. Yet, the results are critical to our nation's Defense posture. I strongly recommend that someone in your office immediately obtain the document and read the Executive Summary in detail. The consequences of this report are substantial and it is highly credible. Here are the key results to that $1M, three-year study:

a) At present use rates (30,000 acre-feet per year), the China Lake aquifer is being significantly depleted. Recharge rates, based on this exhaustive study, range from 3000 to 9000 acre-feet per year with a best estimate of 6000 acre-feet per year. The depletion rate at present use falls in the range of 24,000 acre-feet per year.

b) If China Lake increases activities at their facility, the depletion rate will accelerate accordingly. Explosives and Propellants activities use enormous amounts of water. You might have some of your staff check this at other propellants explosives facilities.

c) Present use from present draw-down areas at China Lake indicates the water supply will last only 14-52 years at which time the useable aquifer will have been depleted presenting a critical situation for all residents, commercial interests, farmers, and government facilities in the Valley

d) Options for increased time of water availability include pumping contaminated and low quality water from distant places, pumping water from 2000 feet down with associated poor economies, and mixing the aquifer with nearby contaminated water. All these options incur significant costs for water treatment facilities, drilling, pumping, etc. Facilities costs could go as high as $50M to extend water lifetime to the vicinity of 100 years.

Clearly, the results of this highly credible and detailed study are critical to decisions being made in the Base Consolidation process, and the results are important to key clients of mine. Again, I strongly urge someone on your staff to check this with the Bureau of Reclamation. The ramifications are major. Some objective and analytical person needs to take the two hours necessary and read the report summary, in detail.

My very best wishes to you and your staff in these tumultuous times.

Sincerely,

Bob

L. R. Lawrence, Jr
President

Document Separator

SUPPLEMENTAL DATA TO:
Please refer to this number
when responding 950508-10

IWV 2000
PARTNERSHIP FOR PROGRESS
Ridgecrest–Inyokern–China Lake, California

May 24, 1995

Defense Base Closure and Realignment Commission
Attn: Mr. Lester C. Farrington
1700 North Moore Street, Suite 1425
Arlington, Virginia 22209

Dear Mr. Farrington,

In a letter to the Commission dated May 5, 1995, Bob Lawrence & Associates communicated their concerns regarding the availability of adequate water in the Indian Wells Valley. The City of Ridgecrest and the Indian Wells Valley Water District responded to these concerns in letters to the Commission dated May 19, 1995, copies of which are included as enclosures (1) and (2) to this letter.

As supporting documentation I am forwarding herein:

a. Volumes I and II of the Indian Wells Valley Groundwater Project Report of December 1993,

b. Final Environmental Impact Report for the City of Ridgecrest General Plan 1991-2010, and

c. a separate copy of Section II, Chapter 16 of the EIR entitled "Water Supply."

IWV 2000 fully concurs with and strongly supports the positions and plans described in enclosures (1) and (2). We hope the remainder of the documentation will be helpful to you in understanding the issue. If I may be of further assistance do not hesitate to contact me at 619-371-2722.

Sincerely,

Jack P. Connell
Executive Director

P.O. Box 2000, Ridgecrest, California 93556
815 North Downs Street, Suite D
(619) 371-BRAC (371-2722)
Fax: 619-371-2724

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CITY OF RIDGECREST

May 19, 1995

Honorable Alan J. Dixon, Chairman
Defense Base Closure and Realignment Commission
1700 North Moore Street, Suite 1425
Arlington, VA 22209

Subject: China Lake Naval Air Weapons Station Water Resources

Dear Chairman Dixon:

The citizens of the City of Ridgecrest appreciate and thank you for the dedicated and important effort that you and the Base Realignment and Closure Commission are performing on behalf of the strategic defense of our nation. We are very aware of how difficult and yet how necessary your task is.

Due to the importance of the BRAC process to future national security, it is imperative that the information you receive be as factual and accurate as possible. We have reason to believe that you were recently supplied information that is inaccurate and potentially misleading. (Attached is information clarifying China Lake water resource issues).

From the BRAC library, we obtained a letter sent to you from Bob Lawrence and Associates stating that the China Lake Groundwater Basin is in a state of depletion. The letter misrepresents the very positive conclusions and recommendations of the Bureau of Reclamation Study, the objective of which was to "refine estimates of the life of the natural groundwater resource and identify management concepts to conserve and extend the useful life of this resource." This recent study along with dozens of other hydrological studies conclude that storage within the ground water basin is larger than previously identified, and additionally, that numerous sources of ground water basin recharge, as yet unquantified, exist. Copies of these studies being sent to your staff via separate cover should dispell the view of our alarmist friend who utilizes limited data, a 'do nothing' alternative, and presents it as a 'reasoned' future and inescapable condition.

100 WEST CALIFORNIA AVENUE • RIDGECREST, CALIFORNIA 93555-4054 • PHONE (619) 371-3700

The studies conclude that there is more than 2.2 million acre feet of water in the ground water basin. The Indian Wells Valley is utilizing 24,000 acre feet per year. Identified sources of ground water recharge conservatively indicate that recharge is occuring at a rate at least greater that 9,850 AF per year, other hydrological estimates are substantially higher. Utilizing a balanced view of the water resource, the China Lake Basin, at least, has 92 years of groundwater available. Management techniques can extend this life significantly. Each successive hydrological study in this vast, unexplored ground water basin discovered additional ground water resources to serve the present and future Ridgecrest and China Lake. Sources of ground water replenishment from the Sierra Nevada's are still being identified.

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Sincerely,

Curt V. Bryan
Mayor

Document Separator

INDIAN WELLS VALLEY WATER DISTRICT

May 19, 1995

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Defense Base Closure and Realignment Commission
1700 North Moore Street, Suite 1425
Arlington, Virginia 22209

Re: China Lake Water Supply

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Indian Wells Valley Water District

Honorable Alan J. Dixon, Chairman
May 19, 1995
Page Three

I want to conclude by mentioning that this Valley has accomplished a very unique, cooperative approach with regard to water management. Virtually every major water provider, including the Navy, is working with each other to manage the water in the Valley. This unprecedented cooperation should be noted and should provide the confidence that we will meet the challenges of providing adequate water supplies to all users in the future.

Thank you again for your commitment to this arduous task. Please contact me at (619)375-5086 if we can be of additional assistance.

Sincerely,

Arden Wallum
General Manager

AW:le
cc: Board of Directors, Water District
Jack Connell, IWV 2000 Committee
Curt Bryant, Ridgecrest City Council
Ken Kelley, Ridgecrest City Administrator

Document Separator

FINAL

ENVIRONMENTAL IMPACT REPORT FOR THE CITY OF RIDGECREST GENERAL PLAN 1991-2010

CITY OF RIDGECREST
COMMUNITY DEVELOPMENT DEPARTMENT
100 W CALIFORNIA AVENUE
RIDGECREST, CA 93555

SECTION II

Chapter 16.0

WATER SUPPLY

This analysis was prepared by the Community Development Department and hereby incorporates the "Indian Wells Valley Water District Domestic Water System 1990 Water General Plan" adopted October 15, 1990 (copies of this plan are available at the office of the IWVWD).

16.1 SETTING

16.1.1 Introduction

The following section provides an introduction to general concepts utilized in this report to evaluate potential impacts to water resources.

Water supplies are usually measured in acre-feet per year (AFY). An acre-foot (AF) is the amount of water needed to cover one (1) acre to a depth of one (1) foot and is equivalent to 325,851 gallons.

Because water supplies are constantly being used and replenished, water sources are defined in terms of their "safe yield." When used in reference to water from groundwater storage, the term safe yield refers to the maximum rate of net extractions from the groundwater basin which, if continued over an indefinitely long period of years, results in the maintenance of certain desirable fixed conditions. Groundwater safe yield is determined by a variety of means. One or more of the following criteria are usually utilized:

- o Mean seasonal extraction of water from groundwater basin does not exceed mean seasonal replenishment.
- o Water levels are not so lowered as to cause harmful impairment of the quality of the groundwater by intrusion of other water of undesirable quality or by accumulation of mineral degraders or pollutants.

- o Water levels are not lowered to such a degree as to cause excessive costs of pumping from the basin or to exclude the user from the supply by virtue of inadequate depth of pumping facilities.

Safe yield is also affected by pumping patterns, the magnitude of groundwater basin utilization by others and other factors. It is possible to withdraw from a basin more than the safe yield. This is called overdrafting. Continued overdrafting resulting in lowered water levels, may result in the degradation of water quality due to concentration of degraders in a reduced volume of water and by intrusion of lesser quality waters.

16.1.2 District Boundaries of Regional Purveyor and City Service Area

The City of Ridgecrest is located within the boundaries of the Indian Wells Valley Water District (IWVWD), the sole purveyor of water for the City. The IWVWD utilizes the groundwater basin to supply the users within its service area. There are some private well owners within the City limits, the majority of which are used for landscape irrigation (Heritage Village and City).

The IWVWD presently provides water to urban, commercial and rural customers as illustrated in Figure 16-1. This service area's general boundaries includes China Lake Acres to the west, Inyokern Road (Highway 178) as the approximate northern edge, one mile east of San Bernardino County Road as the approximate eastern boundary, one mile south of Javis Avenue as the southern boundary and Jack's Ranch Road as a western boundary to Drummond Avenue where it would continue west to Victor Street in the China Lake Acres area. The IWVWD service area covers approximately 38 square miles within the Indian Wells Valley and provides water to an estimated population of 36,000 persons.

The Indian Wells Valley Groundwater Basin also provides water to the NAWS, North American Chemical Company (NACC), the Community of Trona, the Community of Inyokern, private agreement water purveyors, private well owners, and agricultural interests.

16.1.3 Sources of City Water Supply

Groundwater is the only source for water presently utilized by the Indian Wells Valley (Valley). Groundwater in the Valley is usually identified as belonging to either the shallow or deep aquifer. The two aquifers appear to be separated by some type of structural control. The deep aquifer is the most utilized by the Valley. The deep aquifer is further divided into subareas or well fields, of which the IWVWD presently pumps all of its supply from the Intermediate Zone. The well fields being utilized by Valley users are presented in Table 16-1. (The City of Ridgecrest is utilizing treated sewer effluent for agricultural purposes. For the purpose of this report, this will not be

considered a water supply.)

a. Shallow Aquifer. The unconfined shallow aquifer, located for the most part in the northeastern part of the Valley centered around the China Lake Playa, is of poor quality and is unfit for potable public uses due to its high Total Dissolved Solids (TDS) and chemical constituents. (USGS, Ground Water Quality, 1975). The shallow aquifer is found in the younger lacustrine deposits of the Valley. The thickness of the shallow aquifer is 300 feet based on an assumed aquifer bottom elevation of 1900 feet. It is not found in the recharge areas at the periphery of the basin.

TABLE 16-1

SUMMARY OF GROUND WATER EXTRACTION IN INDIAN WELLS VALLEY (1985)

	acre-feet/year
Ridgecrest Well Field	4,460
Intermediate Well Field	6,768
Inyokern Well Field	2,969
Other Areas	447
Northwest Agricultural Areas	6,882
TOTAL	21,526

b. Deep Aquifer. The confined deep aquifer is the main aquifer underlying the Valley. It consists of younger alluvium, the younger and older lacustrine deposits and the older alluvium. In the central portion of the Valley, the deep aquifer is separated from the shallow aquifer by the intervening low permeability lacustrine deposits which cause the deeper aquifer to become confined. It has been conservatively estimated that the annual recharge to the deep aquifer is approximately 9,850 acre feet (AF) annually.

In an average year between 400,000 AF and 500,000 AF of precipitation (rain and snow) falls on the mountains, hills and catchment basin that furnishes water to the groundwater supply of the Indian Wells Valley. Of this annual precipitation, groundwater replenishment is only about 11,000 AFY due to the high evaporation rates for the area (St. Amand, 1986). In the draft EIR for the Southwest Well Field (a copy of this plan is available at the IWVWD's offices), it is noted that "about 200,000 AF of precipitation falls on the mountains and hills within the Indian Wells

Valley and about 100,000 AF of precipitation falls on the Valley floor. Of about 300,000 AF of annual precipitation, annual groundwater replenishment is only about 11,000 AF with replenishment of only about 7,000 AF/Yr where most production occurs (Ridgecrest, Intermediate, and Inyokern areas).(IWVWD, 1990 General Plan) Tables 16-2A and B show the deep aquifer recharge distribution. (Estimates of recharge vary, although they consistently indicate that the amount of recharge is less than the quantity of water being pumped)

When groundwater is pumped at a rate greater than water recharge to the basin, an overdraft situation is created. Tables 16-1 and 16-2 demonstrate that more water is being used than is being recharged to the aquifer.

16.1.4 Current Supply and Demand

The IWVWD water production records show the highest recent annual total water demand was 8,727.4 AFY for the year 1989. New connections have historically increased by 5% per year, but are currently increasing at a rate of one and one-half percent per year. Due to aggressive conservation, steel line replacement and meter installation programs, and a tiered rate structure for consumption and perhaps a decline in the population, the total annual water consumption has dropped 1.6% in 1990, 10.4% in 1991 and 1.6% to a total of 7644.60 AF in 1992. Due to the continuance of these programs, and to new construction efficiency standards, new water demand is expected to increase during the next few years by an estimated zero to one percent for residential and commercial connections.

To accurately assess the water demand for the Valley groundwater, one must realize that the Valley supplies water to other agencies and users than just the customers of the IWVWD. Table 16-3 lists these agencies and the water usage by each.

For planning purposes, the IWVWD's records show that most of the water produced by that agency is used by single family (SFR) and multifamily (MFR) residential services. SFR connections average 3.4 residents with 144 gallons per person per day (GPCD) use. MFR connections average 2.8 residents per unit and seven units per connections, with 95 GPCD. In 1989 the IWVWD records indicated that 0.89 AFY per connections was used, while the records for 1992 indicate that water usage has dropped to 0.72 AFY per connection. It is believed that this is a direct result of the aggressive water conservation programs and steel line replacement that the IWVWD has instituted over the past several years. Table 16-4 summarizes the IWVWD usage by type. For the projection purposes of this document the IWVWD provided record data indicating that usage by the City residents for the year 1991 was 6,033 AFY (Oral communication, Roy Tucker, Assistant General Manager, IWVWD).

TABLE 16-2A

AQUIFER RECHARGE DISTRIBUTION

AREA PER Bloyd and Robson, 1971	RECHARGE (AFY)
Coso Wash	1,000
Petroglyph Canyon	590
Renegade Canyon	230
Mountain Springs Canyon	930
Unnamed Canyon (near NE Valley end)	60
Wilson Canyon	350
Burro Canyon	8
El Paso Drainage	400
Little Lake	43
Freeman Gulch	2,040
Freeman Canyon	430
Indian Wells Canyon	400
Grapevine Canyon	1,620
Sand Canyon	495
Nine-mile and Noname Canyons	775
Five-mile and Deadfoot Canyons	475
TOTAL	9,850

TABLE 16-2B

AQUIFER RECHARGE DISTRIBUTION

AREA PER Bean, 1989	RECHARGE (AFY)
Recharge from Sierran Streams	6,3000
Coso Basin Runoff	2,000
Argus Mountains Runoff	1,000
El Paso Range Runoff	400
LADWP	900
Geothermal Leakage	100
Recharge from Sierran Granite	2,500
Recharge from Rose Valley	400
Recharge from Human Activity	1,500
TOTAL	15,100

TABLE 16-3

WATER USAGE BY AGENCY

AGENCY	USAGE
IWVWD	7,645 AF (1992)
NAWS	3,409 AF (1992)
North American Chemical Company*	2,521 AF (1992)
Inyokern Community Service District	140 AF (1992)
Agricultural	7,064 AF (1989)
Private Users**	3,000 AF (1992)
City of Ridgecrest (Non-potable)	19.4 AF (1992)
ASSUMED ANNUAL TOTAL FOR 1992	**23,844.4 AF**

* Includes the Community of Trona

** Estimate supplied by Peggy Breeden, President, Well Owner's Association based on 2,200 connections (includes small agricultural users)

TABLE 16-4

CUSTOMER TYPES

Customer Type	1991 Services	1991% of Services
Single Family	9,740	92.1%
Multifamily	238	2.0%
Commercial	447	4.0%
Industrial	0	0.0%
Public	84	0.8%
Construction	31	0.3%
Fire	27	0.3%
Flat Rate	50	0.5%
TOTAL	**10,567**	**100.0%**

Groundwater quantity and quality vary significantly within the basin. Groundwater availability has been and continues to be the subject of great concern within the Valley. Numerous investigations have contributed to differing opinions which can generally be subdivided into two groups, one group professing a "closed basin" concept with recharge resulting from infiltration and percolation and discharge through groundwater extraction and some evapotranspiration. The other group espouses an "open basin" concept with a regional flow system that has groundwater moving under the basin at depth from the Sierra Nevada Mountains and continuing under the Argus and El Paso Mountains. Regardless of these differing opinions, groundwater levels have been and continue to decline. "Since 1959, annual groundwater pumpage has exceeded annual natural recharge (9,850 AFY) (Berenbrock, 1989) Groundwater replenishment appears to have been insufficient to maintain groundwater levels.

Table 16-5 gives the estimated pumpage by the users of the Valley groundwater basin.

16.1.5 Potential Future Water Sources

a. The IWVWD is currently exploring alternative water sources that could be imported to this Valley. Readers are referred to the IWVWD for further exploration of this source of future water.

b. Reclaimed Sewer Effluent has been brought forward as a valuable asset to the community. The City of Ridgecrest is presently exploring the reuse of this water source. The Sewer Master Plan identifies that this effluent could be developed as a water source for landscape, agricultural, golf course, and industrial waters as proscribed by Title 22 Health Standards. The IWVWD has also advised the City it is ready to make use of treated sewage effluent provided such use is economically feasible.

c. Further test and evaluation of possible blending of potable waters with non-potable waters is being done by the IWVWD. Initial results from those wells drilled at Neal Ranch indicate high levels of TDS. It would be acceptable to blend low TDS waters with the high TDS waters for drinking water purposes.

16.1.6 Water Supply System Components

a. The reader is referred to the IWVWD Master Plan in respect to the components of its domestic water system that includes waterlines, reservoirs, pressure zones and booster pump stations.

b. Wells. The Valley has five potential well fields. The Intermediate Area, the Southwest Well Field (draft EIR for Southwest Well Field was never adopted), the Inyokern Area,

TABLE 16-5

AGENCY WATER PRODUCTION/PUMPAGE IN AFY
FOR THE YEARS 1983-1992

YEAR	ICSD	IWVWD	NAWS	NACC	AG	PVT	COR
1992	140	7644.7	3409.8	2521.8	*	*	19.4
1991	159	7716.6	3365.9	2406.2	*	3000	*
1990	164	8663.3	3715.8	2504.4	*	*	*
1989	171	8167.5	4237.6	2318.6	7,064[a]	*	*
1988	174	7220.9	4236.6	2330.1	6,450[b]	*	*
1987	139	6465.3	4584.3	2511.3	5,588	*	*
1986	178**	5901.0	4616.5	2427.2	9,342	*	*
1985	178**	4980.2	4002.0	2399.9	14,150	*	*
1984	178**	4949.8	4694.0	2485.7	13,480	*	*
1983	178**	4316.1	4402.0	2615.8	13,438	*	*
1982		3963.5	4450.0	2887.0	13,402		*
1981		4223.1	4804.0	3065.0	13,638		
1980		3819.2	4995.0	2887.0	11,156		
1979		3401.9	5154.0	3081.0	6,857		

ICSD	Inyokern Community Service District
IWVWD	Indian Wells Valley Water District
NAWS	Naval Air Weapons Station
NACC	North American Chemical Company
AG	Agricultural Users
PVT	Well Owners Association and other Private Wells
COR	City of Ridgecrest
*	Data not available for this year
**	Average production figure
N/A	Not Available
a	Neal Ranch Closed
b	Spike Leroy Ranch closed

(The figures for the IWVWD may not reflect their acquisition of smaller water purveyors in this time period)

the Northwest Area, the Southeast Area (NAWS well fields are not listed). See Table 16-7 for the capacity and status of the production wells that are online as well as the reservoir capacity of the system.

16.1.7 Current System Deficiencies

The IWVWD is the sole commercial purveyor of water for the City of Ridgecrest, it is a public agency separate from the City. The IWVWD as of 1992 had undertaken the following measures to address supply deficiencies.

- Development of additional wells to augment existing capacity during peak demand periods.
- Construction of two additional production wells.
- Completion of the "Ridgecrest Heights" assessment district improvements that replaced substandard and leaking water lines and lifted the building moratorium for this area.
- Completion of the Ridgecrest Heights Water Storage Reservoir that increased storage capacity for this elevation.
- Completion of the "Bowman Road" water storage reservoir that brings the reservoir capacity of the IWVWD to fifteen (15) million gallons.
- Interconnection agreements with the NAWS and NACC so that adequate supply is available should they suffer equipment failure.
- Replacement of water line on State Route 178, that allows for more efficient distribution from wells 17, 30, and 31.
- Continued testing and evaluation of the Valley water aquifer.
- Research and evaluation of the feasibility of importing water to the Valley.

16.1.8 Long Term Assessment

As the City and the surrounding area continue to develop and buildout, the IWVWD will, by necessity and good practice, review their General Plan to address the changing needs of the community. It will be the IWVWD's responsibility to ensure that their customers are adequately

serviced by potable water. It can be reasonably foreseen that they will review their plan in order to accommodate anticipated growth with the following options in mind:

- o Rotation of the use of wells in order to "rest the area" and to lessen the pumping depression.
- o Coordinate the timing of well pumping, to employ energy efficiency techniques.
- o Continue to research and explore the importation of potable waters to the customers of the Indian Wells Valley.
- o Water fees increases due to the rising demand for potable water in a "closed basin"

16.2 Impact Analysis

16.2.1 Significance Thresholds

In evaluating the impact of the development alternatives on the water system, each alternative is reviewed in terms of available sources of supply, and the ability of the major system components to deliver that supply to the area of demand.

a. System Supply. The water demand for each of the alternatives is compared against current available sources of supply. If demand for an alternative exceeds available sources of supply, a significant impact would occur.

Determining a threshold of significance for groundwater extraction is difficult, given the unknown character of the Valley groundwater basin. Due to the two theories (open or closed basin) being contradictory regarding the nature of the groundwater basin (See Section 16.1.4), the City for the purpose of this report will utilize the closed basin theory, as a more conservative approach.

The U.S. Bureau of Reclamation's study of the Valley groundwater basin is expected in early 1994 and may clarify the discussion between the "open" and "closed" basin camps. It is anticipated that this study will further reiterate a very conservative view of the groundwater situation of the Valley.

In St. Amand's paper "Water Supply of Indian Wells Valley, California", April 1986, there is an estimate of the water supply available to Valley users. "About 2,200,000 AF of useful water is stored in the basin. Of this, only about 600,000 AF are available under the present pumping pattern before the aquifer is contaminated with saline water from the playa." In the text, he describes

three separate storage units and indicates surface area, saturated volume, specific yield, and storage quantity. The combined storage units contain 600,000 AF of useable groundwater (Unit 1 = 131,000 AF; Unit 2 = 161,000 AF; and Unit 3 = 295,000 AF) within the upper 200 feet of the saturated aquifer.

It is further stated "The safe perennial yield of the Indian Wells Valley is 10,000 AFY, provided that evapotranspiration in the playa area can be reduced to 1,000 AFY or less. If more water is used it must come from the naturally stored underground water." St. Amand recommends in his paper that water use in the Valley should be limited to 10,000 AFY.

Ignoring potential contamination of the groundwater supply by migration of saline water from the China Lake Playa, 3,200,000 AF of available groundwater in storage would provide 200 years of water supply with groundwater overdraft at 16,000 AFY and about 120 years of available groundwater supply with groundwater overdraft at 26,500 AFY

The IWVWD in their "Urban Water Management Plan", January 1991" were and still are concerned regarding the major pumping depressions in the Intermediate and Ridgecrest Area and the overdraft of the valley aquifer. In an effort to better manage the basin, the IWVWD is studying the development of well fields in the northwest and southwest, that will serve to disperse groundwater extractions more evenly throughout the Valley. Berenbrock (USGS 89-4191) provides water quality and level models based upon a wider distribution of the wells fields. It is believed that through this effort, contamination from the China Lake Playa will be reduced or delayed. The IWVWD using their past user records and extrapolating those numbers using a moderate growth rate state, "the available groundwater supply will last at least 20 years under existing pumping conditions and with appropriate management will last about 70 years". It is estimated that the present groundwater supply can sustain a population of 75,000 for 100 years.

b. Major System Components. The IWVWD is responsible for identifying what system components are incapable of delivering the expected demand with the four alternatives proposed in the General Plan. Their evaluation could include the need to expand major pump stations, reservoir storage, and/or add pipeline capacity. (It is the responsibility of the developer to assure that the lines serving their developments have adequate carrying capacity without deteriorating the service to adjoining areas.)

16.2.2 Water Demand of Buildout Under Each Alternative

In order to evaluate the increase in total water supply to meet the needs of the four development alternatives, average per capita water consumption was utilized. For planning purposes, the IWVWD records show that unit production has ranged from 0.76 to 0.87 AF per connection per year since the late 1970's.

Table 16-6 shows current and projected water demands under each of the four alternatives and the expected amount of water supply needed. It should also be noted that the estimates do not account for reductions in water use due to implementation of water conservation measures in addition to what is presently in use over the entire planning period. Table 16-7 lists the well supply sources and their possible production rate.

TABLE 16-6

Current and Projected Water Demands (City Only)

	Population	**Water Demand on Record (AFY)**	**Typical Water Demand (AFY)**
Present(1991)	28,241	6,033	7,060
Alternative 1	50,000	10,628*	12,500*
Alternative 2	75,000	16,048*	18,750*
Alternative 3	100,000	21,357*	25,000*
Alternative 4**	62,000	13,245*	15,499*

* Estimates based on extrapolation from 1991 record
** No Project Alternative
Water Demand Records from the IWVWD indicates 0.214 AFY per person.
Typical Water Demand indicates 0.25 AFY per person

Although the availability and use of reclaimed water is anticipated to occur during the planning period, the resulting reduction in the use of other available water sources has been excluded from this assessment.

The IWVWD Master Plan indicated that as a purveyor, it currently has sufficient supplies and delivery capabilities to accommodate current demand and the water demand of buildout of Alternatives 1 (50,000 pop.), 2 (75,000 pop.), and 4 (62,000 pop.).

The Plan does indicate that there is insufficient storage to meet the demands of Alternatives 2 (75,000 pop.), 3(100,000 pop.), and 4 (62,000 pop.). Although available supplies in 1990 could meet the bulk of demand under Alternative 2, water demand would exceed storage capacity of the IWVWD. The anticipated shortfall for Alternative 3 could be met through increased well production and storage capability, although this would shorten the life of the groundwater basin

considerably. New sources of water supply should be studied for Alternatives 3.

TABLE 16-7

IWVWD Supply And Storage Facilities

Wells:	Well #	CAPACITY (GPM)	STATUS
	2	200	Standby
	3	200	Standby
	5	200	Standby
	6	200	Standby
	7	150	Standby
	8	1,200	Standby
	9	1,000	Operating
	10	1,100	Operating
	11	1,200	Operating
	12	840	Operating
	13	1,100	Operating
	14	250	Standby
	16	450	Standby
	17	1,200	Operating
	18	---	Not Equipped
	19	400	Standby
	30	1,200	Operating
	31	1,200	Operating
	Capacities:	8,840	Operating
		3,250	Standby

Reservoirs:	NAME	CAPACITY (MG)
	Bowman No. 1	2.0
	Bowman No. 2	5.0
	Kendall	2.0
	Ridgecrest Heights	3.0
	Well Field	1.0
	Gateway	0.6
	C-Zone	0.4
	D-Zone	0.1
	College	0.6
	China Lake Acres	0.1
	Lane Acres	0.2
	TOTAL	15.0

(This data was taken from correspondence dated November 23, 1993)

Because of the pumping depressions in the Ridgecrest and Intermediate areas, the buildout expected under Alternatives 2 and 3 would necessitate the further development of the Southwest and Northwest Well Fields. Of concern to researchers is that high usage of the groundwater basin could lead to a lateral migration of water from area of possibly poor water quality, hence degrading waters where deep pumping depressions occur. Of special concern is the possible migration of sodium-chloride waters into the Ridgecrest well field from the southern and southeastern parts of the City. This concern is not presently substantiated by the 1989 study prepared by Whelan and Baskin, in which they state that except for some isolated wells in the Valley, they believe that the "quality of water in the Valley is changing little, if any, at most wells".

Changes in permeability associated with urbanization under each of the development alternatives would not significantly reduce the recharge occurring from Valley floor rainfall. Studies indicate that the majority of the recharge to the groundwater basin occurs at the basin margin near the Sierras.

It should be noted that urban development may potentially pollute local water resources from point and non-point sources such as oil spills, parking lot runoff and dumping of chemicals. These potential pollution sources are typically regulated in the development review process or by local, state and/or federal requirements, and are not anticipated to result in a significant impact.

16.2.3 Impact on Major System Components for Each Alternative

As the sole purveyor of potable waters to the City of Ridgecrest, it is the ultimate responsibility of the IWVWD to review the ability of its water system to deliver the increased water demand necessitated by growth under each of the alternatives. Although the IWVWD will prepare any study of their system, criteria that will likely be addressed includes supply facilities, storage volumes, and the distribution systems.

The City will cooperate to its fullest capability with the IWVWD, as the sole water purveyor, in performing a review of its water system upon the adoption of the revised General Plan for the City of Ridgecrest. This review should address average annual water demands, maximum daily demands and peak hour demands utilized wherever possible to review the system components. Additionally, reservoir storage, fire demand and a distribution system to meet the demands of an increased population without appreciable pressure loss, should be studied with particular attention to the pressure zones.

16.3 MITIGATION MEASURES

16.3.1 Water System and Supply Deficiencies

a. Alternative 1 (50,000 population). Development to levels indicated under this alternative will require the IWVWD to address existing system deficiencies as outlined in the IWVWD 1990 Water General Plan. The development of water conservation guidelines that further encourage wise water usage, and more evenly distributing water pumpage throughout the valley. No other improvements would be required. These deficiencies are not considered significant. The City of Ridgecrest will assist and co-operate in the implementation of these mitigations to the extent allowed.

Residual Impact. Implementation of these mitigation measures would reduce the impacts of Alternatives 1 on the existing distribution system to less than significant levels.

b. Alternative 2 (75,000 population) and 4 (No Project Alternative) 62,000 population). These alternatives would require, in addition to those improvements required for Alternative 1, the following improvements to be made to the existing water system:

- o Additional pumping capacity
- o Additional well development
- o New well field development
- o Additional reservoir storage
- o Completion of recommended improvements as noted by IWVWD
- o Expanded distribution zone

Residual Impact. The above improvements would reduce the impacts of Alternative 2 and 3 buildout on the City water system to less than significant levels. The City of Ridgecrest will assist and co-operate in the implementation of these mitigations to the extent allowed.

The provision of a sufficient water supply to serve full buildout under Alternatives 2 and 4 would result in potentially significant secondary impacts. As discussed in Section 16.2.2 additional extractions from the Valley groundwater basin would contribute to the existing overdraft as well as cause poorer quality waters from the China Lake Playa to enter the Intermediate Well Field.

c. Alternative 3 (100,000 population). Alternative 3 would require, in addition to those improvements described above for Alternative 2, the following improvements to the existing water system.

- o Development of outside sources of water would be necessary.
- o Development of treated wastewater effluent as a water resource
- o Additional reservoir storage
- o Increased well capacities
- o Blending/mixing of the high and low quality waters

Residual Impact. If these measures are implemented, the impacts of Alternative 3 buildout on the existing water system is anticipated to be reduced to less than significant.

The provision of a sufficient water supply to serve full buildout of Alternative 3 could necessitate the development of an outside source of water. Another option could be the blending of the poorer quality water with the high quality water.

Should Alternatives 2 or 3 be adopted, it is recommended that the IWVWD complete a detailed review of the water system for the City. Only in this way can the City be assured of a balanced water distribution and supply system capable of serving the increased growth. The City of Ridgecrest will assist and co-operate in the implementation of these mitigations to the extent allowed.

16.3.2 Water Conservation Measures

Because of the Valley groundwater basin being in an overdraft situation, conservation measures are applicable regardless of the development alternative adopted by the City. As part of this effort in 1992, the City adopted Ordinance 92-18 (December 2, 1993), which is a water conservation ordinance mandated by Assembly Bill 325. Further the IWVWD has adopted a Water Management Plan that address water conservation measures. The City of Ridgecrest will gladly work with the IWVWD in examining these issues and developing any requried guidelines for thier implmentation. The following measures incorporate, augment, and reinforce the requirements of the City ordinance and the IWVWD's plan:

- o Public Awareness
- o In-School Education
- o Water Audits

- o Landscaping
- o Leak Detection
- o System Management and Maintenance
- o Demonstration Garden
- o Wastewater Reclamation
- o Commercial Landscape Measures
- o ULF Toilet and Fixture Requirements for New and Existing Customers
- o Low Water Consumption Requirements
- o Annual water use/conservation report to study and track usage by new and existing developments to monitor effectiveness of mitiagions

Each of these elements have a series of components which are currently being implemented or are proposed as future measures. At this time, the program emphasizes educational/informational services intended to increase public awareness and provide useful information regarding conservation techniques.

The following are other recommended conservation measures which would help reduce per capita water consumption:

- o Complete and implement the Landscape Guidelines currently under preparation.

- o Develop incentive program encouraging the retrofit of existing structures with low flow fixtures. Program should target owners of multi-unit residential or commercial facilities.

- o Use mulch extensively in all landscaped areas. (Mulch applied on top of soil will improve the water-holding capacity of the soil by reducing evaporation and soil compaction.)

- o Install efficient irrigation systems that minimize runoff and evaporation, and maximize the water which will reach the plant roots. Drip irrigation, "leaky pipe", soil moisture sensors and automatic irrigation systems are a few methods of increasing irrigation efficiency.

- o Prepare and protect existing trees and shrubs. Established plants are often adapted to low water condition.

- o Implement new water reduction and wastewater treatment technology in institutional, industrial, commercial, and certain residential uses.

- Continue to support the IWVWD in its conservation oriented rate structures.
- Review the present water waste Ordinance to determine its strength.
- Protect the fire hydrants from waste usage.
- Research with the IWVWD and the Kern County Fire Department on reducing water pressure to new developments from 80 psi.
- Adopt an ordinance strengthening local building code standards and support state and federal legislation improving new construction standards for water efficiency.
- Continue to encourage the IWVWD to offer water-use audits in regards to landscaping, residential, and commercial usages.
- Encourage the Cerro Coso Community College to offer a training program for the landscape professional that addresses wise water usage.
- Develop water conservation landscaping demonstration projects throughout the City.
- Investigate offering free water conservation devices to the public.
- Investigate the usage of "gray water" for irrigation purposes and if feasible developing code amendments permitting the use of graywater.
- Investigate the procedures, restriction, etc. and construction of an infrastructure for the delivery of treated wastewater effluent.
- Encourage the IWVWD to continue to be the leader in providing water conservation information.
- Investigate financial incentives to promote water reclamation
- Support the IWVWD in their investigations to provide an alternative (non-local) water source for the Valley
- Encourage the IWVWD to continue in their development of conservation staff to initiate, monitor, and implement water conservation programs targeted to reduce the water use per connection.

- o Adopt ultra low flow and water conservation appliances for all new construction.

- o Require approval of water conservation landscape prior to final occupancy of new structures.

- o Continue to require all new construction and development to obtain a "will serve" letter from the IWVWD.

Document Separator

FINAL

ENVIRONMENTAL IMPACT REPORT FOR THE CITY OF RIDGECREST GENERAL PLAN 1991-2010

CITY OF RIDGECREST
COMMUNITY DEVELOPMENT DEPARTMENT
100 W CALIFORNIA AVENUE
RIDGECREST, CA 93555

FINAL ENVIRONMENTAL IMPACT REPORT FOR THE CITY OF RIDGECREST 1991-2010 GENERAL PLAN UPDATE

SCH# 92012011

ABSTRACT

This environmental document serves as an informational document for decision makers and the public, that assesses the potentially significant, adverse impacts of implementation of the General Plan. It serves as the foundation of the Master Environmental Assessment for the City of Ridgecrest and functions as a first tier EIR, in assessing the impacts of full development under the Draft General Plan and three development alternatives and a No Project Alternative. Subsequent EIRs would need address only the site specific issues related to each project and could summarize and incorporate by reference the discussion of cumulative impacts in this document, as appropriate. Additionally, this document updates the base data of and provides as orderly transition from the 1981 General Plan Master EIR.

CITY COUNCIL MEMBERS

Mayor Kevin S. Corlett

Vice Mayor Howard Auld

Mayor Pro Tempore Brian V. Bitney

Council Member Curtis V. Bryan

Council Member Harlan D. Parode

ADOPTED MARCH 2, 1994
BY
CITY COUNCIL RESOLUTION #94-07

PREPARED BY
THE
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RIDGECREST, CALIFORNIA 93555

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Chapter 1.0

EXECUTIVE SUMMARY

1.1 PURPOSE OF EIR

The purpose of this EIR is as follows:

- To serve as an informational document for decision-makers and the public, that assesses the potentially significant, adverse impacts of implementation of the General Plan;

- To serve as the foundation of the Master Environmental Assessment for the City of Ridgecrest;

- To function as a first tier EIR in assessing the impacts of full development under the Draft General Plan and three development alternatives. Subsequent EIRs (i.e., second tier documents) would be prepared for specific projects subsequent to the adoption of the General Plan. These EIRs would need address only the site-specific issues related to each project and could summarize and incorporate by reference the discussion of cumulative impacts in this document, as appropriate;

- To update the base data of and provide an orderly transition from the 1981 General Plan Master EIR.

1.2 GENERAL PLAN UPDATE

The focus of the City's General Plan Update process is the draft General Plan. The draft Plan is intended to function as a policy document to guide land use decisions within the City planning area through and beyond the year 2010. The draft Plan incorporates goals, objectives, policies, and programs from the adopted 1981 Plan, as well as an update of these in response to changes in the City's environment and identified public needs. The draft Plan was developed by citizen volunteers, working in committee, with technical support provided by City staff. Further individual participation was solicited through the public review process. The committees and participants consisted of representatives from all walks of Ridgecrest's rich and diverse community life. The draft Plan consists of a policy document and technical appendices, and includes seven mandatory elements (Land Use, Circulation, Housing, Open Space, Conservation, Safety and Noise) and one optional element (Economic Development). Maps are an integral part of the draft Comprehensive Plan. Two other state mandated elements, Household Hazardous Waste and Source Reduction and Recycling have been prepared as a joint project with Kern County, these elements, according to the State Office of Planning and Research, are not part of the General Plan and are published separately, although their issues are discussed in the Conservation element.

1.3 SYNOPSIS OF DEVELOPMENT ALTERNATIVES

Buildout includes all existing development within the planning area in conjunction with the future and potential development of residential projects, and commercial, industrial, and institutional and open space projects that could be developed under the City's current land use designations. The following development alternatives were assessed in this EIR.

- **Alternative 1.** This scenario constitutes growth that is presently planned to occur under the City's adopted (1981) General Plan. The population of about **50,000** (post 2010) that would result from this low to moderate growth alternative could occur with continued buildout under the City's current 1981 General Plan and Sphere of Influence, whether or not the City adopts a General Plan Update.

- **Alternative 2**. This scenario comprises the moderate buildout recommended by the General Plan Committees, and is reflected in the draft General Plan. This alternative would result in a population buildout of approximately **75,000** after the year 2010.

- **Alternative 3.** Buildout under this high growth alternative would generate a maximum population of approximately **100,000** after the year 2010. Water District staff indicate that buildout under this scenario would result in the maximum amount of residential and non-residential uses that could be served with available and foreseeable water resources, if the City received the entire Water District allocation.

- **No Project Alternative (Alternative 4).** Under this scenario the City would not adopt a revised and updated General Plan, buildout would occur within the existing City Limits and only within those areas of the sphere of influence where land uses have been predesignated and annexation can occur in accordance with the 1981 Plan.

1.4 SUMMARY OF SIGNIFICANCE THRESHOLDS, IMPACTS, MITIGATION MEASURES AND IMPLEMENTATION SCHEDULE

Matrix I-1 provides a summary of the following:

- o Significance thresholds (i.e., criteria recognized, or developed especially for this assessment that are used to determine whether potential impacts are significant);
- o Significant and less than significant adverse impacts that would result from buildout under the development alternatives;
- o Mitigation measures for each identified impact. The applicability of each measure to the development alternative is indicated;
- o Schedule for implementation of the mitigation measures (e.g., who is responsible, how are the measures to be implemented, and when);
- o Residual adverse impacts, if any, that would result following implementation of the measures. This column identifies whether significant adverse impacts would still occur once the measure is implemented, or whether the measure would fully mitigate the impact. Under Sections 15091 and 15093 of the State CEQA Guidelines, any unavoidable adverse impacts would necessitate that the city issue written findings and a "Statement of Overriding Considerations," since they cannot be mitigated to less than significant levels. In addition, secondary impacts that may result from implementation of the mitigation measures are also identified;
- o Identification of the environmentally superior alternative among the "No Project," and the three development alternatives.

1.5 SUMMARY OF SIGNIFICANT, UNAVOIDABLE ADVERSE IMPACTS FOR WHICH WRITTEN FINDINGS AND A STATEMENT OF OVERRIDING CONSIDERATIONS MUST BE ISSUED

A summary is provided for the significant adverse impacts identified in Matrix I-1 that would occur from cumulative buildout under each development alternative and would not be fully mitigated with the imposition of any of the measures described in Section II and listed in Matrix I-1.

In addition, the summary includes those significant, adverse impacts that can be mitigated to less than significance, as identified in Matrix I-1, but the Planning Commission and/or City Council may find the measures to be economically, politically, or socially infeasible. These two types of impacts are summarized in a single location in Section 1.0 of the EIR for the benefit of the Public, Planning Commission and City Council, and so that those impacts that may require findings under Sections 15091 and 15093 of the State CEQA Guidelines are readily identified.

Section 15091 provides the following:

(a) No public agency shall approve or carry out a project for which an EIR has been completed which identifies one or more significant environmental effects of the project unless the public agency makes one or more written findings for each of those significant effects, accompanied by a brief explanation of the rationale for each finding. The possible findings are:

(1) Changes or alterations have been required in, or incorporated into, the project which avoid or substantially lessen the significant environmental effect as identified in the final EIR.

(2) Such changes or alterations are within the responsibility and jurisdiction of another public agency and not the agency making the finding. Such changes have been adopted by such other agency or can and should be adopted by such other agency.

(3) Specific economic, social, or other considerations make infeasible the mitigation measures or project alternatives identified in the final EIR.

(b) The findings required by subsection (a) shall be supported by substantial evidence in the record.

(c) The finding in subsection (a)(2) shall not be made if the agency making the finding has concurrent jurisdiction with another agency to deal with identified feasible mitigation measures or alternatives.

Section 15093 requires that additional findings be made:

(a) CEQA requires the decision-maker to balance the benefits of a proposed project against its unavoidable environmental risks in determining whether to approve the project. If the benefits of a proposed project outweigh the unavoidable adverse environmental effects, the adverse environmental effects may be considered "acceptable."

(b) Where the decision of the public agency allows the occurrence of significant effects which are identified in the final EIR but are not at least substantially mitigated, the agency shall state in writing the specific reasons to support its action based on the final EIR and/or other information in the record. This statement may be necessary if the agency also makes, a finding under Section 15091(a)(2) or (a)(3).

(c) If an agency makes a statement of overriding considerations, the statement should be included in the record of the project approval and should be mentioned in the Notice of Determination.

It should be noted that while cumulative buildout would result in significant unavoidable adverse impacts, or significant impacts that cannot be feasibly mitigated, as noted below, individual projects may not result in similar impacts. Because all of the impacts of each development alternative either cannot be fully mitigated, adoption of any of the alternatives assessed in this EIR, or a scenario which combines characteristics of more than one alternative, would necessitate the issuance of the written findings and statement of overriding considerations as required under Sections 15091 and 15093.

MATRIX I-1

SUMMARY OF ENVIRONMENTAL IMPACTS, MITIGATION MEASURES, AND IMPLEMENTATION

Impact (Applicable alternatives in parentheses)	Mitigation Measures (Applicable alternatives in parentheses)	Implementation (Who/How/When)	Residual/Secondary Impacts (Are there any unavoidable impacts or secondary impacts after implementation of Mitigation Measures)

I. Significant Environmental Impacts for which findings must be made under Section 15091 of the State CEQA Guidelines, and if unavoidable, for which a statement of overriding considerations must be issued under Section 15093 of the State CEQA Guidelines if any project alternative is adopted.

CLIMATOLOGY AND AIR QUALITY (SECTION II, Chapter 13)

Significance Thresholds

First Tier Impact Analysis. Both site preparation and construction associated with development will result in short-term effects on ambient air quality. The determination of significant impact upon air quality must be made during project specific review subsequent to the adoption of the General Plan Update.

Second Tier Impact Analysis. Currently the SEDAB portion of Kern County is listed as serious non-attainment for ozone with respect to attainment of National Ambient Air Quality Standards. Cumulative population increases would worsen the SEDAB's current non-attainment of the state ozone and PM-10 standards as well. As such, a significant air quality impact is identified for cumulative population growth in the planning area.

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1. Increased vehicular emissions will result from buildout and con-tribute to an increase in ozone and PM-10 levels (All Alts.)	1.1. Provide convenient access to transit stops. Through site plan review, require development of projects to provide for transit convenience and accessibility. (All Alts.	1.1. Public Works Department and the Kern County Air Pollution Control District.	

MATRIX I-1

Mitigation Measures	Implementation	Residual/Secondary Impacts	Impact
AIR - (continued)			
	1.2. To reduce vehicle use, provide easy pedestrian ac-cess, maintenance of street lights, curbs, sidewalks and walk lights.	1.2. Development of streets and sidewalks would be required to meet city standards. 1.2.2 Initiate curb, gutter and sidewalk completion projects where applicable.	1.2 Areas where no construction occurs may lag behind in the development of curb, gutter and sidewalk.
	1.3. An increased number of designated bicycle lanes will be provided per the General Plan Update.	1.3 Development review to insure that all city roads are constructed to provide for development of bicycle lanes where applicable.	1.3 Areas where no construction occurs, may lag behind in development of bicycle lanes.
	1.4. The existing grid system will be maintained and expanded as the most efficient traffic carrying system.	1.4 Development review to insure that all plans are in conformance to the General Plan and Ridgecrest Municipal Code.	1.4. Same as 1.3.
	1.5. Traffic flow improvements will be implemented as necessary to ease periodic congestion, including: o additional off-street parking o restrict on-street parking o synchronized signalization o restrict left/right turn lanes o provide good design of parking facilities and signs	1.5 Development review to insure that all plans conform to the General Plan and the Ridgecrest Municipal Code.	1.5. Same as 1.3.

MATRIX I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
AIR - (continued)			
	1.6. Under the California Clean Air Act (CCAA), vehicle emissions in the Indian Wells Valley air basin are required to be tested bi-yearly.	1.6. Compliance with CCAA emission standards is required prior to car licensing or relicensing.	1.6 Does not apply to pre-1966 vehicles.
	1.7. Encourage balanced urban areas with homes close to employment and shopping.	1.7. Review all development applications at time of application to Building, Engineering and Community Development Departments for conformance to Chapter 20 of the Ridgecrest Municipal Code.	
	1.8. Encourage balance of low and high density development.	1.8. Develop land use, planning and zoning ordinances, that allow for an increase in residential density.	

MATRIX I-1

Impact Residual/Secondary Impacts	Mitigation Measures	Implementation	Residual/Secondary Impacts
AIR - (continued)			
2. Particulate and combustion emissions with potential short term impacts on ambient air quality would be emitted during construction. (All Alts.)	2.1. Normal construction preventative measures for fugitive dust would be re-quired. (All alts.) 2.2. To aid in the control of emissions from construction equipment, all equipment engines should be maintained in proper tune and use low sulfur fuel (.05% by weight) when possible (All alts.)	2.1. and 2.2. As conditions of project approval, developers would implement measures during construction to effective professional standards.	2. Potential short-term in-creases in air pollution levels (All alts.)
3. Nuisance and toxic emissions and objectionable odors may be generated by industrial land uses. (All alts.)	3. Adopt development standards to prohibit industrial activities that would produce nuisance emissions and objectionable odors within 1/4 mile of upwind sensitive receptors or re-quire control equipment to reduce emissions to below detectable levels at property line. Additional state/federal laws needed to determine appropriate measures to mitigate potential impacts from toxic air emissions (All Alts.)	3. City must adopt development standards in zoning ordinance prior to allowing development of specific projects.	3. None (All alts.) Unknown for toxic air emissions.

MATRIX I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

BIOLOGICAL RESOURCES (SECTION II, Chapter 18)

Significance Thresholds Any reduction of native vegetation or introduction of new plant species resulting from any alternative is a potentially significant effect. Any change in the numbers, habitat, range, or introduction of any wildlife species is also a potentially significant effect. Loss of critical habitat for state or federal designated endangered species is identified as significant as is any change in numbers, range or introduction of any "listed" wildlife species as a result of any alternative.

	Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1.	Introduction of non-native vegetation will result from landscaping of development. (All Alts.)	1. City shall develop landscaping guidelines to recommend use of native plants throughout the City and require such at interfaces with natural areas to the extent feasible.	1. City shall develop landscape guidelines set requirements for all development approvals. Education and enforcement shall occur during permit process.	1. Desert urbanization can bring with it non-native vegetation, that once established, cannot be eradicated.
2.	With the development of vacant lands, the native vegetation in the planning area will be decreased, and barriers will be formed that isolate native vegetation and limit their replenishment.	2.1 Encourage use of native vegetation in landscaping design. 2.2 As development occurs open space lands within the City shall be reviewed for potential as "native vegetation" sites.		2. Minimal net loss of native vegetated lands.

MATRIX I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
<u>BIOLOGICAL RESOURCES</u> - (continued)			
3. Introduction of noxious weeds into native habitat may result as development occurs (All Alts.).	3. Proper control of noxious weeds (e.g. Russian Thistle) would be achieved per weed control requirements. (All Alts.)	3. As conditions of project approval, developers would implement weed control measures during construction to the approval of the Community Development Department Director.	3. None.
4. As residential development occurs, accompanying domestic animals will be introduced (All Alts.)	4. Dogs and animal licensed as per the Ridgecrest Municipal Code.	4. Revise the Ridgecrest Municipal Code where necessary.	4. None
5. The number of native animal species will be reduced as native vegetation is impacted (All Alts.)	5 and 6. Coordinate development in the City and sphere of influence with the parameters delineated in the BLM's Habitat Management Plan for the Northern Mojave Desert.	5. Adopt the BLM's Habitat Management Plan to insure acquisition of Section 2081 and 10(A) permits.	5. Minimal loss.
6. Development will negatively effect the habitat of the Desert Tortoise, and possibly the Desert Kit Fox. (All Alts.)		6. Development will be re-quired to provide mitigation per the City's Section 2081 and Section 10A guidelines.	6. None
7. The Mohave Tui Chub habitat may be effect-ed by changes in sew-age production resulting from growth. (All Alts.)	7. Maintenance of the Mo-have Tui Chub habitat will be addressed in the City Master Sewer Plan by providing for continued percolation to the ditches above the habitat area.	7. The City will cooperate with NAWS in maintaining the habitat.	7. None.

MATRIX I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

ENERGY (Section II, Chapter 4)

Significance Threshold Future natural gas, fuel oil, and gasoline resource extraction is difficult to determine due to the relationship of supply and demand factors, and the political, social and economic factors influencing production. Therefore, it is difficult to project future supply and demand which makes it difficult to determine the thresholds of significance for the development alternatives. For the purposes of analysis, the demand for energy resources is assumed to increase at the same rate as the planning area population increases under each alternative. See Section 6.3 for additional calculation assumptions.

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1. Buildout of Alts. 1, 2, 3, and 4 would increase the demand of energy re-sources by 60%, 150%, 330%, and 100%, respectively.	1. Although no measures are necessary to mitigate energy impacts, see Section II-4 for recommended conservation measures and alternative energy resources to conserve valuable energy resources and to minimize indirect air quality impacts.		Because no significant energy impacts would occur as a result of buildout of Alternatives 1, 2, 3, and 4, there would be no mitiation measures necessary and, therefore, no residual energy impact. Further, over the twenty year life of these alternatives, conservation measures and advances in energy technology may serve to decrease demand upon existing sources. However, under current technology, energy resources generation to accommodate buildout of each alternative may indirectly contribute to pollution levels.

MATRIX I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

GEOLOGY (also encompasses "Earth" section from Initial Study [Section II, Chapter 14])

Significance Threshold Though human habitation structures would not occur within a liquefaction zone, there are areas of geologic concern due to their proximity to faults. Site specific reviews must be conducted prior to any construction for any projects located within a suspected fault zone. Further any disruption, displacement, or compaction of topsoil is potentially a significant impact.

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1. Potential liquefaction impacts on development may constitute expo-sure to geologic hazards. (All Alts.)	1. Site specific reviews must be conducted prior to construction for any projects located within a suspected fault zone.	1. Prior to construction approval, all reports would be subject to the review of the Public Works Director and/or a City retained State registered geologist.	
2. Soil will be disrupt-ed, displaced, and compacted during con-struction. As the City develops, vacant lands will be over-covered by streets, structures, and other impermeable surfaces (All Alts.)	2. Developers shall provide dust palliatives on disturbed lands greater than three acres that are not slated for initial construction after grading.	2. City shall develop guidelines as soon as possible after Update approval and set requirements for all development approvals. Enforcement shall occur during permit process.	
3. Erosion of soil by winds will take place during development construction. (All Alts.)	3.1. Normal construction preventative measures for erosion of soil would be required. (All Alts.) 3.2. Construction vehicles would be confined to designated roads and parking areas to prevent compaction of outlying areas.	3. Construction management would enforce measures to professional standards.	3. None.

MATRIX I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
GEOLOGY - continued (also encompasses "Earth" section from Initial Study ([Section II, Chapter 14]			
4. Erosion of soil by water. With increasing overcovering related to development, waters will have a higher carrying velocity. (All alts.)	4. Development shall be required to conform to the City's Master Storm Drainage Plan and F.I.R.M. standards.	4. Design engineering standards for development to meet the objectives of the City's Master Storm Drainage Plan.	4. None.
5. The direction or rate of flow of ground-waters may be altered because of increasing overcovering and higher carrying velocity.	5. Development shall be required to conform to the City's Master Storm Drainage Plan.	5. Development shall follow engineering standards for the flow of ground waters when overcovering sites.	5. None.

MATRIX I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

HOUSING AND POPULATION (SECTION II, Chapter 11)

Significance Thresholds Cumulative population increases would effect existing air quality, affordable housing deficiencies, and traffic circulation. As such, a significant population impact is identified for cumulative population growth in the Ridgecrest planning area.

A significant housing impact could result if the total housing need for the buildout population increase is not met by the total units provided by the alternative.

A significant housing impact would occur if the affordable housing need is greater than the projected number of affordable units provided by the alternative.

	Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1.	Under all alternatives, the population distribution and density of the planning area will be altered as a direct result.	1. Zoning standards and designations may need periodic review and revision to accommodate such growth.	1. All zone standards and designation changes are subject to public hearings and planning commission approval.	1. None
2.	Cumulative population growth could create significant air quality, affordable housing and traffic impacts (Alt. 3).	2. Adequate measures are not available to fully mitigate population dependent impacts (i.e. affordable housing, air quality, traffic).	2. Planning efforts will strive for a balance of housing and jobs and implementation of the circulation plan.	2. Significant impact under Alternative 3 to air quality and traffic. None, Alts. 1,2, and 4.
3.	Employment opportunities created by new industrial, commercial, and institutional land uses in the planning area would exceed the number the local households accommodated by new housing units. (All Alts.)	3. Approval of commercial, industrial, and institutional land uses should be balanced by approval of residential projects.	3. City should institute policies to achieve a jobs/ housing balance. Implementation should occur through project approval. City shall ensure that adequate land use designations are in place to support balances.	3. None.

MATRIX I-1

	Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

<u>HYDROLOGY (SECTION II, Chapter 15)</u>

<u>Significance Thresholds</u> A significant impact is identified if any change to the quality of potable water sources resulted from any alternative. Further, a significant impact is identified if any change to the amount of surface water or quantity of groundwater resulted from any alternative.

	Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1.	Runoff waters will in-crease as vacant lands continue to be over-covered by structures, paving materials, and other impermeable surfaces. (All alts.)	1. Natural drainage pat-terns will not substantially change as all development will be required to conform to the Master Drainage Plan and federal standards.	1. Prior to construction permitting, all development would be subject to the review of the Public Works Director for conformity to the Master Drainage Plan.	1. Storm waters may be temporarily diverted from historical drainage channels during construction of drainage infrastructure.
2.	Development may alter course or flow of flood waters. (All alts.)	2 and 3. As development within flood zones occurs, each project will be required to conform to the Master Drainage Plan which defines water courses.	2. See Implementation 1, above.	2. None
3.	An increase in runoff waters may effect the dry lake beds on a seasonal basis (All alts.)		3. See Implementation 1, above.	3. None.
4.	The level of the sewage treatment ponds may rise as population increases (necessary) (All alts.)	4. The City has proposed a plan to utilize increasing amounts of effluent water, thereby, stabilizing those effluent water levels.	4. The City shall provide reclamation project management.	4. This positive impact would provide irrigation from other than potable sources.
5.	As development occurs, the potential exists for the public to be exposed to water related hazards through increased runoff waters.	5 Natural drainage pat-terns will not substantially change as all development will be required to conform to the Master Drainage Plan and federal standards.	5. Prior to construction approval, all development would be subject to the review of the Public Works Director for conformity with Master Drainage Plan. Development shall be sited in accordance with F.I.R.M standards.	5. None

MATRIX I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

NOISE (SECTION II Chapter 2)

Significance Thresholds Exceedance of an exterior CNEL (community noise equivalent level) of 60/or 65 dBA in noise sensitive land uses such as residential-low density family, duplex, or mobile homes or an interior CNEL of 45 dBA at noise sensitive land uses due to potential increases in traffic noise is considered significant and regulated by state law.

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1. New commercial developments adjacent to residential areas can cause significant nuisance noise and exceedance of standards (All alts)	1. Design of all new commercial facilities adjacent to residential areas should site truck loading areas, garbage dump sites, and loud speaker systems distant from residences. Construction of sound attenuation walls.	1. City shall require mitigation measures for permit approval during permit review process.	1. None.
2. Any growth alternative will naturally result in a corres-ponding increase in ambient noise levels (All alts.)	2. Adopt appropriate noise control measures that interact with the zoning ordinances to mitigate intrusive noise. Setbacks and noise attenuation walls and acoustical design shall be utilized in all noise interior corridors.	2. Through site plan review and as a condition for approval, Community Develop-ment Department will require appropriate noise controls be provided based on zoning ordinances.	2. None.
3. The public may be ex-posed to limited time periods of severe noise levels during construction activities (All alts.)	3. Restrict hours of construction activities through the use of zoning standards.	3. At project permitting review.	3. None

MATRIX I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

PARKS AND RECREATION/CULTURAL ARTS (SECTION II, Chapter 8)

Significance Thresholds Currently the City meets the City established park acreage/population ratio of 3 acres per 1000 population. A significant impact is identified for any **alternative which would create a deficit ratio.**

Demand for cultural arts facilities and activities cannot be quantified because such demand generally stems from cultural awareness, a characteristic not amenable to measurement. **Therefore, no significance threshold is identified.**

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1. Buildout would result in **insufficient public park acreage causing neighborhood, service area, and city wide parks to operate above intended capacities or to be inaccessible to portions of the planning area** population (Alt. 4)	1.1. Acquire approximately 10.3 acres of parks (Alt. 1). 1.2. Acquire approximately 160 acres of parks (Alt. 2) 1.3. Acquire approximately 0 acres of parks (Alts. 3 and 4).	1.1. City shall continue to develop action programs that generate new park and recreation facilities commensurate with demand. 1.2. City shall continue to develop action programs that generate new park and recreation facilities. City shall implement Parkland Dedication Ordinance at time of approval of project specific subdivision maps.	1. Potentially. Accessible park acreage **may not be feasible to provide unless city** relies on increased co-operation with other public jurisdictions and private contracts or other innovative means to disperse use over a larger resource base, because not enough revenue is available in developed portions of planning area and jurisdiction to address need alone. Resulting fees may impact overall development costs. Buildout may also result in significant loss of open space and increase in ambient night light. (All alts.)

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
PARKS AND RECREATION/CULTURAL ARTS - continued			
2. The number of residents that would participate in cultural arts activities is expected to increase above existing levels. This would increase the use of existing cultural arts facilities and could adversely affect certain activities that have a "small town" appeal. However, the increased demand could also pro-vide an audience to support other cultural arts activities that must have certain revenues to be viable. (All alts.)	2.1 Alternatives could involve redevelopment of the county fairgrounds to include a cultural arts center, construction of a new facility, joint use of a facility developed as part of the Cerro Coso campus, or city involvement in joint use agreements with school district to maximize use and defray costs of existing or new facilities. Coordinate with existing cultural arts organizations and solicit public input for the appropriate functional design of such facilities.	2.1. City, Sierra Sands School District and local arts organizations should work cooperatively. Funding could be provided through cooperative use agreements, development fees, bonds, private and corporate grants, loans, gifts, land lease agreements, land exchanges, etc.	2. None. All alternatives)
	2.2. Encourage financial and formal public support of existing cultural arts organizations to promote cultural art activities and public awareness and education of cultural arts resources in planning area.	2.2. See 2.1. above for mechanisms through which City could assist funding. City could adopt policy commitment as part of the General Plan Update adoption and implementation.	

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
PARKS AND RECREATION/CULTURAL ARTS - continued			
	2.3. Consider an art in public places program, requiring all new development to participate in such a program by commissioning a work of art for public display onsite, subject to a public arts review board or through an in-lieu fee for projects less than a size specified by a City Art in Public Places advisory committee and review board.	2.3. City could adopt a policy commitment as part of the General Plan Update Open Space Element and adopt an implementing ordinance that sets standards and creates an advisory committee and review board.	2.3 Resulting fees may have a secondary affect on development costs.

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

POLICE AND FIRE PROTECTION (SECTION II, Chapter 3

Significance Thresholds

Police Services: The significance of the increase in demand for police protection services is dependent upon staffing levels and response time to existing and new development. Per Local Police Safety Standards, the police office ratio is 1.5 per 1000 persons. Ridgecrest has available personnel from City P.D., Sheriff's Dept. China Lake P.D., and California Highway Patrol. Acceptable staffing levels are dependent on community characteristics, active demand for services (service calls) and needs, economic conditions, technological advances and other factors. Therefore, these standards which are used in the EIR/MEA analysis to project the number of additional officers needed to provide adequate emergency response time (5 minutes) may need to be monitored and adjusted in the future.

Fire: The significance of the increase in demand for emergency response services for any project alternative is dependent upon staffing levels, the ability to maintain adequate response times to existing and new development, and the provision of proprietary fire systems. A significant impact would occur if an emergency response time of 5 minutes is exceeded.

	Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1.	Buildout would result in insufficient police officer staff to provide adequate service levels. (All alts.)	1. Alt. 1: Increase officer staff level by 24 to reach a total of 60 officers. Alt 2: Increase officer staff level by 54 to reach a total of 90 officers. Alt 3: Increase officer staff level by 84 to reach a total of 120 officers. Alt 4: Increase officer staff level by 38 to reach a total of 74 officers.	1. City Police Department should: o Hire additional police officers prior to approval of any develop-ment that would impact existing police ser-vices or demand additional police protection services. o Consider implementation of safety and security fees as necessary to ensure that demand can be accommodated.	1. No. (All alternatives)

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
<u>POLICE AND FIRE PROTECTION</u> - continued			
2. Buildout would increase the size of the service area that would require police protection services (Alts 2 and 3)	2. Redesign beats to serve demand for service.	2. P.D. should establish additional or realign existing beat areas prior to the issuance of building permits for proposed deve-lopment in the affected area.	2. No. (All alternatives)
3. Buildout would result in an insufficient number of fire depart-ment staff to provide adequate fire protec-tion and emergency services (All alts.)	3.1. Increase fire department staff by a total number of employees to be determined by the Kern County Fire Department. (All)	3.1. Kern County should: o Hire required number of staff prior to approval of any development that would impact existing fire/ emergency services or demand additional protection services. o Institute development fees prior to issuance of building permits if funding is inadequate for construction of stations and acquisition of capital equipment.	3. None.
4. Additional office facilities would be required to accom-modate additional staff (All alts.)	4. Office facilities to accommodate the additional staff should be provided. (All alts.)	4. Kern County should provide equipment and facility space.	4. None. (All alternatives)

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
<u>POLICE AND FIRE PROTECTION</u> - continued			
5. Buildout could result in development outside satisfactory emergency response time of 5 minutes (All Alts).	5.1. Construct new fire stations as development occurs (All Alts.) 5.2. Additional stations, equipment and staff should be added as determined by the Kern County Fire Chief. Existing stations would as necessary be improved to accommodate the additional equipment and staff. (All Alts.)	5. Kern County could use existing funding sources and create assessment dis-tricts, acquire land, im-prove existing stations, and construct new fire sta-tions prior to approval of any development that would impact existing fire pro-tection services or demand additional fire protection services.	5. None. (All alternatives)
6. Buildout would gene-rate a demand for additional equipment (All Alts.).	6.1. Acquire new fire-fighting equipment, additional engine companies stations as development and demand occurs. 6.2 The existing mutual aid agreement with NAWS should be continued (All Alts.)	6. Kern County (or City) and NAWS continued aid agreement.	6. None. (All alternatives)
7. Buildout would create need for additional fire protection mea-sures (All Alts.)	7.1. Consider prohibiting the use of shake and flammable roofs in all areas. Use of fire rated assembly roofing materials is recommended. (All Alts.)	7.1. City could implement as conditions of approval for project specific tenta-tive parcel maps or by Code.	7. None. (All alternatives)

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
POLICE AND FIRE PROTECTION - continued			
	7.2. Require removal of dry brush from property boundaries of outlying residential development (All Alts.).	7.2. City could implement as conditions of approval for project specific tenta-tive parcel maps.	
		7.3. Homeowners to remove brush annually prior to the onset of the fire season as required per city ordin-ance and the Uniform Fire Code. City should imple-ment as soon as is feasible and prior to approval of any development that would impact existing fire pro-tection services or demand additional fire protection services.	
	7.4. Provide adequate access/circulation system to accommodate fire equip-ment (All Alts.)	7.4. City should implement as development standards based on Fire Department recommendations and require as conditions of approval for specific projects.	
	7.5. Provide adequate water pressure to meet fire flow needs for fire protection throughout City boundaries (All Alts.)	7.5. City, IWVWD and Fire Depart-ment should require development to demonstrate that adequate water pressure would be provided as condition of approval of specific project.	

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
POLICE AND FIRE PROTECTION - continued			
8. Buildout would create a need for (an) addi-tional fire station/s (Alts. 2,3, and 4).	8. New fire stations should be constructed as development occurs.	8. Kern County should ac-quire land and fund con-struction of new stations as buildout occurs.	8. None. (All alternatives)

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

SCENIC RESOURCES (SECTION II, Chapter 5)

Significance Thresholds

First Tier Impacts Transformations in the physical environment are potentially significant as the alternatives will eliminate some of the pure desert environment and create a more urbanized setting. Alteration of natural resources with a poor visual quality could result in potentially beneficial impacts. Changes in urban areas with high or low visual condition ratings could result in significant declines or improvements in the overall visual quality of the planing area. Absolute determinations of visual quality cannot be ascertained at this level of evaluation because the visual impacts of development relate not only to modifications that would occur on the land, but also to an individual project's location and the circumstances under which it is viewed. The actual significance of development on the scenic resources cannot be determined until specific projects are reviewed.

Second Tier Impacts Siting and design of specific projects can significantly affect project visibility and the degree to which it blends or contrasts with natural or urban elements.

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1. Buildout would occur adjacent to scenic drives, scenic high-ways, scenic ap-proaches, and entry-ways significantly changing the visual image of the entire planning area. (All alts.)	1.1. Establish precise scenic corridor boundaries and create design standards for them. (All alts.)	1.1. City shall prepare new land use map identifying exact scenic corridor boundaries that coincide with property limits, city zoning or other legal delinea-tions as soon as is feasible and prior to allowing action that would affect the visual condition of the scenic resources.	1. Buildout may result in significant loss of open space that would not be fully mitigated by any of the recommended measures. Buildout would result in a significant increase in ambient night light that would not be fully mitigated by the recommended measures. (All alternatives)

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
SCENIC RESOURCES (Continued)			
1. continued	1.2. Create a visual identity in the planning area through aesthetic treatment of natural features and enframement of public views. (All alts.)	1.2. City should develop and implement architecture/ landscape standards for the scenic roadway system to promote public viewing of scenic resources in the foreground, middle distance, and background prior to allowing action that would affect the visual condition of the scenic resources.	2. None.
2. Buildout would occur on large parcels of highly visible desert land adjacent to sce-nic corridors, signi-ficantly changing the rural character of the planning area. (All Alts.)	2.1. Subject scenic corridor development to visually sensitive design review pursuant to standards as developed. (All Alts.) 2.2. Implement land use and zoning regulations that result in more intense evaluation of visually sensitive areas (All Alts.)	2. City should prepare new land use map that redistributes development to less visually sensitive areas or provide design reviews at development approval.	

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
SCENIC RESOURCES (Continued)			
2. continued	2.3. Implement scenic preservation zones that would require architecturally sensitive development in visually sensitive areas. (All alts.)	2.3. City should prepare scenic corridor standards prior to allowing development that would affect the scenic resources.	
3. **Buildout would significantly alter public viewing opportunities of natural areas. (All Alts.)**	3. Protect public viewing opportunities. (All alts.)	3. City should encourage conservative dedication of scenic resource areas for passive recreation and hiking.	3. None. (All alternatives)
4. Buildout would poten-tially alter the visual character of the urban landscape (All alts.)	4.1. Prescribe design and land use criteria for visitor and resident serving commercial establishments, encourage public participation, create a lively urban flavor, and promote the historic heritage of the city (All alts.)	4.1 City should develop and adopt design policies and standards prior to allowing any action that permit development in "special design districts".	4. None. (All alternatives)
	4.2. Encourage use of landscaping throughout the planning area. (All alts.)	4.2. City should initiate an urban planting program for the planning area that incorporates drought tolerant landscape materials which reflect the character of the area; provides buffers between dissimilar uses; and maintains existing trees in flourishing conditions.	

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
<u>SCENIC RESOURCES (Continued)</u>			
5. Buildout could potentially result in diminished middle and distant view opportunities from increased pollutants in the atmosphere (All alts.)	5. Reduce air emissions of NOX and TSP (All alts.)	5. See Air Quality Section.	5. See Air Quality Section (All alts.)

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
SCHOOLS (SECTION II, Chapter 9)			

Significance Thresholds The thresholds of significance for each educational facility are based on the current design capacity of Sierra Sands School District's facilities and any planned improvements, including any property owned by the educational institutions.

A. Sierra Sands Unified School District (SSUSD)

1. Buildout would result in increased student enrollment (adding to the existing over-capacity problems (All Alts.)	1.1. Alleviate the overcrowded conditions by implementing the appropriate finance mechanisms to provide for portable classrooms at the schools until such time that long term solution can be put into effect. Appropriate finance mechanisms include: o General Obligation Bonds o Mello-Roos Bonds o Certificates of Participation o State Grants o Developer Fees	1. Depending on the type of improvement to be funded, the SSUSD should implement the listed finance mechanisms where appropriate prior to city issuance of building permits for any residential development that would generate the need for improvements.	1. None. (All alternatives)
	1.2. Consider year-round sessions throughout the city to alleviate over-capacity problems throughout the city (Alts 2 & 3.)	1.2 Implementation of this measure would be at the discretion of the Sierra Sands Unified School District.	

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
SCHOOLS (Continued)			
2. Alternatives 1 and 4 buildout may substantiate the need for 1 elementary school. Alternative 2 buildout could require 4.4 elementary schools, .39 middle schools and .52 High Schools. Alternative 3 buildout could require 7.8 elementary schools, 5.1 middle schools and 1.03 High Schools.	2. See 1.1. and 1.2., above.	2. See 1, above.	2. None. (All alternatives)
B. Cerro Coso Community College			
3. Buildout would result in increased student enrollment that would exceed state enrollment projections. (All Alts.)	3.1. Community college funding allocated by the state should be increased to accommodate the additional enrollment. 3.2. Enrollment fees should be assessed to supplement funding. 3.3. Enrollment fees assessed to non-California residents should be increased to supplement funding.	3. The state and Cerro Coso Community College District should implement the measures as soon as feasible and prior to city approval of developments that would cause exceedance of the state enrollment projections.	3. None. (All alternatives)

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
SEWAGE (SECTION II, Chapter 17			

Significance Thresholds Significant impacts on the sewer system would occur if:

a. Trunk line capacities are exceeded due to increased sewage flows generated by buildout under each alternative;

b. Exceedance of capacity and/or allowable discharge levels of the NAWS/Ridgecrest Wastewater Treatment Plant as shown by increased sewage flows generated by buildout under each alternative;

c. Structural modifications and/or new plant facilities are required to accommodate the sewage flows generated by buildout under each alternative.

	Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1.	Buildout would result in sewage flows in excess of 75% of the existing City plant capacity (All Alts.)	1.1. Complete planning for future plant in conformance with existing RWQCB discharge permit (All Alts.)	1.1. City should implement Master Sewer Plan and EIR upon adoption by City Council with the associated EIR.	1. None. (All alternatives)
		1.2. Review and develop funding for future plant design and construction. (All Alts.)	1.2. Same as 1.1	
		1.3. Design and construct treatment plant (All Alts.)	1.3. Scope and timing is dependent upon adoption of Master Sewer Plan (All Alts).	
2.	Buildout would result in sewage flows in excess of existing sewer trunkline capacity (All Alts.)	2. Items 1.1. and 1.2., above, plus construct added sewer capacity to trunks noted in Section III, Chapter 17, Table 17-3 (All Alts.)	2. City shall collect appropriate fees from new development at time of permit issuance and/or implement sewer improvement districts prior to improvement of WWTP facilities.	2. None. (All alternatives)

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
<u>SEWAGE (continued)</u>			
3. Buildout would result in increased sewer flows (All Alts.)	3. Institute water conservation measures to reduce sewage flow (All Alts.)	3. City, county, and special districts within service area should implement conservation measures.	3. None. (All alternatives)

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
SOCIOECONOMIC (SECTION II, Chapter 10) and OTHER IMPACTED AREAS as IDENTIFIED by THE INITIAL STUDY			
Significance Thresholds			
a. Land Use Any alteration in land use designations.			
1. Land use designations may be substantially altered over the life of the project (All Alts.)	1. Urban reserve areas will be the focus of most zone changes. Urban reserve is used in the context of this project as a holding classification of land use to be determined by the needs of the community at a later date.	1. Following review by the Community Development Department and subject to Planning Commission and City Council approval, zone changes may be made.	1. None

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

SOLID WASTE

Solid Waste issues are addressed in the City Council Adopted Source Reduction and Recycling Element and its accompanying Program EIR.

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

TRAFFIC/CIRCULATION (SECTION II, Chapter 12)

Significance Thresholds Given the rural nature of the planning area, any alternative which would result in a Level of Service (LOS) C or worse would be significant. The exception to this is at State owned or shared intersections where roadway improvements have not been implemented and correction is dependent on state priority list. In this case LOS C is accepted until improvements are made)

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1. Buildout under Alts.1 and 2 would result in most road segments at LOS C or better and some arterial intersections with a.m. and p.m. peak hour LOS of D or worse.	1. Road improvements on arterial road segments would be needed. The grid system will be continued and maintained for approach widening and mitigated by signal timing and capital improvement planning.	1. City should implement development fees for dedications, traffic management programs, Capital improvement programs to continue strengthening the grid system.	1. None, LOS C or better.
2. Buildout under Alt.3 would result in road segments at LOS D or worse and intersections with a.m. and p.m. peak hour LOS of D or worse.	2. Road improvements on arterial road segments would be needed. Arterial intersections need approach widening, express ways should be constructed. The grid system will be continued and maintained for approach widening and mitigated by signal timing and capital improvement planning.	2. City implement utilizing developer fees, dedications, exactions, etc.	2. Some intersection would not be fully mitigated due to unrealistic/unachievable widening needed to achieve satisfactory LOS. Mitigation measures may result in significant secondary impacts to archeological and scenic resources and displacement of residents and land uses. Some arterial intersections at LOS D or worse..
3. Buildout under Alt.4 would result in some road segments at LOS D or worse and some intersections with a.m. and p.m. peak hour LOS of C or worse.	3. The grid system will be continued and maintained for approach widening and mitigated by signal timing and capital improvement planning.	3. City implement utilizing developer fees, dedications, exactions, etc.	3. None, LOS C or better.

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
TRAFFIC/CIRCULATION (Continued)			
4. Cumulative traffic volumes (including that generated by buildout under the development alternatives) would reduce the LOS to D or worse at NAWS gates, along segments of China Lake Blvd, Ridgecrest Blvd, and outside the city boundaries. (Alts. 2, 3, and 4)	4. Proposed improvements for Alts. 2 and 4 could improve LOS to acceptable levels. Alt 3 would require redesign and of city/county circulation system.	4. City/County should implement through traffic mitigation fee programs.	4. None Alts. 2 & 4. Alt. 3 impacts on roadway segments may not be fully mitigable if widening cannot be achieved. Redesign and reconstruction of road system may result in significant secondary impacts involving the displacement of people and land uses.

Matrix I-1

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts

WATER SUPPLY (SECTION II, Chapter 16)

Significance Thresholds

a. A significant impact would occur if water demand generated from buildout of the development alternatives exceeds available sources of water supply.

b. A significant impact would occur if water distribution facilities within each pressure zone cannot deliver water necessary to serve the additional growth within that zone resulting from buildout of the development alternatives.

Impact	Mitigation Measures	Implementation	Residual/Secondary Impacts
1. Water demand from buildout would exceed available system if used at its present rate per household (alts. 2 and 3)	1.1. Location and construction of new wells should be provided to assure adequate supplies. (Alts. 2 and 3)	1.1. IWVWD should construct necessary wells as appropriate to assure adequate supply.	1.1. Even with implementation of the mitigation measures secondary impacts, could result in the provision of poor quality groundwater to customers, exacerbation of the existing poor water quality conditions in the basin by drawing down the supply, increasing the concentrations of constituents, and the exacerbation of the overdraft situation.
	1.2. Require water conservation design in construction and landscaping of new structure. (All Alts.)	1.2 Adopt water conservation guidelines in conjunction with development of the water conservation ordinance.	
	1.3 Provide incentives to encourage the retrofit of existing structures and landscapes to water conserving devices and design		
	1.4 IWVWD should locate new sources of water.	1.4 IWVWD is a separate agency from the City of Ridgecrest.	1.4 Significant impact could occur if other sources of water are not found.

SECTION I

Chapter 2.0

INTRODUCTION

2.1 LEGAL AUTHORITY

In accordance with provisions of the California Environmental Quality Act (CEQA) Guidelines as amended August 1, 1986 (California Administrative Code, Title 14, Division 6, Chapter 3), the City of Ridgecrest, lead agency for the proposed General Update, has prepared an initial study. The initial study, included in this document as Appendix A, determined that implementation of the Update could result in potentially significant, adverse environmental affects; therefore, preparation of an environmental impact report (EIR) is required.

In accordance with Section 15121(a) of the State CEQA Guidelines, the purpose of this EIR is to serve as an informational document that:

> "... will inform public agency decision-makers and the public of the significant environmental effects, and describe reasonable alternatives to the project ..."

This EIR compares the potential impacts of buildout under the Draft General Plan and development alternatives to buildout.

2.2 BACKGROUND

The Draft General Plan is intended to function as a policy document to guide land use decisions within the Ridgecrest planning area. This area is located in the northeastern portion of Kern County and includes property presently within the city limits, unincorporated properties to the west and south of the City, parts of the military reservation to the north, and the lands in the Indian Wells Valley to the east of the City in San Bernardino County. The boundaries of the planning area generally include the lands adjacent to Highway 395 to the south and southwest, the hills rimming the Indian Wells Valley to the east, Ridgecrest Boulevard's section line south of Inyokern's Sphere of Influence to the northwest, Inyokern Road and the inhabited portions of the Naval Station to the north including the City's wastewater treatment plant, and those lands and terrain south of Cerro Coso College within the common watershed and adjacent to Highway 395.

The General Plan committees recommended revisions to the Open Space, Conservation, Land Use, Circulation, Housing, Safety, and Noise Elements of the City's Plan. In addition, the policies and programs contained in the existing Scenic Highways Element have been incorporated in the Circulation Element, the Community Design and Public Facilities Elements have been incorporated into the Land Use Element, Environmental Management and Energy into Conservation, and Seismic Safety within the Safety Element. Buildout under the recommended Draft Plan preferred alternative would result in a population of 75,000 subsequent to the year 2010. The Draft Plan presently consists of a policy document; technical appendices and maps.

In addition to the recommended buildout scenario, City staff developed, based on discussions within the Plan, additional alternatives to be assessed in this EIR. These alternatives were selected to reflect the feasible ranges of population that could occur in the planning area, given the amount of remaining undeveloped land and potential water resources available to the City. Buildout under the three scenarios could result in populations of 50,000, 75,000, or 100,000 post year 2010 depending on growth rates of approximately 3, 5 and 7 percent respectively. It should be noted that Ridgecrest's population growth fluctuates greatly in response to micro (Valley) and macroeconomic (national) conditions and during the 1980's varied from 3% to 8%. There is no "steady state" economic growth rate and projections are statistical only. The value of the alternative scenarios from the standpoint of environmental analysis, is the positing of identified outside parameters of impact within which the scenario occurs. Thus, an examination of the impacts of a population of up to 75,000 will enable an accountability of environmental, fiscal, public service, cultural impacts of any population less than that posited. The land use plan to be adopted by the City Council as part of the General Plan Update may incorporate any of the alternatives, reflect elements of one or more alternatives, or include land use changes made during the review process. Changes will require reexamination, but the scenarios are thought to accommodate anticipated changes that may occur within their parameters of study.

2.3 PURPOSE/OBJECTIVES OF THE EIR

2.3.1 EIR As Master Environmental Document

In addition to functioning as an information document, this EIR also serves as the basis for a Master Environmental Assessment for the City. The EIR provides a comprehensive data base for all the issue areas addressed that can be used for the preparation of future analyses or during the review of specific development projects. The EIR is also intended to serve as the base environmental document for the revision of the City's sphere of influence and annexation of properties within that sphere.

2.3.2 Tiered EIR

This EIR has also been prepared as a "Tiered" EIR, as permitted under Section 15152 of the State CEQA Guidelines. The tiering concept is designed to promote streamlining and efficiency in the environmental assessment process, and focus review on the issues which are relevant to the action under consideration (in this case, an update of the City's General Plan). This first tier EIR assesses the impacts of full development under the proposed plan and development alternatives. Subsequent EIRs (i.e., second tier documents) that would be prepared subsequent to the adoption of the Update for specific development projects, need address only the site-specific issues related to each project, and could summarize and incorporate by reference the discussion of cumulative impacts in this document, as appropriate. Providing the new project proposed nothing outside of the scope of the original study, there would be no need for repetition of the broad analyses and information contained in this EIR. As stated in Section 15152(a) of the Guidelines:

> "This approach can eliminate repetitive discussions of the same issues and focus the EIR on the actual issues ripe for decisions at each level of environmental review."

Section 15152(b) provides that discussion in the subsequent EIRs shall be limited to:

"... effects which:

(1) Were not examined as significant effects on the environment in the prior EIR; or

(2) Are susceptible to substantial reduction or avoidance by the choice of specific revisions in the project, by the imposition of conditions, or other means."

2.3.3 EIR As Transition From 1981 Master EIR

In 1981, the City prepared an EIR for the General Plan. This document facilitated the comparison of the post-project conditions with existing conditions. The 1981 EIR has functioned to date as the Master Environmental Assessment for the City.

The analysis contained in this EIR is based in part on the background data found in the 1981 Master EIR for each issue area. In addition, the mitigation measures contained in the document have been incorporated in this EIR as appropriate. As such, the analysis contained in this EIR is consistent with, and provides for an orderly transition from the previous document. The base data contained in the 1981 Master EIR has been updated in this EIR to reflect the most recent data available for each issue area. As a result, this EIR supersedes while incorporating prior documents as the City's Master Environmental Data Base.

2.4 RESPONSIBLE AND TRUSTEE AGENCIES

The Plan Update involves expansion of the existing City sphere of influence and future annexations of land to allow for urban development. Consequently, the Kern Local Agency Formation Commission is a responsible agency as regards to annexations and Sphere of Influence amendments. The County of Kern would serve as a responsible agency for subsequent development under the update that would require county permit approvals, such as environmental health and fire permits. The California Department of Fish and Game (CDFG) and U.S. Fish and Wildlife are trustee agencies responsible for all fish and wildlife resources that could be affected by buildout under the update. As many of the lands within the City's Planning area are under the ownership of the Bureau of Land Management and the United States Navy they are also regarded as responsible agencies. Additional agencies with responsibility in the planning area include the California Department of Transportation, Kern Council of Governments, Air Pollution Control District, Regional Water Quality Control Board, Indian Wells Valley Water and Community Service Districts, Inyokern Airport District, Airport Land Use Commission, and, due to proximity to the City, San Bernardino County.

2.5 SCOPE OF EIR

This EIR addresses the potentially significant environmental issues identified in the City's initial study, and recommends technically feasible mitigation measures that will reduce or eliminate these impacts. The EIR assesses the primary impacts that would occur as a result of adoption of the Comprehensive Plan Update, as well as those secondary effects which may occur from specific projects made possible by land use changes resulting from the Update. The EIR further identifies environmental issues for which additional, specific analysis will be required, either as soon as feasible or in conjunction with development proposals. This document also identifies, in the text and in the executive summary (Section 1.0), mitigation measures that should be incorporated in the Update or that may be appropriate for later decision-making stages.

Issue areas addressed in this EIR include:

- Agricultural Land Conversion
- Air Quality
- Biological Resources
- Energy Resources
- Geology
- Historic and Archaeological Resources
- Housing and Population
- Hydrology
- Noise
- Parks and Recreation/Cultural Facilities and Activities

- o Police and Fire Protection
- o Scenic Resources
- o Schools
- o Sewage
- o Socioeconomics
- o Solid Waste
- o Traffic/Circulation
- o Water Supply

The proposed project evaluated by this EIR is a Comprehensive Plan Update. CEQA recognizes that the required level of detail in an EIR for a General (Comprehensive) Plan is less than for a specific development project. Section 15146 of the State CEQA Guidelines states:

> "The degree of specificity required in an EIR will correspond to the degree of specificity involved in the underlying activity which is described in the EIR.
>
> (a) An EIR for a construction project will necessarily be more detailed in the specific effects of the project than will be an EIR on the adoption of a local General Plan or comprehensive zoning ordinance because the effects of the construction can be predicted with greater accuracy.
>
> (b) An EIR on a project such as the adoption or amendment of a comprehensive zoning ordinance or a local General Plan should focus on the secondary effects that can be expected to follow from the adoption or amendment, but the EIR need not be as detailed as an EIR on the specific construction projects that might follow." [emphasis added]

"Secondary effects" refer to the impacts that would result from development that would be allowed by the adoption or amendment of the zoning ordinance or General Plan.

This EIR focuses on the changes in the environment that would occur from buildout under any of the four development alternatives. The level of specificity of this EIR is more than required by CEQA because the amount of residential and non-residential buildout for all communities in the City was projected by City staff for each development alternative. However, because no specific projects were assessed, the actual extent of physical changes could only be estimated. Further environmental review will be necessary for specific development proposals regardless of which alternative is adopted as part of the Plan Update.

Many of the issue areas evaluated in this EIR, particularly social and aesthetic issues, are either subjective or involve methodologies that are imprecise. It must be recognized that precise answers are not possible from imprecise sciences, but require a degree of speculation by the analyst. The State CEQA Guidelines recognize the inherent problems with speculation in an EIR and place limitations on its use. Section 15145 states:

> "If, after thorough investigation, a Lead Agency finds that a particular impact is too speculative for evaluation, the agency should note its conclusion and terminate discussion of the impact."

This section of the State CEQA Guidelines is intended to deal with the difficulty of forecasting when thorough investigation is unable to resolve an issue, and the answer remains purely speculative. It is intended to relieve the lead agency from a requirement to engage in idle speculation. Once an agency finds that a particular effect is too speculative for evaluation, discussion of that effect can be terminated. This EIR has been prepared consistent with Section 15145 and bases conclusions on available data rather than speculation.

The standards for adequacy of an EIR are based on Section 15151 of the State CEQA Guidelines:

> "An EIR should be prepared with a sufficient degree of analysis to provide decision-makers with information which enables them to make a decision which intelligently takes account of environmental consequences. An evaluation of the environmental effects of a proposed project need not be exhaustive, but the sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible. Disagreement among experts does not make an EIR inadequate, but the EIR should summarize the main points of disagreement among the experts. The courts have looked not for perfection but for adequacy, completeness, and a good faith effort at full disclosure." [emphasis added]

2.6 EIR ORGANIZATION

As noted previously, Section I, Chapter 1 of this EIR contains the Executive Summary of the impacts and mitigation measures for the four development alternatives. Section I, Chapter 3.0 provides a detailed description of the location and amount of buildout that would occur under each alternative. Section I Chapter 4.0 provides a broad description of the environmental setting of the planning area (the existing condition). Section I Chapter 5.0 assesses the consistency of buildout under the four alternatives with the goals, objectives, policies and programs of the adopted and draft Comprehensive Plans, as well as City and county plans and programs.

The assessment of each issue area (Section II, Chapters 1 through 18) has been divided into three parts: setting, impact analysis, and mitigation measures. The setting addresses the existing condition within the planning area for each issue area. The impact analysis identifies "significance thresholds" (i.e., criteria adopted by the City or county, universally recognized, or developed especially for this assessment that are used to determine whether potential impacts are significant). This section provides a discussion of the effects that would occur from buildout of each of the development alternatives, and assesses their significance using the thresholds. Lastly, the mitigation measures section addresses those actions that would fully or partially alleviate the impacts of each alternative. Certain measures may not be pertinent to all alternatives; other measures may fully alleviate the impacts of certain alternatives, but only partially alleviate the impacts of others. The test identifies which measures are applicable to which alternatives; who is responsible for implementation of the measure and how and when they are to be implemented; and the residual, adverse impacts, if any, that would result from imposition of the measures.

The latter section (Section III) of this EIR includes a discussion of the potential for growth inducement under the development alternatives (Section III ,Chapter 1); the irreversible environmental changes that would result from buildout under the Draft Comprehensive Plan (Section 8.0); and the relationship between short-term uses and long-term productivity under the Draft Comprehensive Plan (Section III, Chapter 3.0)). In addition, this EIR identifies the environmentally superior alternative from among the "no project" and the development alternatives (Section III, Chapter 5).

2.7 MONITORING AND REPORTING OF MITIGATION MEASURES REQUIRED BY ASSEMBLY BILL 3180 (CORTESE)

Assembly Bill 3180 (Cortese), effective January 1, 1989, requires a lead agency, in making findings under Sections 15091 and 15093 of the State CEQA Guidelines related to significant impacts, to adopt a monitoring and reporting program for adopted or required changes to mitigate or avoid significant environmental effects. Assembly Bill 3180 indicates that the monitoring and reporting program is required for changes made to a project or imposed as conditions of project approval in order to mitigate significant environmental impacts. The definition of a "project" in Section 15378 of the CEQA Guidelines includes the adoption of a local General Plan; therefore, the adoption of a monitoring and reporting program is required for the mitigation measures identified for buildout under the development alternative that is adopted. However, Assembly Bill 3180 refers to mitigation measures imposed on specific development projects, as opposed to those identified in an EIR for a General Plan. The mitigation measures identified in the General Plan EIR to alleviate the impacts of buildout under the development alternatives reflect two levels of mitigation: those that can be included as policy statements within the General Plan, and those that are appropriately implemented at the time specific development would occur. The City is presently developing a program for the monitoring and reporting of mitigation measures for specific projects, as required by Assembly Bill 3180, and will also develop a program for the mitigation measures identified in this

EIR. It should be noted that Assembly Bill 3180 does not require a monitoring and reporting program to be included in an EIR.

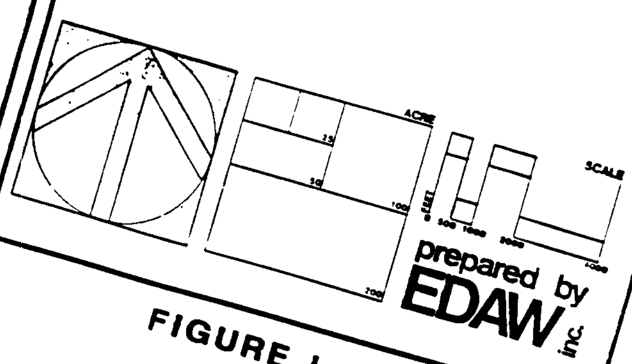
RIDGECREST GENERAL PLAN

Ridgecrest, California

GENERAL PLAN STUDY AREA

Legend

- City Limits
- County Boundary
- NWC Boundary (After Completion of Excessing Program)
- Sphere of Influence (After Annexation)
- County Designated Urban Area
- Potential Federal Excess Property
- Pending Annexation



prepared by EDAW inc.

FIGURE I-2

SECTION I

Chapter 3.0

PROJECT DESCRIPTION

3.1 PROJECT LOCATION AND BOUNDARIES

The City of Ridgecrest General Plan Update addresses the area within the city limits, as well as unincorporated properties within the Sphere of Influence and Indian Wells Valley. The boundaries of the planning area proposed for the General Plan include the east/west valley lands between Highway 14 and to the east of the City in San Bernardino County, the lands in the common watershed to the south along Highway 395 and south of Cerro Coso college. To the northwest the plan includes those lands south of the Inyokern Specific Plan area, southward of a line extended from Ridgecrest Boulevard to the West; those lands south of Inyokern Road and east of Jack's Ranch Road, the northern perimeter of the planning area follows Inyokern Road eastward, then along the existing city limits line and continues east along Ridgecrest Boulevard (Highway 178) into the Indian Wells Valley portion of San Bernardino County.

The proposed planning area is an expansion of the existing planning area to the south and west, to include additional lands adjacent to highway 395 and in the hillside areas. The proposed planning area includes properties both within and outside the adopted sphere of influence (the ultimate city boundary) of the City.

3.2 DRAFT GENERAL PLAN

The focus of the City's General Plan Update process is the draft General Plan, which was developed by the General Plan Element Review Committees with technical support provided by City staff. The Committee consisted of representatives from the business sector, civic groups and the public at large. The committees held public meetings, and conducted an element by element reviews of the adopted General Plan. Their efforts have culminated in the draft General Plan which guides development in the City through and beyond the year 2010. The draft Plan contains goals, objectives, policies, and in some instances, specific programs, for each element of the Plan in addition to technical appendices for the various elements.

The City''s current Comprehensive Plan was adopted in 1981. The planning time horizon of the adopted Plan, as amended, is to the year 1995. Buildout under the Plan's land use scenario would result in a population of approximately 65,000+. The Plan itself targeted a population of 26,495 for year 1995, the population in 1992 was 29,313. The population has increased at a rate faster than that anticipated by the 1981 General Plan, but is well below the carrying capacity of the land use element within the City Limits and Sphere of Influence.

3.3 PURPOSE OF THE GENERAL PLAN UPDATE

The California Government Code requires that local General Plans contain seven mandatory "elements": Land Use, Circulation, Housing, Open Space, Conservation, Safety and Noise. In addition to these elements, the City's draft General Plan includes an "optional" element: Economic Development. The General Plan presently contains a Scenic Highways Element. This element is proposed to be deleted and its contents incorporated into the mandatory elements; policies relating to scenic highways are included in the draft Land Use, Conservation and Circulation Elements. Land Use Plan, Circulation Plan, and Special Study maps are an integral part of the draft General Plan.

The draft General Plan is intended to function as a policy document to guide land use decisions within the City planning area through and beyond the year 2010. The purpose of the update process is one of renewal to address changes in economic and environmental circumstance, culture and technology, and in public policy on a periodic basis. Typically General Plans receive a comprehensive update every decade with an intermediate update review at five year periods. The Plan incorporates goals, objectives, policies and programs from the adopted General Plan, as well as an update of these in response to changes in the City's environment and identified public needs. The goals, objectives, policies, and programs included in the draft Plan have been developed to ensure that adequate public services will be available to serve City growth to the year 2010, and that the City's natural resources will be effectively conserved and managed to provide for a high quality of life. As noted in the Draft General Plan, the General Plan Update also is intended to allow development of a mix of land uses in the City planning area that will generate balanced economic growth and sufficient revenue to provide a satisfactory level of municipal services.

3.4 DEVELOPMENT ALTERNATIVES

This EIR assesses the potential impacts of four development alternatives identified by the Ridgecrest Planning Commission and General Plan Committees. These alternatives include the draft General Plan, and three scenarios that would generate 50,000 to 100,000 residents. Community

Development Staff utilized these alternatives to reflect the feasible range of population that could occur given the amount of undeveloped land in the planning area and the support resources available to the City. The population assumptions developed by staff were based on existing land use designations, undeveloped acreage, and census information regarding the average number of people per dwelling unit. Staff found this to be the most objective and defensible method of deriving the four buildout alternatives.

In developing the types of residential land uses that would result from buildout under the development alternatives, City staff derived a maximum number of units from three generalized buildout populations: 50,000, 75,000 and 100,000. Land Use designations were already assigned, because the no project scenario includes existing, approved and pending development as well as existing land use designations that could develop without changing the plan. The number of units that would occur from buildout at the maximum density permitted under each residential designation for each development alternative were then aggregated by residential land use type (single and multiple family). The additional housing units, jobs, traffic etc. that would occur under each alternative was generated by City staff using an average population per dwelling unit type derived from the census, and multiplying the average population factor times locally established or professionally statistical basic units of consumption and impact for each land use.

Ultimate buildout under the four alternatives includes infill development in existing, largely developed neighborhoods as well as residential, commercial and industrial development in undeveloped areas within the City limits and Sphere of Influence. However, intensification of existing land uses or redevelopment of existing uses to other uses outside the Redevelopment Area has not been considered in detail. All of the scenarios assume that land use designations will remain essentially the same with differences between scenarios limited to ultimate buildout. The specific land use plan to be adopted by the City Council may: (a) duplicate any of the four alternatives; (b) result in a population within the low to high end of the range of buildout scenarios; (c) include elements of one or more of the alternatives; or (d) incorporate land use changes made during the review process.

The following discussion describes the four development alternatives and provides a breakdown of the incremental land uses proposed under each alternative; number of dwelling units, densities, acreage, and population. Table 3-1 shows the existing level of development in the current planning area, and the incremental buildout that would result in a populations of 50,000, 75,000 and 100,000 people through and beyond the year 2010. The no project alternative would extend existing land uses and development within them with minimal reconsideration of the impacts on sewer, transportation, schools etc. and is posited as a base for CEQA purposes.

Development under Alternatives 1 (50,000) and 2 (75,000) could be limited to the existing City limits and with some recommended changes to the existing Sphere of Influence. Alternative 3 (100,00) would result in development of portions of the area outside the existing sphere and planning area. These figures are consistent with working maps utilized by the City Planning Commission and staff for use in the preparation of this EIR.

3.4.1 No Project Alternative (Alternative 4)

A base year of 1990 was used to identify land use and population buildout. The No Project buildout includes those land uses and the intensity of development that have occurred and will continue to could occur as a result of buildout of the 1981 General Plan e.g.: As such, some of the impacts of the No Project Alternative could be considered to have already occurred. This scenario constitutes growth that is presently planned to occur under the City's adopted General Plan, and would result in a population within the City of about 50,000. The No Project Scenario development will be consistent with the land uses shown in the Land Use Map of the existing Plan. The Land Uses within the 1981 General Plan could result in a Buildout Population of up to 55,000 post year 2010 but the adopted General Plan and companion programs (including the Air Quality Management Plan Implementation program and Congestion Management Plan) would need to be amended. Without amendment to incorporate the Master Waste Water Treatment Plan, The No project alternative would result in a significant impact on wastewater treatment plant resources

The No Project Alternative would result in an additional 8,000+ dwelling units on approximately 2000 acres within the existing city limits, or an increase of approximately 20,000 persons within the planning area. Approximately 630 Acres would be developed with new commercial uses and approximately 200 acres of land would develop with industrial uses. Upon completion of buildout, significant tracts of land within the planning area would remain in Urban Reserve.

3.4.2 Alternative 1

Buildout under Alternative 1 is anticipated to result in a population of approximately 50,000 + post the year 2010 but not expand or provide for the ultimate populations projected by Alternatives 2 and 3. Alternative 1 differs from the No Project Scenario in that it would be amended to accommodate revisions to the General Plan such as the Congestion Management plan, Master Sewer Plan, Circulation Element that would better accommodate and facilitate quality of life issues. While accommodating the same population as the No Project Alternative, it represents a modernization of the General Plan and serves as an update to accommodate new social, economic and environmental circumstance.

Development under Alternative 1 would not necessitate amendments to the City sphere of influence and the future number of households would increase from 10,577 by 8,082 to 18,659. The City's population could be accommodated by the development of approximately 14,000 acres. This alternative requires the expansion of the City's wastewater treatment system to process approximately 6 million gallons of sewage per day. Buildout under any of the population scenarios represents a significant impact on water supplies.

3.4.3 Alternative 2

Alternative 2 comprises the buildout and ultimate population of 75,000 recommended by General Plan Committee. Ultimate buildout under this scenario may necessitate some minor amendments to the sphere of influence and will require the ultimate development of 20,000 acres of land.

The attached Table 3-1 provides a breakdown of the incremental residential and non-residential land uses, residential densities, and population proposed under Alternative 2 and the other scenarios. This buildout includes the revisions to the adopted land use designations proposed by the General Plan Committees. The residential land uses and population recommended by the Committees would result in an additional 17,509 households or 28,086 at buildout. In the proposal approximately 12,969 additional acres of development will occur. The Wastewater Treatment System would require expansion to accommodate 9 million Gallons of Inflow per day.

3.4.4 Alternative 3

Alternative 3 would generate a population of approximately 100,000 at buildout post year 2010. Buildout under this scenario would result in the maximum amount of residential and non-residential uses that could be served with available water for a hundred years, if the City utilized a significant portion of the Indian Wells Valleys water resources. As with the other alternatives, the impact is considered to be significant.

This alternative would result in complete development of the existing City Limits, Sphere of Influence and require the annexation of an additional 8,000 acres. Under this alternative, it is anticipated that all of the areas of the City, a significant portion of the lands to the south and west and most of the southern hillside areas would be either developed or under development.

Table 3-1 provides a breakdown of the incremental residential and non-residential land uses, residential densities and population proposed under Alternative 3. This alternative is anticipated to result in an additional 19,000 dwelling units, for an increase of approximately 25,000 persons beyond the buildout under Alternative 2.

Alternative 3 would require significant changes to the City's traffic and circulation system, expansion of the wastewater system to accommodate treatment of 12 million gallons per day, and result in a community of more than 37,000 households.

3.4.5 Comparison of Development Alternatives

Table 3-1 provide a comparison of the population and types and amount of residential and non-residential uses existing within the planning area and proposed under the four development alternatives. The following observations can be made from the table and figure:

- Full buildout under the No Project and Alternative 1 scenarios would add an additional 20,000+ persons to the 1990 population (approx. 30,000) in the planning area (60 percent increase), Alternative 2 would add 45,000 persons (150 percent increase), Alternative 3 would add 70,000 persons (210 percent increase);

- Under all alternatives the proportional relationship between the acreage of existing land uses and the intensities of those uses would remain similar to 1990 distributions. 31% of existing land in the City is vacant. Buildout Scenarios do not include vacant lands.

- Most of the additional commercial, industrial, and recreation/park development is anticipated to occur proportionately although new institutional uses would be developed to accommodate the service population of Alternative 3.

TABLE 3-1

INCREMENTAL RESIDENTIAL AND NON-RESIDENTIAL LAND USES, RESIDENTIAL DENSITIES AND POPULATIONS

Category	Alternative 1	Alternative 2	Alternative 3
1991 Population	28,241	28,241	28,241
New Population	21,759	46,759	71,759
Total Population	**50,000 (2025)**	**75,000 (2025)**	**100,000 (2025)**
1991 Households	10,577	10,577	10,577
New Households	8,082	17,509	26,876
Total Households	**18,659**	**28,086**	**37,453**
1991 Jobs	8,136	8,136	8,136
New Jobs	6,217	13,468	20,674
Total Jobs	**14,253**	**21,504**	**28,810**
1991 Land Acres	City Limits 11,359	Sphere 9,636	1991 Total 20,995
Land Existing Use	7,838	7,838	7,838
Future need	6,035	12,969	19,003
Total Land	**13,873**	**20,807**	**27,741**
Parks, existing (acres)	115	115	115
New Park	66	141	216
Total Park Acres	**159**	**234**	**309**

TABLE 3-1 (continued)

Category	Alternative 1	Alternative 2	Alternative 3
1991 Housing Units	8,714 Single Family 2,535 MultiFamily		
With 8% Vacancy Rate	8,017 Single Family 2,332 MultiFamily		
New Single Family	6,177	13,274	20,371
New MultiFamily	1,797	3,861	5,926
Total Single Family	**14,194**	**21,291**	**28,388**
Total MultiFamily	**4,129**	**6,193**	**8,258**
H_2O Existing Use (AFY)	6,033	6,033	6,033
H2O Gals Annum	1,965,847,616	1,965,847,616	1,965,847,616
Future Total AFY	**10,678**	**16,048**	**21,357**
Future Total Gals/Y	**3,479,550,280**	**5,229,154,658**	**6,959,100,560**
Sewer Existing (MGD)	3.4	3.4	3.4
New Use	2.6	5.6	8.6
Total Sewage 2010	**6.0**	**9.0**	**12.0**
1990 Capacity	4.2	4.2	4.2
Additional need	**1.8**	**4.8**	**7.8**
Traffic existing SF (ADT)	76,675	76,675	76,675
Existing MF	13,292	13,292	13,292
Future SF	58,682	126,103	193,525

TABLE 3-1 (continued)

Category	Alternative 1	Alternative 2	Alternative 3
Future MF	10,243	22,007	33,778
Total ADT's	**158,892**	**238,077**	**317,270**
School Grade K-5	2,644	2,644	2,644
New students	2,021	4,377	6,719
2010 Total	**4,665**	**7,021**	**9,363**
School Grade 6-8	740	740	740
New students	565	1,226	1,881
2010 Total	**1,305**	**1,966**	**2,621**
School Grade 9-12	1,058	1,058	1,058
New students	808	1,751	2,688
2010 Total	**1,866**	**2,809**	**3,746**
Total Students K-12	4,442	4,442	4,442
New	3,394	7,354	11,288
2010 Total Students	**7,836**	**11,796**	**15,730**
Solid Waste, 1991	57,894	57,894	57,894
New	44,606	95,856	147,106
Total Tons 2010	102,500	153,750	205,000
Landfill capacity net	1,171,500	1,171,500	1,171,500

TABLE 3-1 (continued)

Category	Alternative 1	Alternative 2	Alternative 3
Existing annual waste	130,400	130,400	130,400
2010 annual waste	**171,000**	**256,500**	**342,000**

Notes on Assumptions: Households(HH) = 2.67 person per household. Jobs = 1.3 per HH; Parks = 3 acres per 1000 persons; Solid Waste = 2.05 tons pp/y; 1200 lbs = cu.yd.

SECTION II

Chapter 4.O

ENVIRONMENTAL SETTING

4.1 LOCATION OF CITY IN KERN COUNTY

This section briefly describes the regional setting of the City of Ridgecrest in Kern County. A detailed discussion of the environmental setting in each category of potential impacts is discussed in Section 2.0.

4.1.1 Topography

Ridgecrest is located in the northeast corner of Kern County in the Northern Mojave Desert. Located 125 miles northeast of Bakersfield and approximately 150 miles northeast of Los Angeles, this desert community is elevated approximately 2400' above sea level and is the only incorporated City within the Indian Wells Valley. The Indian Wells Valley is bounded by four mountain ranges, the Coso, Sierra Nevada, Argus and El Paso Ranges.

4.1.2 Regional Access

The City of Ridgecrest can be directly accessed from State Route 178 with ingress at the northern portion of town from the west and east. The City can also be accessed from the south by State Route 395, the major transportation corridor for the Eastern Sierra Nevada.

4.1.3 Regional Climate

Being a desert community, Ridgecrest is relatively arid with approximately 4.75 inches average annual rainfall. Temperatures can reach upwards of 118 degrees in the summer months and can drop to as low as 25 degrees in the winter. Heavy winds are prevalent during the spring months with winds often exceeding 60 miles per hour and occasionally exceeding 70 miles per.

4.1.4 Surrounding Land Uses

The City of Ridgecrest is immediately surrounded by the China Lake Naval Air Weapons Center to the north, the County of San Bernardino to the east and unincorporated areas of Kern County to the south and west. The Weapons Center serves as a Test and Evaluation and Research and Development Facility for the Navy and Department of Defense. There is a minor amount of commercial development in San Bernardino County adjacent to the east of the City limits with some estate residential and predominantly open space.

4. 2 LOCAL SOURCES

4.2.1 Natural/Scenic Resources

4.2.1.1 Mountain Ranges

Ridgecrest is surrounded by 4 different mountain ranges, the Coso Range to the north, the Sierra Nevada Range to the west, the Argus Range to the east and the El Paso Range on the south. Each of these ranges have sensitive ecosystems that are well maintained as natural scenic resources.

4.2.1.2 Open Space

Open Space and clear skies are typical of the region and allow the four mountain ranges to be viewed from within the City. At night there is a scenic vista of the town provided to the residents living in the College Heights area at the south end of town.

4.2.1.3 Parks

Ridgecrest has approximately 115 acres of City parks and playing fields that accommodate various recreational activities. Besides recreational opportunities, City parks provide visual and aesthetic qualities inherent to the undeveloped/open space nature of a park setting. In addition to City parks, a golf course exists at the China Lake Naval Weapons Center and is open to the public.

The City's largest park is the Leroy Jackson Regional Park (leased from Kern County), which is approximately 40 acres. The City maintains baseball and soccer fields, tennis courts, picnic areas horseshoe pits and other amenities there.

4.2.1.4 Agricultural Lands

Very little agricultural development exists within the City limits. During the 1940's prior to the incorporation of Ridgecrest, the area was heavily farmed with alfalfa as the predominate crop. Currently no agriculture occurs in Ridgecrest other than 40 acres of alfalfa fields maintained by the City of Ridgecrest for the purpose of sewer effluent disposal.

4.2.2 Cultural Resources

4.2.2.1 Ethnic/Historic Heritage

Historically, Ridgecrest was inhabited by three native American cultures, the Koso, Kawaiisu and Chemehuevi. Due to the harsh climate of the region these tribes were nomadic. Evidence of these Native American cultures can be found in the Coso, Argus, and Panamint Mountain Ranges.

Mining became very prevalent within the surrounding area of Ridgecrest during the early 1800's. Silver and gold were heavily sought after during this time period. Ranching also became popular during this time period with cattle, sheep and goats being raised in the area. Ranching was prevalent in the 1940's when NOTS (Naval Ordinance Test Station) located in the Indian Wells Valley. Later becoming the China Lake Naval Weapons Center and now China Lake Naval Air Weapons Station (NAWS).

Along with the military and Department of Defense (DAD) presence in the Indian Wells Valley a significant amount of development occurred. In 1963 Ridgecrest became an incorporated City with a population of over 6,000 and has now nearly reached 30,000.

4.2.2.2 Cultural Facilities and Activities

The City of Ridgecrest is a highly educated community. As a result of this, there is much appreciation and numerous activities in the finer arts such as symphony orchestras, art guilds, theater and other fine arts. In addition to these cultural activities, the Desert Empire Fairgrounds within Ridgecrest provides the opportunity for recreation and at the same time allows for cultural activities to occur. For instance, several rodeos occur at the fairgrounds during the course of a year. This is reminiscent of the old west and the farming communities.

4.3 EXISTING LEVEL OF DEVELOPMENT

Non-residential uses total about 3,524 acres: 2,101 acres of commercial, 210 acres of industrial, 1,213 acres of institutional, and an additional 3,137 acres of parks and open space lands. Residential development totals 4,698 acres.

4.4 PHYSICAL CONDITIONS/CURRENT LEVEL OF ENVIRONMENTAL QUALITY

The Ridgecrest planning area is located in the southeast desert air basin. The majority of air pollutants in the region are particulate matters that are dispersed by prevailing winds. Occasionally, air quality measurements in Ridgecrest exceed the state and federal standards for particulate matters. Recently a monitoring station has been set up in Ridgecrest to determine if Ridgecrest exceeds the standards set for ozone within the air basin.

The major existing storm drainage system in Ridgecrest consists of a natural flow of water from the west to the east. Drainage facilities are currently inadequate to accommodate storm water runoff in most of the planning area, isolated portions of the City currently experience localized drainage or flooding problems. (The problems stem from inadequate or non-existent facilities, often in low areas and flat lands.)

The planning area lies within a highly active earthquake region of southern California (In seismic zone 4). Portions of the planning area are subject to such geologic hazards as fault displacement, earthquakes and ground shaking, liquefaction, soil subsidence, and flooding.

The base year (1990) population in the Ridgecrest planning area is 27,594. The average annual population growth rate was 4.7% between 1985 and 1990. Housing prices have remained relatively low in the planning area. There is a sufficient housing stock within Ridgecrest to maintain affordable housing.

Police protection in Ridgecrest is provided by the Ridgecrest Police Department. The City has a considerably low crime rate for a City of its size. The existing staff level of 1.2 officers per 1,000 residents is considered sufficient by the police department to provide for the law enforcement needs of the current planning area population.

The City of Ridgecrest contracts out fire service to the Kern County Fire Department. The China Lake Naval Air Weapons Station provides fire assistance by mutual aid agreements. There are two Kern County fire stations located within Ridgecrest and one located within the unincorporated area of Inyokern, approximately 13 miles from Ridgecrest.

The Sierra Sands Unified School District is comprised of 7 elementary schools, 2 middle schools, and 2 high schools within city limits. Cerro Coso Community College provides a 2-year program in a variety of studies leading to an AA or AS degree, vocational training, and community interest classes. Extension programs for Bachelor and Master Degrees are currently (1993) being offered by Cal State University Bakersfield.

The City of Ridgecrest provides sewer service for those properties located within the incorporated areas of Ridgecrest. There are few City residences served by septic systems. Currently, the City's Wastewater Treatment Plant does not have the capacity to handle much more growth. Several detailed studies have been formulated to determine what improvements are needed.

Municipal solid waste generated in the planning area is disposed at the Ridgecrest Landfill on Bowman Road west of Jacks Ranch Road. This landfill is operated by Kern County Public Works Department. The City will be implementing a solid waste reduction program in conjunction with the county to meet the state mandated waste reduction goals.

The planning area's traffic circulation system consists of 2 state routes, 8 primary arterial, 7 secondary arterial, several collector streets and many residential roads. Currently there is no fixed route bus system in Ridgecrest, however the Ridgecrest Area Transit System, a dial-a- ride program provides transportation on an as needed basis. Bike lanes exist mainly on arterial in the northeast portion of town. The rest of the arterial are slated for bike lane improvements under the proposed general plan.

Major sources of noise in the planning area include traffic noise along the two state routes and major arterial streets. In general, traffic is the single greatest source of noise, including off-road vehicles that are driven in the area. The Navy's Test and Evaluation operations also create noise impacts. However, test flights are directed away from the denser populated areas.

The City's planning area is serviced by the Indian Wells Valley Water District which boundaries far exceed city limits. Water conservation is one of the main concerns of the community because of the overdraft situation to the underground water aquifer in the Indian Wells Valley. Over a long period of time we may see the quality of water diminish along with quantity if preventative measures are not taken.

4.5 FUTURE CONDITIONS DISCUSSED IN EXISTING GENERAL PLAN

The proposed General Plan intends for development and growth to be orderly such that adequate capital improvements are in place without jeopardizing the viability of further development of property in Ridgecrest or the integrity of open space land.

The General Plan adopted in 1981 identified a population of 19,800 persons and estimated that there would be a total of 23,660 (including 4,100 Naval Weapon Center personnel) persons by 1995. This total was exceeded in 1986. The growth rates from 1983 to 1988 were between 3% and 8% and were not anticipated to go this high.

Alternatives 2, 3, and 4 address these growth rate ranges. Any potential growth impacts should be addressed in this environmental impact report.

SECTION I

Chapter 5.0

CONSISTENCY WITH EXISTING AND PROPOSED GOALS, OBJECTIVES, POLICIES AND PLANS

The purpose of this section is to compare and analyze the interrelationships between the adopted and draft General Plans, policy document, the proposed development alternatives, and several other existing City and County planning documents that affect the City and its planning area. This analysis shows how and where the draft General Plan policy document and the development alternatives establish new direction for development in Ridgecrest, and how this direction might differ from established planning goals in the City and the region.

Section 5.1.1 compares the policy statements found in the adopted General Plan to the buildout proposed under the four development alternatives to identify where the alternatives may depart from adopted policy.

Section 5.1.2 compares the draft General Plan policy statements to the four development alternatives to identify where buildout under the alternatives potentially differs from proposed policy. It is understood that land use policy and mapping revisions proposed in the draft General Plan reflect buildout under Alternative 2, so the greatest consistency would be expected to occur between the draft policies and buildout under Alternative 2, or one of the previous alternatives. In some instances the draft policies and mapping revisions are not applicable to Alternatives 1 and 3.

Section 5.4 compares the goals, objectives, policies and programs of the elements of the draft General Plan to one another to identify any internal inconsistencies.

5.1 GENERAL PLAN GOALS/OBJECTIVES/POLICIES

5.1.1 Comparison of Adopted Plan Goals/Objectives/Policies to Development Alternatives

The purpose of a comparison of the adopted goals, objectives, policies, and programs of the existing General Plan with the development alternatives is to identify how each alternative conforms with current City policy. Much of the existing policy document contains programming statements and directives that could be applied to any long range development scenario and therefore do not represent areas of inconsistency. There are not many goals, objectives, and policies that conflict directly with one or more of the four alternatives.

5.1.1.1 Open Space and Conservation Elements

The existing General Plan contains an Open Space Plan as an implementation program of the Environmental Management Element and not an individual element. This implementation program addresses habitat preservation, natural hazard protection, water reclamation and recreation. The proposed Plan addresses habitat preservation, natural hazard protection and water reclamation in the Conservation and Safety Elements.

The proposed General Plan has an Open Space Element with 4 goals and 10 objective statements. A majority of these objective statements deal with establishing recreational standards city wide and acquiring facilities to develop and meet those standards.

All four 4 alternatives of the proposed Plan differ from the existing implementation program in that the Element mainly addresses recreation and establishes development policies that would be parallel to the growth of the community. No development standards for recreation were addressed in the Environmental Management Element of the adopted General Plan.

The Environmental Management Element of the adopted General Plan lists goals and objectives for air quality, desert habitat, soils, and ground water. These goals and objectives are very similar to those of the proposed General Plan.

Good Air Quality is very important to the operations of the Naval Weapons Center and remains a priority of the City of Ridgecrest. Ground water is the most precious resource available in the Planning Area and is given serious consideration in both documents. Soils preservation and habitat preservation have also been identified in both documents as being important to the community and there is no major change in any of the alternatives of the General Plan.

5.1.2 Comparison of Draft General Plan Goals/ Objectives/ Policies to Development Alternatives

The purpose of this section is to compare the proposed goals, objectives, policies, and programs developed during the General Plan Update process to buildout under the development alternatives to identify where inconsistencies might exist. Through this process, one can identify the alternative that is most consistent with the draft policy statements, or identify policy statements that need amending to conform to the desired development alternative.

Alternatives 1 and 3 are inconsistent with the General Plan in that populations of 50,000 and 100,000 are not full buildout that maximize public facilities and services. Services would be under-extended at 50,000 and over-extended at 100,000.

Alternative 2 (population of 75,000) is consistent with the proposed land use designations and would not significantly impact public services and Alternative 4 (population 62,000) would be ideal for the land use designations.

This section is organized to review the policy document element by element. Only policy statements that are inconsistent with one or more of the development alternatives will be mentioned. To avoid duplication and to minimize confusion, policy statements are not restated verbatim. Instead, a brief description of the policy is provided, and the discussion of consistency is presented in a way as to clarify statement intent (for the exact wording of each policy statement refer to the draft General Plan policy document).

a. **Land Use Element**: Land use changes in the proposed general plan update focus primarily on providing increased commerce on arterial streets; and on land use changes within the sphere of influence.

b. **Circulation Element** : The proposed draft circulation element extends the existing grid traffic system and proposes no new concepts. The City and County Circulation Element are consistent and each prepare for a "smooth flow of goods services and people."

   o Encouragement of Alternatives to Motor Use The update continues and extends bike trails along existing corridors and asks for service of transit programs for feasibility.

c. **Open Space and Conservation Element:** Provision and funding of parkland. Subsequent to completion of the Draft General Plan a significant amount of parkland was acquired and recreational facilities have been expanded. Most of the deficiencies as noted in the General Plan no longer exist. The City of Ridgecrest now meets the standard of 3 acres of parkland per 1,000 persons.

- o Policy 2.2 - Establishment of Park Acreage Standards. Sufficient park acreage has been allocated to meet anticipated demands under all alternatives.

- o Policy 3.1 - Protection of Historic and Archaeological Resources. All alternatives are considered because mitigation measures to preserve and protect historic and archaeological structures are implemented to avoid alteration.

d. **Economic Development Element:** This element is consistent in that it calls for maintenance and enhancement of the economy and a stable market.

e. **Noise Element**: The proposed element is consistent in all alternatives. Mitigation measures will be installed to reduce sound impacts because ambient community sound will increase as the City grows.

f. **Safety Element**: The Seismic Safety and Safety Elements of the existing plan have been combined into one Safety Element.

There has been a new Seismic Special Studies Zone added to the region since the adoption of the existing General Plan. As required by state law a geologic report has been required prior to development of habitable structures in that zone.

An upgraded ISO rating for Fire Insurance has been received since the adoption of the General Plan (1984). These rating evaluations should occur every 10 years.

The Police officers ratio of 1.5 officers to 1,000 population has never been met. This standard has never been met and no significant impact has occurred to the Police Department. Unless crime drastically increases this standard may be over estimated, although when the China Lake Police Dept., Sheriff's Dept., and Highway Patrol are counted the standard is significantly exceeded.

- o Establishment of Acceptable Levels of Risk. All alternatives may be inconsistent with Police staffing if levels are not maintained at the noted police officer ratio. However, levels are currently below established standards and there is no significant impact.

  Construction of habitable structures has occurred over known fault lines. Although geologic reports have been submitted and accepted there is a minimal amount of risk accepted with construction.

Major drainage improvements are needed to protect the existing community and future buildout in flood plain areas. Flood standards will be implemented for new development.

- o Policy 7.2 - Retention of Drainage Channels in Natural State. Drainage channels can be considered important habitat areas supporting migrating birds and other animal species found in this area.

- o Policy 2.2 - Designation of Non-Residential Uses in 65 CNEL Contour Areas. All alternatives are potentially inconsistent with this policy statement which provides for the location of non-residential uses within 65 CNEL contour areas, wherever possible. Residential designations are present along arterials and Bowman Road in 65 CNEL areas under each alternative. Special residential design will limit residential exposure.

- o Policy 2.6 - Exterior Noise Levels Adjacent to Noise Sensitive Land Uses. Alternatives 3 is potentially inconsistent since new school sites have not been selected by Sierra Sands Unified School District.

g. **Source Reduction and Recycling Element** : This is a new element of the County of Kern Integrated Waste Management Plan as required by AB939. This element addresses solid waste issues and landfill capacity. Environmental review of this element has been done in the environmental impact report that was developed for the Source Reduction and Recycling Element.

h. **Household Hazardous Waste:** Refer to Source Reduction and Recycling above.

5.2 ADOPTED PLANS AND PROGRAMS

5.2.1 Applicable City/County Plans and Programs

The following City and county plans and programs are applicable to and may be affected by, the proposed development alternatives. Reference to additional discussion of these plans and programs in Section III is made, as appropriate.

5.2.1.1 City Flood Plain Management Program

The City's Master Drainage Plan is consistent with the Federal Flood Insurance map requirements established by Federal Emergency Management Agency (FEMA).

5.2.1.2 LAFCO

The sphere of influence is defined as the probable ultimate city limits. The sphere boundary can be amended, upon the request of the City and approval of LAFCO. Under established guidelines, unincorporated land within the sphere should be annexed to the city prior to being developed with urban uses or prior to receiving municipal services. The portion of the planning area located within the sphere is shown on Figure 3-1. The sphere includes all property within the planning area with the exception of lands to the east of the City. The City area of interest includes the entire planning area, and provides for City input in planning matters occurring outside of the city limits but within the Indian Wells Valley.

Buildout under Alternative 1 and 4 would occur within the present city limits and the boundary of the sphere of influence. Therefore, no amendment to the sphere boundary would be required. A minor amount of buildout would occur outside the sphere under Alternatives 2. Substantial development under Alternative 3 would occur in the south and west areas presently outside the sphere. Under the Guidelines, the urban development proposed by Alternatives 2, and 3 for property outside the sphere could not occur without amendment of the sphere and annexation of the property.

5.2.1.3 Kern County Air Quality Attainment Plan (AQAP) and Searles Valley State Implementation Plan (SIP) for PM10

In accordance with Federal Clean Air Act requirements, the "Kern County Air Quality Attainment Plan (AQAP) for the Southeast Desert Air Basin" was adopted June 25, 1991, amended and readopted June 8, 1992 and the "PM-10 State Implementation Plan (SIP) for the Searles Valley Planning Area" was adopted December 6, 1991. These two plans have been adopted by the Kern County Board of Supervisors and approved by the California Air Resources Board. These plans are administered by the Kern County Air Pollution Control District (KCAPCD). The purpose of these plans are to meet the National Ambient Air Quality Standards (NAAQS) and the California Ambient Air Quality Standards (CAAQS). The AQAP assesses eastern Kern County's air pollution problems and contains control strategies for reducing air pollutant emissions.

The SEDAB portion of Kern County cannot rely on a model to predict ozone attainment in the AQAP for this area, since no accurate model currently exists. Furthermore, until adequate monitoring exists in this area, a database for a model will not be available.

The modified linear rollback method demonstrates that the district is mitigating the emissions under its responsibility. However, being that the SEDAB has been documented as experiencing overwhelming transport from both the SCAB (South Coast Air Basin) and the SJVAB (San Joaquin Valley Air Basin) demonstrate that future ambient concentrations will have to rely on the photochemical model that is presently being used in the SCAB and the model that is expected to be developed as a result of the $16 million San Joaquin Valley Air Quality Study. These models will provide important data about the amount and composition of transport into the SEDAB.

The Kern County Air Pollution Control District (KCAPCD) has established through the Searles Valley PM10 Plan, a level of emission reductions at about 25 percent. It is expected that similar reductions could be made in the same targeted source categories of unpaved roads, process related fugitive dust, and wind erosion, so a 50 percent emission reduction across the board could be realized. Kern County APCD also asserts that residential waste combustion control measures would be implemented to assist with making the necessary reductions as required.

Buildout under all Alternatives is consistent with the AQAP and the SIP. Any development under these alternatives will be required to provide site engineering, circulation design, recreational features, water and energy conservation measures and provisions for affordable housing to meet the requirements of the plans.

Further discussion of the potential effects of the AQAP and the SIP on buildout under the development alternatives is found in Section II Chapter 13.

5.2.1.4 "Indian Wells Valley Water District Domestic Water System 1990 Water General Plan"

The above named plan was developed and adopted by the Indian Wells Valley Water District (IWVWD), an agency that is separate from the City of Ridgecrest. The IWVWD is tasked with providing water of a quality to support the existing and future population of the City. Studies of the water basin suggest that it can support a population of 75,000 (Alternatives 1,2 and 4) with the appropriate conservation measures, indefinitely. A larger population (Alternative 4) would likely lead to the importation of water from other areas.

5.2.1.5 County Solid Waste Management Plan

The County Integrated Waste Management Plan (CoIWMP) was adopted in October 1988 and is scheduled to be updated in 1995. The Plan identifies existing and potential landfill sites within the county. The Ridgecrest Landfill is the disposal site for the City of Ridgecrest and is expected to reach capacity in the year 2007.

Buildout under all four alternatives will be consistent with the existing landfill remaining capacity and the long term goals of Kern County to develop a regional landfill in the Indian Wells Valley.

5.2.1.6 County Hazardous Waste Management Plan

The Hazardous Waste Management Plan for Kern County and it's incorporated Cities was adopted in May of 1991. The purpose of the CHWMP is to provide the public and decision-makers with a document which will contain information and policies for the management of hazardous wastes/materials county-wide. The Plan includes two documents - a technical document and a policy document. The technical appendix presents information and background on the existing county-wide programs for regulation and management of hazardous waste and materials and discusses issues and problems. The second document comprises the actual policy document which contains the recommended solutions, policies, implementation schedules, siting criteria, and general siting locations for facilities. The overall objective of the CHWMP is to ensure that safe, effective, and economical facilities for the management of hazardous wastes are available when they are needed, which protects public health and the environment.

The plan must be adopted by a majority of the cities containing a majority of the incorporated population and the Board of Supervisors.

The technical appendix provides hazardous waste volume projections through the year 2000 for each waste group in Kern County. These projections are based on the number of existing waste generators in each city and industrial growth factors. The year 2000 volume projections were then translated into hazardous waste facility needs. These needs are addressed in the technical appendix. It is projected that approximately 52,746 tons of commercial hazardous waste will be generated and require treatment in the year 2000. This volume can be reduced by treatment of residuals requiring subsequent disposal.

Industrial buildout under the development alternatives is likely to include hazardous waste generators that will generate waste included within the above projected demand. The discussion of disposal needs and potential mitigation found in the CHWMP is herein incorporated by reference. A copy of the document is available in the City Clerk's Office of Ridgecrest City Hall, 100 W. California Avenue, Ridgecrest, CA 93555.

5.2.1.7 County General Plan

The County of Kern is completing an update and reformat of its General Plan in stages. The County General Plan, similar to the City's Draft General Plan and is a policy document which contains county-wide goals, policies, and programs; four appendices, which contain background data in support of county-wide goals, policies and programs; and several Area Plans which contain specific goals, policies and programs for specific geographic areas of the county.

Planning policies in the Indian Wells Valley are consistent with the City's existing and proposed General Plan.

5.2.1.8 County Circulation Element and Congestion Management Plan

The County's Element and Plan for the Indian Wells Valley are consistent with the City's existing and proposed General Plan.

5.3 COMPLIANCE/CONSISTENCY OF ROADWAY IMPROVEMENTS REQUIRED FOR DEVELOPMENT ALTERNATIVES WITH ADOPTED AND DRAFT CITY CIRCULATION PLAN

In general, the road improvements described in the City adopted Circulation Plan are the same as those proposed in the draft Circulation Element. However, the draft plan includes a few important additional improvements that extend roadway designations into the Planning Area to create consistency with the County Plan.

5.4 INTERNAL CONSISTENCY AND COMPLIANCE BETWEEN THE DRAFT GENERAL PLAN ELEMENTS

The purpose of this section is to indicate where policy statements within the draft General Plan may conflict or otherwise be inconsistent with other policy statements in the same element or other elements. Policy statements are defined as statements of intent contained in the nine General Plan elements, and may be in the form of goals, objectives, policies, or programs.

This exercise, in conjunction with Sections 1.1 and 1.2, meets the objective of California Government Code Section 65300.5 which requires that the General Plan and elements and parts thereof comprise an integrated, internally consistent and compatible statement of policies for the adopting agency.

This section differs from Section 1.1, which compared policy statements in the existing and draft General Plans to the four development alternatives. This should consider the buildout alternatives but instead focuses on program statements and their operational, rather than spatial, consistency. However, no inconsistencies are found in the elements and are therefore not addressed.

SECTION II

SECTION II

Chapter 1.0
AGRICULTURAL LAND CONVERSION

1.1 AGRICULTURAL LAND PRODUCTION

The following analysis was prepared using primarily three references:

(a) the zoning map of the city planning area
(b) discussion with the United States Soil Conservation Service
(c) California Department of Agriculture.

1.1.1 Setting

In the early 1940's agriculture played an important role in the economy and livelihood of the City of Ridgecrest. Ridgecrest was at one time considered a farming community where alfalfa production and grazing were prevalent. There is now only approximately 40 acres of agricultural zoned land within the City of Ridgecrest and there is a minimum amount of agricultural zoned land within the Kern County portion of the City's Sphere of influence.

1.1.2 Types of Products.

Information as noted by the Soil Conservation Service:

The USDA soil conservation survey identifies the types and locations of soils. The majority of soils in this area are composed of sand, silt, and clay. These are not typically good prime agricultural soil types. Therefore, agriculture is very sparse within Ridgecrest. Generally speaking, "prime" farmlands in California are irrigated soils (Class I and II) over 40 inches deep with an available water-holding capacity of four inches or more.

There are some orchards within the sphere of influence which average between 1/4 and 1/2 acre in size. However, there is no gauge to measure the productivity of these crops. The Statistics Division of the California Department of Agriculture keeps records of only State productivity and not by county or city production.

1.1.3 Land Conservation Act Contracts

A primary tool to preserve farmlands is the California Land Conservation Act (LCA) or Williamson Act contract program. State Government Code Section 51282 provides specific findings that must be made for the approval of LCA contract cancellations. There are no Williamson Act contracts within the City of Ridgecrest

None of the agricultural zoned lands in the Ridgecrest planning area falls under the Williamson Act.

1.2 CITY OF RIDGECREST LINEAR PARKS

The City of Ridgecrest has designated the Bowman Road area as a linear park. The linear park areas have been adopted to provide flood control, aesthetic enhancement of drainage right-of-ways, wastewater reuse and wind mitigation.

Because there is no agricultural land within the city limits that are in production there would be no large employment loss by rezoning those lands. The Primary Agriculture District within the existing city limits total 80 acres.

There is no revenues generated from agricultural lands other than property tax. Since agricultural land has no production there would be no negative fiscal impact of the conversion of agricultural land.

SECTION II

CHAPTER 2.0
NOISE

2.1 NOISE DEFINITION

Excessive noise can be classified as a dangerous and unhealthful nuisance. Generally, most concerns regarding noise evolve around residential neighborhoods. Noise can be generated by vehicles on residential streets, off-road vehicles, and by aircraft. Traffic along arterials have the greatest impact to residential areas. Off-road vehicles which are also a noise generator are prevalent in certain areas of the community.

The City of Ridgecrest General Plan addresses goals to reduce noise sources and lessen noise source impacts.

2.2 NOISE LEVELS

Noise levels are measured on a logarithmic scale because of physical characteristics associated with noise transmission and reception. Decibel changes represent a change in sound energy not sound loudness. A three (3) dB(A) change represents a doubling in sound energy, but not a doubling of sound loudness. Because of the structure of the human auditory system, a 10 (ten)decibel increase in noise is required to perceive a doubling of noise. A one (1) to two (2)decibel change in noise level is generally not perceptible to sensitive receptors.

Attenuation of noise levels occur as the distance to the source is increased. For example, an average industrial facility noise level decreases at a rate of six (6) dB per doubling of distance. Noise levels can also be decreased as barriers are constructed.

The State Office of Noise Control has issued land use compatibility guidelines (Figure 2-1) in which all Cities are recommended to be within. The City of Ridgecrest meets these recommended levels.

Time of day, duration and levels of noise are important in determining the impacts in land use planning. Exposure of noise impacts for extreme periods of time can be a nuisance in certain land uses. Exposure of extreme levels of noise can be detrimental to the health of the general public.

2.2.2 AICUZ Study

Armitage Airfield is located on the China Lake Naval Air Weapon Station (NAWS) and serves the military in flight operations and test and evaluations of military aircraft. An Air Installation Compatible Use Zone (AICUZ) study for the Navy facility was completed in 1977 to reduce noise impacts to the City.

As a result of the AICUZ study all departures from the Naval Air Weapons Station are to the south-southwest to avoid the major populations within and outside of the NAWS. The aircraft noise contours are located within the Noise element of the General Plan.

Although most air traffic is directed away from incorporated areas, this is a military community in which some impact from noise will occur. The City of Ridgecrest is supportive of the Naval Air Warfare Station's mission and must assume that testing of naval ordinance will continue as well as military flights.

2.2.3 Other Noise Impacts

Off-road vehicle noise in the City of Ridgecrest and surrounding study area is another major source of environmental noise which must be considered in land use planning for the community. At the present time, off road vehicle use (primarily motorcycles) occurs in nearly all undeveloped areas within the City. Estimated standards for dBA readings for unshielded (unmuffled) off-road motorcycles indicate that noise levels of approximately 100 dBA at fifty (50) feet from the source can be expected.

Table 2-1 is a comparative scale for noises which commonly occur in a community in order to provide a perspective on the impact of off-road vehicle noise. Recognition of recreational noise generating activity and the frequency of its occurrence will ensure that planning solutions and updating of existing enforcement policies can be developed and effectively applied.

2.3 IMPACT ANALYSIS

2.3.1 Significance Threshold

The California State Highway Design Manual requires specific design criteria to abate

TABLE 2-1

COMMON NOISE AND REPRESENTATIVE DECIBEL LEVELS

Sound Level in dB	Environmental Conditions
140-----	
Threshold of Pain	
130-----	
	Pneumatic Chipper
120-----	
	Loud Automobile Horn (distance 1 m)
110-----	
100-----	
	Inside Subway Train
90-----	
	Inside Motor Bus
80-----	
	Average Traffic on Street Corner
70-----	
	Conversational Speech
60-----	
	Typical Business Office
50-----	
	Living Room, Suburban Area
40-----	
	Library
30-----	
	Bedroom At Night
20-----	
	Broadcasting Studio
10-----	
	Threshold of Hearing
0-----	

Encountered Noise Levels (Sound Pressure Levels)
Source: Olinda Off-Road Vehicle EIR, EDAW, Inc.

noise along existing, new, and reconstructed highways. Caltrans is responsible for locating, designing, constructing and operating highways to minimize the intrusion of traffic noise into adjacent areas. Upon noise levels exceeding those maximums as noted in the highway design manual, mitigation measures should be used to reduce noise impacts.

The City of Ridgecrest should adopt the Office of Noise Control standards (Figure 2-1) for noise levels. To prevent noise levels from exceeding those standards, the City of Ridgecrest should continue its policy of requiring a minimum of six (6) foot high sound walls along arterials.

Residential areas adjacent to arterials have been required to have six (6) foot high block walls to mitigate traffic noise. This height may need to be increased if dB(A) exceeds those standards as set by the Office of Noise Control.

In addition to block walls being used as noise attenuation, Chapter 35 (Sound Transmission Control) of the Uniform Building Code should be enforced. This section of the Building Code establishes minimum noise insulation performance standards to protect residential dwellings from excessive noise.

2.3.2 All Alternatives

Periodic noise studies should be conducted to determine CNEL impacts to residential areas along arterials streets. If significant impacts are found the minimum height for sound walls should be increased to reduce excessive noise.

New residences constructed near arterial streets, parks and commercial and industrial areas should be reviewed for conformance to the insulation standards of Chapter 35 of the Uniform Building Code (Sound Transmission Control). Residential buildings within noise control areas exceeding state standards should be designed by Acoustical Engineers.

The below table shows the average daily traffic totals at the major intersections within Ridgecrest, these intersections generate more noise than other intersections within town. However, they are located in commercial areas and should have no impact to residential areas.

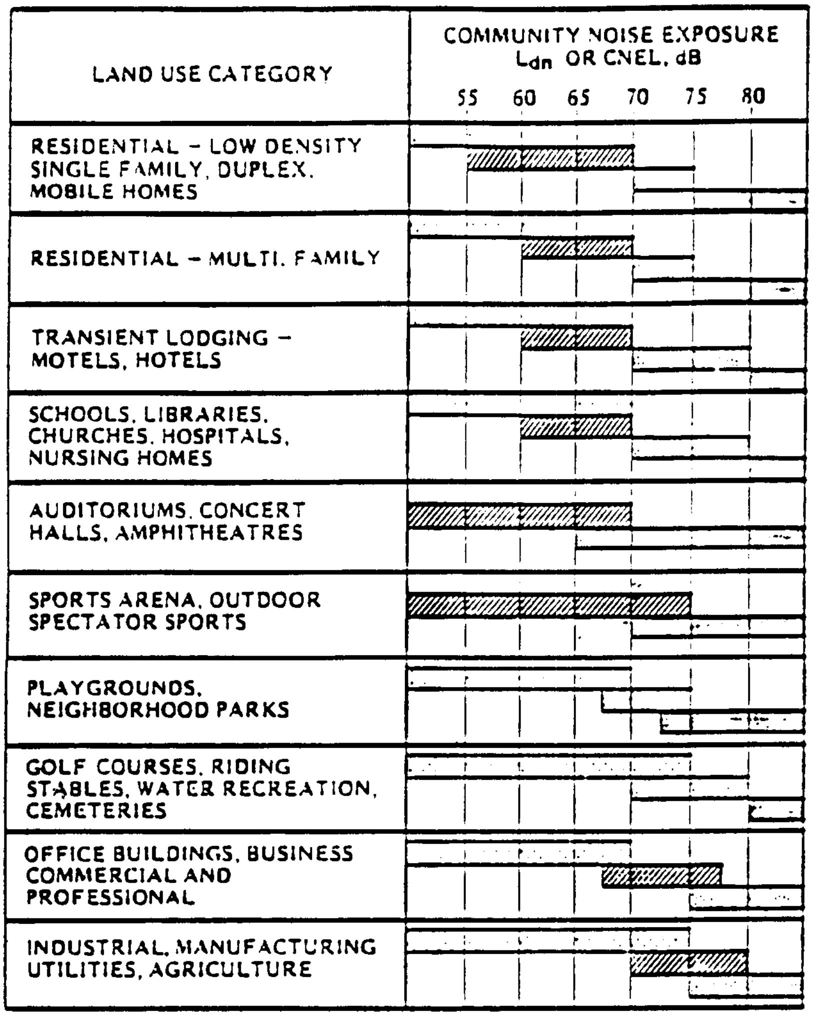
TABLE 2-2

State Route 178 CNEL Contours
1991

Roadway	Peak Hour	Pk. Mo.	ADT Annual
STATE ROUTES 178 & 395			
Intersection of Inyokern Rd & Mahan Avenue	980	10,500	9,800
Intersection of Inyokern Rd & China Lake Boulevard	2,050 2,500	20,010 26,000	18,800 24,800
Intersection of Ridgecrest Blvd & China Lake Blvd	1,550	15,800	15,200

ADT Average Daily Traffic Total
Pk. Mo. Peak Month (Average Daily Traffic Total For The Peak Month)
Annual Average Annual Daily Traffic Total
Source CALTRANS - 1991 Traffic Volumes on California State Highways

LAND USE COMPATIBILITY FOR COMMUNITY NOISE ENVIRONMENTS



INTERPRETATION

NORMALLY ACCEPTABLE

Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

CONDITIONALLY ACCEPTABLE

New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

NORMALLY UNACCEPTABLE

New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

CLEARLY UNACCEPTABLE

New construction or development should generally not be undertaken.

CONSIDERATIONS IN DETERMINATION OF NOISE-COMPATIBLE LAND USE

A. NORMALIZED NOISE EXPOSURE INFORMATION DESIRED

Where sufficient data exists, evaluate land use suitability with respect to a "normalized" value of CNEL or L_{dn}. Normalized values are obtained by adding or subtracting the constants described in Table 1 to the measured or calculated value of CNEL or L_{dn}.

B. NOISE SOURCE CHARACTERISTICS

The land use-noise compatibility recommendations should be viewed in relation to the specific source of the noise. For example, aircraft and railroad noise is normally made up of higher single noise events than auto traffic but occurs less frequently. Therefore, different sources yielding the same composite noise exposure do not necessarily create the same noise environment. The State Aeronautics Act uses 65 dB CNEL as the criterion which airports must eventually meet to protect existing residential communities from unacceptable exposure to aircraft noise. In order to facilitate the purposes of the Act, one of which is to encourage land uses compatible with the 65 dB CNEL criterion wherever possible, and in order to facilitate the ability of airports to comply with the Act, residential uses located in Community Noise Exposure Areas greater than 65 dB should be discouraged and considered located within normally unacceptable areas.

C. SUITABLE INTERIOR ENVIRONMENTS

One objective of locating residential units relative to a known noise source is to maintain a suitable interior noise environment at no greater than 45 dB CNEL of L_{dn}. This requirement, coupled with the measured or calculated noise reduction performance of the type of structure under consideration, should govern the minimum acceptable distance to a noise source.

D. ACCEPTABLE OUTDOOR ENVIRONMENTS

Another consideration, which in some communities is an overriding factor, is the desire for an acceptable outdoor noise environment. When this is the case, more restrictive standards for land use compatibility, typically below the maximum considered "normally acceptable" for that land use category, may be appropriate.

SOURCE: CALIFORNIA DEPARTMENT OF HEALTH, OFFICE OF NOISE CONTROL

Figure 2-1

SECTION II

Chapter 3.0
POLICE AND FIRE PROTECTION

3.1 SETTING

3.1.1 Police Protection

a. Existing Level of Service. Ridgecrest Police headquarters are located at 100 West California Avenue (Figure 3-1). Areas outside the city limits, but within the planning area boundaries, are served by the Kern County Sheriff's Department. The California Highway Patrol, located in Inyokern, also has jurisdiction on State Route 178 and Highway 395. There is typically one (1) sergeant and seven (7) officers operating out of the Inyokern office. The China Lake Naval Air Weapons Station adjacent to the City has their own police force. Mutual aid agreements exists between all of the four mentioned agencies.

The police department has a staff of 37 civilian personnel and 36 sworn personnel. The department maintains 10 unmarked support vehicles and 13 patrol cars.

The City is patrolled on a 24-hour basis. Response time goals within the City are 3.5 minutes for emergency calls and 5 minutes for non-emergency calls. The police force works out of one police facility, and patrol officers are assigned to various locations throughout the City. There are three (3) officers and one (1) sergeant assigned to emergency and non-emergency calls on each shift. Evaluation of the 3.5 minute response time is monitored by the Police Department to make sure that sufficient service is being provided. The department responds to an average of 15,680 service calls per year.

The existing city police headquarters were built in 1989. The facilities have been designed to service a population up to 75,000. An evaluation of the communications center for expansion should be considered at a population of 65,000. A site for a police substation has been considered for possible future expansions.

One measure of law enforcement protection services is a desired police officer/population ratio, generally stated in terms of the number of police officers per 1,000 population. Such measures are strictly employed by other cities as standards or guidelines, however, Ridgecrest has a low crime rate and may not necessarily need the standard officer ratio (Compton, personal communication, 1992). However, the police department may be currently negatively impacted.

Based on a total of 34 sworn officers and the current (1991) City population of 28,675, Ridgecrest's current patrol officer/population ratio is approximately 1.2:1000. The average ratio statewide is 1.5:1,000 and 1.4:1,000 nationwide, but the City has a low crime rate in comparison to other California cities with a similar population.

b. Planned Improvements. The police department has a public relations program in place and is working on improving the public perceptions of the police force through public interaction, and community affairs.

There is a minor trace of "gang" related activities within the City of Ridgecrest that the Police Department and DARE (Drug Awareness and Resistance through Education) Officers are addressing with the primary age school children. Two sworn officers are assigned as DARE officers on a rotational basis. Their main responsibility is to educate primary age school children about drugs and substance abuse. This is done by addressing the kids through the media, during community functions, at school activities and numerous other activities. The Police Department is planning on continuing it's Dare program.

If the demand on police protection service increases, the type of service provided by sworn officers may change. An evaluation will need to be made by the Police Department. In order to maintain certain services the police department will need to expand it's civilian volunteer personnel. Currently four (4) additional volunteers are needed, but that number will expand as time goes on. An evaluation of adding volunteers will need to be made by the police department.

In addition to the sworn officers there are five (5) dispatchers, two (2) administrative clerks, one (1) support manager, 10 police reserve (volunteers), 10 explorers, 12 explorer volunteers, one (1) full time Community Service Officer (CSO), five (5) part time Community Service Officers, one (1) Secretary and two (2) crossing guards.

3.1.2 Fire Protection

a. Existing Level of Service. Fire protection services for the City of Ridgecrest are provided by the Kern County Fire Department through a contractual agreement. Areas outside the city limits but within the planning area boundaries are also served by the Kern County Fire Department. The China Lake Naval Air Weapons Station assists Kern County Fire through a mutual aid agreement signed by the two agencies in 1988. This agreement is a standing agreement until canceled by the two agencies. (ED Bishop, Kern County Fire Marshall, personal communication).The locations of the county fire departments and the China Lake facility are shown on Figure 3-2.

Station 74 is located at 140 E. Las Flores and Station 77 is located at 815 W. Dolphin Ave. Station 74 maintains two fire engines, one patrol car, and four fire fighters per shift. Station 77 maintains two engines, one patrol car and three fire fighters. In addition to the two stations within the city limits, the Kern County Fire Department maintains a station in Inyokern, available to assist in emergency situations within Ridgecrest, when necessary. The fire department provides fire prevention, fire inspection and investigation services, hazardous materials enforcement functions and emergency medical support. The Fire Department responds to approximately 699 calls for emergency services (CFES) per year. The greatest number of CFES are for emergency medical assistance. All of the fire personnel are certified emergency medical technicians. The fire department who responds to 487 (487 out of 699) CFES annually coordinates with Liberty Ambulance Service to transport the victims of medical emergencies. The response time within the current City boundaries ranges from 3 to 10 minutes. Response times are calculated by multiplying 2.8 (a coefficient established by I.S.O.) by the number of miles to the site. Insurance Service Office (I.S.O) is responsible for evaluating the level of fire protection for each county within the state. Each county receives a new rating every 10 years.

b. Existing Deficiencies. Station location and response time to fires and other emergencies are the key elements in measuring fire protection service. The City of Ridgecrest which has an I.S.O rating of 4, has not received a survey since Station 77 was constructed in 1988. Typically cities receive an I.S.O. survey every ten years and in which case the City of Ridgecrest should receive a survey in 1994.

Response times are currently between 5.6 and 8 minutes at the northwest area of town and also at the eastern most area. There is a 10 minute response time at the Cerro Coso Community College located at the southern most area of town. Most other areas are under 5.6 minutes.

c. Planned Improvements. The fire department currently has no plans for improvements. With the recent addition of Station 77 a sufficient response time exists throughout most of the City. Upon the City reaching a population of 75,000 the Fire Department may determine the need for an additional fire station. The Fire Department has noted that an appropriate general location for a new fire station, would be in the area of the corner of Mahan Street and Inyokern Road shown on figure 3-3 (personal communication, John E. Bishop, Kern County Fire Marshall) .

3.2 Impact Analysis

3.2.1 Police Protection

a. Significance Thresholds. The significance of the increase in demand for police protection services would be dependent on the staff level of officers, and response time to new sites. Upon buildout of the current city limits and any future expansion of the city limits, the police officer ratio may have to be adjusted to meet any increased police needs. Although not necessarily sufficient, the existing ratio of 1.2 officers per 1,000 population is used as the threshold of significance for the City reaching a population of 50,000, 75,000, 100,000 and 62,000. The acceptable community policing level needs to be carefully monitored as the City grows. Another threshold of significance addresses the emergency response time to development in the planning area. A significant impact would result if an emergency response time of 3.5 minutes is exceeded (existing Police Department standard). To assess this impact, the response times to new development, based on the boundaries of police patrol beats, will be estimated.

Upon reaching a population of 65,000 the Police Department should begin evaluating the need for a police substation or expansion of existing facility. A substation may need to be completed upon the City reaching a population of 75,000.

b. Impacts Common to All Alternatives. Buildout under the three population scenarios would convert currently undeveloped land to residential, commercial, and industrial land uses. Changes in land use and the increases in population could result in increased crime and calls for service (CFS). Table 3-1 illustrates the additional police officer staff required by buildout of Alternatives 1, 2, 3, and 4.

c. Alternative 1. Buildout of Alternative 1 (population of 50,000) would convert currently undeveloped land to mostly residential land use. Alternative 1 provides additional buildout development within current City limits. The majority of residential development would probably occur along the southern areas of the City. There is a significant amount of Urban Reserve land available for residential zoning. There is currently a sufficient amount of commercial zoned land within the community for buildout of alternative 1. Increased demand for police protection services throughout the City would require additional police protection services and might cause a needed increase in the 1.2:1,000 police officer ratio. Emergency response times to new development are not expected to exceed the 3.5 minute standard if the increased demand on police protection services is met by an increase in staff and a higher percentage of service calls do not occur.

TABLE 3-1

Personnel and Equipment at Fire Stations

STATION #74

Location:	140 East Las Flores Avenue
Personnel:	Four Firefighters per shift
Equipment:	Two Engines, One Patrol Vehicle

STATION #77

Location:	815 West Dolphin Avenue
Personnel:	Three Firefighters per shift
Equipment:	Two Engines, One Patrol Vehicle

The demand for police protection services generated by buildout of Alternative 1 would require a staff of 60 sworn police officers. The current staff level of 34 is considered adequate for existing conditions. To meet the police officer/population ratio of 1.2 officers per 1000 residents, buildout of Alternative 1 would require an additional 26 officers. If additional staff is not available to meet the increased police protection service demand, buildout of Alternative 1 could result in significant adverse impacts to the police protection services of the City.

d. Alternative 2. Buildout of Alternative 2 would convert currently undeveloped land to residential, commercial, and industrial land uses throughout the planning area. The majority of development would occur as residential, industrial, and commercial development. As currently zoned there would be complete buildout within the existing city limits.

The demand for police protection services generated by buildout of Alternative 2 would require a staff of 90 police officers. The current staff level of 34 is considered adequate for existing conditions. To meet the police officer/population ratio of 1.2 officers per 1000 residents, buildout of Alternative 2 would require an additional 56 officers. If additional staff is not available to meet the increased police protection service demand, buildout of Alternative 2 could result in significant adverse impacts to the police protection services of the City.

e. Alternative 3. Buildout of Alternative 3 would convert currently undeveloped land to residential, commercial, and industrial land uses. Existing city limits would be built out under existing zoning regulations and adjacent County areas would be incorporated in order to meet the development needs.

This alternative would result in buildout of the areas currently zoned for residential development. Residential development would also occur in much of the urban reserve area located in the southern portion of the City.

The Police Department is located within a central area of the City which enables response times throughout the City to be approximately the same. Increased demand for police protection services within the City would require additional police protection services. This might cause the need for Police Officer ratio of 1.2:1,000 to increase. Currently traffic congestion is not a large concern within the City. During the commute hours of employees of the Naval Air Weapons Station a minor amount of traffic congestion exists along China Lake Boulevard and along secondary arterials. Any impact to this existing traffic congestion may result in time delays for police responses, resulting in the need for additional patrol units. Emergency response times to new development are not expected to exceed the 3.5 minute standard if the increased demand on police protection services is met by an increase in staff and patrol units. The expanded police facilities addressed in alternative 3 would also be required to accommodate this projected population of 100,000.

The demand for police protection services generated by buildout of Alternative 3 would require a staff of 120 police officers. The current staff level of 34 is considered adequate for existing conditions. To meet the police officer/population ratio of 1.2 officers per 1000 residents, buildout of Alternative 3 would require 86 additional officers. If additional staff and facilities are not available to meet the increased police protection service demand, buildout of Alternative 3 would result in significant adverse impacts to the police protection services of the City.

f. Alternative 4. The scenario is the current growth rate of the City, which would bring the total population to approximately 62,000. This buildout within the existing general plan scenario would require a total of 74 police officers at the existing level of service.

3.2.2 Fire Protection

a. Significance Thresholds. The significance of an increase in fire risk would be dependent upon the installation and maintenance of proprietary fire protection systems (fire protection systems owned by the structure owners), conformance to the Uniform Building and Fire Code, the level of fire department staffing, technical equipment support and the ability of fire suppression units to maintain a response time of 5 minutes or less. A significant fire protection impact could result if an emergency response time of 5 minutes is exceeded in numerous areas of the City (existing fire department standard). To assess this impact, the response times to new development, based on the location of existing and proposed fire stations and service areas, should be analyzed.

b. Alternative 1. Buildout of Alternative 1 would convert currently undeveloped land to residential, commercial, and industrial land use. Alternative 1 provides buildout within the City boundaries and beyond some existing development. Development can conceivably occur throughout all areas of the City with most residential construction occurring in the southern and western portions of the City. Commercial areas tend to develop along China Lake Boulevard. Industrial development would primarily occur in the northwest and southeast portions of town. Increased demand for fire protection services would occur within the response districts of all county fire stations.

The demand for fire protection services generated by buildout of Alternative 1 would require the installation and maintenance of proprietary fire protection systems in new structures as well as conformance to the Uniform Fire Code. Buildout of Alternative 1 is anticipated to require a staff increase proportionate to the anticipated maximum growth rate of this scenario. An increase in tax revenue as a result of the increased growth shall be used to pay for increased fire services.

d. Alternative 2. Buildout of Alternative 2 would convert currently undeveloped and agricultural land to residential, commercial, and industrial land uses throughout the planning area. In addition to the development identified for Alternative 1, the majority of development under Alternative 2 would occur in the same general locations and directions as residential development in alternative 1, however the boundaries would obviously be expanded. Increased demand for fire protection services would occur within the response districts of all county fire stations.

The demand for fire protection services generated by buildout of Alternative 2 would require the installation and maintenance of proprietary fire protection systems and conformance to the Uniform Fire Code, in the buildout areas. Buildout of Alternative 2 is anticipated to require a staff increase proportionate to the anticipated maximum growth rate of this scenario. An increase in tax revenue as a result of the increased growth shall be used to pay for increased fire services.

e. Alternative 3. Buildout of Alternative 3 would convert currently undeveloped and agricultural land to residential, commercial, and industrial land uses. In addition to the development identified for the previous alternatives there would be additional industrial lands located in the southwest portion of the City. There would also be other residential developments to the south and west as well as some additional commercial development in the northwest portion of the City. The development of parks would occur at designated areas to the south and west and possible neighborhood parks within residential developments. Natural open space would be maintained at the southern most area of the planning area and also to the north on Navy lands. All new structures would require the installation and maintenance of proprietary fire protection systems. Additional lands would need to be incorporated in the City sphere of influence.

Development of areas near the boundaries of the sphere of influence would increase the demand for fire protection services in the south, west, and southeast areas of the City. The increased demand would require additional fire stations, staff, and equipment.

The demand for fire protection services generated by buildout of Alternative 3 would require the installation and maintenance of proprietary fire protection systems and conformance with the Uniform Fire Code in the buildout areas. Buildout of Alternative 2 is anticipated to require a staff increase proportionate to the anticipated maximum growth rate of this scenario. An increase in tax revenue as a result of the increased growth shall be used to pay for increased fire services.

f. Alternative 4. The population of the City under the current growth rate would reach a total of 62,000. There would be a need for expanded fire protection service consistent with the existing level of service under buildout of the existing general plan designations.

3.3 Mitigation Measures

3.3.1 Police Protection

a. Impacts Common to All Alternatives. The following measures should be implemented by the City police department to mitigate the significant impacts to City police protection services by buildout of all the Alternatives. The measures should be implemented as soon as feasible and prior to buildout of any development that would impact existing police protection services. The city police department would analyze response times, the number of police officers, and patrol units to be added, depending upon service calls. General Plan revenues need to continue to increase and allocation of funds need to be made by future city councils.

- o The City could investigate development fees, to finance the city police department, by all new development for capital improvements. Fees could be assessed prior to the issuance of building permits, based on a monetary amount per square foot of building area coverage to be developed.

Currently school fees are required at building permit stage for residential development. A nexus has been established by the state to determine the fee. ($1.58/ft^2$ for residential units and $0.26/ft^2$ for commercial structures)

b. Alternative 1. Buildout of Alternative 1 would significantly impact police protection service demand, unless the following mitigation measure is implemented:

- o To adequately serve the new planning area population, the existing city police officer staff level should be increased by 24 officers to a total of 60 (based on the 1.2:1,000 population ratio).

c. Alternative 2. Buildout of Alternative 2 would increase police protection service demand requiring the following mitigation measure:

- o To adequately serve the new planning area population, the existing number of sworn officers should be increased by 54 to a total of 90 officers (based on the 1.2:1,000 population ratio).
- o Additional community service officers would be required to provide non-emergency services.
- o An evaluation of a police sub-station should be made. Depending upon the evaluation a police sub-station may need to be constructed.

d. Alternative 3. Buildout of Alternative 3 would increase the police protection service demand requiring the following mitigation measures:

- o To adequately serve the new planning area population, the existing number of sworn officers should be increased by 84 to a total of 120 officers (based on the 1.2:1,000 population ratio).
- o Additional community service officers would be required to provide non-emergency services.

e. Alternative 4. Buildout of Alternative 4 would require additional police officers and staff consistent with the current growth rate of the City of Ridgecrest. The current growth rate would bring the population of Ridgecrest to approximately 62,000 by the year 2010 and require a total of 74 officers (based on the 1.2:1,000 population ratio).

f. Residual Impact. Implementation of mitigation measures in a timely manner would result in less than significant residual impacts. If mitigation measures are not implemented the result would cause the police protection services of the City to decline, resulting in significant adverse unavoidable impacts such as increased crime and exceedance of emergency response times.

3.3.2 Fire Protection

a. Impacts Common to All Alternatives. The following measures are recommended to mitigate the significant impacts to fire protection service demand by buildout of Alternatives 1,2,3, and 4. The measures are to be implemented by Kern County Fire Department prior to the approval of development that would increase the demand for fire protection services. Kern County would ultimately determine the number of firefighters, type, and amount of equipment required, and location of fire stations based on community need. Funds to employ additional firefighters and supply additional equipment would be provided by the City; however, the City fire department will be competing with other City agencies for the allocation of funds.

- The City should make all applications for new subdivisions, development plans, conditional use permits, environmental impact reports, and business license applications available for review by the fire department to ensure compliance with fire safety regulations. The Kern County Fire Department plans to continue to enforce fire prevention programs to minimize fire hazards to an acceptable level of risk along with assistance from the City of Ridgecrest. Fire prevention programs shall continue to include:

  -- Public education programs;

  -- Annual fire prevention inspections;

  -- Enforcement of State smoke detector laws;

  -- Fire retardant roofing ordinance;

  -- Enforcement of Uniform Fire Codes as adopted by the City of Ridgecrest

- o The installation and maintenance of proprietary fire protection systems would be required in all new structures.

b. Alternative 1. Buildout of Alternative 1 would increase fire protection service demand, requiring the following mitigation measures:

- o To adequately serve the new planning area population, the existing fire department staff level should be increased proportionately to the growth of the City.

c. Alternative 2. Buildout of Alternative 2 would increase fire protection service demand, requiring the following mitigation measures:

- o To adequately serve the new planning area population, the existing fire department staff level should be increased proportionately to the growth of the City.

d. Alternative 3. Buildout of Alternative 3 would increase fire protection service demand, requiring the following mitigation measures:

- o To adequately serve the new planning area population, the existing fire department staff level should be increased proportionately to the growth of the City.

e. Alternative 4. This is a no project scenario that would require additional staff and equipment that would maintain the existing level of service.

The following table (Table 3-2) is a summary of the potential personnel staffing needed to adequately staff the police and fire departments under the four different growth alternatives. However, no specific staffing numbers have been made available by the Kern County Fire Department.

TABLE 3-2

Additional Emergency Service Demand of Development Alternatives

Emerg. Ser.	Existing Deficiency	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Police	0 officers	26 additional officers	56 additional officers	86 additional officers	38 additional officers
Fire	0 fire dept. staff	additional fire dept. staff contingent	additional fire dept. staff contingent	additional fire dept. staff contingent	additional fire dept staff contingent

NOTE: Police Officer demand based on current 1.2 police officer per 1,000 population ratio for Alternatives 1, 2, and 3.

City Of Ridgecrest

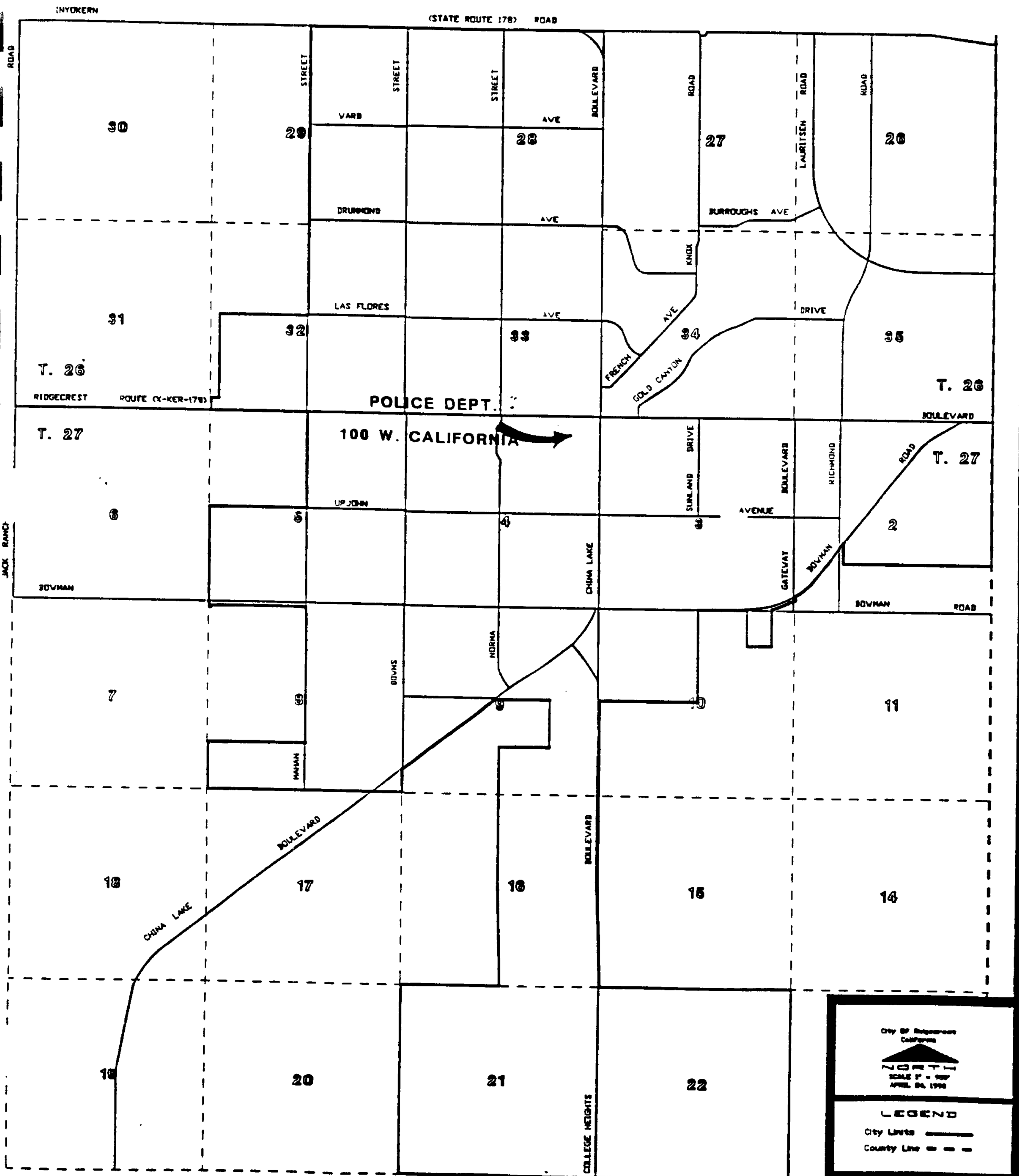


Figure 3-1

City Of Ridgecrest

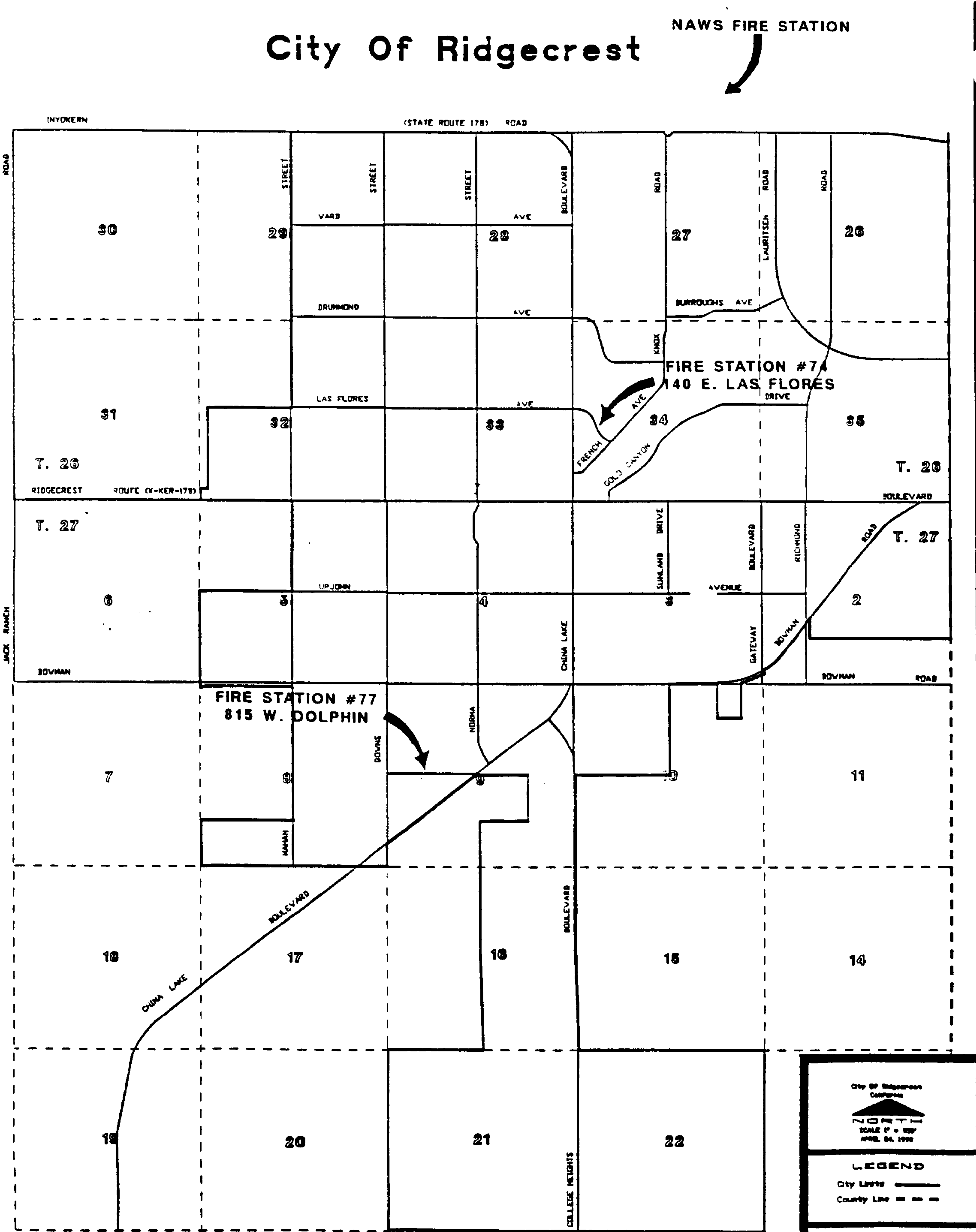


Figure 3-2

City Of Ridgecrest

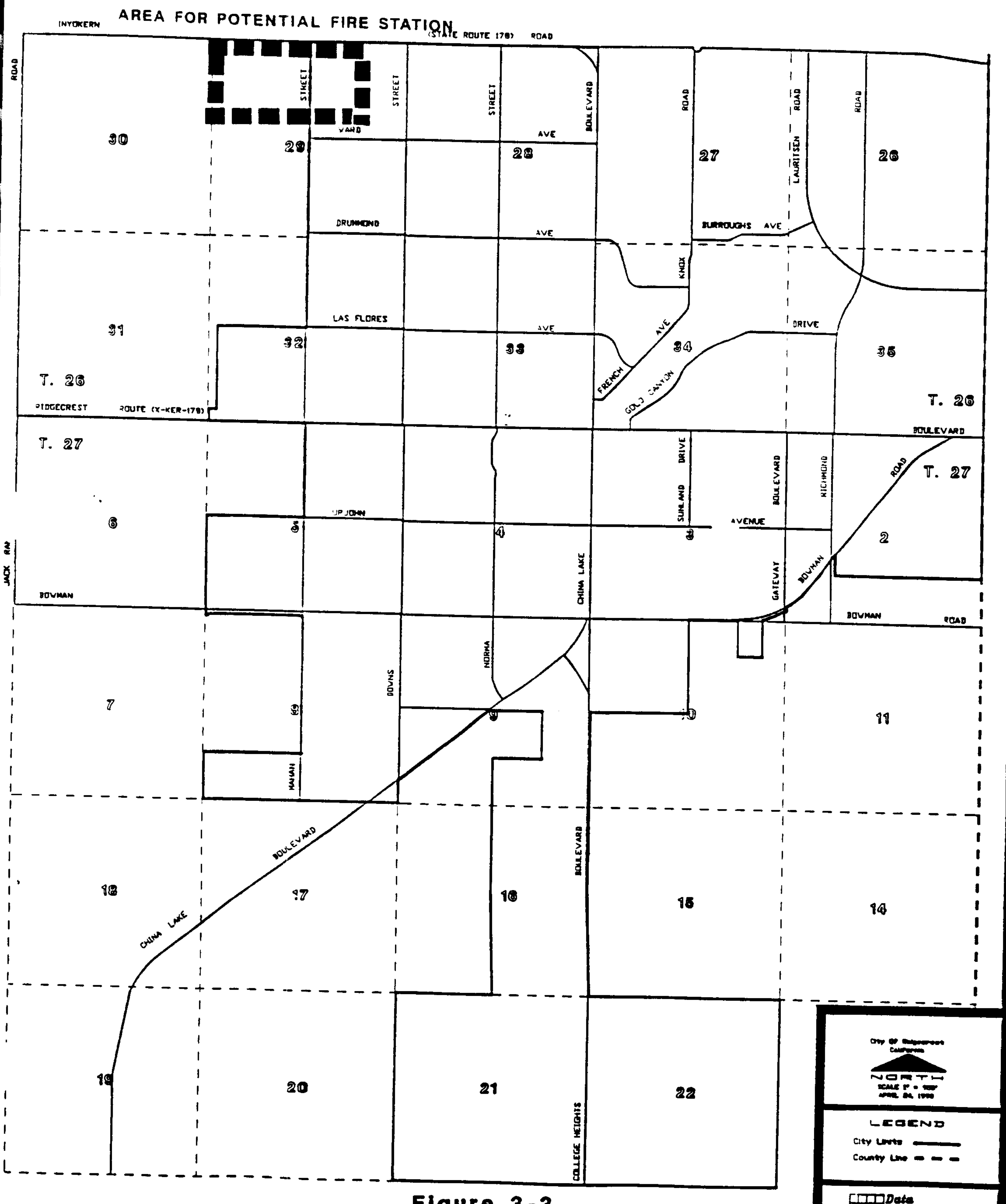


Figure 3-3

SECTION II

Chapter 4.0
ENERGY RESOURCES

4.1 SETTING

4.1.1 Natural Gas

The Pacific Gas and Electric Company serves the Ridgecrest planning area with natural gas. Natural gas consists of approximately 85% methane and 15% ethane, it is typically used in residences for the purposes of heating, water heating, and for cooking.

Due to its burning cleanliness, natural gas is being utilized in some industries as an alternative fuel for vehicles. Many (fleet) vehicles throughout the United States may be required to convert to natural gas sometime in the future. The availability of natural gas resources will play an important role in the conversion of automobiles from gasoline to natural gas. Natural gas is relatively inexpensive and can be easily and economically transported through pipelines. Upon conversion of vehicles to natural gas use, the construction of natural gas service stations will have to occur.

The Pacific Gas and Electric Company has stated that they will be able to serve any growth within our planning area as required by Rules 15B, 15C, and 16 as on file with the California Public Utilities Commission. "Any upgrades in distribution facilities, pressures, etc, will be directly related to demand, as would additional manpower and or facilities" (DeCarlo, written communication 1992).

4.1.2 Electricity

Southern California Edison Company provides electricity to the Ridgecrest planning area. There are three sub-stations located within the city limits that distribute electricity throughout the planning area. Edison has stated that they can currently meet the needs of Ridgecrest through 1997. The needs generated due to growth will be accommodated by Edison. They have stated that

"As population increases, substation transformers are increased or where need be, new substations are built. (Beck, written communication 1992).

4.1.3 Fuel Oil and Gasoline

There are several oil and gasoline purveyors within the Ridgecrest planning area that provide gasoline to the existing population. The amount of oil and gasoline consumed within the Ridgecrest planning area is unknown, however, California Division of Oil and Gasoline has stated that approximately 231,685,000 gallons of oil are produced within Kern County (Mitchell, oral communication 1992). No production of oil occurs within the Ridgecrest planning area.

4.2 Impact Analysis

4.2.1 Thresholds of Significance

Thresholds of significance are difficult to determine for the production and consumption of energy resources. Political and economic climates greatly influence the production and supply of these resources. Without the complex information available on the economic and political factors, the demand for energy resources is assumed to increase at the same rate as the planning area population increases under each alternative. A free market economy as well as federal laws will insure the availability of natural gas, electricity, fuel oil, and gasoline.

4.2.2 All Alternatives

Upon buildout of Alternatives 1, 2, 3, and 4, there would be an increase in demand of energy resources by 43%, 63%, 75%, and 50% respectively. These increases in demand are assumed to be at a constant and equal rate. However, the local level of consumption of the different resources will be affected by social, political, economic, and environmental factors as determined at higher levels (state and federal).

As stated earlier in this section (section 4.1) the utilities will meet any increase in demand of the energy resources. Therefore, the impact to any increases in demand of energy resources would be less than significant. New discoveries of any of these resources can positively impact availability.

4.3 MITIGATION MEASURES

Although no measures are necessary to mitigate energy impacts, the following conservation measures and alternative energy resources are recommended to conserve valuable energy resources and to minimize indirect air quality impacts.

Energy conservation measures offer a low cost method of conserving valuable energy resources, saving the consumer money and forestalling the development of costly power plants. In addition, conservation measures offer the benefits of decreasing wasted energy resources, air pollution, and traffic congestion.

- o All development proposed under the four (4) alternatives should incorporate energy efficiency in building design and materials to minimize the need for heating, cooling, and lighting.
- o Reduction of automobile use can be achieved by providing alternative means of transportation to the public, particularly for commuter uses.
- o Businesses should offer employees incentives to carpool to reduce single-occupant vehicle use.
- o Bike lanes should be installed in appropriate areas in the planning area to separate motor vehicle traffic from bicyclists and encourage commuter use.
- o Encourage solar energy features in new public buildings
- o Initiate monthly reporting on public (City) energy use.
- o Research the viability of a building retrofit program.
- o Develop a library of solar and energy conservation references for use by local residents.
- o Evaluate the feasibility of using alternative fuels in public vehicles.
- o Encourage solar access plans for new development proposals.

a. Alternative Energy Resources. Alternative energy allows energy conservation resulting in cost savings and existing sources of energy offers more flexibility to the consumer. Possible alternative energy resources that could be used in the future are cogeneration, liquified natural gas, geothermal, solar, and wind.

- o Cogeneration (Processes Involving the Use of Waste Heat). Cogeneration is a process that involves transferring steam heat into energy resources such as electricity. Generation of carbon dioxide and water purification are other potential benefits of cogeneration.

- o Liquified Natural Gas Liquified natural gas is being used as an alternative energy resource by some companies within the United States. Its storage capacity (1/600 the volume of room temperature natural gas) and its ability to be transported from abroad by storage tankers makes it favorable during a natural gas shortage.

- o Geothermal Energy is that which is generated from steam from the interior of the earth. Geothermal energy can be used as a heat source for various uses. Byproducts such as sulphur and many others can also be generated as a result of this energy source.

- o Solar energy also exists as a possibility within the City's planning area. Currently Southern California Edison attains some of its electricity from the Kramer Junction Company solar energy plant located near Kramer Junction, approximately 18 miles east of Boron, an area outside of the Ridgecrest planning area.

- o Wind Intermittent heavy winds occur often within the planning area, especially in the spring. The possibility of harnessing some of the wind for energy does exist.

Residual Impact. Because no significant energy impacts would occur as a result of buildout of Alternatives 1, 2, 3, and 4, there would be no mitigation measures necessary and therefore no residual energy impact. Some of the alternative energy resources are cleaner to produce and use than others. For example Coal and Cogeneration production can produce pollutants. One particular byproduct of cogeneration, carbon dioxide, is one of the gases that may have to attain California and Federal ambient air quality standards. However, alternative energy resources offer the potential to create positive impacts.

SECTION II

Chapter 5.0
SCENIC RESOURCES

5.1 SETTING

5.1.1 Existing Scenic Resources Surrounding Ridgecrest

The City of Ridgecrest has a surrounding panorama of mountain ranges and desert valley floor. Visual quality involves a degree of subjective evaluation which depends on the perception of the individual viewer. Moreover, viewing location can greatly affect the perceived visual quality of the terrain. The movement of the viewer and the speed of that movement in relation to an area creates constantly changing perspectives and visual sequences. Therefore, the amount of time spent viewing an area will have a direct impact on the viewer's perception of the site.

a. Evaluation Criteria The methodology used to assess scenic resources in the planning area is a three-tiered evaluation process. The visual resources within the Ridgecrest planning area have been evaluated on the basis of visual character, sensitivity level, and quality.

Key to the evaluation process was the overall impression of the landscape as perceived from travel routes, and public use areas. Section 5.1.2 discusses recommended scenic drives within the planning area and the scenic approaches to Ridgecrest from which travellers can view the planning area's varied view scapes.

Visual Character. The character of the planning area has been evaluated on the basis of relative variations in such natural characteristics as general landscape character and landforms.

Visual Sensitivity. The viewer's sensitivity level is based on a determination of factors that reflect the viewer's awareness of the resource. Relevant factors include public concern, and frequency and level of detail with which the resource is viewed. Great concern over visual quality is assumed to be felt by those driving for pleasure or those engaged in recreational activities. Conversely, less concern is assumed to be exhibited by those commuting to and from or during work.

Visual Quality A determination of the overall attractiveness of the region is defined as visual quality. This determination is based on the inherent characteristic variety of the resources and the degree to which introduced features appear uncharacteristic and incongruous with their surroundings, thereby attracting attention and disrupting the continuity of the scene. Factors that impact the viewer's determination of visual quality include the magnitude and visibility of uncharacteristic elements, as well as duration of the view studied. Larger, conspicuous elements constantly in a viewer's field of sight will have the most significance in rating the visual quality of a landscape. Visual quality is key to determining potential visual impacts resulting from buildout of each alternative, because it evaluates the viewer's perception of potential changes in the existing viewsheds.

b. Natural Visual Resources. In its natural state the planning area contains scenic resources that give it a unique visual character. These include views of and from the mountains, and desert valley floor area.

General Landscape Character. The planning area is defined by these major mountain ranges: Sierra Nevada, El Paso, Coso and Panamint. A visual boundary is created along the ridgelines that define the Indian Wells Valley. Situated in this physical location, the City of Ridgecrest offers distinctive views of mountains with extensive open space on the valley floor. Transportation corridors are Highways 14, 395, and 178. These transportation corridors carry a significant number of users traveling through the planning area to tourist or recreation serving destinations who would have a major concern for the visual quality of the travel route.

Landforms. The northern portion of the planning area consists of the mountain facades of the Coso and Panamint Ranges. The southern portion of the planning area is bounded by the El Paso Mountains, the west by Sierra Nevadas, and east by the Panamints.

The visual quality of these hillside areas is a function of their open space and topographic diversity. The visual impact of the hillsides varies widely depending on whether the hillside area has been developed and how it has been developed (residential, commercial), as well as how visible the hillside area is, for example. There is significant housing development on the El Paso Mountain Range as well as the Cerro Coso Community College. The hillsides dominate the city's landscape and can be seen throughout the planning area. This distinctive topography helps to create a sense of city identity as the first series of ridgelines creates a visual community boundary.

In addition to providing distinctive views from the urban core looking south, the hillsides provide residents and visitors panoramic views of the city and the desert. The hillsides to the north, east and west also include visually sensitive areas but were not included in the planning area.

b. Significant Visual Urban Assets. While natural resources make up an important part of the character of a community, they do not create the entire pictorial image of an urban area. Recognizing that urban elements in a community impart a distinct impression of the community's visual identity, the draft Community Design portion of the Land Use Element has developed general design guidelines and recommended scenic corridors in those portions of the planning area meriting special attention.

Determinations regarding the scenic qualities associated with Ridgecrest's existing urban components are based on (a) city-wide setting, (b) neighborhood setting, and (c) site specific setting. Most of these determinations focus on developed areas in the planning area and would not be directly impacted by future development. However, they do offer a perspective on the urban design assets that make up the identity of the City of Ridgecrest and provide a framework for assessing the impacts future development will have on the urban character of the planning area.

City-Wide Setting. The City of Ridgecrest is characterized by a variety of architectural forms and urban land use patterns that have developed over the last 50 years. Most of this development has occurred on the level terrain of the valley floor leaving large open vistas of the planning area's distinctive scenic hillsides available for public observation. Historically, building densities have been low and building heights have been less than 35 feet. Commercial and government agencies are mainly centralized along the China Lake Blvd corridor. Over the last several years this land use pattern has been altered with the development of the Ridgecrest Towne Center and the WalMart Shopping Center. Large, undeveloped parcels comprise the areas surrounding the entire City creating an open desert environment.

Neighborhood Setting. Within the planning area the city proposes to encourage development activities that would preserve, enhance, restore and improve the unique features of downtown; residential neighborhoods; and industrial parks.

c. Scenic Corridors and Approaches. The image of the city is often initiated and experienced from an automobile traveling along one of the planning area's circulation corridors. To a lesser extent, the image of the city is also formulated by traveling through the planning area by bus, bicycle and on foot.

The state highway system is the most widely traveled circulation corridor in the planning area. Consisting of Highways 14, 395, and 178, this system is more widely used by motorists than any other combination of urban thoroughfares. Highways 14 and 395 are the primary routes east of the Sierra Nevada Mountain Range linking northern and southern California. Highway 178 is the primary route to the Death Valley area. Highway 178 also serves as the major commuting route within the planning area. All three of these highways have views of the city's most distinctive natural elements (mountain ranges).

5.1.2 Planned Improvements/Additions to Scenic Resources

a. Scenic Corridors. The City has not initiated any funding or study program to promote Highways 178 and 395 as official state scenic highways. To gain recognition, a local scenic highway survey must be conducted by the state to ensure statewide consistency with this scenic resources program. Criteria that must be considered include: consistency in land use and intensities; grading and landscaping; outdoor advertising; design and placement of structures and equipment; and land site planning.

Scenic Drives. The 1986 General Plan defines scenic drives as those roads which typically provide natural rather than a man-created views, and has indicated the following routes for consideration as scenic drives in Ridgecrest:

- China Lake Blvd.
- Bowman Road

The proposed General Plan update adds these corridors to the list of scenic drives:

- Inyokern Road
- Norma Street
- Ridgecrest Blvd.
- College Heights Blvd.
- Downs Street

While these drives offer unique viewing opportunities, more often than not, man-created views dominate the viewer's field of vision and greatly influence the visual perception of the planning area. This allows the city to give special consideration in environmental review to the lands adjacent to these roadways as potentially distinctive and valued for their scenic resources.

All these drives are primary travel routes and have distinctive views of the mountain ranges. Given this criterion, these drives have a high sensitivity level.

Scenic Approaches and Entryways. The city has three clear distinctive entryways; Inyokern Road, East Ridgecrest Blvd. and South China Lake Blvd. The purpose of these approaches is to inform even the causal visitor that they are entering the city of Ridgecrest. All approaches offer a scenic backdrop of mountain ranges. These areas are an important element in creating a city identity by providing opportunities for focal points that convey a strong initial visual image.

The city does not have a funding program established to enhance the visual character of areas located within developed areas of the city or to protect viewsheds seen from these scenic approaches and entryways. However, undeveloped parcels located within designated scenic approaches and entryways scheduled for development must meet the design criteria prepared in the Land Use Element for these specific areas.

5.2 IMPACT ANALYSIS

5.2.1 Significance Thresholds

A determination of significant visual impacts resulting from buildout under each alternative is based on standards of visual character, visual sensitivity, and visual quality. A potentially significant visual impact is assumed to occur when the casual viewer can perceive a transformation in the physical environment that results in a change in the quality of a scenic resource. Changes in the visual quality of the planning area have been assessed by estimating declines or improvements in visual condition classifications that would occur as a result of buildout from each alternative. Areas where future development would have a significant adverse, significant but mitigable, less than significant, or beneficial impact on the existing visual character of the planning area were evaluated.

5.2.2 Impacts on Existing Resources From Buildout of Each Alternative

The potential significance of the visual impacts for each buildout scenario is based on the degree to which existing scenic resources could potentially be altered. Absolute determinations of visual quality cannot be ascertained at this level of evaluation because the visual impacts of development relate not only to modifications that would occur on the land, but also to an individual project's location and the circumstances under which it is viewed. Siting and design of specific projects can significantly affect project visibility and the degree to which it blends or contrasts with natural and urban elements. Therefore, actual impacts should be reviewed on a project by project basis during the permitting process.

a. Changes in Views From Freeways and Major Roadways Associated with Each Alternative.

The motorist's perception of the planning area is generally gained from initial impressions of the region formulated at the scenic routes identified in Section 5.1.2.

Changes in the viewshed associated with the elimination or degradation of natural resources visible from the planning area's scenic approaches and corridors would adversely impact the adopted and recommended scenic routes. This could potentially result in streets and highways loosing their eligibility as scenic drives and highways. Reductions in visual quality would also lower visitor and resident assessments of the planning area as a unique visual resource area.

Buildout that would result in creating a sense of urban identity at City entry points could have a potentially beneficial visual impact on the planning area.

Section 5.1.2 identifies highly sensitive and moderately sensitive scenic corridors and reflects the visibility of the hillsides from the scenic approaches.

b. Visual Effects of Night Lighting and Glare Increases. Increased development generated from buildout of Alternatives 1 through 3 would incrementally increase the amount of ambient night light in the planning area. Under all alternatives, the hillsides in the southern portion of the planning area would be most significantly and adversely impacted by the increased light which could alter the nocturnal atmosphere of these areas. This could change the visual condition classification of the hillsides as the viewer's perception of this area shifts from rural to suburban.

5.3 MITIGATION MEASURES

The City of Ridgecrest has no current policies or ordinances to preserve the aesthetic quality of the natural and open areas of the community. To fully mitigate the impacts associated with the buildout generated by each alternative; the following measures should be implemented as soon as is feasible and prior to allowing any action that would adversely affect the designated resource areas:

- Alternatives 1, 2, and 3. These measures would be required by the City to reduce the impacts of development under Alternatives 1, 2, and 3 to a less than significant level.

- Establish precise scenic corridor boundaries located adjacent to the designated scenic drives (process has the potential to affect property owner's use of their land within scenic corridor boundaries).

- Adopt architectural and landscape standards for scenic corridors, scenic approaches, and entryways to create a sense of identity through aesthetic treatment of natural features and enframement of public viewing opportunities.

- Incorporate plant materials that are resistant to NOX, TSP, ozone, and acid deposition into the city plant list.

- Implement standards requiring developers to hood light fixtures and orient them away from surrounding residential units.

- Orient structures so longest dimensions are not in full sight of public views along sensitive scenic corridors to minimize structural mass and optimize views of open space/landscaping.

- Provide building setbacks a minimum of 20 feet from property lines and vary setbacks to prevent a solid wall of development along scenic corridors and to provide adequate buffering between dissimilar land uses.

- Encourage clustering of structures and development of open space easements to minimize visual impacts in view shed areas.

- Place utilities underground in new developments and when redevelopment requires replacement of existing utilities.

- Develop architectural standards restricting heights of structures to below tree lines to minimize their impact on distant views within scenic corridors.

- Maintain existing trees in flourishing condition in future development plans whenever possible.

- Use landscape materials that reflect the color, size, and texture of the surrounding area and that require minimal supplemental water to flourish.

- Require vegetative buffers, consistent with the natural setting of the region within scenic corridors.

Residual Impacts. Implementation of all measures described above would not fully mitigate the following impacts in the planning area:

- Buildout under all alternative would result in a potential increase in atmospheric pollutants (NOX, ROC, TSP, ozone and acid deposition). This increase could cause potential damage to vegetation and building surfaces. Potential damage may be unavoidable over the long-term. Significance of residual impacts would increase progressively with each succeeding alternative.

- Buildout would result in significant loss of open space that would not be fully mitigated by any of the recommended measures.

- Buildout would result in a significant increase in ambient night light that would not be fully mitigated by the recommended measures.

SECTION II

Chapter 6.0
SOLID WASTE

6.1 SETTING

6.1.1 Source Reduction and Recycling Element and Household Hazardous Waste Element

The City of Ridgecrest City Council adopted a Source Reduction and Recycling Element (SRRE) and a Household Hazardous Waste Element (HHWE) by Resolution 93-17 on April 7, 1993. These elements address solid waste issues for the City of Ridgecrest as directed by Assembly Bill 939. In the same resolution, the City Council found that the Program Environmental Impact Report adopted by the Kern County Board of Supervisors by Resolution No. 92-604 adequately addressed the impacts associated with the SRRE and HHWE.

SECTION II

Chapter 7.0

HISTORIC AND ARCHEOLOGICAL RESOURCES

7.1 INTRODUCTION

This section is an analysis of the archaeologic and historic resources in the planning area supplemented by consulting professionals in their respective areas of expertise. An archaeological literature search of the planning area was conducted by Dr. Mark Q. Sutton of the Southern San Joaquin Valley Information Center, California State University, Bakersfield. The scope of work entailed: (a) a cultural resource records search of archaeological documents, (b) an impact analysis, and (c) the formulation of appropriate mitigation measures. An historical literature search of the planning area was also conducted. The scope of work was similar to (a), (b), and (c) above, augmented by a broad field survey of areas not previously surveyed for potential resources.

7.1.1 Setting

The Indian Wells Valley has been identified as a prehistoric and historic area. However, only a portion of the Valley area has been extensively surveyed for prehistoric or historic archaeological sites. In reviewing the literature, it was noted that even though this area has a harsh, dry climate, extensive travel through the area occurred. Prehistoric peoples used the area for such seasonal activities as hunting and the procurement and reduction of lithic resources. Historic use of the area has been focused on the mining of mineral deposits.

Most cultural activity within the City of Ridgecrest occurred in recent history. Historic reference is uniformly confined to NAWS perimeters. The following information on local resources was taken from the Preliminary NAWS Master Plan.

This chronological summary is based on Coombs and Greenwood (1982), Elston and Zeier (1984) and NAWS Environmental Division (1984), except where noted.

7.1.2 Prehistoric and Historic Overview

a. Early Prehistoric Inhabitants. The earliest human occupation dates for the China Lake area have been debated among archaeologists. Some archaeologists, most notably Emma Lou Davis, believe that occupation dates back to when Pleistocene Lake China covered most of the area between the White Hills and the present southern boundary of the China Lake Complex. Indian artifacts and mineralized bone fragments from Rancholabrean animals have been found in the dry playa of the ancient lake (Davis, 1978).

Other archaeologists believe that the earliest cultural period in the base area is the Lake Mojave Period (10,000 B.C. to 5000 B.C.). Diagnostic artifacts include large leaf-shaped and stemmed points, crescents, and a variety of knives, scrapers and gravers. Groups were apparently small and highly mobile. The Pinto Period (5,000 to 2,000 B.C.) was a time of sparse human occupation or perhaps abandonment of some areas. A hunting and gathering society rotated between permanent base camps with storage facilities adjacent to rivers and springs, and temporary base camps and task sites in upland areas. The subsistence pattern during the Gypsum period (2,000 B.C. to A.D. 500) apparently emphasized hunting, although seeds were also processed. The petroglyphs in the Coso Range may indicate the importance of hunting ritual. The Saratoga Springs Period (A.D. 500 to A.D. 1200) saw the introduction of the bow and arrow. Other artifacts of the period include milling stones and manos, incised stones, and slate pendants. The Shoshonean Period (A.D. 1200 to the present) includes groups who occupied the area at the time of historic contact and had large winter villages in the Coso Range. Diagnostic artifacts include projectile points and pottery (Coombs and Greenwood, 1982; Elston and Zeier, 1984).

c. Historic Background - Early Indians In historic times, the NAWS area was the province of three Numic peoples: the Koso, Kawaiisu and Chemehuevi. The Chemehuevi and Kawaiisu, southern Paiute groups, occupied the southern portion of the NAWS, including the southern end of the China Lake Complex. However, this was not their primary area. In the west, the Kawaiisu were concentrated in the Tehachapi Mountains, while the principal Chemehuevi settlements were located further east, particularly along the Colorado River.

The Koso, or Panamint Shoshone, the western most member of the Shoshoni-Comanche division of the Plateau Shoshoneans, occupied the northern portion of the NAWS, including the Coso Mountains, Indian Wells Valley, the Argus Range and Panamint Valley. This was the core of the Koso territory. The Coso Mountains and the Little Lake area formed the Kuhwiji district, an area of approximately 1,000 square miles which contained four villages. Two of the villages were on what are now base lands, one at Coso Hot Springs and the other at an unidentified spring area, perhaps Coso (Cold) Springs, located approximately five miles south of Darwin.

The harsh desert environment permitted only sparse populations. Groups moved with the season and in response to the local water and food supply. They traded with both coastal and central valley groups to the east. They apparently traded for goods that were consumed locally as well as serving as intermediaries in commerce. Obsidian was heavily mined and was used for trade as well as for local uses. Remnants of extensive obsidian mining, covering several miles, have been found in the vicinity of Sugarloaf Mountain, in the China Lake Complex.

d. Mining/Ranch Activity Jedediah Smith and Joseph Walker passed through the general area between 1825 and 1935. They are credited with the development of a north-south transportation route along the east side of the Sierras; it passed just west of the base boundary. Several other groups passed through the China Lake area, most notably the Death Valley Party of 1849. The records of these lost emigrants may well be the first account of travel on land presently within the naval base boundaries. Since little was known of the China Lake/Owens Valley area, surveyor A.W. Von Schmidt was hired to do the first official survey in 1855. He recorded a roadway leading to a spring called Granite Wells, near Pilot Knob. This site is perhaps the earliest known historical use of land in the China Lake area.

The first permanent Euro-American settlement in the China Lake area was the direct result of silver and gold mining activity. In 1860, Dr. Darwin French's party discovered silver in the Coso Mountains, in the northern part of the China Lake Complex, and shortly thereafter, discoveries were made in the Slate Ranges, in the northern portion of the Mojave B North area. Miners swarmed to the Coso and Slate Ranges, and the mining camps became the chief places of population south of Mono Lake. Coso Village (old Coso) is considered to be the first Euro-American settlement on the naval base, and was inhabited through the early 1940s. It played a major role in the development of the mining industry in the area.

In 1873, the first mining discoveries were made in the Panamints, northeast of China Lake. One of the transportation routes traversed across the Mojave B Ranges. A mining center was located at Copper City, in Mojave B South, and a few hundred people inhabited the area until around 1890. The roads in the area increased traffic and settlement and facilitated the growth of the borax mining industry, particularly the development of the Death Valley borax trade in 1882. The famous "20-mule teams" traveled in a northeast/southwest orientation across the Randsburg Wash/Mojave B Complex. In addition, the San Bernardino Borax Mining Company, formed in 1873 to compete with the 20-Mule Team trade, traversed a portion of the China Lake region.

The mining activity was responsible for the establishment of the ranching industry in the China Lake area. The first documented ranching activity near China Lake was at Haiwee Meadows, where Bart Bellows maintained the Goat Ranch, with 8,000 imported angora goats. It is probable that Bellows, and others like him, utilized what is now the naval base for grazing. The only permanent ranch known to have been located on China Lake was Junction Ranch, which was located near the present project area by that name. From the 1880's to the early 1900s, the Ranch served as a way station, from which trails branched to Darwin, the Panamint Valley, and along the ridge of Renegade Canyon.

The ranching industry was the catalyst for the beginning of the Indian Wars, which continued sporadically from 1862 to 1867 but apparently had little impact on Indian Wells Valley. Seasonal cattle grazing continued in the area through the 1940s. Cattle were wintered in the Junction Ranch, Mountain Springs Canyon, and Argus Range areas, with limited activity in the Randsburg Wash/Mojave B Complex.

A minor mining boom apparently took place about 1900 near the western edge of Mojave B North. In addition, an epsom salt deposit was discovered in Mojave B North and a monorail was completed in 1924 to bring the mineral out of the inaccessible area. Numerous technical and legal problems were encountered, and the operation ceased in 1928.

Mining continued in the China Lake area, primarily in the Randsburg Wash/Mojave B Ranges, between 1925 and 1945. Little mining took place on the China Lake Complex during this period, although some quicksilver mining occurred at Devil's Kitchen. No major deposits appear to have been developed.

e. Early Ridgecrest.

The first introduction of Euro-Americans to Indian Wells Valley occurred in 1849 when the Manley and Jay Hawker parties found their first water at Indian Wells after five days of trekking across the Argus Range.

Early settlement of Indian Wells Valley centered around Inyokern. Inyokern was originally called Siding 16, as a stop for the railroad during the construction of the Los Angeles aqueduct. Siding 16 was eventually named Magnolia, finally Inyokern in 1910.

Early homesteaders, like the Carrs and the Sterlings were forced to give up their homestead in 1943 to the Navy for as little as $4 an acre for developed lands and $1 for undeveloped. The Sterling Ranch, located north on China Lake property, raised and broke pack mules and horses. The animals were used for backpacking into 9-Mile Canyon, and for packing products which included

Borax for Trona. The Sterling family owned and operated several local mines, including, the Sterling Queen Mine at "B" Mountain, now on Navy property. The mine produced gold and silver.

Another homestead, the Stare Ranch produced peaches, grapes, vegetables and chickens. Military personnel utilized this ranch as Sandquist Spa for recreation once the ranch was taken by the Navy. This park area was the spot for dances, barbecues and family gatherings.

Another 1912 homestead by a family named Robertson was purchased by Mr. and Mrs. John McNeil. The McNeils, who owned and operated a store in Inyokern, established a dairy on their newly purchased property. Robert and James Crum bought the McNeil Ranch after McNeil's death. The Crum Dairy was located on the north side of Ridgecrest Boulevard near where Norma Street is now. By late 1912, the small community was known as Crumville.

Grant Bowman came to the Valley in 1913 and homesteaded 160 acres under the Desert Entry Act. He called his ranch Las Flores. Family members took up claims to ultimately own almost 1000 acres of land. Bowman Ranch, which was called Shangri-la, is located in the area of So. China Lake Blvd. and Bowman Road. The Bowmans also homesteaded 160 acres located between W. Ridgecrest Boulevard to Sunset, then south to Upjohn.

On June 27, 1941, Ridgecrest got its name and post office. The first post office was located in Bentham's store at the southwest corner of China Lake Blvd. and Ridgecrest Blvd. Bill Bentham became the first postmaster. This is the current site of the Bank of America. The name for the community was selected through a contest, initiated by the Bentham girls. Names were submitted. Sierra View was first choice. However, Sierra View was officially rejected because it was felt that there were too many towns in California that contained the name Sierra. Ada Thompson, a visiting friend of the Benthams, suggested the name Ridgecrest. Ridgecrest won over "Gilmore" (the name of the gasoline sold by Bentham) by only one vote.

Prior to 1943, most residents were Depression era farmers that came to this area for a new start. It was generally an agricultural community with cattle ranching, alfalfa fields, dairies and truck farms.

NOTS (Naval Ordnance Test Station) was established in November 1943 at its first headquarters at Inyokern Airport which was called Harvey Field by the Navy until deactivation in 1946-47. The station consisted of eight quonset huts and test ranges. The airport was returned to the county in 1947 after construction of facilities at China Lake. One of the most significant construction projects was Michelson Laboratory (named for the first American Physics Nobel Laureate).

After the Navy came, Ridgecrest was a boomtown. Many lived in make-shift housing in Ridgecrest and Inyokern. Tents and small house trailers provided the housing for construction people, Navy personnel, and Department of Defense employees. People lived in trailer parks that had central bath houses and restrooms. The first religious structure was the First Southern Baptist Church on the corner of what is now Ridgecrest Boulevard and Norma Street.

f. China Lake/Navy Influence

When the Navy came in 1943 to build the Naval Ordnance Test Station at China Lake, Ridgecrest had approximately 30 homes and 100 residents. Total school enrollment for Ridgecrest and Inyokern was 28 students. By spring of 1944, it had risen to 2,800 students. There were only two small grocery stores, five gas pumps, one school, one church, no hospital or bank.

To prevent possible health problems unless some sanitation and civic planning was done immediately, Commander Sandquist sent a crew of engineers to help lay out a subdivision on Joe Fox' property with roads and waterlines. Fox laid water lines during the day and at night sold lots. Construction material was at a premium. Anything that could be located from corrugated steel to packing crates was utilized. Joe Fox even used the native tufa rock (from the Trona Pinnacles) as building material for several of the homes that he built. A few tufa structures remain and are generally located in the vicinity of Ridgecrest Blvd. and Norma Street.

Navy personnel found housing in mining shacks while quonset huts and pre-fabs were being constructed on base. The Navy operation was referred to in the Saturday Evening Post as the Navy's Land of Oz.

> "Following V-J Day, when both the Army and the Navy sweated over cutbacks and cancellations, one military project was accelerated to full steam ahead. This was operation NOTS-the Navy's Land of Oz-a hitherto secret base, in a forbidden area about the size of Rhode Island, isolated in California's vast, rugged Mojave Desert.
>
> "...Naval Ordnance Test Station was a top priority undertaking hurriedly set up in 1943 to overcome the German's lead in deadly rocket missiles.
>
> "...an inspection of this fearsome desert Naval Base provides an awful glimpse into the fate of humanity if ever another world war breaks out.
>
> " '...Our job is not so much to prepare for the next war, but to help the United States get so far ahead in weapons that there will never be another war,' explained Capt. James B. Sykes, second commanding officer of the NOTS.

"...The Navy's Land of Oz is here to stay, insurance that never again will the United States be caught 10 years behind or 10 hours behind in the rocket fire. As Capt. Sykes says, '10 hours may decide who wins the war."

The Saturday Evening Post, June 29, 1946.

A Cal-Tech program at NOTS, headed by Dr. C. C. Lauritsen, tested the first rocket modification from the dry China Lake during the winter of 1943. The first major contract for the construction of facilities on NOTS involved more than $25,000,000. Fifteen months after the start up date, the contract was terminated. Only 93% completed, an expenditure of over $54,000,000 was realized. The first year after construction, over 7,000 people worked on the base. NOTS was renamed the China Lake Naval Weapons Center, and then again renamed the China Lake Naval Air Weapons Station (NAWS).

The following chronology was culled from local newspapers' headlines and articles:

1952, January - First Sanitation District formed in January of 1952. It was partly financed by a $375,000 federal grant and the remaining $242,000 was raised through a newly formed assessment district.

1953, December - Wherry Housing construction begins. Rents started at $81.50 for a three bedroom unit and $71.50 for a two bedroom unit.

1954, August - Development of Balsam Street as a 110 foot thoroughfare with a four foot plaza section down the center started with the development of a new post office (4,752 sq. ft.) located at the northwest corner of Balsam and Station Streets.

1954, September - First Street light in Ridgecrest goes in at the corner of Ridgecrest Blvd. and China Lake Blvd. (better known as Miracle Mile).

1955, June 16 - New billboard installed on Highway 6 (14) - "Death Valley - High Sierras via Ridgecrest - A modern Shopping Center - Pop. 6,700

1955, December 29 - Federal Court Jury comes to Ridgecrest to take testimony on a federal case where "Rocket Town" promoters were charged with using the mail to defraud in connection with the sale of lots in the Rocket town tract (Ridgecrest Heights).

1956, - Indian Wells Valley Water District formed.

1956, February 14 - The seeds for incorporation were planted when the Ridgecrest Chamber of Commerce made available a report on "Should Ridgecrest Incorporate?"

1956, April 5 - Eight men connected with the Rocket Town promotion were convicted of fleecing more than $2 million from investors. They were found guilty of 68 counts of mail fraud.

1958, December 4 - Efforts were made to form a Ridgecrest Area Planning Committee to request that the Kern County Board of Supervisors authorize a planning study of the community. This study would include a zoning map of the area.

1960, February 4 - Ground Broken for Las Flores Elementary School.

1960, March 31 - Interim Zoning goes into effect

1962, July 19 - County Board of Supervisors approve adoption of General Plan for the Ridgecrest area

1963, April 25 - Petition for Intention to Incorporate was filed by the Ridgecrest Incorporation Committee.

1963, June 7 - President John F. Kennedy visits China Lake/Ridgecrest.

1963, November 19 - Ridgecrest incorporates by a 12% margin - 896 to 794. Of the 2,317 registered voters, 73 percent cast ballots.

1963, December 26 - First Planning Commission appointed.

1964, June 25 - The budget for the first full year as an incorporated city was approved at expenses of $237,212 and revenue at $288,250. The first City General Plan consisted of only three elements: Land Use, Transportation and Community Facilities.

1967, the first assessment district (A.D.1) was formed to provide street improvements to the "Miracle City" tract (area southwest of Las Flores Ave. and China Lake Blvd.).

1969, Feb 27 - New pool at Henry Hellmers Park named John Pinney Memorial Swimming Pool in honor of local resident Sgt. Pinney who died in Vietnam.

1983, Dec 13 - Councilmembers L. Neal Webb and Donavon Padgett were recalled.

1985, May 31 - Ridgecrest Redevelopment Agency formed.

1988, Sept. - Ridgecrest Housing Corporation purchases Cimmarron Gardens Housing Project.

1989, Sept. 9 - Cornerstone for new Ridgecrest Civic Center laid.

7.1.3. Significant Recorded Prehistoric and Historical Sites Present in Planning Area.

a. Significant Recorded Prehistoric Sites An inventory of archaeological surveys within the study area was completed by the Southern San Joaquin Valley Information Center, Bakersfield, the official repository for all data concerning Kern County surveys, site records, excavation reports, and relevant literature. Summary of information found is conditioned by certain constraints:

- o There are no recorded archaeological sites within the project boundaries. It is unknown if archaeological sites exist there.
- o Very little of the planning area has been examined for archaeological resources - 400 acres and five miles of linear survey along roadways in a 44 square miles project area (only 1.5% of the total area.)
- o There are several recorded archaeological sites and isolated artifacts within a one mile radius of the project boundaries. These sites include rock alignments, lithic scatters, rock shelters, bedrock milling features, and a site complex of approximately 40 acres that contains several loci of both aboriginal occupation and early mining activities.
- o Numerous archaeological resources exist on the China Lake NAWS to the north of the City of Ridgecrest, including some of the highest concentration and best preserved petroglyphs (rock art) in the United States. One site located three miles north of the City of Ridgecrest boundary is a very large complex covering approximately one square mile. This site contains many thousands of lithic debris and hundreds of artifacts including diagnostic projectile point styles suggesting an occupation that may date to 10,000 years ago.
- o Within the City of Ridgecrest project boundaries there are no historic properties listed on the National Register of Historic Places, the California Historical Landmarks, the California Inventory of Historic Resources, nor the Directory of Determination of Eligibility (for the National Register of Historic Places).

- Although there are no recorded archaeological sites in the study area, there is a possibility that archaeological resources might be present. The project area encompasses 44 square miles, yet only 400 acres (approximately 1.5%) has been systematically surveyed for cultural resources. The entire Indian Wells Valley is considered to be archaeologically sensitive and numerous sites are known and recorded in other portions of the valley. It is likely that prehistoric archaeological sites exist within the study area. In addition, sites associated with early mining activities may also exist.

b. Significant Historic Resources. Potential historic resources in the Ridgecrest area generally comprise of structures that are of unique architectural design or material (tufa structures on Ridgecrest Blvd. and Norma Street and 50's style buildings with curved corners on Balsam Street and southeast China Lake Blvd. and Ridgecrest Blvd.) and of significant local history (U.S.O. building on West Ridgecrest Blvd.) (Refer to Table 7-1 for a listing of potential historical sites/structures). No structures were found to be eligible for the National Register. Potential resources were found to be of local interest only. Historic and/or subsurface resources may exist in other parts of the planning area that have not been recorded. Any future changes to these areas would require a comprehensive survey of historic resources to determine their significance.

7:1.4 Policies and Regulations for Protection and Preservation of Archaeologic/Historic Resources

Historic resources within the City of Ridgecrest are afforded protection if they are found to be listed under one of the following categories: potential local landmark/district, local landmark/district; National Register of Historic Places; State Landmark or Point of Interest.

Those properties listed as state landmarks or points of interest are afforded some protection under the California Environmental Quality Act (CEQA). If the designated property is potentially affected by any development action, a study of impacts and mitigation is required. Currently, in the City of Ridgecrest, there are no State Historic Landmarks. CEQA also applies to archaeological sites, and Section 21083.2 defines "uniqueness," which must be evaluated by professional investigation, usually on the basis of fairly substantial subsurface testing.

Potentially eligible historic structures remain unprotected unless they come under the CEQA review process when a project site is proposed for development. If historic resources appear to exist, a report as to the historic significance of the property shall be done and reviewed by the Planning Commission as to the significance of the property or for the potential that it may contain archaeological resources.

TABLE 7-1

POTENTIAL HISTORICAL SITES INVENTORY

1.	Joe Fox home at s/w Norma Ridgecrest Blvd.	Structure built of Tufa Rock and lumber from old desert homes and mines
2.	First Baptist Church n/e Norma and Ridgecrest Blvd.	First Church in Ridgecrest built in 1943. Land was donated by the Foxes.
3.	Holland and Lyons Mortuary (Norma St)	United Methodist Church was originally located at this site.
4.	Early Ridgecrest homes off Sunset	Structures made from Tufa Rock and lumber from old desert homes and mines.
5.	Kern County Health Clinic (R/C Blvd.)	Original site of the Ridgecrest Library
6.	Old Kern County Building (R/C Blvd)	Old U.S.O. site donated by Joe Fox. In 1946, Kern County the building acquired for staff offices and courts.
7.	The Drawing Room (Ridgecrest Blvd.)	Oldest business under the same management for 47 years.
8.	123 N. Balsam	Site of Ridgecrest Post Office, Sears Catalog Store and a Bank of America Branch.
9.	Various Structures located on Balsam St. and s/e China Lake Blvd and E. Ridgecrest Blvd.	50's architectural style curved corners

Human remains are protected under Section 7050.5 of the State Health and Safety Code, and Section 5097.94 of the Public Resources Code. In the event of such discovery, work is to be halted in the vicinity or any nearby area reasonably expected to overlie adjacent remains. The County Coroner is to be notified promptly to determine whether the remains are Native American. If the Coroner finds that the remains are not subject to the authority of that office, he or she is charged with notifying the Native American Heritage Commission, which will then identify and notify descendants of the deceased to arrange for the removal, study, and reburial of the individual(s).

7.1.5 Native American Representatives

The Native American community has deep concern for sites and places that provide ties to the lifeways of their ancestors and those who came before them. Such areas provide a material link to world views and mythologies that are still alive within Indian communities. Such places may include gathering places that are habitat for dwindling plant and animal life, shrines or other ceremonial locations where development would have a direct impact on current cultural and religious practices, properties containing burials, and open spaces where it is still possible to view the undeveloped world, as well as the recorded villages and known archaeological sites.

7.2 IMPACT ANALYSIS

7.2.1 Thresholds of Significance

Archaeologic and historic resources are not amenable to quantitative measures of impact; the total inventory is unknown, the current condition of many sites recorded is uncertain, and in contrast to certain natural resources that can be restored, they are irreplaceable and non-renewable. The National Register of Historic Places was designed as a planning tool; to meet the criteria for significance, an archaeologic or historic resource need not be the last, only, biggest, or oldest of its kind, only an important representative. Numbers of resources do figure into determinations of significance, however, in the sense that the scientific values of a given site may become more critical if all, or most, other examples of its type have disappeared.

The approach to assessing archaeologic or historic resources is, instead, qualitative and site-specific. The criteria for significance, which determines whether mitigation is required, are made explicit in the guidelines for CEQA and eligibility to the National Register of Historic Places. Both set standards for evaluating whether a site possesses integrity and scientific (or unique, under CEQA) research potential. Archaeological sites may require subsurface testing to gather the data needed for this assessment, and to develop recommendations for the mitigation of impacts upon those found to be significant. It is necessary to ascertain the site boundaries, depth, complexity, chronology, cultural affinity, components, and integrity. The evaluation is a professional opinion, subject to the final determination by the State Historic Preservation Officer.

There is, therefore, no acceptable ration of expendable archaeologic and historic sites. Each resource is evaluated separately. For those found to be not significant, no further attention is necessary; for those evaluated as significant, mitigation of impacts is required.

A potentially significant impact would result if recorded archaeological and historic resources (all local, county, state, and national register landmarks) and potential historic landmarks exist within any of the following development areas identified under each alternative:

- Undeveloped or rural areas proposed for development;
- Currently developed areas in which the density proposed is higher than currently designated or a different land use designation is proposed than currently exists; and
- Partially developed areas that are currently designated for higher density than presently allowed.

Potentially significant <u>unknown</u> archaeologic and historic resources could exist throughout the planning area that could be significantly impacted by specific projects proposed under any of the three alternatives. Such resources can only be identified through site-specific research survey and inventory.

The significance of an archaeologic or historic resource is most appropriately determined during the site-specific project planning and review stages of the development process. More detailed and conclusive testing and evaluation should be conducted at that time based on state and national guidelines. Once that determination is made, the significance of a proposed project's site specific impacts can be identified by deciding if the resource would be demolished or altered or if the surface would be significantly disturbed.

7.2.2 Impacts on Existing Archaeologic Resources

Impacts upon archaeological resources may be caused by any process which disturbs, removes, redistributes (i.e., scatters), or otherwise affects the contents and integrity of a cultural deposit. Such impacts may be caused directly by the more obvious activities related to grading or construction, but also by developments on one property which may cause erosion on another, or by exposing heritage remains to vehicular traffic or unauthorized collecting. Even the most rigorous of archaeological excavation results in loss to the cultural resource, so the use of heritage sites for the training of students is another form of impact, as well as contrary to the ethics of the profession.

Significant unknown archaeologic resources could exist throughout the planning area that could be significantly impacted by specific projects proposed under any of the three alternatives. Such resources can only be identified through site-specific research survey and inventory.

7.2.3 Impacts on Sensitive Native American Resources

Development of the three alternatives could occur in areas considered sensitive by Native American representatives. Particularly, sensitive lands in and adjacent to the El Paso Mountains and the NAWS may be impacted by direct alteration or destruction or by limiting access. Specific sensitive areas that may be affected cannot be determined at this time. The City would need to consult with Native American representatives prior to allowing development in the broad areas of sensitivity to avoid or mitigate potentially significant impacts.

7.2.4 Impacts on Existing Historic Resources

a. Alternative 1, 2, and 3. Under present development conditions, significant historic resource impacts could occur in the Ridgecrest Blvd. area, Balsam Street area, and the area located at the southeast corner of Ridgecrest Blvd. and China Lake Blvd., due to inadequate existing protection of these resources from alteration or elimination.

For structures or sites that may be eligible for the National Register of Historic Places, alteration of the setting is an impact which must be considered. Thus, it's not just pressure to convert an historic building to another use which may result from growth, but effects of higher buildings, greater density, loss of open space or viewshed, etc., which affect designated resources.

7.3 MITIGATION MEASURES

7.3.1 Archaeologic Resources

Prior to approval of a specific project proposed under any of the three development alternatives, the City should develop a program for the mitigation of impacts upon significant archaeologic resources. This program should include completion of three phases:

- The City should require project developers to fund site-specific research surveys and inventories of site resources conducted by professional archaeologists, if existing information is not adequate, on any property where the data base and professional experience suggest that prehistoric or historic remains may be present. (This determination should be made by a professional archaeologist, either on staff or as a consultant to the City, or through consultation with the local archaeological/historical society.)

For most of the planning areas, the existing inventory is not complete, and the existing list of known archaeological sites cannot be accepted as identifying all of the potential resources. If an area being considered for development has not been surveyed according to contemporary professional standards, this step is necessary; for sites recorded in the past, an inspection may be required to determine its current condition.

The results of investigations in other areas have demonstrated that intact Indian and historical deposits may survive even on properties which have been developed. When undertaken timely in the planning process, such studies no not delay project development; without them, resource management is impossible.

- o The significance of any such resources should be determined according to the criteria of CEQA and the National Register of Historic Places (NRHP);

Once the resources of a given area are identified, they must be evaluated for significance, since mitigation for potential impacts from development is required only for those identified resources which meet established criteria. The assessment of archaeological sites will almost always involve subsurface testing to establish the site boundaries, depth, complexity, chronology, and integrity. Such data are needed to evaluate the significance of a site under criteria for nomination to the NRHP or its importance under CEQA, and to formulate a program for mitigation. The assessment is made by professional archaeologists qualified in the appropriate disciplines (prehistoric or historical archaeology), and the determinations of significance are ultimately confirmed by the SHPO (State Historic Preservation Officer). The definitions under CEQA and NRHP do differ, and evaluations under the former guidelines do necessitate a more substantial test investigation.

- o Based on the recommendations of the professional survey and prior to project approval, the City should approve and the developer should implement a plan that is designed to avoid or ameliorate impacts upon resources which have been found to be significant.

For sites, features, objects, or structures deemed significant, mitigating measures may take many different approaches. The most responsible and preferred method is preservation of the resource, or avoiding impact. This may often be achieved by redesign of a proposed development or, where circumstances permit, by capping a subsurface deposit with sterile fill. A site may be preserved in open space or as an interpretive display for the public benefit. Depending on the significance of the setting surrounding an historic structure, structures may be relocated without losing their landmark eligibility, although any subsurface archaeological deposits that may be associated with the location must still be addressed.

When impacts cannot be avoided by any other means, mitigation can be accomplished by scientific data recovery as follows:

- For archaeological sites, data recovery shall take the form of scientific data recovery (typically excavation) conducted according to a research design, combined with artifact analysis technical studies such as radiocarbon dating, obsidian hydration and sourcing, identification of faunal remains, and others as appropriate; a comprehensive report; and provision for curation of the cultural materials recovered.

Residual Impact. Implementation of the recommended measures would reduce the potentially significant impacts to a less than significant level.

7.3.2 Native American Resources

The Native American community has developed certain recommendations that should be implemented to the maximum extent feasible by the City to mitigate potentially significant impacts to sites considered important to Native Americans:

- All Native American cultural sites and archaeological sites should be protected as open space wherever possible, by easements or other means;

- All areas proposed for development should be surveyed for significant Native American resources before planning is finalized;

- Native American participation should be included in the City's guidelines for resource assessment and impact mitigation; Indian monitors should be present during archaeological excavation, and during construction in an area likely to contain cultural remains;

- Many sites should be regarded as sensitive culturally, even if they have been disturbed or have lost their archaeological/scientific integrity; artifacts may also possess intrinsic value even if their archaeological context is impaired;

- The Native American community should be consulted further as more information is gathered, and the City moves toward implementation of the General Plan Update;

7.3.3 Historic Resources

a. Alternative 1, 2, and 3. The significant impacts on recorded and potential historic resources resulting from buildout under all alternatives would be mitigated by implementation of the following recommendations:

- The City should declare as historic landmarks buildings identified as potential landmarks or districts to offer structures some protection as soon as is feasible, and prior to allowing any action that would affect those resources;

- The City should direct a site-specific historic assessment to be completed by a qualified historian to determine the significance of a structure that is threatened by demolition or alteration when specific development applications are submitted. For older structures, an historical archaeologist should evaluate the potential for significant subsurface resources. This would address the potentially significant unknown resources in the planning area. Once the assessment is made, it should be reviewed by the local historical society to determine if the property is eligible for landmark status. If the site is eligible for landmark status, landmark designation should take place in order to preserve the buildings.

The following measures would fully or partly mitigate site development impacts:

- The archaeological potential associated with a structure should be evaluated. If a property is potentially sensitive, testing should be conducted to determine the integrity and scientific research potential and a program of mitigation should be implemented if it is found to be significant.

- o The developer should incorporate historical structures into the development for use as a recreation or office building and maintain some of the landscape features. The change in use is not always the preferred method, because it leads to quicker deterioration of the building and often a change of significant interior features;

- o To partially mitigate the impact, the developer could move the structure at his own expense. This is rarely a preferred mitigation measure since moving an historically significant building violates its integrity of place and setting;

- o A final measure exists that would not reduce impacts to a insignificant level but would preserve some of the site's characteristics. This should not be considered a fully mitigating measure. A qualified architectural historian should be retained to thoroughly document all structures planned for removal. This documentation should include photographs, measured-to-scale drawings, and narrative descriptions of architectural and construction features;

- o If an historic resource remains onsite, new development should be sensitive to the historic resource. The Historical Society should review new development plans with careful attention to height, scale, density, building materials, and buffer zones with landscape features.

The following measures should be implemented to the maximum extent feasible to strengthen further the protection of historic resources in the planning area:

- o The City should consider creating historic districts and/or institute some type of design control for historic neighborhoods.

- o The City should increase awareness among property owners of economic incentives for preserving their buildings through the use of various funding methods or tax incentives. These financial incentives include participation in one of the following: Historic Preservation Bond Act Grants, Conservation Easements, Incentive Tax Credits, Mills Act, and Marks Historical Rehabilitation Act;

- o The City should direct existing funding sources and loan programs to historic neighborhoods in need of rehabilitation as soon as is feasible, and prior to allowing any action that would affect those resources;

- Existing funding sources are generally limited; therefore, the City should also explore any new possible funding sources and economic incentives to preserve historic structures and districts; and

- The City should conduct an area-wide survey as soon as is feasible, and prior to allowing new development in the areas of Balsam Street, Ridgecrest Boulevard and the area southeast of the intersection of Ridgecrest Boulevard and China Lake Boulevard, to determine which historic resources are worth preserving. All buildings over 50 years of age should be included in the survey. In addition, buildings that are not 50 years of age but with architectural significance should be included.

Residual Impact. The measures that would mitigate significant historic resource impacts to a less than significant level include: Historic Landmark declaration of the identified potential landmarks or district; and site-specific historic assessments by a qualified historian to determine the significance of all structures that are threatened by demolition or alterations (this should also include evaluation by a qualified archaeologist of the archaeological potential associated with such structures). Other remaining measures would strengthen the protection of historic resources in the planning area, but would not in and of themselves fully mitigate the impacts to a less than significant level.

SECTION II

Chapter 8.0

PARKS AND RECREATION/CULTURAL ARTS FACILITIES AND EVENTS

8.1. SETTING

8.1.1 Existing Parks and Recreation Facilities

The City of Ridgecrest parks and recreation system encompasses the entire planning area. Situated in a unique natural setting that includes mountains and deserts, the City offers a variety of park and recreation facilities and services to visitors and residents alike. There are 1547 acres of land identified for parks and recreation and open space uses in the planning area in the draft Land Use Plan Summary. This park acreage includes both developed and undeveloped land within the City limits, NAWS, and the unincorporated area of Kern County located within the City of Ridgecrest's Sphere of Influence. The purpose of these facilities and services is to improve the quality of life in the community.

The draft Park and Recreation Element uses 8 (eight) planning neighborhoods as basic building blocks to establish neighborhood needs, and then combines these neighborhoods to address broader community and city-wide needs. The eight neighborhoods, in conjunction with the linear park network, focus on the provision of facilities, parks, and open space.

Figure 8.1-1 locates the City's park and recreation facilities and identifies each of the recreation neighborhoods within the planning area. Table 8.1-1 shows the distribution of the City's developed park acreage. A significant number of the park and recreation facilities are located on the NAWS in the northeast section of the planning area (see Figure 8.1-1).

Table 8.1-2 shows the planning area's current park acreage needs and deficiencies based on the adopted standard of 3 acres of parkland for every 1000 population provided in Chapter 19 of the City of Ridgecrest Municipal Code. Evaluation and specific standards shall be addressed in a Parks, Recreation, and Cultural plan to be developed subsequent to the General Plan.

Park acreage is not the sole measure used to determine the needs of potential park users. Location is an important criterion developed in the draft element to evaluate park needs. The extent to which the City's park and recreation system is used depends largely on the accessibility of the facilities and availability of services for the people it is intended to serve. Key to developing a park and recreation system is providing a varied circulation network for accessibility. The draft Open Space Element identifies the need for auto, pedestrian, and bicycle routes. Other important criteria include housing densities, population characteristics, land use patterns, and phasing.

The draft Park and Recreation Element takes the position that the City is not the sole provider of park and recreation services to the community. When identifying the need for existing and potential park and recreation services, the City should take into account providers other than the City.

a. Planning Communities/Neighborhood Needs. Neighborhood parks are one of the most important components of the city park system. These parks are designed to serve local residents within each of the neighborhoods. According to the standards adopted by the City in Chapter 19 of the Municipal Code, the city should provide 3 acres of parklands per 1000 population. The draft Parks and Recreation Element standards, which are based on National Park and Recreation Association, state, and other local jurisdictions standards, also recommends the city provide 3 acres of park land per 1000 population in the community. This parkland shall be provided through a combination of services at the neighborhood, city, and regional level.

Existing Parks Needs. A neighborhood park is to be a maximum of 5 acres in size and within a one-half to three-quarter-mile radius of the community's residents the park is designed to serve. Local residents should be able to access their local parks by walking or bicycling without encountering hazardous barriers.
As shown in Table 8.1-1, only Neighborhood Zone 1 has neighborhood parks. However, unique features or developments may be more important than the neighborhood area park size.

Park Access. Neighborhood parks should be centrally located and readily accessible by automobile, bicycle, and public transportation with respect to the segment of the population they are intended to serve. Within the planning area, neighborhood parks are most often reached by automobile which results in a significant portion of available neighborhood park land being developed as parking lots. When safe and pleasurable walking and bicycling opportunities are available, these activities gain favor as a means of transportation, and as a recreation activity of their own merit.

Bus service provides access to all of the neighborhood parks within the planning area. However, the public transportation system serving the planning area was not developed to accommodate recreation users. Bus service is reduced on weekends and is non-existent after 6 p.m. and during major holiday weekends, all peak recreation use times. In addition, there are no provisions for carrying sports gear on the buses. The youth and senior members of the community are the city residents most likely to be deterred from using auto dependent park systems. They are also more likely to perceive major arterial streets as barriers which limit their access to park sites.

Neighborhood 1. Neighborhood 1 is bounded by Inyokern Road on the north, China Lake Blvd. on the east, Drummond Avenue on the south and Mahan Street on the west. This area is served by Pearson Park with approximately 3.96 acres of park facilities located at the northwest corner of Downs Street and Vicki Ave. Pearson Park is located on major roads with easy access available to the entire Neighborhood 1 area by driving, riding a bike, walking, and public transportation. This park provides barrier-free access to the facility. There is also a small (approximately 8,000 sq. ft.) tot lot located in the 400 block of Moyer (Eagle Park). The parcel is City owned, but is maintained by the surrounding neighborhood. In addition to the City owned facilities, there are private open space/recreation buildings located at Heritage Village, Arrowhead Mobilehome Park, Town and Country Mobilehome Park, and Westwood Manor Mobilehome Park. Also located in this neighborhood are Mesquite Continuation School and a vacant 10 acre site located on the northwest corner of Downs Street and Ward Avenue. Both sites are owned by the Sierra Sands School District.

Neighborhood 2. Neighborhood 2 (bounded on the north by Drummond Avenue, east by China Lake Blvd., south by Ridgecrest Blvd. and the west by Mahan Street,) currently has no developed park sites. Several sites were identified as potential park sites. Approximately 5 acres located at the 600' north of the northeast corner of Florence and Norma was identified for a possible sump/park use area. Another 5 acre area was identified near the northwest corner of Traci and Argus. The third site (City owned) is located at the northwest corner of Kern and Argus (4.47 acres). Las Flores Elementary School is located within this neighborhood.

Neighborhood 3. The recommended service area for Neighborhood 3 consists of a northern boundary of West Ridgecrest Blvd., eastern boundary of China Lake Blvd., southern boundary of Bowman Road and western boundaries of Mahan and Brady Streets. This neighborhood has the largest concentration of developed City parks in Ridgecrest outside of the NAWS. Helmer's Park (9.12 acres-developed with a tot lot, picnic areas, tennis court, senior center and the John Pinney Pool) located on Warner Street, the Civic Center Park (approximately 4 acres of lawn area and trees) located behind the Ridgecrest Civic Center buildings, the Kerr McGee Community Center (a recreational and convention center facility) located at the Ridgecrest Civic Center, and the Kerr McGee Softball Fields (10 acres of developed softball fields) located on Downs Street and an undeveloped 1/3 acre park site located on Helena Street. These parks provide this neighborhood with the most comprehensive and best distribution of services, land and facilities in the City. All parks have barrier-free access, public transportation, walking, bike riding, and pedestrian access.

Neighborhood 4/5. These neighborhoods are located south of Bowman Road. One potential undeveloped park site is located in this neighborhood at Downs and Burns. Other sites include 160 acres of undeveloped land identified for future parks (potential nature interpretive area) immediately south of the College and the 360 acres surrounding Cerro Coso Community College are also identified as natural open space.

Bowman Channel is also located within Neighborhood 4/5. Conceptual development of the Channel will include a linear parkway approximately 100' wide from City limits on the west to the City limits on the east. An approximate 12.12 acre linear parkway, suitable for bike/pedestrian trails would be appropriate for this channel as an ancillary use of the drainage way.

Neighborhood 6. Neighborhood 6 is a mixture of older housing and newly developing residential tracts located south of Ridgecrest Blvd., north of Bowman Road and East of China Lake Blvd. Upjohn Park (a City-wide park) was dedicated in May of 1992. Gateway Elementary (19 acres) was opened September of 1992. Desert Empire Fairgrounds (20 acres) is also located in this neighborhood as well as the 20 acre City-owned and operated miniature golf center.

Neighborhood 7. Neighborhood 7 includes the NAWS which according to the Naval Weapons Center China Lake Draft Master Plan Volume 1 "offers the following facilities and recreational programs to the military, DOD employees and their dependents: (1) the auto hobby center; (2) children's centers; (3) the craft/hobby shop; (4) stables; (5) a skeet and trap range; (6) a golf course; (7) the Information, Ticket and Tour Office; (8) the station theater; (9) sports; (10) bowling; (11) aquatics; (12) youth activities; (13) the library; and (14) messes. ...The recreational facilities were originally constructed for sole use by the military and DOD civilians stationed at the Center. As the City of Ridgecrest developed and its population grew, non-DOD civilians were given permission to use the facilities as associate members of the Center recreational program. However, in recent years, maintenance and operational funding for these facilities has been greatly reduced. In order to retain the existing recreational facilities and programs, and to minimize their maintenance, it may be necessary to establish a new Command policy which would deny non-DOD personnel access to these facilities." Also included on the Station site are these school sites: Viewig Elementary School, Burroughs High School, Pierce Elementary School, Richmond Elementary School, Murray Middle School, and Groves Elementary School.

Other facilities located in Neighborhood 7 but not on the NAWS site include the Sandlewood Paseo (City owned-it is an approximate .6 walkway located within the Eastridge Estates housing tract), and the Kern Regional/Jackson Park. The Kern Regional/Jackson Park is a 39 acre site located on China Lake Blvd. and French Avenue. Major portions of this site was newly developed by the City of Ridgecrest in 1992-1993. Some of the new improvements are softball fields, soccer fields, tennis courts, basketball courts, pedestrian walking trail, and picnic areas.

c. City-wide and Special Use Parks. City-wide parks focus on offering single or specialized activities that attract a wide range of age groups and interests. Activities and facilities may be specialized or unique enough to draw upon the whole resident population. City-wide parks often feature large open spaces, unique natural or cultural areas, group picnic facilities, interpretive centers, equestrian facilities, and bicycle trails. Unique amenities that permit single or specialized recreation facilities can include golf courses, historic sites, nature centers, zoos, arboretums, display gardens, gun ranges, arenas, amphitheaters, plazas, and squares. Within the City's parks and recreation system, specialized uses include a miniature golf course, a public swimming pool, an indoor recreation center, and field sports complexes.

A list of parks with special use areas identified in the draft element is provided on Table 8.1-1.

d. Tourism. Ridgecrest's unique natural and cultural amenities drew about 40,000 overnight tourists and conventions, and 75,000 day tour visitors in 1991. China Lake visitors totaled 40,000 (Ray Arthur, Convention and Visitor's Bureau, August, 1992). Most of these visitors are drawn to special use facilities. The City's special tourism features include unique and sensitive natural habitats (Pinnacles, Petroglyphs), gateway to Death Valley and the ski areas, and geological interest areas.

e. Linear Park Network. The concept of the linear park network was broadened in the 1990 Draft General Plan to include two purposes: (1) to protect and preserve natural areas; and (2) to enhance pedestrian and bicyclist mobility in the City by providing trails and bikeways for commuting and recreational purposes. This network is not intended to provide a continuous circulation corridor, but to develop a combination of pedestrian and bicycling trails and view space areas that preserve and enhance the community.

The proposed network shown on the Future Land Use Map connects most of the developed urban areas. Local bike clubs were canvassed as to appropriate travel and leisure routes for biking use. These identified routes are shown on Figure 2.3 of the Draft General Plan.

8.1.2 Leisure Trends

In an effort to recognize the role that community leisure patterns play in designing recreation services, the City conducted a leisure preference survey in 1988 to determine, and then incorporate, the public's needs into the park and recreation system planning process.

The data presented in the draft element appendices were compiled in 1988, and the proposed subareas reflect population and leisure preferences at that time. The subareas need to be evaluated on a regular basis to ensure that they continue to provide a valid reflection of current demographics and preferences.

8.1.3 Planned Parks and Recreation Improvements

a. Neighborhood Parks. As new residential developments are proposed throughout the City, an examination of impacts on park needs is made.

b. City-Wide and Special Use Parks/Facilities and Tourism Areas. Funding has been allocated and development of Kern County Regional Park into a special use facility that would meet City-wide and tourist oriented regional recreational needs has occurred. In addition, the City is currently working with Cerro Coso Community College to develop plans for additional recreational and cultural facilities on the campus that would fulfill a special use facilities need.

8.1.4 Cultural Arts Activities and Facilities

The word "culture" may be defined in varying terms, interpreted narrowly or broadly, depending on personal viewpoint. The common definition provided by Webster's dictionary states that "culture" is the "acquaintance with and taste for fine arts, humanities, and broad aspects of science..." These interests could include drama and performing arts, arts and crafts, and cultural heritage, etc.

a. Existing Cultural Arts Facilities in the Planning Area and Selected Facilities in Ridgecrest. Cultural arts activities provided in the City of Ridgecrest currently use a range of facilities. A network of public facilities is available as well, most notably the Kerr McGee Civic Center, Cerro Coso Community College, NAWS, and the state-owned Desert Empire Fairgrounds. Other private and public facilities of a smaller scale are scattered throughout the City, including facilities at local public schools. The NAWS Auditorium is the largest auditorium in the City, with a seating capacity of 998, followed by Burroughs High Schools auditorium which seats 621. The Cerro Coso Lecture Center has a total seating capacity of 225.

Table 8.1-3 lists the cultural facilities available in Ridgecrest and broadly describes the functions that are accommodated by the facilities. Selected facilities in other parts of the City available to Ridgecrest residents for cultural exhibits, special events, and on-going activities are also listed in Table 8.1-4. Small theaters groups (some very successful), art galleries (mostly commercial), and galleries and theaters run by the community college provide other cultural opportunities for Ridgecrest residents.

b. Existing Cultural Arts Events in the Planning Area and Selected Events in Ridgecrest. In Ridgecrest, art, drama, music, dance, educational, and historical activities are available to community residents. The City, through its Parks and Recreation Department, and a variety of private groups and non-profit organizations are involved in providing these opportunities which are supplemented and/or enhanced by City-sponsored programs in many cases.

Table 8.1-4 lists the cultural activities currently provided in Ridgecrest. Many of the activities listed are sponsored by the City. These activities are augmented by non-profit organizations and commercial ventures that offer periodic or ongoing live dramatic, musical, and dance performances and art exhibits. Cultural events are also provided by local schools, Cerro Coso Community College, and local religious organizations.

c. Participation in Cultural Activities. The leisure survey conducted by the Kern Council of the Arts in 1988 included arts activities as part of several cultural activities in Ridgecrest. As defined in the survey, arts activities include visual arts, dance (ballroom, other, and square dance), hobbies, music (playing, listening), and theater (performing, watching - not movies). Both the lack of time and money were the most frequently cited constraints on participation in all leisure activities.

d. Support Provided by the City for Cultural Arts Activities. The role of government in cultural activities is generally one of encouraging and promoting the development or preservation of a variety of resources through planning, coordination, administration, and possible provision of facilities and programs that further the evolution of a culturally healthy community. The arts are increasingly regarded by the City as an essential ingredient to the quality of life of a community. Cultural arts activities are provided directly by the City through the Park and Recreation Department and in cooperation/partnership with local arts organizations, the Sierra Sands Unified School District, Cerro Coso Community College, NAWS and other agencies. Such activities exemplify the City's approach of being a broker or partner in delivering these services to the community. The Arts Council mission is to develop and promote the arts in Ridgecrest through education, presentation, and marketing. These types of efforts addressed in a long range plan are intended to deliver the cultural opportunities needed by the community. In addition to the arts, stewardship and interpretation of the City's historic resources are directed by policy statements contained in the draft Open Space Element and in site specific plans. Emphasis is placed on stabilization, preservation, restoration and interpretation of these resources.

e. Improvements Under Consideration. Cultural arts facility resources exist in the community that could be maximized through cooperative efforts and agreements between facility owners and interested arts and governmental agencies. Discussions have occurred between the City and the Cerro Coso Community College in regard to the joint development of a 1000+ seat Auditorium as a community theater. The Maturango Museum has contracted a consultant to assess the needs to be addressed in future expansion to include visual arts exhibits (indoors and outdoors) and expanded historical programs.

The City intends to continue to work with the Cerro Coso Community College, the Arts Council, the Maturango Museum, and others to develop arts programs and special events in Ridgecrest. The Maturango Museum is in the process of formulating ultimate goals and objectives to guide its efforts in the most effective manner. The goals and objectives include enhancing youth and adult cultural education, increasing interest in art and artists, and stimulating artistic development and professionalism by establishing a cultural center. Funding for these efforts is expected to be from corporate and foundation grants, city sponsorship and grants, and museum members.

8.2 IMPACT ANALYSIS

8.2.1 Parks and Recreation

a. Significance Thresholds. The Open Space Element establishes park acreage standards based on the population ratios shown in Table 8.1-1. Park standards shall be based on acreage/population ratios, minimum parcel sizes, and locations within neighborhood, and city-wide zones. The impact analysis has been prepared based on the draft standards shown in Table 8.1-2 because these standards provide a more comprehensive base for evaluating the significance of the impacts of anticipated growth on the public park and recreation system. Based on the draft element, a potentially significant impact would result if there is not sufficient park acreage to meet the acreage/population rations identified in Table 8.1-2, or if the size or location of the park does not meet the recommended standards.

b. Parks and Recreation Demand Rate Based on Population. Park and recreation facilities available to residents of the City of Ridgecrest are identified in Table 8.1-1. A summary of the City's total existing demand for park acreage and anticipated deficits is shown on Table 8.1-2.

c. Park Acreage Demand Upon Buildout of Each Alternative. Adverse impacts on existing park facilities would result when the acreage/population ratio is such that these facilities are operating above their intended capacity or are not accessible to the population they are intended to serve. These impacts may be direct - the neighborhood park acreage does not meet the park needs within that immediate area, or they may be indirect - adjacent neighborhood deficiencies result in spill over to surrounding park facilities. Following is a summary of existing deficiencies and impacts associated with the growth (changing acreage/population ratio) anticipated by each alternative for neighborhood, and City-wide parks.

Without the acquisition and development of sufficient neighborhood park acreage to meet the deficiencies outlined below, on-going impacts associated with overburdened existing facilities would continue. Existing development in Neighborhood 1 precludes acquisition of additional park land in that neighborhood. This area is experiencing, and would continue to experience, significant unavoidable adverse impacts associated with operating park facilities above the recommended standard of 3 acres per 1000 population for parks. According to the draft standards, school open space may help to alleviate this deficit.

Currently there are 4.11 acres of neighborhood parks or .14 acre of neighborhood park land per 1,000 population. This represents a significant planning area deficiency of neighborhood parks. This deficit would be aggravated in many neighborhoods by a population increase unless there is park/recreation acreage development in conjunction with growth. Neighborhood Zone 1 is the only planning area with a neighborhood park as defined although most zones have access to City parks or school sites that meet some of the existing local needs. Based on the current acreage deficit, it is assumed that all the neighborhood parks in Neighborhood Zone 1 is operating above capacity. Therefore, growth in any of the neighborhoods would result in significant adverse impacts associated with overcrowding and deterioration of existing facilities.

Neighborhood 2 through 7 have a base year population great enough to warrant neighborhood facilities.

The development of future residential projects in these neighborhoods could result in the dedication and reservation of lands for neighborhood parks in these areas to meet the upcoming needs of the new residents.

Alternative 1. Alternative 1 would generate a population of 50,000. This population would result in a park need of 150 acres City-wide. Approximately 22.42 acres of parks are proposed leaving a deficit of approximately 12.97 acres.

Alternative 2. This alternative would generate a population of 75,000 representing a park need of 225 acres City-wide. There are 160 acres of parks proposed for this alternative. Development of the open space land south of the Cerro Coso Community College as a nature preserve/interpretive area would meet the needs of Alternative 2.

Alternative 3. Alternative 3 would result in a population of 100,000, generating a need for 300 acres of parks City-wide. Development of the 160 acres as discussed in Alternative 2 would meet the needs of this Alternative with an unmet need of 2.97 acres.

While additional park acreage does not mitigate the impact of the increased population throughout the City, it does fully provide for the overall needs of the entire community.

Special Use Facilities/Areas, Visitor Serving Areas, and Linear Park Networks. There are 88.5 acres (see Table 8.1-1) of designated special use facilities within the City. Miles of linear park network will provide recreation opportunities throughout the planning area. In addition, special use facilities under other jurisdictions (e.g., the Desert Empire Fairgrounds, Ridgecrest Golf Center, Kerr McGee Center) contribute to meeting Citywide and regional needs. However, minimum park acreage standards have not been established for these types of recreation areas. Therefore, potential special use and linear park acreage deficiencies that would occur as a result of buildout under each alternative have not been addressed.

d. Potential Deficiencies of Proposed Comprehensive Plan in Serving Parks and Recreational Needs of Population at Buildout of Each Alternative. The draft element recommends standards for assessing park needs that provide a strong framework for determining park acreage requirements. Potential deficiencies that could result from basing demand solely on these standards relate to deficiencies in services and facilities and inappropriate boundaries. These factors need to be addressed in the proposed Parks and Recreation plan because buildout of any of the alternatives would result in individual and cumulative significant and adverse impacts on the facilities and service levels.

8.2.2 Cultural Arts Facilities and Events

a. Significance Thresholds. Demand for cultural arts facilities and activities cannot be quantified or measured because such demand stems generally from cultural awareness, a characteristic not amenable to measurement. Therefore, no threshold of significance is available to measure the impacts of the four development alternatives on existing cultural arts facilities and activities.

b. Impacts on Existing Cultural Arts Facilities and Events. The population increase above existing levels resulting from the adoption of any of the four development alternatives is likely to increase the use of existing cultural arts facilities and the participation in existing cultural arts activities.

Increased public awareness of cultural arts resources and the desire to participate in cultural arts activities above existing levels due to education, exposure, and out-reach programs conducted by the City or other non-profit organizations could significantly increase the demand on existing cultural arts facilities and activities as the percentage of the total population that participates in such activities increases. As an adverse impact of such an increase, overcrowding of existing activities such as the Maturango Museum Mining Days could alter their "small town" appeal. Paradoxically, an increase in population can generate a "market" or audience that can support certain cultural arts activities that must have sufficient revenues to be viable. Thus, substantial increased population can result in a beneficial impact by allowing for the growth and development of cultural arts facilities and activities.

8.3 MITIGATION MEASURES

8.3.1 Parks and Recreation

The following measures should be implemented to mitigate demands for park acreage as soon as it is feasible and prior to allowing any action that would further impact existing park acreage deficiencies:

- Alternative 1. The City should acquire/and or develop the following park acreage:

  22.42 acres

- Alternative 2. The City should acquire the following park acreage in addition to Alternative 1 acreage:

  160 acres

- Alternative 3. The City should acquire the following park acreage in addition to Alternatives 1 and 2 acreage:

  0 acres

- Alternative 4.(Existing) The City should acquire the following park acreage in addition to Alternatives 1,2 and 3 acreage:

  0 acres

These deficiencies are based on unmet needs for each alternative as shown on Table 8.1-2. These mitigations are based on existing data and do not account for additional purchases not identified by the City as of June 1991. As an example: if the City were to fully mitigate the existing citywide park acreage deficiencies by acquiring land, they would only need to acquire 160 additional citywide park acres to mitigate the impacts to recreation resulting from the population of 75,000 anticipated under Alternative 2.

To meet the demands identified above, the City should continue to develop action programs that generate new park and recreation facilities. New programs and design developments the City should consider include:

- Preparation of a new linear park network map that provides connections to all existing and proposed communities in the planning area; and

- o Preparation of budget requirements for acquisition, development, operations, and maintenance.

- o Preparation of a new parks and facilities map and new community profiles that include the entire planning area;

- o A priority acquisition/development schedule; and

- o Programming and facility requirements that include carrying capacity figures to meet residential demands; demands of employees in commercial/industrial areas; and college student demands.

Following is a discussion of mitigation measures that the City should consider as means for implementing the action program:

- o Acquisition of Additional Park Land. The City Parks and Recreation Department should continue acquiring additional park acreage by implementing:

  - -- Park land Dedication Ordinance No. 87-01 (Quimby Ordinance) which require the City to determine whether the subdivider should be required to dedicate lands for recreational purposes, pay an in-lieu fee, or both according to standards and formula contained in the Park land Ordinance at the time of approval of a Tentative Parcel/Tract Map.

  - -- Linear Park Subdivision Conditions - require developers to dedicate and improve where appropriate portions of the linear park network located adjacent to subdivisions built in the planning area;

  - -- Land Trusts - the City could acquire park lands that could be set aside for development at a future time when demand increases. This measure would ensure that the City would be able to provide service area parks and City-wide parks and special use facilities in areas not scheduled for full buildout until Alternative 2;

  - -- Land Exchanges - trading properties between the City and another party, private or public, could result in a better distribution of facilities in communities where existing development precludes acquisition of undeveloped land for recreational use;

- Buildout of Existing Underutilized Parks. The City should consider achieving higher utilization of existing City park lands by implementing the following measures identified in the draft Open Space Element:

  -- Dedicate and improve where appropriate a linear park network that includes neighborhood facilities, as well as connections between existing communities and proposed hillside development;

  -- Prepare and implement master plans incorporating neighborhood and service area facilities where feasible into existing City-wide parks that are underutilized.

- Consideration of Existing Parks Belonging to Other Jurisdictions. When developing the priority/acquisition schedule, the City should consider taking into account all the regional park acreage/and school sites located within the neighborhood zones belonging to other jurisdictions. If total credit was given to these recreation areas, which are used by the residents to meet citywide needs, the total citywide park acreage would be increased to approximately 12 acres per 1000 population. Based on this figure, citywide parks would adequately serve the estimated resident population associated with full buildout of Alternatives 1 through 4, as well as anticipated visitors to the planning area. Alternative 2 would augment this citywide park land with the development of 160 acres. Considering a total acreage of 160 acres of available park land to meet citywide park needs attained as a result of the park development in Alternative 2, the planning area would provide 3 acres of citywide parks per 1000 population for a population of 75,000 persons. Using this information as a data base, the City should consider addressing neighborhood and service area park deficiencies which are not being provided by other jurisdictions.

- Cooperative Use Agreements. The City should consider pursuing opportunities for establishing cooperative use agreements and financing strategies that would enable both parties to provide services neither party has the resources to implement separately. Recreation service providers that the City should consider when formulating cooperative use agreements include:

  -- NAWS

  -- The Sierra Sands Unified School District (SSUSD);

  -- Cerro Coso Community College;

- Private sports clubs;

o Funding Resources. The City should consider a variety of monetary resources for funding the substantial costs necessary to mitigate the existing park deficiencies in the planning area. Because of the high costs associated with developing and maintaining park facilities, the City Parks and Recreation Department should consider establishing policies for accepting real or personal property as gifts or acquiring properties with public funds prior to initiating any of these funding measures. Following are potential funding resources the City should consider pursuing in their park facilities and services acquisition and operating programs:

- General Fund - provides day to day operating costs;

- Bonds - could be sold by the City to finance acquisition or construction of park lands upon voter approval;

- Public Subscription - the City or civic-minded community organizations could sponsor subscription drives to fund recreation facility development;

- Public and Private Foundations or Trusts - could be established by the City in response to community interest to develop, operate, and maintain recreation facilities;

- Gifts - the City could establish a gift catalog approach to facility acquisition which could enable private citizens to purchase specific items for the City parks that meet City standards;

- Land Lease Agreements - a developer could lease property acquired by the City for 20 to 30 years. During this time they would develop and manage the recreation facility. The City would receive an annual income and at the end of the leasing period the improved property would revert back to the City. This type of financial arrangement would be well suited to special use facilities such as golf courses;

- Contractual Agreements - the City could defer operations and maintenance costs by contracting with concessionaires and park maintenance operators to provide services on a long-term basis. Special events can be contracted out to local business through a variety of short-term agreements;

-- Joint Powers and Use Agreements - financial and use agreements between the City and other jurisdictions or private real estate developers could be established to share capital outlay and operating expenses in exchange for shared use of facilities;

-- Assessment Districts and Developers /Homeowners /Property Owners Associations - formation of assessment districts by the City could off-set costs of maintenance, thereby lowering long-term financial impacts on the parks and recreation department;

-- Grants - though less available due to reduced funding, grants from a variety of sources could still provide monies for park land acquisition and park and facility development;

-- Fees and Charges - revenues generated from charges levied by the City or concessionaires for services such as greens fees, league fees, and aquatics fees could provide financial support for recreation services;

-- Volunteer Programs and Student Work Experience Programs - initiated by the City, could help offset operating and programming costs for park and recreation services; and

-- Legislation - through active lobbying the City could support passage of bills that could be critical to meeting City recreation demands.

o Park Site Selection Criteria. Provision of adequate park acreage would not ensure that each park is used at the desired capacity or that it satisfies all public recreation demands. Safe access, appropriate siting, and facility designs should complement the park acquisition program in order to create a highly efficient, cost-effective public park network. The City should consider incorporating park siting criteria in the draft element:

-- Pertaining to the selection of potential recreation programs, park sites, and open space that would increase park use and decrease operating and maintenance costs;

-- Which eliminate architectural barriers to recreation facilities and parks that limits access by the elderly and the disabled; and

-- That would minimize water consumption at City parks.

Residual Impacts. If the City acquires sufficient park acreage to meet existing demand and demand upon buildout of each alternative, residual impacts would be fully mitigated. However, unless the City relies on increased cooperation with other public jurisdictions and private contractors or other innovative means to disperse use over a larger resource base, not enough land would be available in the developed portions of the planning area for park land acquisition to satisfy recreation demands.

Secondary impacts that could result from building out existing underutilized parks include overcrowding of facilities, degradation of parks, increased traffic, noise, and off-street parking in developed neighborhoods adjacent to the parks.

8.3.2 Cultural Arts Facilities and Events

All four alternatives would potentially add to the existing demand for cultural facilities and activities; therefore, the following measures should be adopted as soon as is feasible;

- The City should work in cooperation with other agencies or commercial organizations to develop a community theater or cultural center. This could be developed as a new structure on undeveloped or redeveloped property or it could be a renovated and remodeled existing structure. Other alternatives could involve redevelopment of a facility in the Downtown area, the joint use of facilities developed as a part of the Cerro Coso Community College, or City involvement in joint use agreements with the School District to maximize the use and defray costs of existing or new facilities. The City should coordinate with existing cultural organizations in the planning area and should call for public input to determine the anticipated functions that should be accommodated in the designs of such facilities.

- The City should consider a variety of resources to fund the costs required to develop and maintain cultural arts facilities. The funding resources discussed previously (see Funding Resources in Section 6.11.3.1) could be used to acquire, construct, and maintain cultural arts facilities in the planning area. Cooperative use agreements, development fees, bonds, private and corporate grants, loans and gifts, land lease agreements, land exchanges, contractual agreements, public subscription drives, etc. should all be actively pursued by the City as potential innovative funding sources.

- The City should increase its financial and formal public support of existing cultural arts organizations as such groups can focus their efforts and resources on promoting cultural arts activities and public awareness and education of cultural resources in the planning area. This would augment the efforts of the City Parks and Recreation Department.

- The City should adopt formal commitments to provide art in public places, as discussed in the draft Land Use Element as part of the General Plan update. To this end, all new development should be required to participate in the program by commissioning a work of art for public display onsite subject to review by a public art review board, or through an in-lieu fee for projects less then a certain size, as identified by a City Art in Public Places program advisory committee. The in-lieu fees should be accumulated for the placement of works of art on a predetermined site. An implementing ordinance should be adopted that sets standards and creates an advisory committee and review board prior to approving new development.

Residual Impact. Implementation of the recommended mitigation measures would reflect a strong City commitment to enhancing the cultural arts opportunities available to Ridgecrest residents. No residual adverse impact is expected to occur.

TABLE 8.1-1 PARK USE AND ACREAGE

ZONE	Facility Name/Location	Neighborhood Park	City-wide Park	Special Use	Private Park	School Outside Naws	School Inside Naws	Vacant		Total
1	Eagle Park	0.15								0.15
	Pearson Park	3.96								3.96
	Mesquite High School					4				4
	Heritage Village Park				3					3
2	Las Flores Elementary School					8.8				8.8
	Argus/Kern Site							5		5
3	Faller Elementary School					40				40
	Monroe Middle School					7.8				7.8
	Kerr-McGee Fields			8.2						8.2
	Hellmers Park		12							12
	Pinney Pool			0.2						0.2
	Helena/Buckskin Site							0.3		0.3
	Kerr-McGee Civic Center/Park		5	0.5						5.5
4	Burns/Downs Site							5		5
5	Cerro Coso Community College							160		160
6	Gateway Elementary School					20				20
	Desert Empire Fair			20						20
	Miniature Golf Course			20						20
	Upjohn Park		5							5
7	Kern Regional/Jackson Park			39						39
	Viewig Elementary School						15.1			15.1
	Burroughs High School						47.5			47.5
	Pierce Elementary School						16.9			16.9
	Richmond Elementary School						14.8			14.8
	Murray Middle School						28.7			28.7
	Groves Elementary School						27.7			27.7
	Sandlewood Paseo			0.6						0.6
	Total	4.11	22	88.5	3	80.6	150.7	170.3	0	519.21

Table 8.1-2

Park Needs and Deficiencies

Population and
Park Acreage Needs

Existing (Alternative 4)	
Population	28241 (1991 base year)
Needed Acres*	84.72
Existing Public Parks (acres)	114.61
Unmet needs	0
Alternative 1	
Population	50000
Needed Acres	150
Proposed Additional Parks	10.3
Bowman Channel Linear Parkway**	12.12
Total Parks	137.03
Unmet needs	12.97
Alternative 2	
Population	75000
Needed Acres	225
Proposed Additional Parks	160
Bowman Channel Linear Parkway**	12.12
Total Parks	297.03
Unmet needs	0
Alternative 3	
Population	100000
Needed Acres	300
Proposed Additional Parks	0
Bowman Channel Linear Parkway**	12.12
Total Parks	297.03
Unmet needs	2.97

*Based on draft standard of 3 acres per 1000 population

**Bowman Channel Linear Parkway calculated at 4 miles x 100'

Table 8-1.3

Cultural Arts Facilities in the Ridgecrest Area

Cultural Arts Facilities	Function
Mataurango Museum	Museum
Kerr McGee Civic Center	Convention Center and Gymnasium
NAWS Theater	Theater/Live Performances
Burroughs High School Theater	Theater/Live Performances
Kern County Library	Educational Enrichment
Ridgecrest City Hall	Art Exhibits
Desert Empire Fairgrounds	County Fair, Special Exhibits, Music Performances
Cerro Coso Community College Lecture Hall	Live Performances
Local Churches	Musical Performances
Service Clubs (Eagles, Elks, Veterans)	Dances, Musical, Charity shows
NAWS Museum	Museum
Chamber of Commerce/Convention and Visitors Bureau	Resource

Table 8.1-4
Cultural Arts Activities in the Ridgecrest Area

Cultural Arts Activities	Activity Schedule
Mataurango Museum (Tours, Fundraising Auctions, etc.)	Ongoing
Desert Empire Fair	Yearly - October
Joshua's Jamboree	Yearly - May
Annual Easter Egg Hunt (Service Group)	Yearly - Spring
Rodeo Association	Ongoing
Family Connection	Ongoing
City of Ridgecrest (Annual Halloween Party)	October 31st
Annual Children Christmas Parade	December
Santa's Art Shop	December
Theater Groups (Clota, China Lake Players, LL & Company, Randsburg Players)	Ongoing
Desert Art League	Ongoing
Sierra Artists Guild	Ongoing
Balsam Street Fair	Yearly - Winter
Local Choral Groups	Ongoing
Desert Community Orchestra Association	Ongoing
Local Dance Clubs	Ongoing
Indian Wells Valley Concert Association	Ongoing
BLM - Tours	Ongoing
Cerro Coso Community College (Arts/Drama)	Ongoing
Sister Cities Association (Dances)	Ongoing

RIDGECREST GENERAL PLAN

Ridgecrest, California

PARKS, RECREATION AND OPEN SPACE

Legend

CITY OF RIDGECREST

1 RIDGECREST PARK
PINNEY POOL
SENIOR/COMMUNITY CENTERS

2 GOLF DRIVING RANGE
MINIATURE GOLF

3 EAGLE PARK

4 UPJOHN PARK /5 PEARSON PARK

KERN COUNTY

4 KERN DESERT REGIONAL PARK / Jackson

NAVAL WEAPONS CENTER

5 GOLF COURSE

6 BENNINGTON PLAZA/SCHOEFFEL FIELD

7 MCBRIDE PARK/KNOX FIELDS/REARDON FIELD

8 DARIDORE FIELD

PRIVATELY OWNED FACILITIES

9 DESERT EMPIRE FAIRGROUNDS

10 STAUFFER BASEBALL PARK

SIERRA SANDS UNIFIED SCHOOL DISTRICT

E ELEMENTARY SCHOOL

M INTERMEDIATE SCHOOL

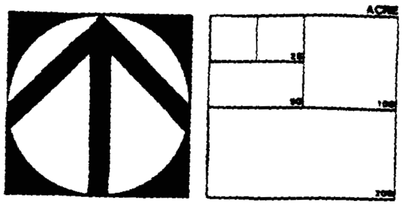
H HIGH SCHOOL

CERRO COSO COMMUNITY COLLEGE

BLM

UNDEVELOPED CITY PROPERTY

PARK ZONES



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SECTION II

Chapter 9.0
SCHOOLS

9.1 SETTING

9.1.1 Existing Public Education Facilities

Educational services are provided to the City of Ridgecrest by the Sierra Sands Unified School District, the Cerro Coso Community College, State of California College System, and private educational facilities.

a. Sierra Sands Unified School District(SSUSD). Information provided by SSUSD staff was used to prepare the following description of the existing elementary, middle, and high school educational facilities of the City of Ridgecrest. The SSUSD staff has identified the operating capacity, structural condition, and future enrollment of each of the SSUSD schools.

The SSUSD currently operates nine elementary schools for grades kindergarten through 6th; two middle schools for grades 7th through 9th; one high school for grades 10th through 12th, and a continuation/opportunity school not only for the City of Ridgecrest, but also the Randsburg-Johannesburg, Inyokern and China Lake communities. Table 9.1-1 lists the capacity and enrollments of each school within the planning area for school years 1992-1993 and 1993-1994. The percent capacity used at each school for both school years are shown. The SSUSD schools are experiencing approximately a 1 percent increase in growth per year according to the 1991-1992 and 1992-1993 enrollment figures.

Existing conditions. In general all SSUSD facilities are in severe need of rehabilitation. All schools (with the exception of Gateway Elementary School) at are least 20 years old and are experiencing various degrees of need for upgrading. Continued use of these facilities would require major rehabilitation to ensure an environment that is safe and conducive to education.

Elementary Schools. All of the elementary schools are currently operating near or at capacity (Table 9.1-1). Portable classrooms at most of the elementary schools were phased out upon the development of the new Gateway Elementary School although some schools still utilize these temporary classrooms. The use of portable classrooms is a viable alternative to permanent classrooms due to fluctuations in population age distribution. The portable classrooms can be moved from school to school to alleviate temporary overcapacity problems. Currently, portables are in use as classrooms and several vacant units are located on school sites (Table 9.1-1).

The demographic trends of the NAWS and the fact that there are 4 schools on base has made for a very unique commuting situation for the students in the Ridgecrest community. Most students living off-base who attend these schools are bussed in/or are required to have a pass. Although the base and the school district maintain an amicable relationship concerning access to base schools, occasional problems do arise as an increasing number of parents are providing the transportation for their children.

Middle Schools. Currently, Monroe Junior High School is experiencing an overcapacity problem with enrollment at 104%. Murray Junior High School is operating at 81% (Table 9.1-1). Jurisdictional boundaries of the middle schools could be adjusted as needed to balance enrollments.

High Schools. The SSUSD currently operates one comprehensive high school and one continuation school. The location of these schools are shown in Figure 9.1-1. The comprehensive high school (Burroughs) is operating at 69% capacity. The district's high school enrollment projections indicate that the capacity of the current facilities will be adequate throughout the 1993 school year. Mesquite Continuation High School is currently operating at 68% capacity. Neither Mesquite nor Burroughs High School have jurisdictional boundaries.

b. Private Schools. As mentioned before, the 6 private schools that operate within the Sierra Sands Unified School District are integrally involved in the provision of education as shown by their enrollment the past few years. In 1991-1992, private school enrollments constituted almost 15 percent of the total enrollment for grades K-12 within the Sierra Sands Unified District's boundaries. Table 9.1-2 presents recent trends in private school enrollment.

Available Funding Sources. Several methods of financing school facility projects are available to the SSUSD. Funding mechanisms include (but are not limited to) General Obligation Bonds (GOB), Mello-Roos bonds (community facilities district), Certificates of Participation (COP), Developer Fees, Interagency Cooperation, Joint Ventures, and inclusion of schools as part of residential developments. GOB's, Mello-Roos bonds, COP's, and Developer Fees represent the current popular methods (Office of Local Assistance, 1988). These funding mechanisms differ in a variety of ways; some require voter approval, some use taxes as a resource base, each have restrictions on the use of the funds, and some are more expensive to finance. The State Allocation Board (SAB) may require the district to match SAB funds; referred to as "matching share funds" for new construction, modernization, or reconstruction projects. This SAB policy can often reduce state apportionments to districts. When considering all available financing methods, a key point to consider is the cost of the financing. Some methods include capitalized interest, underwriter fees, and issuance costs and therefore are more expensive.

Ordinary operating expenses (i.e., salaries, supplies) are generally paid from current revenues, which is known as a "pay as you go" (cash) method. This is the least expensive approach to finance capital projects; however, it must be used prudently because early commitment of available cash may restrict the district's ability to meet unanticipated needs. Capital items (buildings), which have useful life over a long period, may be financed over this period, and are known as a "pay as you use" (debt) method. This is more expensive but tends to provide the district greater flexibility and alternatives to meet rapidly changing requirements. Each method is discussed below. There are advantages and disadvantages to each.

General Obligation Bonds (GOB) are bonds secured by the issuer's full faith, credit, and usually, taxing power. A bond is an interest-bearing promise to pay a specified sum of money (the principal amount) due on a specific day. A GOB is considered a "pay as you go" (cash) method of financing and therefore is a lower cost method. Issuance of bonds can be timed with district needs. The tax is based on assessed value of property district-wide. Permitted fund use includes purchase or improvement of real property. A GOB requires a two-thirds vote and voters may be influenced against approving a bond if they recently approved a local bond issue. Under current SAB policy, funds obtained by a GOB may reduce state apportionments and therefore reduce the incentive of the district to support approval.

The Mello-Roos Community Facilities District Act of 1982 (§ 53311 et seq., California Government Code) established a method whereby school districts (and other agencies) may form a separate (community facilities) district to finance certain public facilities on a "pay-as-you-go" basis (a lower cost method). The school district is authorized under the Act to raise funds by collecting a special tax within the district. The tax is not based on assessed property values. The Community Facility District (CFD) boundaries are defined by the school board, and do not have to be contiguous areas. The tax rates can be adjusted depending on need and the established maximums approved by the voters. Permitted fund use includes construction or improvement of any facility with a useful life of 5 years or more. Mello-Roos bonds may be unfamiliar to voters and may include restrictions by the SAB.

Certificates of Participation (COP) are obligations of a public entity based on a lease or installment sale agreement. Payments to certificate holders may originate from the City's general fund (in the case of a lease) or a special fund (in the case of an installment sale). A COP does not constitute indebtedness and can be structured fairly quickly (within 8 to 10 weeks). Permitted fund use includes construction of facilities, purchase of equipment, and refinancing of existing leases. The sale or lease of property may include restrictions by the SAB. A COP requires a revenue source for repayment; sources usually include general funds and developer fees.

Developer fees, as permitted by Government Code Sections 65995 and 5308, provides school districts with the ability to generate revenue locally by assessing fees on new residential, commercial, and industrial development, and additions to existing residential units. Fees are assessed based on a square footage per monetary amount rate. This method is one of the few methods of generating revenue. Revenue flow fluctuates depending on the amount of new development, and for older districts in urban areas, this may be an almost nonexistent revenue source. If the district is in the State program and enters a "Match Period" or Matching Share Requirement, the fees collected would be used to pay the district's matching share and thereby reduce the State's apportionment to that project.

c. Cerro Coso Community College. The Kern Community College District (KCCD) operates the Cerro Coso Community College located at 3000 College Heights Boulevard (Figure 9.1-1). The College offers a 2-year program leading to an Associate degree in a wide range of fields as well as vocational training. The State determines capacities for community colleges based on a formula that defines capacity for lecture, laboratory, and office space. The operating capacity of the college is based on Weekly Student Conduct Hours (WSCH) which is the amount of hours students spend in classes per week. Cerro Coso Community College's current 1992-1993 design capacity is 32697 WSCH. According to the WCCD, the college lecture rooms are operating at 76 percent capacity overall, laboratories at 344 percent capacity, and office space (for full-time faculty) at 66 percent capacity. However, during the morning and evening hours the college operates near capacity and parking is at full capacity. Additional parking is planned as future projects are funded.

Cerro Coso Community College also holds classes off-campus. For example, classes are held at SSUSD school sites, NAWS, and City facilities.

d. Other Higher Education Opportunities. Various higher education institutes offer a variety of degrees and classes on a limited basis. California State Universities and Colleges like Chico, Bakersfield, and Northridge, as well as private facilities such as University of LaVerne and Redlands University, offer four year and six year degree programs.

9.1.2 Enrollment Projections to 2010/Growth Trends

a. Sierra Sands Unified School District. Enrollment projections for the SSUSD are conducted on a year-to-year basis by SSUSD staff. They have projected a 1% growth rate for the 1993-1994 school year. State projection rates of K-5 = 0.46 student/residential unit, 6-8 = 0.08 student/residential unit, and 9-12 = 0.14 student/residential unit were utilized to extrapolate projections to the year 2010 under each alternative.

b. Cerro Coso Community College District. Enrollment projections for the community college are made by the State. The state estimates that Cerro Coso Community College will grow 22 percent from 1991 to 1995 from 4,532 to 5,522 students, and 37% between 1991 and 2000 from 4532 to 6190 students. The college will have enough lecture space in 1997 but would need additional laboratory and office space before that time. Enrollment projections beyond year 2000 are not currently available.

9.1.3 Planned Improvements

a. Sierra Sands Unified School District. Planned improvements by the SSUSD include the possible refurbishment of all school facilities as funding is made available(SSUSD, staff, Oct. 16, 1992). The SSUSD owns several properties to be developed as school sites, although no specific development plans have been made. Property includes 10 acres near the intersection of Downs Street and Ward Avenue and additional acreage at the Faller Elementary School site. Typically, elementary schools are located on 10-acre sites, middle schools on 20-acre sites, and high schools on 40-acre sites. When the current high school facilities become overcrowded, the SSUSD may build additional facilities on the existing campus or open a second high school possibly in the southwest end of the Sphere of Influence for the City.

b. Kern Community College District. Planned improvements by the KCCD include an Architectural Barrier Removal project which will remove all barriers in order to provide equal access to all students. This $1.5 million project is scheduled for construction in 1993-1994 and 1994-1995. A $9 million Performing Arts Center scheduled for construction in 1994-1995 will provide additional space for existing programs that cannot reach their full potential because of inadequate facilities. A $4.5 million Cafeteria facility will provide adequate food service facilities on campus for students, and is slated for construction in 1994-1995. A secondary effects project of the Cafeteria facility will provide additional space for the Learning Assistance Center to meet the growing student demands for learning assistance services at Cerro Coso. This will be accomplished by remodeling the vacated snackbar/student center. The $2 million project is scheduled for construction in 1995-1996.

9.2 IMPACT ANALYSIS

9.2.1 Significance Thresholds

The thresholds of significance for each educational facility are based on the current design capacity of each facility and any planned improvements, including the design capacity of currently closed schools and any property owned by the educational institutions.

9.2.2 Student Generation Rates

a. Sierra Sands Unified School District. To project new student growth generated by new residential developments, the state applies student generation factors per residential unit. The factors are averages used for all residential types including single-family and multi-family residential units. At the writing of the Draft EIR, the SSUSD projects new student generation growth on a year to year basis and, therefore, the impact analysis for each alternative is based on the state rates. The state student generation rates for each grade level are listed below:

- K-5 = 0.46 student/residential unit
- 6-8 = 0.08 student/residential unit
- 9-12 = 0.14 student/residential unit

The generation rates for the three grouped grade levels (K-5, 6-8, and 9-12) were not intended to be used to project student generation beyond several years for long-term projections. Use of the state-provided student generation rates may not accurately project actual student generation for new residential development beyond several years because of potential demographic fluctuations in age distribution.

b. Kern Community College District. There are no specific student generation rates available to project new student generation for the Cerro Coso Community College by buildout of Alternatives 1, 2, and 3. Increased student enrollment is determined by assuming that enrollment would increase at the same rates as the planning area population increases under Alternatives 1, 2, and 3.

9.2.3 Projected Student Generation Upon Buildout of Each Alternative

a. Sierra Sands Unified School District. Projected new student generation upon buildout of Alternatives 1, 2, and 3 (including existing students) is shown in Table 9.1-3. For the purposes of this impact analysis, growth under each alternative is assumed to occur at an equal and constant rate per year over the period of time in which buildout is expected to occur. New student generation by buildout of all alternatives is assumed to grow at a constant rate from now until 2010.

Adverse impacts to the education facilities would result when the facilities begin operating above their intended capacity. A school operates at exceeded capacity when the number of students enrolled at a school (enrollment) exceeds the number of students the school was designed to accommodate (design capacity). Schools operating at exceeded capacity are considered overcrowded, causing the quality of educational services to decline. Impacts to schools may be direct (the schools do not meet the education demands within the community) or they may be indirect (schools that meet the educational demands of their area may be impacted by spillover from schools in adjacent area operating at exceeded capacity).

An impact related to the effects on public schools is the effect of additional population on available child care facilities. The issue is becoming an increasingly important consideration in this era of families in which both parents work. An analysis of the demand for child-care facilities would warrant a separate study focusing on this issue county wide, which is not within the scope of this EIR. This section focuses on the impacts to public primary and secondary schools in Ridgecrest.

Alternative 1. Projected new student generation upon buildout of Alternative 1 is illustrated in Table 9.1-3. Alternative 1 would generate approximately 4442 additional new students citywide. The new student generation would result in an increase in enrollment at SSUSD schools. One new elementary school is proposed under Alternative 1. Some attendance area boundary changes would be required as well as interim use of portable units.

The majority of new student generation would occur in the south, southwest, and west areas of the City. New student generation would significantly impact Gateway, Faller, and Las Flores Elementary schools, which are currently operating at capacity. New student generation would cause all existing elementary schools to exceed capacity, resulting in significant adverse impacts to the education services of those schools.

New student generation would increase enrollment at the two middle schools, Burroughs High School, and Mesquite Continuation School but would not cause the schools to exceed capacity. The result would be less than significant impacts to the schools.

The location of four SSUSD schools within the base presents an issue of accessibility and convenience for students in all three of the Alternatives. The migration of local population away from the NAWS has to a large extent separated these schools from most of the student population. A solution has been to bus students from the surrounding area.

Alternative 2. Projected new student generation upon buildout of Alternative 2 is illustrated in Table 9.1-3. Alternative 2 would generate approximately 7354 new students citywide. Five new elementary schools, one middle school and one high school is proposed under Alternative 2.

The majority of new student generation would occur in the south, southwest and west portions of the City.

Alternative 3. Projected new student generation upon buildout of Alternative 3 is illustrated in Table 9.1-3. Alternative 3 would generate approximately 11288 new students citywide. The new student generation would result in increases in enrollment at SSUSD schools and substantiate the need for eight new elementary schools, one middle school and one high school above existing levels.

The majority of new student generation would occur in the south, southeast, and east portions of the City. New student generation would significantly impact Gateway, Las Flores, and Faller Elementary schools which are currently operating at full capacity, resulting in significant adverse educational service impacts to these elementary schools.

b. Cerro Coso Community College. Currently, the Cerro Coso Community College lecture rooms are operating at 76 percent capacity overall, laboratories at 344 percent capacity, and office space (for full-time faculty) at 65 percent capacity. Funding for improvements (construction of classrooms, etc.) at the community college is provided by the state. The state allocates funds based on state enrollment projections. Therefore, if enrollment is at or below state projected enrollment, funding is available to accommodate the increased enrollment. If enrollment exceeds state projected enrollment, state funding would not be available to accommodate the increased enrollment.

Alternative 1. Alternative 1 would result in a citywide population of 50,000. The state projects that enrollment at the Community College will grow 22% from 1991 to 1995 and 37% from 1991 to 2000. If the community college enrollment increases at the state projected rate, enrollment would exceed state projections.

An increase in enrollment would incrementally increase the operating capacity of the lecture rooms, laboratories, and offices; however, this would not be significant. Indirect impacts of the increased enrollment would add to the existing parking problems resulting in indirect parking, public transportation services, and road safety impacts.

Alternative 2. Buildout of Alternative 2 would result in a citywide population of 75,000. State enrollment projections for the community college are not estimated to 2010, only to 2000, and are projected to increase 37% from 1991 to 2000 If the community college enrollment increases at the same rate as the planning area population, the increase would exceed the state projection. The result would be a significant impact to the education services capacity of the community college.

An increase would incrementally exceed the operating capacity of the lecture rooms, laboratories, and offices. Indirect impacts such as overcapacity parking facilities would occur as a result of the increased enrollment.

Alternative 3. Buildout of Alternative 3 result in a citywide population of 100,000 in the year 2010. If the community college enrollment increases at the same rate as the planning area population, the increase would exceed the state college enrollment projection. The result would be a significant impact to the educational service capacity of the community college. Indirect impacts such as parking problems may occur as a result of the increased enrollment.

9.3 MITIGATION MEASURES

9.3.1 Sierra Sands Unified School District

The following mitigation measures should be implemented by the SSUSD to mitigate demands for educational services as soon as feasible and prior to approval of any development that would impact existing educational facilities or increase demand for additional educational facilities (specific mitigation measures are addressed following the impacts):

a. Existing. Significant impacts would worsen the currently overcrowded conditions of several SSUSD schools. These impacts would be unavoidable until the overcrowded conditions are alleviated.

- o The SSUSD should alleviate the overcrowded conditions of Viewig and Faller Elementary Schools by implementing the appropriate finance mechanisms to provide for portable classrooms at the school until such time that a long-term solution can be put into effect.

b. Transportation. Properly locating future school sites must reflect population changes on a subarea basis. Although the total School District enrollment has been only slightly increasing, some attendance areas have experienced significant changes. Adjustment for this situation can be made through busing. However, at some point, development of new schools may be necessary, and provision for their location in the General Plan is advisable. Where population growth will occur and its density will be determined by the City' land use and zoning decisions. The District currently owns one potential school site located on North Downs Street, and additional vacant acreage on the Faller Elementary School site. Both sites offer opportunities for new development. Consideration should be given to the appropriateness of these sites in relation to overall planning objectives.

Currently, considerable joint use of building and recreational facilities by the School District, Community College, City of Ridgecrest and NAWS occurs. While some inconvenience in scheduling results, this system allows maximum utilization of resources. In planning for future development in Ridgecrest, further consideration should be given to the effectiveness of this system and means of resolving difficulties. Increased efforts at coordination, expansion of heavily used facilities (i.e. recreational) and increased accessibility to facilities located within the NAWS are possible approaches for consideration.

c. Alternative 1. Implementation should be made by the SSUSD to mitigate the following impacts associated with buildout of Alternative 1:

- o Existing overcapacity problems of three SSUSD elementary schools; and
- o Exceeded capacity of all remaining additional elementary schools.
- o One new elementary school

Year Round Sessions. The SSUSD should implement a year round session school to alleviate overcapacity problems throughout the City.

Implementation of Finance Mechanisms. Depending on the type of improvement to be funded, the SSUSD should implement one or more of the following finance mechanisms. Money from these finance mechanisms should be used by the SSUSD to implement the improvements needed to mitigate the impacts of the additional student generation prior to City issuance of building permits for any residential development that would generate the need for improvements.

In evaluating each of the funding mechanisms addressed, the SSUSD must provide adequate financial planning to ensure that the district does not incur debt beyond that of needed, definable projects for which (if necessary) an adequate repayment revenue exists. Selection of a funding mechanism should consider "all costs" of financing including interest, underwriter fees, and issuance costs.

- o Developer Fees State law requires the payment of developer fees by individual homebuilders (developers) to affected school districts. Therefore, prior to the issuance of building permits, the developer should pay the SSUSD development fees (the current amount is $1.58 per square foot of living space). Developer fees can finance improvement of existing school facilities and construction of new schools.

- o General Obligation Bonds The SSUSD should consider placing a General Obligation Bond on the ballot (voter approval is required). Passage of a

General Obligation Bond raises funds to finance the purchase or improvement of real property.

- o Mello-Roos Bonds The SSUSD should consider placing a Mello-Roos Bond on the ballot. Passage of a Mello-Roos Bond can be used to finance construction or improvements of any facility with a useful life of 5 years or more.

- o Certificates of Participation The SSUSD should consider selling Certificates of Participation. Certificates of Participation can be used to finance construction of facilities, purchase of equipment, and refinancing of existing leases.

- o State Grants. The SSUSD should consider applying to the state for grants to be awarded to finance construction and improvement projects.

d. Alternative 2. The SSUSD should implement the measures listed above to mitigate the following impacts associated with buildout of Alternative 2:

- o Existing overcapacity problems of all SSUSD elementary schools; and
- o Projected exceeded capacity of all elementary schools;
- o 5 new elementary schools
- o One new middle school
- o One new high school

e. Alternative 3. The SSUSD should implement the measures listed above to mitigate the following impacts associated with buildout of Alternative 3:

- o Existing overcapacity problems of all elementary schools;
- o Projected exceeded capacity of all elementary schools;
- o The need for 8 new elementary schools in the community

Residual Impact. If the mitigation measures addressed above are successfully implemented under each alternative, the existing and new student generation would be accommodated by schools operating at or below capacity, resulting in no residual significant impacts. If the finance mechanisms are not implemented, no funds would be available to accommodate existing overcapacity schools and the new student generation, resulting in significant adverse residual impacts to the elementary schools.

9.3.2 Cerro Coso Community College District

Buildout under all alternatives would result in increased student enrollment that would exceed state enrollment projections and funding availability to accommodate the increased enrollment. The following mitigation measures should be implemented by the state as soon as feasible and prior to the approval of any residential development that would increase the demand on educational services of the community college to mitigate the full capacity problems associated with buildout under all alternatives.

- Community college funding allocated by the state should be increased to accommodate the additional enrollment;
- Enrollment fees should be assessed to supplement funding; and
- Enrollment fees assessed to non-California residents should be increased to supplement funding.

Residual Impacts. Implementation of the mitigation measures would result in no residual impacts.

TABLE 9.1 -1

Capacity and Enrollment of SSUSD Schools for School Years 1992-1993 and 1993-1994

	Grade Level	Structure Capacity 32 per class	Portables in Use	School Year 1992-1993 Enrollment/% Capacity Used	School Year 1993-1994 Enrollment/ % Capacity Used
Elementary Schools					
Pierce	K-6	448	6	423/94%	427/95%
Gateway	K-6	672	0	655/97%	661/98%
Las Flores	K-6	672	0	636/95%	642/96%
Groves	K-6	448	1	437/98%	441/99%
Richmond	K-6	480	0	411/86%	415/87%
Viewig	K-6	448	0	447/99%	451/101%
Faller	K-6	448	0	449/100%	453/101%
Middle Schools					
Monroe	7th - 9th	704	3	730/104%	737/105%
Murray	7th - 9th	1024	0	817/80%	825/81%
High Schools					
Burroughs	10th - 12th	1824	0	1257/69%	1270/70%
Mesquite	10th - 12th	200	0	137/68%	138/69%

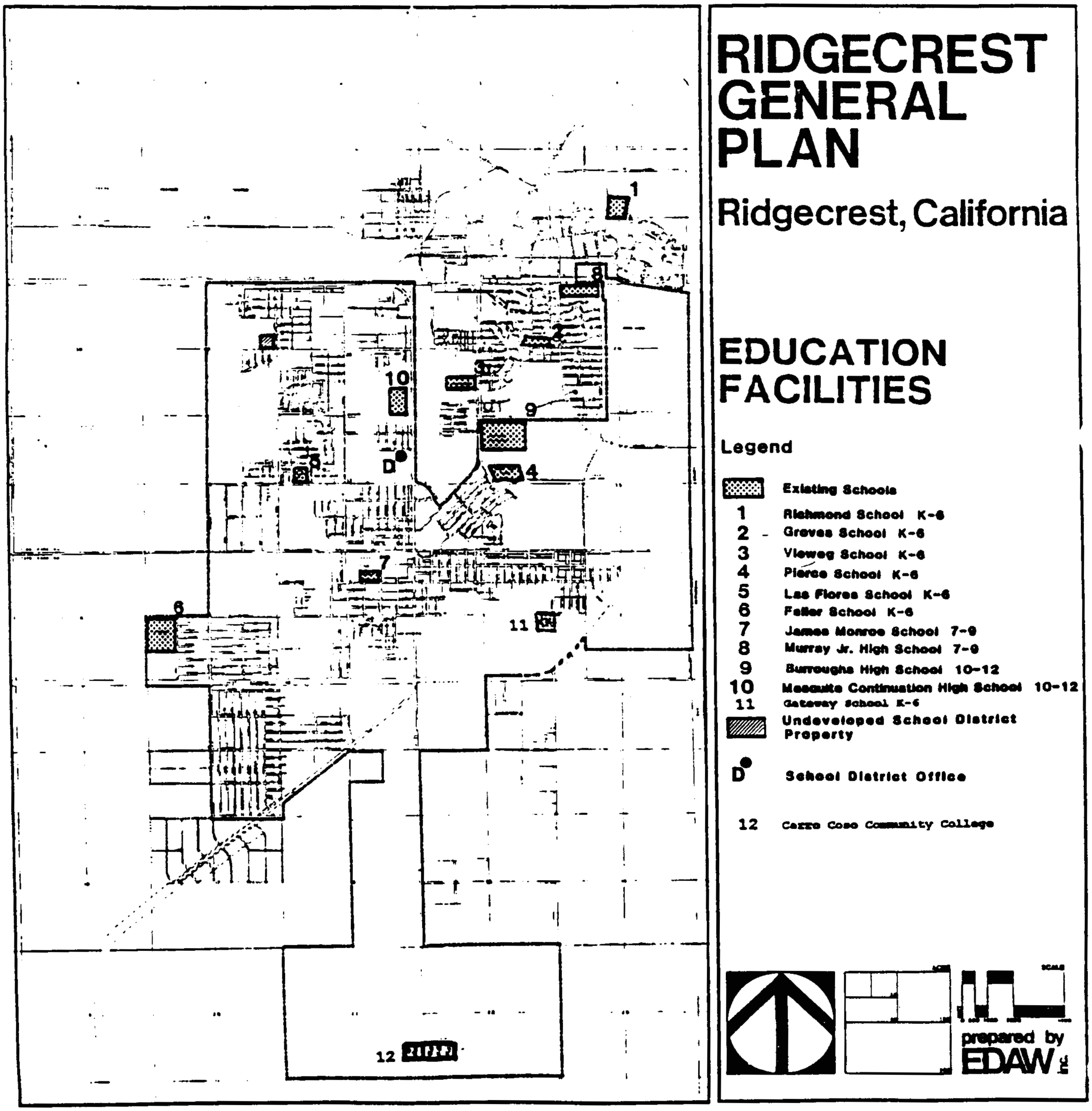
TABLE 9-1-2			
Private School Enrollment Trends			
School	Grade Span	Enrollment 1991-1992	Enrollment 1992-1993
High Desert 7th Day Advt	1 to 8	20	17
Ridgecrest Christian	1 to 8	90	102
St. Anns School	1 to 6	142	151
Pilgrim Christian	1 to 8	16	17
Immanuel Christian	1 to 8	112	100
Ridgecrest Christian-Downs	1 to 8	54	6
Total		434	393

Table 9.1 -3

SSUSD ENROLLMENT PROJECTIONS YEAR 2010

	Alternative 1	Alternative 2	Alternative 3		Existing Capacity	Additional School Needs Alternative 1	Additional School Needs Alternative 2	Additional School Needs Alternative 3
Existing School Grade K-5	2644	2644	2644					
New Students	2021	4377	6719					
Total Students in 2010	4665	7021	9363		4064	601	2957	5299
New Elementary Schools needed						1	4.4	7.8
Existing School Grade 6-8	740	740	740					
New Students	565	1226	1881					
Total Students in 2010	1305	1966	2621		1728	-423	238	893
New Middle Schools needed						0	0.39	0.51
Existing School Grade 9-12	1058	1058	1058					
New Students	808	1751	2688					
Total Students in 2010	1866	2809	3746		1844	22	965	1902
New High Schools needed						0	0.52	1.03

Figure 9.1-1


RIDGECREST GENERAL PLAN
Ridgecrest, California
EDUCATION FACILITIES
Legend
Existing Schools
1 Richmond School K-6
2 Groves School K-6
3 Vieweg School K-6
4 Pierce School K-6
5 Las Flores School K-6
6 Faller School K-6
7 James Monroe School 7-9
8 Murray Jr. High School 7-9
9 Burroughs High School 10-12
10 Mesquite Continuation High School 10-12
11 Gateway School K-6
Undeveloped School District Property
D School District Office
12 Cerro Coso Community College
prepared by EDAW inc.
1
2
3
4
5
6
7
8
9
10
11
12
D

SECTION II

Chapter 10

SOCIOECONOMICS

This section examines the potential impacts of the four development alternatives on certain socioeconomic factors within the City. The socioeconomic factors which are the subject of this analysis include population, employment, tourism, and public finance.

10.1 SETTING

The purpose of this section is to describe in a general fashion the existing socioeconomic conditions in the City of Ridgecrest. This setting provides the foundation upon which the potential socioeconomic impacts of the proposal will be analyzed. The description of existing conditions is intended to provide the level of detail necessary for an evaluation of the potential impacts.

10.1.1 Population and Employment

a. Population. The City of Ridgecrest, remotely located in the high Mojave Desert of eastern Kern County has experienced significant growth as a result of increasing pressures from the Los Angeles Metropolitan Area and the Southern California Region as well as from 50 years of increasing investment by the Department of Defense in military technology research, testing and development. According to figures released in January 1992 by the state Department of Finance, the City of Ridgecrest currently supports a population of 29,313. This is a 2.2 percent increase over the 1991 population of 28,765 and a 86 percent increase over the 1980 population of 15,750. Table 10-1 provides time series information on population changes in the City of Ridgecrest. As the table illustrates, the population grew the fastest during the 1950s and again in the 1970's when the average annual increase in population exceeded 10 percent and with the City nearly doubling it's population each decade. Some of this population increase is attributable to annexation of lands into City boundaries. Since 1950, the average rate of population growth has averaged approximately 9%+ per year, but has slowed to a lower than 3% rate in the 90's decade.

TABLE 10-1

CITY HISTORICAL POPULATION

Year	Population	Increase (%)
1950	**2028**	**--**
1960	**5467**	**170%**
1970	**7629**	**40%**
1971	7900	
1972	9024	
1973	12950	
1974	13050	
1975	13500	
1976	13600	
1977	13750	
1978	14610	
1979	15050	
1980	**15750**	**106%**
1981	16148	
1982	20704	
1983	21315	
1984	22162	
1985	22967	
1986	23716	
1987	24973	
1988	26836	
1989	28639	
1990	**27725**	**76%**
1991	28675	3.4%
1992	29313	2.2%

Sources: **Federal Census Bureau.**
State Department of Finance

The most recent information on the age distribution of the City's population is based on 1990 data from the Federal Bureau of Census. These data indicate that 30 percent of the population is younger than 18 years old. The median age in the City of Ridgecrest of 31.5 has varied only slightly since 1960.

b. Employment. Data from the 1990 Census indicates that the civilian labor force (persons 16 years and older) within the City of Ridgecrest was 15,197, equivalent to 55 percent of the City's population. Those persons (16 years and older) outside the labor force numbered 4,944. The military force numbered 751. The number of employed in the civilian force was 13,710, which yields an unemployment rate of 4.8 percent. The unemployment rate has grown since the census and in 1993 stands at about the state average of 9%. While the growth rate points to the fact that the City of Ridgecrest is host to a growing and healthy economy, it certainly is not immune from and is responsive to short term trends. With a significant workforce in the Department of Defense and the Bureau of Land Management, Ridgecrest is very susceptible to changes in budget and economy at a national level, and is also to the state economy's influence on tourism, settlement and retirement. It can be estimated that approximately 13,631 of the 14,461 employed individuals within Ridgecrest, work within 30 minutes of their homes with a median commute of 13 minutes. 13,000 people travel to work by motor vehicle.

The following fiscally describes the distribution of the City's employment by economic sector based on information from the Bureau of Census. While the largest single employment sector within the City is the private sector with 7,686 jobs, the public sector (local government including the Sierra Sand School District 837, state 245, and federal 4917 jobs) has an unusual ratio of jobs, 43% of the total. The largest single employer within the City is the Department of Defense, other major employers are the Mining and Chemical Industry (North American Chemical Company and Rand Mining).

Following is a list of the various economic sectors of the City and an indication of expected trends for each sector.

- Agriculture. Never a large component in the local economy, Agriculture is waning, employment has decreased. This decrease in agricultural employment is due to the urbanization of agricultural lands within the City and lack of competitiveness with other regions.

- Mining and Chemical Manufacture. These commodities and special manufacture goods are a function of the international market which has provided a steady demand over the long term. It is difficult to forecast future activity in this sector, although product is present to meet demand.

- Manufacturing. Employment in the manufacturing sector now provides (including DOD manufacture) 1,195 jobs in the City.

- Construction. After a period of decline in the 1970s, and a boom in the 1980's the construction trade is experiencing a slowdown with a 1990 level of employment of 1,139. Traditionally the most cyclical of the economic sectors, we forecast a continued strong increase in this sector as the current economy recovers and investment by Public and private sectors resurges.

- Transportation, Communication and Utilities. Major employers in this sector include Southern California Edison, Contel, Pacific Gas and Electric, Indian Wells Valley Water District, the News Review and the Daily Independent. The importance of these sectors to the City's overall economy remains relatively constant. This sector accounts for 2.5 percent, 332, of the City's jobs. The major subsector in this group is electric, water, gas and sanitary services, however, it is the telecommunications sector that is anticipated to experience major increases in growth as technologies develop and demand increases.

- Wholesale and Retail Trade. The wholesale sector has declined as somewhat as Department of Defense purchases in the Indian Wells Valley have declined. The wholesale industry employs some 116 members of the labor force. Providing employment for 1782 persons in the City's labor force, the Retail Trade sector is a major employment provider. It is estimated that 30 percent of the jobs in this sector are within the City's hotels, restaurants and bars.

- Finance, Insurance and Real Estate. Following a period of rapid growth, employment in this sector has declined since 1990. Much of this was due to a decline in the number of employees in banking and in real estate. This industry will revive in conjunction with the Construction Industry.

- Services. The Services sector has increased since 1974 and now employs almost 30 percent of the City's labor force. Major employers in this sector are personnel and business services, recreational services, health services, legal services, and educational and social services. The total employment in this area is 4,586

- Local Government. The two major employers of the 873 jobs in this category are the Sierra Sands Unified School District and the City of Ridgecrest.

- Federal and State Agencies. The largest single employer in the Indian Wells Valley is the Department of Defense. Due to the unique location and mission of the China Lake Naval Station, the prospects for expanded federal activity here is good. With 1.1 million acres, a land area greater than the State of Rhode Island, the China Lake NAWC, renowned for its research accomplishments, serves as the premier Department of Defense research, development, testing, and evaluation facility. Although drawdowns in the defense and aerospace industries have resulted in the loss of 2,000+ jobs in Ridgecrest, 880,000 jobs to California since 1990, with appropriate transfer of technologies, incubation of strategic industries, and a focus on dual use developments the City may reverse that trend by the introduction of new programs and higher paying scientific and technician jobs in our City and our state. Ridgecrest presents a working laboratory in which the technology transfer process can be defined and modeled, utilizing a partnership relationship between a national laboratory, a local government, and a skilled and competitive private sector. The support facilities, infrastructure and scientific-technological skills for these programs are already in place in the community and the prospect; for expanding private sector activity to regain and create jobs is good. Additionally the City is in a position to lobby the Senate and Congress on behalf of introducing new programs into the community and can interface with the Base Realignment and Closure Commission so as to benefit from Mission consolidations as installations close in other areas.

10.1.2 Hospitality and Tourism

It is widely recognized that a thriving hospitality industry can contribute significantly to the local economy of an area. Tourism is an industry that creates employment for the local labor force, injects dollars into the local economy and generates public revenues for the local jurisdiction.

The City of Ridgecrest is impacted by tourism in the Southern California Region, since this area is the primary source of the tourist market for the City. The assets of the City of Ridgecrest that attract visitors include the Mojave Desert, Death Valley National Monument, Inyo National Forest, the South Sierra Nevadas, Red Rock Canyon, the Trona Pinnacles and the Petroglyphs.

It is a goal of the City to increase tourist activity and enhance the local hospitality industry. At this writing, no report on existing and proposed hotel and motel accommodations has been prepared to indicate how many hotel rooms can be supported. In Fiscal Year 1992, the City spent $60,000 to support the efforts of the Ridgecrest Convention and Visitors Bureau in promoting tourism and invested an additional $50,000 in the Chamber of Commerce.

The City's tourist economy is comprised of four main components: overnight visitors, day visitors, business travelers and conference attenders. Data indicates that business travelers generate the largest demand for overnight accommodations, followed by the overnight tourists. While conference attenders only demand a small percentage of overnight accommodations, the number of occasional and annual conferences and events has grown steadily in recent years.

In addition to the number of visitors, an important factor with respect to the effect of tourism on the local economy is the size of the tourist expenditures. Estimates of tourist expenditures for overnight visitors are based on bed tax information, Convention and Visitors Bureau data, and state reports which allocate visitor expenditures among several services. Estimates indicate that in 1992, exclusive of Department of Defense activities, 46,000 overnight visitors to the City of Ridgecrest spent a total of $10,316,000 within the City on non accommodation expenditures. The overnight visitors, including attenders at conferences and meetings, tourists, and people involved in film productions, contributed $186,000 in TOT and $734,570 in sales tax to the community. These figures do not include expenditures by day visitors.

Due to the location of the City of Ridgecrest in proximity to the Sierra and Mojave Desert Regions and to the China Lake Naval Station, the City supports a large number of day visitors, however, there are no estimates for the number of day visitors that the City hosts per year and consequently little data is available on the spending patterns of the City's day use visitors. Information extrapolated indicates that tourists in Ridgecrest spend an approximate $64 per person per day exclusive of accommodations. This is evidence of the importance of the day use visitor to the tourist economy of the City.

The City's finances are also affected by the level of tourist activity that occurs within the City. The City receives revenue in the form of sales taxes on goods and services purchased by visitors and transient occupancy taxes on hotel and motel rooms. The transient occupancy tax is 10 percent. For the fiscal year ending June 30, 1993, the City collected $606,272 in transient occupancy taxes. This is a maintained number as the transient occupancy taxes collected in prior year FY 91-92 was $606,137. While the amount collected from the transient occupancy tax has maintained itself over the last two years, this maintenance has occurred during a downturn in DOD activity and indicates that tourism and other visitation has increased dramatically. While it is not possible to determine the portion of the sales tax revenue that is attributable to the purchase of goods and services by visitors to the City, it amounts to a valuable part of the local economy.

10.1.3 Public Finance

This section will focus on the finances concerning the maintenance and operations of the City's general governmental functions. Table 10-2 provides summary data on general governmental costs and revenues. Expenditures have been grouped into categories to reflect the costs of providing different types of public services. Revenues have also been grouped into categories. These categories utilize the state report format.

TABLE 10-2

Operating Cost and Revenue Summary
FY 1993-94 General Fund Only

OPERATING REVENUES	Estimated FY 93-94
Sales Tax	$2,125,000
Bed Tax	$ 600,000
Franchise Tax	$ 543,200
Property Taxes	$ 478,100
Business License Tax	$ 157,000
Other Taxes	$ 32,500
Total Taxes	**$3,935,800**
Intergovernmental	$1,155,720
License/Permits	$ 199,000
Fines/Forfeitures	$ 39,300
Use of Money/Prop.	$ 163,300
Charges/Services	$ 552,510
Other	$2,113,320
Total Revenues	**$8,159,050**

EXPENDITURES	Estimated FY 93-94
General Government	$2,460,380
Public Safety	$3,094,470
Transportation	$ 480,880
Community Development	$ 722,880
Health (Resource Recovery)	$ 98,700
Culture and Leisure	$1,117,160
Total Expenditures	**$7,974,470**

Source: FY 93-94 Budget City of Ridgecrest

Property tax revenues are those monies, received from the property owners via the County of Kern, which represent the City's share of the property tax levy. As the table indicates, Property Taxes are not the most significant of City revenues. Sales Tax, Transient Occupancy Tax, and Franchise Taxes, all greater than property tax, have been increasing in recent years. The property tax does not constitute the primary source of revenues for cities as it does with counties. This is due to the fact that the City receives only a portion of the property taxes collected from properties within its boundaries; the County receives the remainder and dispenses it to other agencies, such as the School Districts and Redevelopment Agency. The retail sales tax is the primary source of revenues for the City of Ridgecrest due to a strong local business climate. Sales tax represents 26.6% percent of the City's annual revenue and with the exception of occasional economic downturns has increased on an annual basis. This is expected to continue well into the future. In 1992 and 1993, the State of California, in order to balance it's budget, impounded portions of local property tax that are sources of revenue for cities and counties. It is unknown whether the sequestering of local taxes will continue.

The City spends approximately $7.9 million a year providing services to its residents. City government costs have been increasing over the years as providing the level of service required becomes more expensive. Public safety is the most expensive of all local governmental functions. For the City of Ridgecrest, public safety costs constitute approximately 36.8 percent of annual expenditures. This is not just the case with the City of Ridgecrest, but with all local jurisdictions.

10.1.4 Social Programs and Health Care Services

a. Social Programs. Residents of the City of Ridgecrest enjoy the benefits of social programs which are supported by City taxpayers through tax payments to the Federal and State Governments, and through property tax payments to the County. A few programs, such as senior citizen programs, Meals on Wheels, DARE, are run by the City. The majority of the social programs are provided by the County either directly or through contract. These programs are run by a host of different organizations. The various programs address the needs of drug abusers, seniors, abused children, troubled families, teenagers, the homeless and the disabled. In addition, the County Fire District, also supported by City citizens property taxes, provides a social service in the way of non-fire emergency assistance. The Fire Department will respond to calls for assistance in a variety of situations such as childbirth, accident, physical assistance for the elderly and coronary failure.

The County of Kern provides a number of social service and assistance programs to the residents of the entire County. The list of public assistance programs is exhaustive. They include Aid to Families with Dependent Children, Welfare, food stamps, Medicare and Medicaid. The County administers many of these programs on behalf of the State and Federal Governments.

Recent increases in the cost of providing public assistance is associated as much with cost of living increases than with an increase in the number of cases. According to staff at the County Administrative Office, the County's public assistance case load is somewhat more than of other counties of similar size. This is due to the fact that this County's median income is lower than that of many counties of similar size. Of the existing cases within the County, a significant number are single parents who are provided assistance. It is not possible to determine the share of the public assistance budget that is attributable to residents of the City of Ridgecrest since the County Administrative Office does their accounting on a County-wide basis.

b. Health Care Services. The discussion of health care services is limited to the general hospital located within the City of Ridgecrest. Ridgecrest Community Hospital is a private regional hospital and health care center. The City of Ridgecrest and Indian Wells Valley is the primary area served by this hospital although patients are served from nearby Trona, Death Valley and the Eastern Sierras. The hospital capacity is adequate to serve the existing population of the City. Occupancy at the hospital hovers around 70 to 75 percent. This is down from the occupancy rate of approximately 80 percent of a few years ago. This decrease in occupancy is a result of recent trends in health care towards outpatient services. The Executive Director of the Ridgecrest Community Hospital estimates that the hospital will be able to increase capacity to support the growing market population as it increases; depending on demand this increased capacity will require facility modifications or expansion. Drummond and Sage Medical Clinics and Kern County Health Department also provide medical care within the community.

10.2 IMPACT ANALYSIS

10.2.1 Population and Employment

a. Alternative 1. Alternative 1 would result in an additional 20,000 residents within the City for a total population of approximately 50,000 post 2010. Assuming that the characteristics of the population are similar to those which existed in 1990, the age distribution of the population would also be similar.

Based on the estimated population distribution described in the 1990 Census, it appears that almost one-half of the population will be between age 20 and 54. This is the primary age group from which the labor force draws most of its members. It is recognized that many individuals in the 55 to 64+ age group are still members of the work force and also that businesses in the service industry employ individuals in the 15 to 19 age group.

To estimate the effect of this additional population on the size of the City's work force, it is necessary to make an assumption regarding the relationship between the growth in population or households and the increase in the size of the City's work force. According to the 1992 development profile (City of Ridgecrest Department of Community Development, May 1992), it is estimated that there are approximately 0.77 households per employee. Conversely, each new household or dwelling unit is assumed to generate 1.3 new members of the workforce. It is important to note that while not all of the members of the labor force reside within the City, most of Ridgecrest's citizens are employed within the City limits. Because of the presence of other labor markets within commuting distance of the City of Ridgecrest (Inyokern, Trona, Randsburg), some jobs within the City are filled by residents of other communities and some of the City's residents are employed outside of the City. Because of the limited employment opportunities outside the City, it is assumed that a substantial component of the total labor force are employed within the City.

Alternative 1 is projected to result in the addition of 8,082 new households within the City. Using the multiplier of 1.3 new employees per household, it is estimated that Alternative 1 to sustain a population of 50,000 will need to generate 10,506 new members to the work force.

The extent to which these jobs result in employment for the City's residents depends on the types of commercial and industrial developments that occur and the availability of the needed job skills within the local labor force.

Of the existing commercial and industrial acreage within the City, 66 percent are assigned to commercial uses while 34 percent are for industrial uses. More than 50% of the City's commercial/industrial lands are vacant. This balance of commercial and industrial lands is supporting the City's healthy, growing economy. However, these numbers could be misleading as a significant amount of the City's industry is located on the 5,850 acres of the China Lake Naval Station within the City limits. As proposed, Alternative 1 would retain this balance and would further the City's present growing economic trend.

b. <u>Alternative 2</u>. Alternative 2 would result in an additional 46,759 residents within the City above existing conditions for a total population of approximately 75,000 post the year 2010. Assuming that the characteristics of the population are similar to those which existed in 1990, the age distribution of the population would also be similar, and it appears that almost one-half of the population will be between age 20 and 54.

To estimate the effect of this additional population of the size of the City's work force, it is necessary to make an assumption regarding the relationship between the growth in population or households and the increase in the size of the City's work force. As described in Alternative 1, it is assumed that each new household or dwelling unit will generate an addition of 1.3 people to the City's work force. Alternative 2 is projected to result in a total of 17,509 new households within the

City. Using the multiplier of 1.3 employees per household, it is estimated that Alternative 2 will generate 22,761 new members of the work force.

As noted previously, of the existing commercial and industrial acreage within the City, 64 percent are assigned to commercial uses while 34 percent are for industrial uses. Alternative 2 would alter this ratio, decreasing commercial and increasing industrial acreage. This slight change is not expected to noticeably affect the local economy.

c. Alternative 3. Alternative 3 should add 71,759 additional residents to the City for a total City population of approximately 100,000 post the year 2010. Assuming that the characteristics of the population are similar to those which existed in 1990, the age distribution of the population would also be similar, it appears that almost one-half of the population will be between age 20 and 54.

It is assumed that each new household or dwelling unit will generate an addition of 1.30 people to the City's work force. Alternative 3 is projected to result in a total of 26876 new households within the City. Using the multiplier of 1.3 employees per household, it is estimated that Alternative 3 will generate 34,938 new members of the work force.

Alternative 3 would slightly change the existing balance of commercial and industrial acreage to increase the percentage of industrial acreage.

The retail and services sectors are the strongest sectors of the local economy. Together, retail trade and services (1990 Census) provide 6861 jobs or 50 percent of the City's employment opportunities. The vigor of the City's commercial sector not only benefits the local economy, but there are fiscal benefits associated with commercial developments. To move away from the current balance of commercial and industrial acreage toward a land use scenario that includes more industrial than commercial acreage could adversely impact the local economy and the City's tax base. However, under Alternative 1, 2, and 3, the change in the balance of commercial and industrial land uses is too small to create a significant impact.

d. Alternative 4, the no project alternative . Alternative 4 is problematic in that the City would exist without plan and consequently would attempt to maintain jobs, but this could result in stagnation of the local economy, a reduction in competitiveness and loss of primary sectors such as the DOD and the service sectors. Without plans for community transformation and/or expansion jobs and the economy would be likely to erode.

10.2.2 Tourism

The importance of the tourist economy on the local economic climate was discussed in Section 6.16.1.2. With the downturn in the Department of Defense industry, it is more important than ever that the tourist industry in the City continue to thrive and capture the tourist market which is so beneficial to the local economy. Table 10-3 presents a summary of the revenue generated by the Transit Occupancy Tax (TOT).

TABLE 10-3

CITY TRANSIENT OCCUPANCY TAX

Year	Amount Collected ($)	General Fund
1987/88	495,579	$5.1 Million
1988/89*	608,132	$5.6 Million
1989/90	650,541	$6.4 Million
1990/91	656,885	$7.4 Million
1991/92	606,137	$8.2 Million
1992/93	606,272	$6.8 Million

* In 1989 T.O.T. increased from 8 to 10%.

(In 1992 The City had 782 rooms at average rate of $38.29 per night; Occupancy rate of 47.14%.)

Sources: City of Ridgecrest Annual Report of Financial Transactions to State Controller; Convention and Visitors Bureau.

Based on information gathered from the Convention and Visitors Bureau and Chamber of Commerce, factors that affect tourism are: (1) an area's natural resources, particularly the desert, (2) accessibility, (3) cultural and special events, (4) cost, and (5) marketing efforts. None of these factors would be directly affected by the proposed development alternatives. However, all of the alternatives would increase the amount of land designated for commercial use. To the extent that this additional commercial acreage is developed with establishments that are attractive to the visitor, the impact on tourism would be beneficial.

According to the Visitors and Convention Bureau, a problem for the City of Ridgecrest is its distance from highways 14 and 395, the principal tourist routes. Tourists often get lost on Highway 178 trying to navigate the route from the Highways to Death Valley and the Sierras or vice versa. As the additional development envisioned under the four alternatives adds further traffic, this could exacerbate the accessibility problems and discourage tourists from visiting the area. However, given that many of the visitors are from the Los Angeles Metropolitan Area and the Southern California Region, it is not expected that the level of traffic which could occur in the City would be much of a discouragement. Therefore, the potential impact is considered insignificant.

10.2.3 Public Finance

a. Methodology. The purpose of this section is to analyze the potential impacts of the four alternatives on the City's operating expenditures and revenues. This section does not include an analysis of the costs of needed or future capital improvements. These improvements are often wholly or partially supported by developer fees, assessment districts, user fees, etc. It is difficult to obtain an indication of the annual costs or revenues that appear in the City's budget each time an additional person is added to the City's population as numbers represent costs and revenues which are accruing over time. Certain costs and revenues may not become evident until such time as the growth in population or commercial and industrial development reaches a certain level.

Commercial and industrial land uses are important factors to be incorporated into fiscal analysis since it is believed that the demand for services and the public revenues received are associated not only with a growing population but also with a growth in commercial and industrial development.

From a pure fiscal perspective, commercial development is the most advantageous to the City, generating revenues well in excess of the costs of serving the development. Residential developments (when recreation, parks, and other services are factored into the equation) create expenditures in excess of revenues. Industrial developments basically have a neutral fiscal effect (although this is where the spendable incomes are derived from). On whole however, the three appear to balance in the positive.

b. Significance Thresholds. Fiscal impacts have not been established by the City of Ridgecrest, however, a number of communities consider impacts to be "adverse" if a net fiscal deficit is projected which is greater than $10,000 and beneficial impacts are considered "substantial" if the projected budget surplus is equal to or greater than 2 percent of the Fiscal Year budgeted operating revenues.

c. Alternatives 1, 2, and 3. The development permitted under Alternatives 1, 2 and 3 will result in additional residents within the City. Based on the costs of sustaining citizen services, this level of population growth could generate an annual net fiscal deficit, however, it is assumed that residential development will be accompanied and balanced by industrial and commercial development and thus be self sustaining. If it is not, residential development can be a significant draw on local government resource. To be effective, and be in a position to provide public services cities need to be balanced.

The expenditure of revenues by local jurisdictions is limited by Senate Bill 1352 which implements the 1980 Gann Initiative, or Proposition 4. The limitation is based on the appropriations for Fiscal Year 1978-79 adjusted for increases in population and the Consumer Price Index. Therefore, the increase in population will benefit the City by increasing the appropriations limitation. This is a benefit that must be taken into account.

d. Alternative 4. Under this alternative infill will be sporadic and job development will occur without public support. This alternative could be significant in that without lobbying and the loss of jobs at China Lake, and the commensurate downturn in the local economy would result in higher unemployment and a greater demand for government and social services without generating offsetting revenue.

10.2.4 Social Service Programs and Health Care Services

a. Social Service Programs. It is difficult to estimate what percentage of the population added to the City under the development alternatives would require the social services presently provided. It is assumed that the current relationship between population and social service costs continues into the future.

The potential increase in social service costs associated with all four alternatives is considered to be substantial.

The potential impact of the development scenarios on the County's costs of providing public assistance must be examined in light of the economic status of individuals needing assistance from the County's programs. The City's social service programs are not targeted to population of a specific economic status. For example, emergency assistance and the senior programs are not related to the economic status of the recipients of the services. However, the County's programs provide assistance to individuals with lower incomes. The extent to which the additional population within the City would increase the demand for these assistance programs depends on the economic status of the new residents. Recent trends in housing prices within the City appear to maintain the composition of the population to one of predominantly middle income families. According to staff of the County Administrative Office, population growth within the City of Ridgecrest is not expected to significantly increase the demand for public assistance.

b. Health Care Facilities. the Executive Director of Ridgecrest Community Hospital states that the hospital has the capacity to support increased population and continue to provide services with facility modification and/or expansion. Therefore, while Alternatives 1, 2 and 3 contribute to the eventual need for a hospital expansion, they can be accommodated without significantly impacting the hospital. The population proposed under Alternative 4 would not necessitate an expansion of Community Hospital. It is believed that these impacts would occur far enough in the future to allow the hospital to be able to plan for this eventual expansion and therefore, avoid creating a significant impact.

10.3 MITIGATION MEASURES

Based upon the impact analysis, the following impacts should be mitigated:

- The Social Service costs of all the development alternatives.
- The need for new hospital space resulting from the demand likely to result under the alternatives.
- The potential unemployment of a new population.

To offset the potential increase in social service costs, the City should ensure that funding leads expenses by anticipating costs 2 to 5 years into the future to support these programs. However, given the fiscal constraints facing all agencies involved in social service and public assistance programs, it is not certain that a significant amount of funding would be available. Therefore, the City may be unable to support the current level of social services in the future and may have to amend or delete certain programs.

The goals and programs to create jobs and maintain and enhance the economy of Ridgecrest need to be implemented so as to lead population growth with economic development.

Residual Impacts. Imposition of the above mitigation measures would reduce all identified socioeconomic impacts to less than significant levels. No significant housing impacts would result from the creation of new employment opportunities under the development alternatives as a greater number of jobs would be created than the number of units provided to accommodate the new households.

TABLE 10-4

Summary of Impacts

Issue	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Population	50,000	75,000	100,000	unknown
Current Jobs	13,710	13,710	13,710	13,710
Additional Jobs	10,516	22,761	34,938	unknown
Total Jobs	24216	36,471	48,648	unknown
Social Service Cost	YES	YES	YES	YES
Expansion/Modification of Community Hospital	NO	YES	YES	NO

SECTION II

Chapter 11.0

HOUSING AND POPULATION

See Section II, Chapter 10, Socioeconomics, for a discussion of the consequences to housing and population.

SECTION II

Chapter 12.0

TRAFFIC AND CIRCULATION

12.1 SETTING

Transportation facilities, their location, and accessibility have been, and will continue to be, a major influence in shaping the form of Ridgecrest. In addition to their primary purpose as carriers of people and goods, the City's roads influence the development pattern of the environment by affecting the location of housing, employment, recreation and commercial activity. The economic viability of each land use is dependent upon acceptable levels of access. An inadequate circulation system may cause congestion and pollution, result in losses of time, and possible impacts to health.

By the nature of the function they serve, many of Ridgecrest's roadways cross jurisdictional boundaries. As a consequence, decision-making by the City regarding transportation may involve the State, Kern and San Bernardino Counties, and the Kern Council of Governments, perhaps to the point of conflicting interests. These interests must be resolved by inter-agency cooperation, negotiation, and commitment.

The circulation portion of the Ridgecrest General Plan depicts a roadway system designed to ensure public mobility and access that will meet the needs of the existing and anticipated population of the City. The intent of the Circulation Plan is to preserve a corridor unobstructed by any permanent structure for every future road right-of-way for shown on the Circulation Plan Map.

It is the intent of the City of Ridgecrest to provide for a balanced transportation network that will provide for the safe and efficient movement of goods and people through the planning area. This will be accomplished by the development of roadways consistent with the standards and designations delineated in the Circulation Plan. Also, alternative transportation opportunities will be provided for, such as transit, truck routes, pedestrian routes and bikeways. Finally, pedestrian access is planned to facilitate recreational and leisure uses.

The Ridgecrest Circulation Plan serves to designate those roads in the City that, under state law, constitute the City's select system of major roads. This designation is used to determine the eligibility of roads for improvement with certain specified Highway User Tax Funds. The title "Circulation Plan" used in this plan corresponds to the term "General Master Plan" as used in Section 186.4(3) of the Streets and Highways Code of the State of California.

California Government Code Section 65302(b) specifies that all general plans shall include a circulation plan intended to designate the "location and extent of existing and proposed major thoroughfares, transportation routes, terminals, and other local public utilities and facilities."

Located in Northeastern Kern County, the Ridgecrest and Indian Wells Valley area is included in the jurisdiction of Caltrans District 9, Urban Mass Transportation Administration Region 9, and Federal Highway Administration Region 9. Within the City, there are a total of 136 roadway miles, including secondary State Highways.

Because Ridgecrest is situated in the Northern Mojave Desert and is the major urban area at a confluence of roadways serving the East Sierra Nevadas, the Mojave and Death Valley, it is considered locus, regional center, and gateway to many diverse recreational pleasures. Recreational traffic is a significant and often neglected element of transportation demand that must be served by the Ridgecrest circulation system. As the population of the greater Southern California area increases, more people will seek these recreational opportunities, thus creating additional demand for transportation system improvements, regardless of increases in local development. For this reason, the plan includes elements of the state highway system as well as the local street system, and the interface between the two systems.

12.1.1 Introduction

Principals of Effective Circulation Plans

In order to effectively serve the community, the circulation system must be all of the following: **Comprehensible, Complete, Capable.**

Comprehensible: For a circulation system to work in the true sense of the word "system", it is necessary for the user to understand the intent or function of the various streets in the system. The function of the street, whether it is meant to carry large volumes of traffic for relatively long distances or, at the other end of the scale, to provide access to individual small properties, must be obvious from the design and appearance of the street.

Just as the street system must be comprehensible so that the driver can choose his route within the community, the freeway interchange pattern and arterials must be clear so that people entering or leaving the City will be able to find their way. An arterial system which cannot be understood, one which may have been adequate for a predominately rural area, will restrict access to the City and reduce its potential to achieve its goals. To be clear, interchanges and arterials should provide full service to the surface street system; a driver exiting from a freeway to a street should be able to use the same street to get to a freeway entrance for his return or continued trip. The interchange system must also recognize the City's arterial street system, and should serve as many of the system's components as good design will permit.

Complete: A system of streets theoretically must have facilities which (1) carry large volumes of traffic and provide little or no access to individual property, (2) provide free access to property and carry little traffic, and (3) provide a mixture of these extreme functions. The spacing and total mileage of each type of facility must be properly balanced in order to achieve a high level of traffic service. Those streets intended to carry appreciable volumes of traffic should have continuity without jogs at intersections, smooth alignments (with curves) which will allow reasonable urban speeds, and logical termini so that vehicles can travel through the City in a reasonably direct path. Streets which are not meant to carry through traffic may be discontinuous, such as cul-de-sacs or loop streets, perhaps curvilinear to discourage undesirably high speeds, and where practicable, should not intersect arterial streets so that the possibility of becoming by-pass or relief routes is minimized.

The design of a street system cannot be regarded as complete unless the total journey is considered and accommodated. Adequate access, parking, and goods delivery facilities must be provided at each end of the trip. Such inadequacy of facilities can result in the use of the movement portions of the street for storage or loading; a situation which is inconsistent with the objectives of the plan.

Capable: Each individual component of the total system must be capable of carrying, safely and economically, the traffic volumes which are likely to use the facility. These traffic demands will depend on the types and intensities of land uses which the street serves or connects, and the types of areas through which it passes. In addition, especially for the State Highway system, demands will also reflect increases in population in the Southern California area in general, regardless of local land development. The function of the street and the traffic facilities to which it connects will also influence the demands on the street. All of these factors must be considered in the street's design. The major streets, particularly, because they will constitute the traffic-carrying system, must provide adequate capacity to serve existing and future needs.

Implementation of the General Plan will result in increased demands for all types of transportation. Population increases associated with new housing and employment opportunities will create increased traffic volumes on existing roadways and require the construction of new ones. Also, demands for alternative transportation systems, such as bus and bicycle circulation, will expand with the growing population. Development of the complete transportation system will be required over an extended period.

In order to fulfill the above key elements of the circulation plan, the Circulation Plan Map identifies each of the arterial and collector routes found necessary to support the general plan land uses identified for the City.

This section provides introduction to general concepts used in this report to evaluate potential circulation and traffic system impacts. The components of the circulation system of the City of Ridgecrest, sphere of influence and area of interest include the following: Streets and highways, transit, railroads, parking, bicycle and pedestrian facilities, air transportation. The basic components of the city circulation system are described below.

a. Streets and Highways. A city's circulation system is composed of a wide range of transportation facilities which serve two basic functions: mobility and land access. Mobility means providing the ability for people to travel between their points of interest. Land access means providing access to destination properties which may include parking, driveway access and bicycle storage.

The purpose of the circulation plan is to designate an efficient system of streets and highways which will provide enhanced access routes to the city from other areas, and adequate links between land use elements within the city. Such a plan must complement the land use plan in order to contribute to achievement of the economic, physical, and social goals of the community. Mobility is not an end in itself; it merely makes possible the fullest use of the city's facilities. With these broad criteria in mind, the Plan provides the city with a means of implementing a circulation network which can sustain and develop maximum efficiency, safety and community service.

The street plan provides for concentrations of traffic on a minimum mileage arterial street system, locates the streets in the arterial system to efficiently serve and remain compatible with the land uses of the urban area, provides through the design of the grid system an adequate supply of non-arterial streets.

A circulation plan is typically composed of facilities that emphasize both mobility or access in varying degrees. In Ridgecrest the following types of facilities are defined:

Facility Type	Emphasis (Mobility versus Land Access)
Freeway/Highway	Mobility with no land access and limited access to arterial streets only. State Highways conform to the standards of the California Department of Transportation.
Parkway	Mobility with access to arterials and no land access. Parkways, by design are to be fed arterials and convey major cross town traffic. The parkways may contain linear parks and/or drainage channels and provide Class I Bike Trails. Depending on associative functions Right-of-Way (ROW) may vary from 140' to 200'+.
Major Arterial	Mobility with intermittent access to secondary arterials, other streets and freeways, with minimal direct land access. Arterials form the backbone of the circulation system. As such, they must have logical termini, predicated not only on the existing land-use plan, but also on reasonable possibilities of future expansion. In general, locations and classes of arterials are defined by the existing circulation layout, or for future routes, by topography and by estimated future travel patterns. Where future development may affect the actual location of an arterial, schematic locations are shown. Finally, the class of arterials is dependent upon the volume and nature of traffic expected to utilize these routes. Major Arterial Right-of-Ways (ROW) are not less than 110 feet in width and are characterized by divided directional traffic.
Secondary Arterial	Mobility with access to some local streets and major traffic generating land uses. Secondary Arterials serve to connect major arterials with local and collector streets providing access to the various land uses. Thus, while serving this intermediate function, they also provide some albeit minimized access directly. The designation of streets as secondary arterials is an important portion of the circulation element, since secondary arterials form an integrated component of the overall transportation network. It is important for safety purposes and cost of section, however, to avoid mixing traffic from residential development with industrial and commercial traffic on collector or local streets. Secondary Arterial ROW are not less than 90 feet wide.
Collector	Streets with a significant focus on access in which the mobility function is intermediary, collecting and funneling local street traffic to arterials. Collector streets ROW are not less than 64 feet wide.

Local The ultimate purpose of local streets is in their access to adjacent land use; the primary function of local streets, whether in commercial, industrial, or residential land use areas, is to provide access to adjacent properties, and to feed this traffic to collector or arterial streets that extend mobility. Local and Cul-de-Sac streets ROW are not less than 60 feet wide.

Circulation systems are designed with the above hierarchy of streets largely as a means of achieving the goals of mobility and access in an efficient manner. While it might be desirable to provide both access and mobility on all facilities, no one would favor arterial street standards for all facilities in a circulation system. The designation of street types has functional, safety, and economic value to a community.

b. Regional Access. Regional and Inter-regional access for the City of Ridgecrest is provided by a system of freeways, highways and local arterials. Highways 395 and 14 provide south and west linkage to Lancaster/Palmdale, Bakersfield and San Bernardino, and the Los Angeles Metropolitan Region. Northward they link Ridgecrest with Bishop, Mammoth, The Sierra Nevadas, Lake Tahoe and Reno. Highway 178 passing through Ridgecrest provides an important primary arterial and scenic linkage to Bakersfield to the west and Death Valley and Las Vegas to the East.

12.2 BASE CIRCULATION AND TRAFFIC SYSTEM

a. Freeways/Highways: The Indian Wells Valley and City of Ridgecrest are served by three state highway facilities: Highways 14, 395, and 178. Highways 14 and 395, primarily 2 lane highways within the Indian Wells Valley are identified by CalTrans Route Concept Reports as future 4-lane freeway Level of Service (LOS) "C" facilities. Highway 14 and 395 to the west are linked to Ridgecrest via Highway 178 which is planned as a four lane facility with interchanges at each juncture. Additional interchanges are planned for Highway 395 at Bowman road and at South China Lake Boulevard. The Route Concept Report for Highway 178 (RCR 178) states that the roadway segment from Highway 14 to Highway 395 is projected to deteriorate to a LOS of E by the year 2010 due to right-of-way constraints that could potentially make widening to 4 lanes through the Village of Inyokern infeasible. The Kern County Inyokern Specific Plan recommends developing alternate routes and relocation of 178. RCR 178 identifies Bowman Road as a roadway that, if extended to meet 178 West at Highway 14, could divert a significant amount of through traffic, and by serving as the major East/West traffic carrier in the valley make widening of 178 through Inyokern unnecessary. An additional proposed rerouting of 178 would have it circle Inyokern to the North and join existing 178 west of the Inyokern Airport. From the Route 395 junction through Ridgecrest, 178 (Inyokern Road, North China Lake Blvd. and East Ridgecrest Blvd) is planned as a 4-lane urban arterial and will require operational improvements, dividers, signal phasing, turn lanes, transportation demand management programs, and transit facilities if it is to maintain a LOS of "D" through the year 2010. The development of alternative east-west routes off loading traffic from 178 is critical to maintaining a viable LOS.

b. Principal East/West Streets: Inyokern Road (highway 178) is a major 4-lane arterial at the northern City limits and serves as the City's Northwestern Gateway. As the lands to the North of Inyokern Road are under federal ownership and are not anticipated to develop, traffic on Inyokern will increase in response to background traffic from development to the south, regional traffic, and Naval Station activity for which Inyokern Road serves as the main entry. Current LOS is low "C" or "D" due to speed restrictions and is planned to remain at LOS D through traffic control and management programs.

Bowman Road is planned to develop as a major divided parkway and contain bike trails and a linear park with channels conveying the Valleys major storm drainage along its length. As it will be the major east/west roadway bisecting the City at its future center, it is slated to become the major transportation corridor of the community and will be characterized by limited private access. The road will ultimately connect to Highways 14 and 178 to the west, intersect with Highway 395 at a future interchange, cross the City at the center of its north-south axis, link to the commercial center of China Lake Boulevard, and convey traffic to and from Highway 178 East and the Naval Station at Richmond Road. As such it is planned as the major east west thoroughfare of the Indian Wells Valley.

Drummond, Ridgecrest, Springer, and Javis are planned as Major Arterials their full length across the Indian Wells Valley; due to right-of-way constraints West Ridgecrest Boulevard is planned as a Secondary Arterial with a special design section in the segment between China Lake Boulevard and Downs Street, and East Ridgecrest Boulevard is Highway 178 East of China Lake Boulevard; from the college grid Javis follows contours to China Lake Boulevard but schematically continues along the gridline to the West of China Lake, perhaps at Laura Avenue.

Ward, Las Flores, Upjohn, Dolphin and Kendall are Secondary Arterials placed at the half-section line and extended schematically across the Indian Wells Valley. Pilot Plant Road, Knox Road, and Inyokern Road within the Military Reservation are important China Lake Naval Station transportation corridors limited to Department of Defense traffic and not part of the City's street system.

c. Principal North/South Streets: Major Arterials are San Bernardino (County Line) Road, Gateway Blvd, Richmond Blvd. between Bowman and Highway 178, College Heights Blvd, China Lake Blvd, Downs Street, Brady Street, Jack Ranch Road, and further west and schematically along section lines, Herbert Street, Calvert Boulevard and Victor

Street. Brown Road (Old Highway 395 also known as Inyokern-Randsburg Road) intersects with Highway 395 at South China Lake Boulevard and proceeds Northwesterly toward the village of Inyokern.

Secondary Arterials are Olema, Lumill, Sunland, Norma, Mahan, and Primavera Streets.

d. Other Roadways: Pilot Plant Road, Knox Road, and Inyokern and Richmond Roads within the Military Reservation are important China Lake Naval Station transportation corridors limited to Department of Defense traffic and not part of the City's street system.

e. Bikeways and Pedestrian Facilities: The Circulation Plan is based on the assumption that Ridgecrest residents desire to retain the same level of mobility that exists today, and only reasonable changes in the transportation system will be acceptable. One method of anticipating acceptable change in transportation systems involves the development of alternative transportation systems. Alternative forms of transit are those systems that benefit the environment and consider lifestyle. Given these factors, bicycle and pedestrian oriented activities are emphasized in this section.

The City has implemented a bicycle circulation system that encourages bicycling as a community activity for both transportation and recreation. As part of its adopted general plan circulation element, the City has prepared a bikeway master plan. Other activities that may promoted bicycling include expansion of downtown bicycle parking facilities and the installation of roadway hardware that enables bicycles to activate traffic signals.

Surveys indicate that the bicycle represents a viable alternative to the automobile, particularly for the short work trips that dominate Indian Wells Valley travel. Clearly, bicycling to work is not an option available to everyone, but expansion of this travel mode can be achieved by reducing the barriers to bicycle use.

Walking to work, shopping and recreational sites promotes direct interface with the physical environment as well as ecologically benefiting the community. Well-maintained sidewalks, trails and other street improvements, as well as pedestrian-oriented design standards, encourage pedestrian transportation.

f. Public Transportation: Public transit is an integral part of a well-balanced transportation system. To be effective, public transit systems must be integrated into land use plans to provide mobility to the target population of the particular public transit program. In addition, the circulation system must provide viable routes within residential areas to maximize availability of transit stops within reasonable walking distances. Public transit systems can provide cost effective alternatives to automobile fuel costs and to street and highway congestion. Other benefits of the effective utilization of public transit include reductions in air pollution and automobile accidents.

The infirm elderly, handicapped and youth can rely heavily on bus and demand response public transit programs. Commuters can benefit from fixed route and ridesharing transportation programs.

The City managed Ridgecrest Area Transit System (RATS) currently operates as a demand responsive (dial-a-ride/doorstep to doorstep) service to residents of the City and our sphere of influence. It also provides six fixed scheduled trips per day to the Cerro Coso College campus when classes are in session. The transit system carries approximately 35,000 per year. It also contractually, in cooperation with Kern County, provides services to the outlying villages of Inyokern, Johannesburg and Randsburg on a limited basis. With the growing population of the City there may be a developing need for a fixed route system, development of which could additionally aid in emission reduction and compliance with the California Clean Air Act. The American with Disabilities Act (ADA) provides that a para-transit system must be available as a complimentary equivalent to those eligible special case riders who are unable to utilize a fixed route bus service.

Current funding for the City of Ridgecrest transit is predominantly subsidized and governmental based and derives from the City's General Fund, KernCOG, Kern County contracts, and grants and entitlements through the Transportation Development Act (TDA), State Transit Assistance (STA), and with less than 10% of the cost paid by the ridership. Federal Transit Administration (FTA) funds are only made available to communities with populations of more than 50,000 although Ridgecrest derives some section 18 funds from this source.

An analysis, City of Ridgecrest Transit Development Plan, FY 1992/93 - 1996/97, of RATS current usage indicates a demand rate of 100 to 120 boardings per day and that fixed route alternatives to the demand-response system should be reviewed for effectiveness and economy when ridership exceeds 200 per day. In the interim the analysis has recommended systems efficiency improvements, datum collecting and the basis of a long range transit development plan. Long term the study identifies the implementation of a fixed-route service with a supplemental demand response service for the infirm elderly and the handicapped as being the most cost effective transit system.

Through the creation and implementation of a comprehensive Transit Development Plan the City can begin to analyze such issues as: what population size to implement a fixed route system; efficient routes; best route to serve the highest density of the population; additional right-of-way requirements; bus stop locations; number and types of buses needed to serve the community, special population transportation needs, and other transit related issues.

12.3 TRAFFIC AND CIRCULATION SYSTEM COMPONENTS

a. Road Network System The City of Ridgecrest's and the Indian Wells Valley's Land Uses, historically, because of the flatness of the valley floor and ancient lake bed, have developed within USGS Township and Section lines. Thus land uses and ownerships, have developed in geometrical and proportional symmetry. The Kern County and City circulation systems follow this geometrical grid, and the traffic system, a true "grid system," continues this pattern throughout much of the valley except where the foothills and other land forms and geographical features require adaption to contour.

With the exception of Highways 395 and 14, there are few land uses in the valley that are not design responsive to the grid.

The grid system has enabled the development of a street system in which roadways, laid on section lines, have developed as major arterials, half sections as secondary arterials; this pervasive pattern enables local streets considerable access to the mobility offered by the arterials and by diffusing traffic to numerous convenient arterials, has been advantageous to the City in avoiding the congestion other communities have encountered. The circulation element continues and reaffirms the value of the valley's transportation network. The circulation element extends the grid through the sphere of influence and Ridgecrest area of interest schematically; the final placement of the future road system will be contingent on topography and drainage, right-of way surveys, order of development and other determinations.

Certain locations in the community, due to the intensity of the adjacent land uses, such as China Lake Boulevard's Commercial District,and Inyokern Road's China Lake Naval Station Gate area, where the roadways serve as both arterial and destination facilities (mobility and access) experience some deterioration in level of service. Efforts by the City and CalTrans to signalize the flow, and projects by the Navy to provide storage at the NAWS access gates and to institute TSM programs such as staggered shifts have had beneficial results.

b. Intersection Operations, Traffic Volumes and Levels of Service Roadways on which traffic count information was available were analyzed relative to their volume/capacity ratios and the level of service of traffic operation. The technical appendix, "Existing Traffic Volumes," contains traffic volumes for the various streets in the City.

The term "**level of service**" is used to describe the quality or ease of traffic movement for operating conditions that may occur on a roadway or intersection as it accommodates various traffic volumes. Level of service provides an overall qualitative measure of the effect of a range of factors, which include speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. (1) There are six levels of service, "A" through "F", that relate to driving conditions. This technique is the standard method for identifying street deficiencies, and reflects the capacity of the street sections to accommodate traffic volumes (volume/capacity ratio). The characteristics of traffic flow on a roadway for these various levels of service are summarized in Table 12-1

Obviously, level of service is a qualitative description based on traffic flow at any given time. Traffic flows vary by time of day, with the P.M. peak hour usually representing

Although "Level of Service" (LOS) was originally intended as a measure of the type of operation over a distance, it has been recognized that intersections are the primary restrictors of capacity on urban arterials, and that the originally defined values of speed versus distance did not apply to point locations. Since LOS is described in terms of driver satisfaction, LOS for intersections is now usually related to congestion or delay. Intersection service levels are now commonly calculated by the Critical Movement Analysis Method developed by the Transportation Research Board which relates the sum of existing or expected to a maximum value in order to determine a volume/capacity (V/C) ratio and corresponding service level. the method provides an acceptably accurate measure of intersection performance, provided it is remembered that overall route LOS may be affected by other conditions (visibility, approach versus no approach parking) in addition to intersection performance. (See Tables 12-2 and 12-3)

12.4 CAPACITY EVALUATIONS FOR EXISTING ROADWAYS

Capacities of existing Roadways to accommodate traffic is considered good, with the exception of A.M. and P.M. peak demand periods when employment related commuter traffic is at its highest the majority of the City's roadways are level of service A and B.

12.5 IMPACT ANALYSIS

12.5.1 Project Impacts

The Circulation Master Plan (Figure 12-1) establishes the location and extent of major thoroughfares in the City. Major objectives of the plan include coordinating access routes to the delivery of traffic to the Naval Station, concentrating through traffic on arterial and collector

TABLE 12-1

Level of Service (LOS Descriptions

LOS	DESCRIPTION
A	Free flow conditions Low volumes Unrestricted operating speeds Uninterrupted flow No restriction on maneuverability Little or no delay
B	Stable flow condition, little delay Operating speeds beginning to be restricted Design level for rural conditions
C	Stable flow but speed and maneuverability slowed Low to moderate delay, Full use of peak direction signal phase(s) Satisfactory operating speeds for urban conditions Restricted by higher traffic volumes
D	Approaching unstable flow Moderate to heavy delay Tolerable speeds maintained, delays at signals Temporary restrictions Little freedom to maneuver
E	Low operating speed Significant delays, signal time deficiencies Volumes at or near capacity Unstable flow Congestion exists for extended duration through peak period Momentary stoppages, extensive delay at signals
F	Forced flow conditions Very low speeds, traffic volumes exceed capacity Frequent stoppages for short or long periods because of downstream congestion

TABLE 12-2

Intersection Level of Service Ranges
Level of Service by V/C Ratio and Delay Range

LOS	V/C Ratio	Delay Range (Seconds per Vehicle)
A	0.00 - 0.60	00.0 -16.0
B	0.61 - 0.70	16.1 - 22.0
C	0.71 - 0.80	22.0 - 28.0
D	0.81 - 0.90	28.0 - 35.0
E*	0.91 - 1.00	35.0 - 40.0 *Capacity
F	variable	40.1 or greater

TABLE 12-2

Intersection Level of Service Ranges
LOS - Maximum Sum of Critical Lane Volumes, by Signal Phasing Type

LOS	Two Phase	Three Phase	Four or More Phases
A	0960	0910	0880
B	1120	1060	1030
C	1280	1210	1180
D	1440	1370	1320
E	1600	1520	1470
F	Not Applicable	Not Applicable	Not Applicable

roads, developing a computer model suitable for circulation analysis, and coordinating land use and circulation planning to reduce vehicular traffic.

12.5 IMPACT ANALYSIS

12.5.1 Project Impacts

The Circulation Master Plan (Figure 12-1) establishes the location and extent of major thoroughfares in the City. Major objectives of the plan include coordinating access routes to the delivery of traffic to the Naval Station, concentrating through traffic on arterial and collector roads, developing a computer model suitable for circulation analysis, and coordinating land use and circulation planning to reduce vehicular traffic.

The plan shows the location of existing and future arterial, collector and rural collector roads and existing local streets. Arterial and collector roads provide safe and efficient movement between major employment destinations and residential neighborhoods. Rural collectors give access to less populated rural and urban fringe areas. Major Arterial roads are generally located at one-mile intervals along section lines, and Secondary Arterial roads along quarter-section lines. Because of their spacing and function, arterial roads tend to define individual neighborhoods within the City.

The proposed changes to the City of Ridgecrest General Plan Circulation Element, and the impacts thereof, are listed and discussed in this section. These revisions are minor and consist of clarifications in roadway designations, alignments, schematic alignments, freeway access, public transportation, truck routes, bicycle and pedestrian routes, levels of service, and financial impacts.

The Environmental Impact Report has assumed for purposes of extrapolation that future transportation growth will occur proportionate to the existing Land Uses and circulation system of the Valley. Unanticipated large scale single focus development that may intensify and localize traffic impact has remained outside the scope of this report, although the circulation system as planned will have significant carrying capacity. The Naval Station continues to provide the nation with an essential and important defense mission and future activity or timing of activity at the station cannot be reasonably anticipated. Expansion of the station as a Department of Defense Research and Development Center or as a consolidated single service multi-mission or multi-service facility involved in training, development, and readiness is a distinct future possibility. Should such development occur close cooperation and planning between the City and the NAWS will be essential.

The proposed improvements to the circulation system are expected to provide a significant beneficial impact to the Ridgecrest transportation and circulation system. However, significant adverse impacts related to road realignments and freeway access may occur as a result of the General Plan implementation and these are discussed later under "Changes in Roadway

Alignments" and "Freeway Access" in this section. In addition, implementation of the Circulation Element could create significant financial impacts upon the City, as discussed below. The proposal will result in improvements in existing Levels of Service (LOS). In general, the proposed circulation changes are a means to alleviate existing congestion and circulation inefficiencies and a means to accommodate traffic needs for land uses designated in the General Plan.

a. Changes in Roadway Designations: The Circulation Plan continues the traditional grid development system of Primary Arterials on section lines and Secondary Arterials on Quarter Sections, there are no changes proposed to this system.

b. Changes in Roadway Alignments: Bowman Road as per the City and County Plans is to be transitioned at Highway 14 so as to connect directly to the Highway 178. South Norma and West Javis Roads will require special alignment plans at South China Lake Boulevard due to topography and existing development.

c. Schematic Alignments in Areas Outside Present Development: Freeway interchanges are proposed for Bowman and Highway 14 and for Bowman, Ridgecrest, and South China lake Boulevard on Highway 395 as delineated in the County's Circulation Element.

d. Public Transportation: Private companies provide intercity service linking Ridgecrest to other metropolitan areas. The City of Ridgecrest Area Transit System (RATS) provides local demand responsive service through a dial-a-ride program. The Transit Development Plan states that fixed route alternatives and methods of operations need to be reevaluated when ridership exceeds 200.

e. Air Access: The City of Ridgecrest is part of the Indian Wells Valley Airport District and is served by Inyokern Airport, a General Transport and Aviation Airport with air taxi carrier and commuter services. The facility provides the valley with scheduled airline service to the Los Angeles Basin and other areas as well as providing general aviation needs for personal, business and recreational flying. There are several fixed-base operators providing a variety of aviation and transportation related services.

Existing facilities consist of three runways, the longest of which is 7,344 foot runway 15-33. This runway and Runways 2-20 and 10-28 are equipped with medium intensity runway lights (MIRL). There are visual approach slope indicators (VASI) for Runways 20 and 33. There are displaced thresholds on both ends of Runway 15-33 and Runway 20. In 1990, 88 aircraft were based at the airport, with 17,707 passenger emplanements and 16,188 total operations. The District has recently completed an airport master plan that provides for expansion and development of services and delineates uses, noise zones, hazards, and prevents encroachment from and conflicts with incompatible land uses.

Ridgecrest and the Indian Wells Valley is also the location of the Military Aviation Facilities of the China Lake Naval Air Weapons Station and located in the restricted air space R-2508 complex, used for the advancement of weapons systems technology and tactical training. Due to the nature of the speeds, maneuvers and operations within this 110 mile wide and 140 mile long zone (1600 square miles covering portions of Inyo, Kern, Los Angeles, Tulare, San Bernardino counties and the state of Nevada) flight hazards exist for non-military aircraft and flight restrictions (time, locations, altitude) have been in effect since 1955 to provide for public safety and the protection of military activities. This area is also utilized by Edwards Air Force Base, Fort Irwin, and other military installations.

f. Truck Routes: Inyokern Road, China Lake Boulevard, Bowman Road, Jacks Ranch Road, San Bernardino County Line Road, Richmond Road between Bowman and Ridgecrest Blvd., Drummond between Downs and French, Norma and Downs between Inyokern and Drummond, Graaf and Ward between Downs and Jack Ranch Road, and Mahan, Brady and Primavera between Inyokern Road and Ward are the primary truck routes within the community. Additionally RTE 178 is included in the SHELL (Subsystem of Highways for the movement of Extra Legal Permit Loads) system and these trucks are allowed only on Inyokern Rd. to and from the NAWS.

g. Bike Routes and Pedestrian Walkways: Bike Routes and Pedestrian Ways are planned integrally with the street system. Class II Bikeways are provided on major arterials.

h. Level of Service (LOS): Overall, the proposed circulation improvements to the system will have a beneficial impact by maintaining acceptable levels of service as traffic increases due to buildout of the General Plan. If the improvements were not constructed and buildout occurred, many arterial streets and intersections could operate at LOS C, D, E, or F.

i. Finance: Circulation and Infrastructure needs are typically granted high priority in the Ridgecrest's capital budgets. Nevertheless funds are ultimately limited, and there is a long list of competing projects with high levels of need and community support. The City must look to creative financing for obtaining needed rights-of-way, intersection improvements and infrastructure development.

Historically, the State and Federal gasoline tax has been the major funding source for street and highway construction. This source has not kept up with inflation as the gas tax was at fixed rate rather than proportional to the price per gallon. As a consequence of inflation, national, state, and local street and highway infrastructure has not developed at the pace of traffic increases, and communities left to their own devices have sought creative methods for financing facilities adequate to the demand. Frequently communities have deferred needed routine maintenance only to face expensive roadbed reconstruction in the future.

The City of Ridgecrest has implemented the use of a Pavement Management System to prioritize street maintenance projects. This program utilizes an inventory of streets and their age and condition to identify when and how capital maintenance should be applied to maintain the street system. The program recognizes that the life of a roadway depreciates and that initially minor intervention and investment through applications of sealants, thin overlays, etc. can resulting in cost effective restoration. This is a sound alternative to fully depreciating and reconstructing streets at a 100% of their cost, however, the initial years of these programs requires considerable expenditure and an understanding and commitment by the elected.

Increasingly local agencies are relying on "user fees" to offset some of the funding needs for capital improvements. These fees are based on a measure of development impacts creating the need for infrastructure improvements. In the case of a circulation system, such fees are usually related to the traffic which will be add to the street system by a development. While these fees cannot fund all of the improvements which will be necessitated by buildout of the General Plan, they can be applied to those projects which are considered high priority items and which are directly related (nexus) to traffic increases brought on by new development.

Implementation of the Circulation Element improvements could require extensive funding, and could place an extensive burden upon the City. Unless appropriate funding mechanisms are established to assist the City in financing these improvements in conjunction with the creation of a priority rating system to allocate available implementation funding, required circulation improvements could result in significantly adverse fiscal impacts upon the City. The actual distribution of resources and activities also depends upon the availability of funding. Consequently, improvement of streets should be coordinated with development exactions and dedications, capital improvement funds, Ridgecrest Redevelopment Agency (RRA), Transportation Development Act funds (TDA), Community Development Block Grant (CDBG) funds and other revenue sources to optimize the results of street improvement expenditures.

The City should consider all possible alternative means of funding capital improvements needed to meet the circulation needs of the General Plan.

j. Summary: It should be noted that in the absence of roadway improvements identified in the Circulation Element, Levels of Service on area intersections and roadways would be anticipated to degrade to unacceptable levels as future local and regional development occurs. Therefore, build-out of the General Plan without implementation of the Circulation Element and mitigation measures could result in significant traffic and circulation impacts. The Circulation Element and its continuing consistency with the Land Use Element is understood to be a mitigation.

12.5.2 Significance Thresholds

Any Development that will reduce roadway and intersection LOS below "D" will be considered significant by the City, County and KernCOG.

12.5.3 Impacts of Development Alternatives

a. Alternatives 1 and 2: The impacts associated with alternatives 1 and 2 can be provided for within the existing street system and through continuation of the grid system described herein without significant impact.

b. Alternative 3: The impacts associated with a city population of 100,000 persons would in all likelihood require a redesign and realignment of the roadway systems of the Valley, potentially resulting in displacement and displacement of housing, businesses, and redesignation of land uses. Alternative 3 is considered to be a significant impact.

c. No Project Alternative (Alternative 4) The no project alternative is similar to alternative 1 and 2 as the potential for populations of 50,000 to 75,000 lie within the capacity of the existing General Plan.

12.6 MITIGATION MEASURES

The following mitigation measures should be implemented and utilized to expand the existing transportation system, to accommodate existing un-met needs, and to guide and provide for future improvements to circulation within the City of Ridgecrest and the Indian Wells Valley:

1. The City shall implement the circulation plan established in the circulation element of the general plan, which provides for a number of roadway extensions and/or improvements designed to accommodate projected traffic volumes. This circulation plan also sets forth a variety of programs and policies to ensure the adequacy of the circulation system.

2. The City shall explore and support the development of public improvement funding sources to upgrade and improve existing roadways and sidewalks to provide safe and convenient traffic and pedestrian flow and the implementation of the Circulation Element. These potential sources shall include transportation sales tax measures, development impact fees, development exactions, redevelopment agency tax increments, block grant funds, special assessment (area of benefit) districts and other sources that may cost effectively contribute to transportation improvements.

3. The City shall support the provision of, by RATS and others, economical, effective increased mobility for the community through a variety of public transit modes and schedules.

4. The City shall ensure that adequate parking is provided for each new development through the development review process.

5. Ridgecrest shall require paved gutters and storm drain channelization in existing and future roadways, as appropriate.

6. The City shall promote and institute standard infrastructure designs for new development while providing alternative standards and traffic configurations consistent with existing neighborhood character and design within established practices of public safety and the goals of the circulation element.

7. The City shall maintain a cooperative working relationship with all agencies that have jurisdiction over the transportation facilities in the planning area to maximize the service capacities of existing roadways, intersections and transportation systems, thus allowing full coordination of future improvements.

8. The City shall establish a street improvement program and utilizing its pavement management program assign improvement priorities identified by the circulation element within the limits of available funds and schedule necessary improvements based upon these priorities. Urban development shall be phased in accordance with established priorities, finance and service capabilities, and standards.

9. The City shall, through the institution of traffic impact fees addressing local and system wide impacts, and exactions and dedications, ensure that costs of traffic, transportation, circulation, and road improvements made necessary by new development be borne by the developer.

10. The City shall institute as necessary, transportation development fees (Traffic Impact Fees, Road and Thoroughfare Improvement Fees, Signal Lighting Fees, Parking, Transit Fees) reflecting the relationship between the type of development and its associated community

wide impacts, and the need for and cost of maintenance, development and improvement of the City's public infrastructure and transportation system.

11. The City shall form and institute where appropriate, assessment districts and benefit districts so as to authorize and provide bond issues serving areas that benefit from improved transportation systems, services and maintenance.

12. The City shall consider supporting local measures and elections for increased sales or gasoline taxes used for transportation purposes.

13. The City through development review shall encourage private sector employers to prepare and implement transportation systems management plans to achieve a reduction in generated trips.

14. The City shall promote and encourage ridesharing (i.e. carpools, vanpools, etc.) and public transit for residential areas through homeowners associations and through education programs.

15. The City shall ensure that plans for improvements within or adjacent to environmentally Sensitive Habitats and resource areas are coordinated with resource specialists and appropriate agencies to maximize to the extent feasible the enhancement of habitats and resources.

16. The City, to maintain priority land uses, shall ensure that important resource lands identified as needed for transportation improvements in the circulation element are not converted to urban uses until development and circulation need is imminent.

17. The City shall encourage and promote public transit, bicycling, walking and other alternatives to the automobile.

18. The City shall develop a traffic modeling program to maintain and monitor traffic volumes and levels of service on roadways to facilitate the identification of singular, incremental, and cumulative impacts for maintenance and improvement of the acceptable minimum levels of service specified in the circulation element. this traffic modeling program shall be coordinated with the KernCOG, CalTrans, and other transportation agencies.

19. The City shall, as necessary, require professional traffic studies in conjunction with the City's review process for development proposals. Such studies shall provide an analysis of a project's potential impact upon the City's circulation system and shall recommend mitigation measures as appropriate. These studies shall be required whenever it is determined that daily

or peak hour traffic generated by a proposal may have an adverse effect on the City's circulation system.

20. The City shall develop and implement parking district plans to ensure that an adequate amount of private and public parking is provided to meet the needs of residents and visitors.

21. The City, to mitigate the removal of residences which may result from public improvements, shall take all reasonable efforts to relocate displaced persons to suitable locations. Relocation activity shall be conducted in compliance with California Relocation Assistance Law (Govt. Code section 7260 et seq.) and state guidelines.

12.7 REGIONAL ANALYSIS

The Kern Council of Governments (KernCOG) acts in the capacity as the Regional Transportation Planning Agency (RTPA) for Kern County. Its membership consists of representatives from each of the incorporated cities and from the County. The RTPA is charged with the preparation of two federally mandated plans: the Regional Transportation Plan (RTP) and the Transportation Systems Management Plan (TSM).

The KernCOG is receives analysis and recommendations from a Technical Advisory Committee (TAC) that consists of professionals representing CalTrans Districts 6 and 9, County Public Works, Planning and other Departments and professional representatives of each incorporated City in the county.

The RTIP is prepared by KernCOG staff with input from the TAC, and once adopted becomes the basis for local input into the State Transportation Improvement Plan and subsequent allocation of transportation improvement funds. The Plan identifies on a regional basis transportation needs and allocates priority status to each of the member agencies projects.

KernCOG also serves as the Congestion Management Agency for Kern County and, through cooperation with member agencies, has prepared and adopted a congestion management plan for the County. The Federal/State mandated plan identifies local transportation corridors of regional significance and value and establishes interagency means of effecting planned improvements that will prevent these corridors from becoming congested. Highways 14 and 395, Inyokern Road and East Ridgecrest Boulevard (Highway 178), and North and South China Lake Boulevard linking 395 and 178 have been designated as routes of regional significance in the Congestion Management Plan. The Congestion Management identifies Level of Service (LOS) E as the minimum acceptable traffic level for transportation in the Kern Region.

The City of Ridgecrest Circulation Element is consistent with this plan and with the Route Concept Plans prepared by CalTrans District 9. Through traffic on the Ridgecrest Planning Area Corridors has grown by 3 percent per annum and the City's plan to improve those corridors proposes a minimal LOS of D for Highway 178 on Inyokern, North China Lake and Ridgecrest Boulevards. The Current LOS is "D" due to speed restrictions and is planned to remain at LOS D through traffic control and management programs that include synchronized signalization, dividers, transit, and rerouting of traffic.

Bowman Road is planned to develop as a major divided park way and contain bike trails and a linear park element along its length. As it will be the major east/west roadway bisecting the City at its future center, it is slated to become the major transportation corridor of the community and will be characterized by limited private access. The street ultimately will connect to Highways 14 and 178 to the west, intersect with Highway 395 at a future interchange, cross the City at the center of its north-south axis, link to the commercial center of China Lake Boulevard, and convey traffic to and from Highway 178 East and the areas major employer the Naval Station at Richmond Road. As such it is planned as the major east west thoroughfare of the Indian Wells Valley and will reroute and displace a significant amount of commuter and through traffic from business route 178. The development of Bowman Road as an alternate route 178 may improve traffic on route 178 to LOS C.

As stated previously the City's circulation element is consistent with the State and Regional Plan and it's implementation should be regarded as a mitigation for regional and local transportation constraints.

SECTION II

Chapter 13.0

AIR QUALITY

The following is based on the "Kern County Air Quality Attainment Plan (AQAP) for the Southeast Desert Air Basin" adopted June 25, 1991, amended and readopted June 8, 1992 and the "PM-10 State Implementation Plan (SIP) for the Searles Valley Planning Area" (adopted December 6, 1991. The two plans were adopted by the Kern County Board of Supervisors and are administered by the Kern County Air Pollution Control District (KCAPCD). These plans are hereby incorporated by reference and are available for review at the Community Development Department at 100 W. California Avenue, Ridgecrest, California.

13.1 SETTING

13.1.1 Air Pollutants of Concern

a. Ozone. The air pollutants of most concern in Ridgecrest and its sphere of influence are ozone and particulate matter. Ozone (03~, the primary constituent of smog, is formed through a complex series of chemical reactions consisting of reactions involving reactive organic compounds (ROC), nitrogen oxides (NOx), and sunlight. Daily maximum ozone levels require several hours to form. The rate of formation depends principally on ambient temperature, sunlight intensity, and the kinds and quantities of ozone precursor emissions (reactive organic compounds and nitrogen oxides) involved. Peak daily ozone levels normally occur in the early afternoon hours. The sources of reactive organic compounds are listed in Table 13-1.

Significant health effects have been documented at ozone concentrations above the national standard of 0.12 parts per million (ppm), including changes in lung function, aggravation of chronic cardiopulmonary disease symptoms, increased asthma attacks, and decreased physical performance levels during strenuous activities. These effects are more severe under conditions of long exposure and higher levels of ozone. Harmful effects on vegetation have been documented at concentrations below the national ozone standard.

Visible symptoms of leaf damage have been the principal means of identifying the effects; however, yield reduction, leaf drop, suppression of fruit development and the degradation of crop quality can also occur. According to a recent report prepared by the California Air Resources Board, ozone causes more than $300 million worth of annual crop losses in California.

TABLE 13-1

Sources of Pollutants*
Southeast Desert Portion of Kern County

Nitrogen Oxides	Reactive Organic Gases
Mineral Processes..........34.2%	Solvent Use...............17.5%
Other Stationary Sources...10.3%	Pesticide Application.....22.0%
On-Road Vehicles...........36.5%	Stationary Sources..12.5%
Other Mobile Sources.......19.0%	On-Road Vehicles..........27.7%
Transport......................?	Other Mobile Sources......20.3%
Transport......................?	

Ozone

Transport.......................?

*Source: AQAP for the Southeast Desert Kern County

b. Particulate Matter. Atmospheric particulate matter is composed of finely divided soils or liquids such as soot, dust, aerosols, fumes, and mists. The particulates of greatest concern are those less than 10 microns (PM_{10}) in diameter, which have the greatest likelihood of being inhaled deep into the lungs. Particulate matter is generated by a variety of human activities, including agricultural operations, industrial processes, combustion of fossil fuels, construction and demolition operations, and dispersal of road dust into the atmosphere. Natural sources of particulate matter include wind blown dust, sea spray, wildfires, soot, and mineral particles.

13.1.2 Regional Meteorology

The meteorology in the Indian Wells Valley is predominantly influenced by its high desert location. The climate is characterized by hot days and cool nights, with extreme arid conditions prevailing throughout the summer months. The mean annual temperature for the Ridgecrest area is 65° F. There are wide annual temperature fluctuations that occur from a maximum of 117° F to a minimum of 6° to 8° F. (Engineering-Science, 1986)

Strong surface winds occur in late winter and spring as cold fronts move rapidly through the area. These fronts occasionally cause severe dust and sand storms. Strong surface winds with a prevailing speed of 15 knots or greater can be expected 15 days a year and strong gusts of 40 knots or greater can be expected 10 days a year. On about 4 of these windy days the visibility will be reduced to less than 7 miles by blowing dust or alkali.

Average annual precipitation in the Ridgecrest area is reported at less than 3 inches, while the relative humidity throughout the year averages 35 percent.. Because temperatures rarely fall below freezing, snowfall is insignificant. (Engineering-Science, 1986)

Air routinely flows into the Indian Wells Valley through low mountain passes. Air circulates in from the San Joaquin Valley via Red Rock Canyon, Walker Pass and possibly Tehachapi Pass. To the northwest, air from Owens Valley flows through the gap at Little Lake. From the east, air comes into the Valley through Burro Canyon and from the southeast, through the gap between Argus and El Paso Ranges.

a. Air Pollution Transport From San Joaquin Valley Air Basin to the Southeast Desert Air Basin. The climate and topography of the San Joaquin Valley Air Basin is well defined. During the summer, air frequently enters the San Joaquin Valley (SJV) from the San Francisco Bay area and flows in a southeasterly direction down the valley, and moves through the Tehachapi Pass onto the Mojave Desert. This air movement carries with it air pollutants that are transported into the Southeast Desert Air Basin (SEDAB). (See Figure 13-1)

A California Air Resources Board (CARB) staff report used information from a 1978-79 field study which investigated the origin and fate of airborne pollutants in the SJV. This study reported:

- the primary transport route out of the SJV is over the Tehachapi mountains and this transport of pollutants does contribute to the pollutant burden in the Mojave Desert; and

- o increased growth in the southern part of the SJV will impact the Mojave Desert.

Tracer experiments from the study showed:

- o the northern Mojave Desert is impacted by airborne pollutants from the southern SJV during summer meteorological conditions; and

- o the south end of the Sierras between Lake Isabella and Tehachapi are not of significant elevation to pose a barrier to transport of air pollutants from the SJV to the SED

CARB staff concluded that ozone transport occurs from the upwind area of the SJV to the downwind area of the SED and, therefore, identified this as a transport couple.

In preparing for the transport assessment regulation, California Air Resources Board (CARB) staff reviewed past studies and analysis of available air quality and meteorological data from 1986 through 1989. From this work, staff concluded the contribution of SJVAB emissions to exceedences of the state ozone standard in the SEDAB is both overwhelming and inconsequential. An "inconsequential classification" in this case indicates some exceedences without significant transport from the SJVAB.

The overwhelming classification required the SJVAB to develop control strategies to abate the impact of transported pollutants on the SEDAB. 70600, Title 17, of the California Code of Regulations contains specific language with respect to the SJVAB and the mitigation requirements for the SEDAB.

b. Air Pollution Transport From South Coast Air Basin to the Southeast Desert Air Basin. Numerous studies have been conducted which establish the transport couple of the impact of the South Coast Air Basin (SCAB) on the SEDAB, as identified in the California Code of Regulations, Title 17, 70500. CARB staff based their analysis on case studies of transport contributions on days when ozone exceedences occurred in the SEDAB. From this analysis, Kern County APCD staff was able to conclude transport from the SCAB to the SEDAB was both overwhelming and inconsequential.

The overwhelming classification requires SCAB to develop control strategies to abate the impact of transported pollutants on the SEDAB, as mandated in the California Code of Regulations, Title 17, 70600. The inconsequential classification means that SEDAB is totally responsible for some of the days on which the ozone standard is exceeded.

13.1.3 Air Quality Trends

The SEDAB portion of Kern County cannot rely on a model to predict ozone attainment in AQAP for this area, since no accurate model currently exists. Furthermore, until adequate monitoring exists in this area, a database for a model will not be available.

The modified linear rollback method demonstrates that the district is mitigating the emissions under its responsibility. However, being that the SEDAB has been documented as experiencing overwhelming transport from both the SCAB and the SJVAB demonstrating future ambient concentrations will have to rely on the photochemical model that is presently being used in the SCAB and the model that is expected to be developed as a result of the $16 million San Joaquin Valley Air Quality Study. These models will provide important data about the amount and composition of transport into the SEDAB.

The Kern County APCD has established through the Searles Valley PM_{10} Plan, a level of emission reductions at about 25 percent. It is expected that similar reductions could be made in the same targeted source categories of unpaved roads, process related fugitive dust, and wind erosion, so a 50 percent emission reduction across the board could be realized. Kern County APCD also asserts that residential waste combustion control measures would be implemented to assist with making the necessary reductions as required.

13.1.4 Air Pollution Control

Air Pollution control is administered on three government levels in the State of California: federal, state and local (county). The Federal government has established national ambient air quality standards (NAAQS) to protect public health and welfare. The State of California has established separate, more stringent standards. Federal and state standards have been established for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, PM_{10}, and lead. In addition, California has standards for hydrogen sulfide, sulfates, vinyl chloride, and visibility-reducing particles.

The Kern County Air Pollution Control District administers the air pollution control program locally. The Southeast Desert Air Basin portion of Kern County due to a lack of monitoring data has been designated "unclassified" nonattainment until an ozone monitor is sited at a location suitable for establishing an appropriate ozone "design" day. As such it is appropriate for KCAPCD to develop and implement mandates appropriate for a "moderate" classification until monitoring data is available. The Indian Wells Valley sub-area has received a rating of Group I (moderate) for nonattainment of PM_{10} for the Searles Valley Planning Area.

13.1.5 Air Quality Standards

a. Ozone: There have been no officially documented ozone exceedences in the SEDAB portion of Kern County. (There are no sanctioned ambient ozone monitors, either.) However, for the purpose of characterizing the probable air quality in SEDAB portion of Kern County, air monitoring data for Lancaster and Trona (same air basin), both of which are less than 20 miles from the Kern County line, were used. Table 13-2 states the number of days these areas exceeded the state standard for ozone:

Table 13-3 gives the data on maximum 1-hour concentrations for Ozone exceedences in Lancaster and Trona. Data for both sites are presented to represent the diversity of ambient air concentrations to be found near the Kern County portion of the SEDAB. Lancaster represents a station which will receive a significant portion of transported pollutants from both the SCAB and the SJVAB, whereas Trona represents a station which probably receives an insignificant portion of transported pollutants.

In fact the CARB has agreed for the time being the level of exceedence that the SEDAB is solely responsible for, that which was generated in the SEDAB and not attributable to transport is 0.11 ppm. This represents the "design value" for which all AQAP planning activity is based.

The SEDAB portion of Kern County is designated "serious" for the federal ozone standards. (Approximately equivalent to the CCAA "moderate" designation.) As such a federal nonattainment plan must be submitted in 1994.

The SEDAB has no documented exceedences in Kern County. However, there are exceedences documented elsewhere in the SEDAB. Since the California Clean Air Act (CCAA) recognizes ozone as a regional pollutant, an exceedence anywhere in the basin places the entire basin in nonattainment. Kern's actual degree of exceedence has yet to be determined.

In March of 1992 the KCAPCD received notification from CARB that their petition for the SEDAB portions of Kern County to be redesignated had been granted. Therefore, this area has been redesignated as "Unclassified" (equivalent to "moderate") from "Serious" with regard to degree of ozone nonattainment.

The KCAPCD has committed as a result of this action, to instituting an ozone monitoring station as soon as possible for this area.

This classification will require the SEDAB communities of eastern Kern County to conform to the California Ambient Air Quality Standards (CAAQS) mandates for a "moderate" area.

TABLE 13-2

Ozone Exceedences
Number of Days Above State Standard

YEAR	LANCASTER	TRONA
1979	106	9
1980	123	35
1981	82	2
1982	93	1
1983	110	1
1984	106	9
1985	108	6
1986	105	8
1987	105	10
1988	95	5

TABLE 13-3

Ozone Exceedences
Maximum 1-Hour Average Concentrations

Year	Lancaster	Trona
1979	0.29	0.11
1980	0.21	0.13
1981	0.16	0.10
1982	0.18	0.10
1983	0.18	0.10
1984	0.19	0.11
1985	0.20	0.14
1986	0.17	0.11
1987	0.18	0.11
1988	0.21	0.10

b. Particulates. The NAAQS for PM_{10} was established by the Environmental Protection Agency on July 1, 1987 at 150 micrograms per cubic meter ($\mu g/m^3$) for the 24-Hour standard and 50 $\mu g/m^3$ for the annual average standard. These standards were set at levels designed to protect the health of humans who are sensitive to exposure to fine particles.

The closest CARB approved monitoring station to the City of Ridgecrest for PM_{10} is located in the Searles Valley. The Searles Valley Planning Area for PM_{10} is shown in Figure 13-2 Although this station is in another county it is within the same planning area for PM_{10}.

PM_{10} is the only pollutant in the area that has exceeded the NAAQS in the area known as the Searles Valley Planning Area. The standard was exceeded in Trona three times in 1985. Actual exceedences could be greater because PM_{10} sampling is performed on a standardized once every sixth day cycle. In addition, the annual PM_{10} standard was also exceeded for that year. In 1986, neither the 24-Hour nor the annual PM_{10} standard were exceeded. Data from China Lake Naval Air Weapons Station (NAWS) indicates several very high concentrations of Total Suspended Particulate (TSP), which the KCAPCD believe would have probably caused exceedence of at least the 24-Hour PM_{10} standard. Both the PM_{10} and TSP samples taken from Trona and NAWS were collected in accordance with the standard "every sixth day" cycle.

The severity of the particulate matter problem can increase to the level that visibility in the region is diminished. This has been an environmental concern of many, especially NAWS, which has a vested interest in maintaining good visibility. NAWS has been an active military participant in the "RESOLVE" study, which is an air quality study. This study observed that two types of synoptic conditions can lead to degraded visibility in the desert from particulate matter transport. One condition results from mesoscale transport of air pollutants from upwind basins to the desert and is shown in Figures 13-3(a),(b), and (c). In summer, a thermal low pressure condition seen in Figure 13-3(a), is frequently present, while the prefrontal condition in Figure 13-3(b), typically occurs in other seasons. On other occasions (See Figure 13-3(c), the presence of a strong pressure gradient aligned with the north-south desert valleys, can lead to degrading visibility.

13.1.7 Air Quality Attainment Plans

Under the provisions of the California Clean Air Act, Kern County APCD has developed an Air Quality Attainment Plan (AQAP) for the SEDAB portion of Kern County for ozone. In a tri-county (Inyo, Kern and San Bernardino) effort they have generated the "PM-10 State Implementation Plan (SIP) for the Searles Valley Planning Area, which includes the Indian Wells

Valley. These are comprehensive planning documents intended to provide guidance to the APCD and other local agencies on how to progress toward attainment of the ozone and PM_{10} standards.

The AQAP focuses on the ozone nonattainment problem in the SEDAB. Its purpose is to present a comprehensive strategy designed to enable SEDAB to attain CAAQS for ozone (0_3) by earliest practicable date. Presented in this plan are the control measures which act as a "blueprint" to implement the strategy. The AQAP includes Transportation, Indirect, Stationary, Mobile and Area Source Control Measures.

The SIP concentrates on the PM_{10} attainment standards to meet federal requirements for the "Searles Valley Area" (Figure 13-2) which includes the City of Ridgecrest. It presents a strategy fashioned to reduce the emissions in the planning area to meet the National Ambient Air Quality Standards (NAAQS) by December 1994. The control measures presented are tailored to meet the specific problems in the planning area. They include measures that address process fugitives, open areas, unpaved roads. There are different statuses (primary and alternate) of measures defined by federal and state standards.

a. Compliance with Federal Clean Air Act. In accord with the Federal Clean Air Act, as with nonattainment areas, the Searles Valley Planning Area was required to meet the national standards for PM_{10} by December 1994. The SIP for a moderate area must contain "reasonably available control measures (RACM) to be implemented, unless their effect on a source is insignificant. In addition, the EPA mandates the application of RACM to existing sources, through the adoption, at a minimum, of reasonably available control technology (RACT). Also, in the preparation of a SIP, consideration must be given to any control methods suggested by the Air Resources Board and/or the general public.

b. Compliance with California Clean Air Act. On January 1, 1989, the California Clean Air Act (AB 2595, Sher) became effective. This state legislation imposes many new requirements on areas of California that do not meet state and federal clean air standards. The Kern County portion of the SEDAB has been designated as "unclassified" (equivalent to "moderate") until sufficient KCAPCD monitoring data can be collected to accurately determine the degree of nonattainment for this area. The role of KCAPCD and the CARB in achieving attainment of the standards is outlined in the California Clean Air Act, which also outlines the progress schedule that must be included in district plans for attainment. If a plan cannot show attainment and the ARB agrees, the ARB will determine whether the plan contains all feasible measures to ensure progress toward attainment. The ARB can return deficient plans for revision and resubmittal. If conflicts cannot be resolved, the ARB has the authority to revise the plan as necessary.

13.2 IMPACT ANALYSIS

13.2.1 Significance Thresholds

a. **First Tier Impact Analysis.** For the purposes of assessing future air quality the 1991 SEDAB AQAP includes air pollution forecasts through the year 2010 that take into account the effects of future socioeconomic changes. This analysis by the AQAP took into account the Employment Growth, Housing Growth and projected vehicles miles travelled to the year 2010. This area is presently designated moderate for ozone non-attainment and it is calculated that using linear rollback methods the area will attain ozone standards in the future. However, since the SED Air Basin has been documented as experiencing overwhelming transport from both the South Coast Air Basin (SCAB) and the San Joaquin Valley Air Basin (SJVAB) predicting future ambient concentrations will have to rely on the photochemical model presently being used by the SCAB and the model expected to be developed as a result of the San Joaquin Valley Air Quality Study. These models will provide important data about the amount and composition of transport in the SED Air Basin.

The PM_{10} State Implementation Plan for the Searles Valley Planning Area (SIP) foresees that through a moderate level of emission reductions, attainment will be achievable. Some emission source categories may be targeted for reduction such as "process fugitives", wind erosion and unpaved roads. Additionally, residential wood combustion control measures may be implemented to assist in making the necessary reduction. Linear rollback model analysis was made using EPA guidelines to demonstrate that recommended control measures will reduce PM_{10} emissions sufficiently to meet the required Federal PM_{10} standards. Further analysis was found necessary to provide information for future planning purposes. Further model analysis of the Trona, April 23, 1990 design day is currently being prepared and should be completed by December 1992. Some control approaches may be revised based upon this analysis.

b. **Second Tier Impact Analysis.** Cumulative population increases associated with the broad land use alternatives should not result in significant air quality impacts. Specific development projects will be reviewed by the Ridgecrest Community Development Department and by the Kern County Air Pollution Control Board for air quality impacts.

To determine the significance of air emissions generated by specific projects, the current or updated standards by the Kern County Board of Supervisors should be used. Future projects within the SED that emit $\geq$ 137#/Day of NOx will individually and cumulatively jeopardize attainment of the ozone standard and thus would have a significant adverse impact on air quality. This finding is based on the threshold for determining impacts of ROC (Reactive Organic Compounds) emissions used by the KCAPCD, the availability of feasible mitigation measures, and the definition of "significant effect" in the California Environmental Quality Act guidelines: "A project will normally have a significant effect on the environment if it will...violate any ambient air quality standard, contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations." For PM_{10} purposes the NAAQS of 150 $\mu g/m^3$ in a 24-hour period is used to determine a significant impact.

13.2.2 Long Term Impacts

a. Impacts Common To All Alternatives. The AQAP plan predicts that the state and federal ozone standard will be attained by 1994 in the Kern County portion of the Southeast Desert Air Basin. These findings are based on economic and demographic data and the estimated effectiveness of emission control measures.

The analysis presented in the SIP estimates attainment of PM_{10} NAAQS by the end of 1994. If attainment is not met by this date, the planning area (Searles Valley) will be reclassified "serious" and must attain compliance with the standards as expeditiously as practicable, but no later than December 31, 2001.

Exceedance of Ozone Standards. The cumulative population growth associated with development alternative 3 would likely contribute to ozone standard exceedences and therefore result in significant adverse air quality impacts.

During the next several years, the SEDAB is forecasted to reduce ROC and NOx emissions, primarily from the implementation of control measures for motor vehicles and industrial sources. Meanwhile, the City and its surrounding planning area will experience continuous population growth under the City and county general plans. As population increases, motor vehicle travel and domestic, commercial, and industrial activities also increase causing a commensurate increase in emissions. Unlike the earlier years of air pollution control, there are fewer control measures available for adoption, since many stationary sources of pollution are already controlled to the maximum extent feasible. The 5% per year reduction goals of the AQAP will not be achieved in any future year, even with the expeditious implementation of all control measures. By 1994 ROG emissions will be reduced by 24%, and the NOx emissions will be reduced by 14% with ozone attainment projected. Full implementation of the control measures of the AQAP by 1997 will reduce both ROG and NOx emissions by approximately 30%.

Exceedence of PM_{10} Standards. The cumulative population growth associated with the four development alternatives would not contribute to exceedance of the state and federal PM_{10} standards provided that the PM_{10} SIP is fully implemented.

Construction Activities. Construction of individual projects developed under alternatives 1, 2, and 3 would generate particulate emissions during clearing and grading activities, including the operations of trucks and equipment on unimproved roads. The level of particulate generation depends on soil moisture, wind speed, activity level, and silt content of the soil. Particulate generation typically occurs at the rate of 1.2 tons per acre per month of construction activity (U.S. EPA, 1985). Construction operations of major land development projects have the potential to result in concentrations of particulates that exceed the national ambient air quality standards on a short term basis. The dust generated by such activities may also pose a nuisance to those living and working near the construction sites.

In addition to PM_{10} generation, construction equipment used for clearing and grading of individual development sites would produce combustion emissions (ROG and NOx), that would also occur on a short-term basis. Construction emissions can be estimated for individual future development projects using emission rates approved by the CARB. Although the magnitude of the construction equipment emissions would be highly variable day to day depending on the number and size of the equipment operating, the result could be short term increases in the ambient ozone levels, and thus, short term adverse impacts on air quality.

b. Toxic and Nuisance Emissions and Objectionable Odors. Objectionable odors and toxic and nuisance emissions could be produced by industrial development in areas designated for such uses under alternatives 1, 2, and 3. The prevailing seasonal wind pattern in the planning area is a south-southwest flow during the summer. Winters will occasionally see a strong westerly wind of 20 to 30 knots sustained for periods of up to 24 hours. The strongest surface winds occur in the late winter and spring as cold fronts move rapidly through the area. With such variable wind directions, it can direct odors and toxic and nuisance emissions to sensitive downwind receptors such as residences and schools. Sensitive receptors may be subjected to levels of nuisance emissions that may be considered significant, although such a determination is subjective because it is likely to be a lower level than the point at which the emission is considered to be a health hazard. Toxic air emissions could also be produced in the industrial areas by facilities and businesses which do not actually manufacture chemicals, but do use hazardous substances in enough quantities to expose surrounding populations to toxic air emission "hot spots". However, little data is currently available to accurately analyze the amounts, types and health impacts of routine toxic chemical air emissions. Significant uncertainty exists about the amounts of potentially hazardous air pollutants which are released, the location of those releases, and the concentrations to which the public is exposed. Review of such sources, prior to construction, by the KCAPCD will help prevent creation of unhealthful "hot spots".

For the reasons described above, no quantifiable threshold of significance exists for the assessment of nuisance or toxic emissions or objectionable odors. Therefore, potentially incompatible uses in terms of nuisance and toxic emissions and objectionable odors are identified for alternatives 1, 2, and 3 to allow decision makers the opportunity to select adjacent land uses that would minimize potential conflicts.

Alternative 1. Existing sources of potential toxic and nuisance emissions and objectionable odors in the planning area include the wastewater treatment plant (WWTP) located on the NAWS facility, the sewer effluent disposal fields located on San Bernardino County Road and the automotive body repair and paint facilities located on West Inyokern Road. The M-1 district (light industrial zone) at the north end of the community has sensitive receptors (primarily residences) to the east, west and south of these sources. The M-2 district (Heavy Industrial zone, presently vacant) located on San Bernardino County Road has sensitive receptors (residences) to the east in the unincorporated areas of San Bernardino County and to the west (residences and school) within the City limits.

Alternatives 2 and 3. In addition to existing sources identified for Alternative 1, potential new sources of toxic and nuisance emissions and objectionable odors would be allowed in the M-1 and M-2 zones. Additional residential development may be exposed to these emissions from both existing and new industrial sources. All industry would be subject to review by the Community Development Department and Kern County APCD.

Alternative 4. With the no-project alternative, existing sources of emissions as described in Alternative 1 would continue.

c. **Consistency with AQAP Population Forecasts.** The Kern County AQAP forecasts air pollution levels from stationary, mobile and indirect sources to the year 2010 for the Southeast Desert Air Basin, based in part on populations and industrial growth projections for the SEDAB.

Population growth consistent with or less than the AQAP forecasts would result in decreases in air pollution emissions from existing levels. There is currently not enough of a database for the KCAPCD to accurately assess future impact of growth upon the SED. Future AQAPs will address this issue.

Alternative 1 and 2. Alternative 1 and 2 would be compatible with the AQAP population forecast to the year 2010 (Indian Wells Valley population estimate 95,855). Development under Alternative 1 would generate a population of 50,000 and Alternative 2 would generate a population of 75,000 within the planning area without taking into account the non-incorporated areas. If the population stayed within this range to the year 2010 no reduction in air quality is foreseen.

Alternative 3. Alternative 3 would be incompatible with the AQAP population forecast to 2010. Buildout of Alternative 3 would generate a population of 100,000 within the planning area without taking into account the non-incorporated areas. Currently, the KCAPCD does not have enough of a data base for the SEDAB to accurately forecast pollution effects based on growth projection.

Alternative 4. Alternative 4, the no-project alternative, would due to its nature see decreases in air emissions as the mandates of the CCAA are met.

13.3 MITIGATION MEASURES

Due to the planning area's classification as moderate for ozone attainment and Group I for PM_{10} attainment adoption of any of the alternatives by the City as part of its General Plan should include the implementation of all reasonable mitigation measures to reduce ozone precursor emissions and fugitive dust sources to the maximum extent feasible.

Consistent with the California Clean Air Act, the city should cooperate with the Kern County APCD in designing a regional plan for attainment of all air quality standards. The AQAP and the SIP identify several measures for reducing ozone precursor emissions and fugitive dust emissions. The measures are grouped into area and stationary source control measures, development and construction, and transportation control measures (TCM). Nearly all measures available to the City to reduce vehicle emissions fall into the broad category of transportation control measures.

13.3.1 Transportation Control Measures

TABLE 13-4

Projected Vehicle Counts and Vehicle Miles Travelled (If Unabated) In the Southeast Desert Portion of Kern County, 1990-2010

	1990	1995	2000	2005	2010
Number of Vehicles	54,501	57,696	61,513	65,130	68,752
VMT X 1000	2,080	2,293	2,459	2,615	2,771

California Air Resources Board EMFAC 7E Predictions, 1990

Transportation Control Measures (TCM) are methods developed to help reduce emissions from motor vehicles. The methods focus on reducing the number of vehicle trips per day, length of vehicle trips travelled in the area, and vehicle idling and traffic congestion for the purpose of reducing motor vehicle emissions. The CCAA requires the SEDAB to "adopt, implement and enforce" reasonable available transportation control measures. [§40717(a)] and [§40918(a)(3)]. The KCAPCD, as allowed by the CCAA, delegated the responsibility of preparing TCMs to the Kern Council of Governments (Kern COG). Kern COG is an agency that is responsible for coordinating regional transportation in the area. Table 13-4 represents the expected number of registered vehicles in the SEDAB and the number of vehicle miles travelled (VMT).

The City through its adoption of the Congestion Management Program has committed to implement the recommended transportation control measures from Kern COG. Due to this area having a "moderate" designation with respect to degree of non-attainment, some measures have been mandated (primary) and others are recommended (contingency) measures in the event that there is no demonstrated air quality improvement.

Primary TCM's

* *Employer-based Trip Reduction Program* is intended to reduce the number of vehicles trips related primarily to employee commuting.
* *New and Modified Indirect Source Review* is intended to reduce the number of vehicles attracted to a location.

Contingency TCM's

* *Fleet Operator Alternative Fuels Program* would require the use of alternate fuels to replace gasoline or diesel.
* *Parking Management Program* is designed to control access to parking and to influence individual's decisions regarding using single occupancy vehicles for routine trips or commuting.
* *Transit Improvement Program* are designed to induce persons to use public transit instead of their personal automobiles wherever possible.
* *Street and Highway Improvement Program* would emphasize those improvements that would enhance traffic flow and reduce congestion therefore having the potential for air quality benefits by facilitating the smooth flow of traffic or elimination of transportation bottlenecks.

The City should include all measures that are reasonable and feasible for inclusion into a citywide program. This program should be adopted prior to approving new projects under any of the development alternatives.

13.3.2 Stationary Source Control Measures

Stationary Source Control Measures are methods developed to help reduce emissions from such sources as asphalt plants, solid waste landfills, retail gasoline stations, etc. The measures focus on reducing the amount of emissions from new and existing sources. Emission reductions from these sources are based on projected differences between uncontrolled emissions levels and controlled emissions levels. Growth and control values used to calculate baseline and reduced emissions by the KCAPCD are those identified by the CARB in their Growth and Control Turnaround Documents. The AQAP contains a control measure designed to fulfill the CCAA mandate requiring no net increase in pollutant and precursor emissions above 25 tons per year from permitted sources. The control measures adopted by the AQAP also describe "retrofit" emission control measures which will be the basis of KCAPCD rules to be developed and adopted during the next ten years.

The CCAA requires a moderate nonattainment area's existing sources to be equipped with Reasonably Available Retrofit Control Technology (RARCT).

<u>ROG Control Measures (already implemented)</u>

* *Rule 410.5,* Cutback Asphalt Paving Material disallows the use of this paving material in ozone nonattainment areas.
* *Rule 412.1,* Retail Gasoline Station Vapor Recovery requires retail gasoline service stations to install "Stage Two" vapor control devices when refueling vehicles.

<u>Reasonably Available Retrofit Control Technology (RARCT) for ROG and NOx (to be implemented)</u>

* *S-NSR, New Source Review* is intended to limit emission increases from larger emission sources, either new equipment or modifications to existing equipment at facilities regulated by the KCAPCD, by requiring new or modified sources to be completely offset by prior reductions at least as great as the increase.
* *S-1-P, Aircraft and Aerospace Exterior Coating* regulates ROG emissions by requiring the use of low solvent technology or by utilizing control equipment with a control efficiency of at least 85%, as well as storing all organic containing materials in closed containers.
* *S-2-P, Aircraft Refueling and Fuel Storage* proposes that vapor control be used on all aviation storage tanks with significant emissions.
* *S-3, Architectural Coatings* will be required to lower the amount of VOC (Volatile Organic Compounds) contained within such products as paints, stains, sealers and other coatings used to protect and enhance the appearance of large stationary structures.
* *S-4-P, Electronic Industry - Semiconductor Manufacturing* would require both positive and negative photoresist operations to reduce emissions 90%. NAWC has a limited use printed circuit shop.
* *S-5-P, Gasoline Transfer Into Stationary Storage Containers, Deliver Vessels, and Bulk Plants* will phase out exemptions for previously exempt (delivers less than 500,000 gallons per year of gasoline to facilities without vapor recovery) bulk plant over a two year period.

* *S-6-P, Graphic Arts* would require the use of low solvent technology and emissions control equipment at graphic art facilities and also require that VOC materials be stored in closed containers.
* *5-7-P, Hot Mix Asphalt Batch Plants* - Combustion would establish an asphalt batch plant dryer emission standard of 0.13 lb NOx per million Btu of fuel burned.
* *S-8-P, Hot Mix Asphalt Batch Plants* - Fugitives would require that asphalt batch plants optimize equipment efficiency to prevent the emission of fugitive ROG.
* *S-9-P, Industrial and Commercial Package Boilers* is designed to reduce basin wide NOx emissions through establishment of more stringent controls for boilers.
* *S-11-P, Metal Parts Painting* would reduce the VOC emissions from coating of metal parts and products by lowering the control exemption cut-off from 15 lbs/day of VOC to not more than 3 lbs/day and establishing a 100 gallons of total coatings per year exemption.
* *S-12-P, Motor Vehicle and Mobile Equipment Coating Operations* would reduce ROG emissions from spray coating operations by requiring use of lower ROG coatings in refinishing vehicles unless emissions to the atmosphere are controlled to at least an equivalent level by control equipment with a capture efficiency of at least 85 percent and an efficiency of at least 90 percent.
* *S-13-P, Indirect Neat Transfer Fuel Burning Equipment* would require the use of clean fuels in stationary source combustion.
* *S-15, Organic Solvent Degreasing* would require an additional 20% to 40% reduction of ROG emissions from each degreaser.
* *S-16-P, Stationary Piston Engines* would have emission limitations that could be achieved through replacing engines with electric motors, by combustion modifications, and by nonselective or selective catalytic reduction.
* *S-17-P, Portland Concrete Kilns* would target NOx emissions by about a 46% emission reduction from the baseline inventory that can be achieved through use of lower NOx emitting fuels.
* *S-18, Residential and Commercial Water Heaters* would require that a 2.3 lb per year NOx emission limit be established for new and replacement water heaters.
* *S-19-P, solid Waste Landfills*, would require a gas collection system be installed to reduce ROG emissions by 0.01 to 0.02 tons/day in the SED.
* *S-20-P, Stationary Gas Turbine Engines*, would limit the NOx emissions to 20 ppm at 15% O_2 for existing stationary gas turbines. New turbines are required by KCAPCD Rule 210.1 to meet a BACT NOx emissions limit of 5 ppm.
* *S-21-P, Wood Furniture and Cabinet Coating* requires specific application processes be used for all wood furniture and cabinet coating steps, exemptions from this rule would apply to touch-up any repair and any operation with total emissions less than 15 lbs ROG/day.

* *S-22, Charbroiling, Commercial* would require a 90 percent reduction of ROG from commercial charbroilers

13.3.3 Area Source Control Measures For ROC and NOx

Areawide sources only emit small quantities of pollutants individually, but when measured collectively represent a significant source of emissions. The CCAA grants CARB authority to adopt regulations to reduce ROG compounds emitted by area sources such as consumer products. Local air districts are prohibited from adopting any regulations related to consumer products that differ from regulations adopted by the state prior to January 1, 1994. The CCAA defines consumer products as "a chemically formulated product used by household and institutional consumers, including but not limited to: detergents, cleaning compounds; polishes; floor finishes; cosmetics; personal care products; disinfectants; sanitizers; and automotive specialty products, but do not include paint furniture coatings or architectural coatings".

A number of the stationary source control measures presented previously are aerate sources, eg, degreasers. KCAPCD is addressing any aerate control measure that has associated emissions reductions in this manner. KCAPCD plans to address area sources with no associated emission reductions on a local basis by means of public awareness control measure. This measure will commit the District to definite public awareness activities to help fulfill its public education mandate.

* *Public Awareness,* KCAPCD will disseminate public information to assist and to help the public achieve voluntary emissions reductions. Information on the following will be made available:
  - o Use of Household Products
  - o Use of Lawn & Garden Equipment
  - o Reducing Vehicle Trips and Mile Traveled
  - o More Frequent Vehicle Inspection & Maintenance Programs Encourage Use of Alternative Fuels
  - o Use of Barbecues
  - o Use of Fireplaces

13.3.4. Health Effects of Air Pollution

(The implementation agency for all these control measures cited in section 13.3 is the Kern County Air Pollution Control District. These measures will be placed before the Kern County Board of Supervisors for public hearings. Upon adoption of these measures, the KCAPCD will be responsible for enforcement of these measures as well as review of all permits for sources/and or industries that meet the emission thresholds. The city should strive to assist and support the KCAPCD in all their programs and endeavors as well as any enforcement of these measures.)

13.3.5 Development Source Control Measures For ROG and NOx

Development design criteria and development incentives are specific actions that the City could implement to reduce emissions associated with various types of land use development.

* *Provide Support Facilities On-Site,* such as food services, banking, postal service and shower facilities.
* *Provide Pedestrian Connections* to well travelled locations.
* *Encourage Alternative Means of Transportation* such as bicycle racks, transit stops.
* *Develop a Rideshare Program for Facility.*
* *Develop a Rideshare Program with Adjoining Facilities.*
* *Implement a Reduced Work Week.*

13.3.6 Construction Source Control Measures For ROG, NOx, and PM_{10}

Construction sites should be required to conform to the following procedures to reduce short-term emissions:

* *Require a dust control plan for construction, land clearing projects, and road projects.*
* *Regular ground wetting of roads and graded areas at least twice daily.*
* *Graveling of temporary roads.*
* *Increase frequency of watering when winds exceed 15 mph and cease all grading activity when winds exceed 30 mph.*
* *Direct application of water to materials be excavated and/or transported on-site or off-site.*
* *Watering material stockpiles.*
* *Periodic cleanups of accumulated dirt materials from public streets accessing construction site entrances.*
* *Adjust all construction equipment diesel engines to operate with a four degree ignition retard.*
* *Use low sulfur fuel (0.05 % by weight) for construction equipment.*
* *Properly maintain and operate all construction equipment used during project construction.*
* *Schedule construction truck trips during non-peak hours to reduce peak hour emissions.*
* *Require haul trucks to be covered.*
* *Require dust control measures for material storage piles.*

- *Require revegetation, chemical stabilization, or other abatement of wind erodible soil.*
- *No grading of lot or parcel until a building permit has been issued.*
- *Wherever feasible, require parking lots and paved roads to be constructed prior to building construction.*
- *Wherever feasible, maintain the natural topography to eliminate the need for extensive land clearing, blading, ground excavation, grading and cut and fill operations .*
- *Avoid soil/mud deposition by truck on roadways beyond facility boundaries.*

13.3.7 Toxic and Nuisance Emissions and Objectionable Odors Control Measures

The city should adopt development standards that prohibit the development of industrial activities that would produce industrial nuisance emissions or objectionable odors within one quarter mile upwind of sensitive receptors (based on the prevailing regional wind pattern). Similarly, residential development, schools, hospitals, and convalescent homes should be prohibited within one-quarter mile downwind of existing sources of industrial nuisance emissions or objectionable odors.

- *Development standards for Industrial and Manufacturing Zones* should be incorporated into the Zoning Ordinance and applied during review of a proposed industrial or residential project for approval.
- *Require dust control measures for material storage piles.*
- *Support of KCAPCD's Air Toxics Evaluation and Control Programs.*

13.3.8 Fugitive Dust Control Measures

The City should implement measures to reduce levels of PM_{10} generated by industrial, roads, construction and demolitions sources. The air pollutant PM_{10} is not only a nuisance and irritant, some sources of PM_{10} may emit particles which contain toxic and carcinogenic compounds, which can increase the threat to human health. In addition certain sizes of PM_{10} can contribute to degradation of atmospheric visibility and pose a safety hazard during extremely dusty conditions. Other mitigation measures that can apply to dust control may be found in other sections of this document.

<u>Industrial Processes</u>

- *Require Dust control measures for storage piles.*
- *Install Add-On Particulate Matter Control Equipment on the process line or series of operational processes.*
- *Enclose process line, to reduce likelihood of wind-borne fugitives escaping the*

processing operation.

- *Require haul trucks to be covered.*

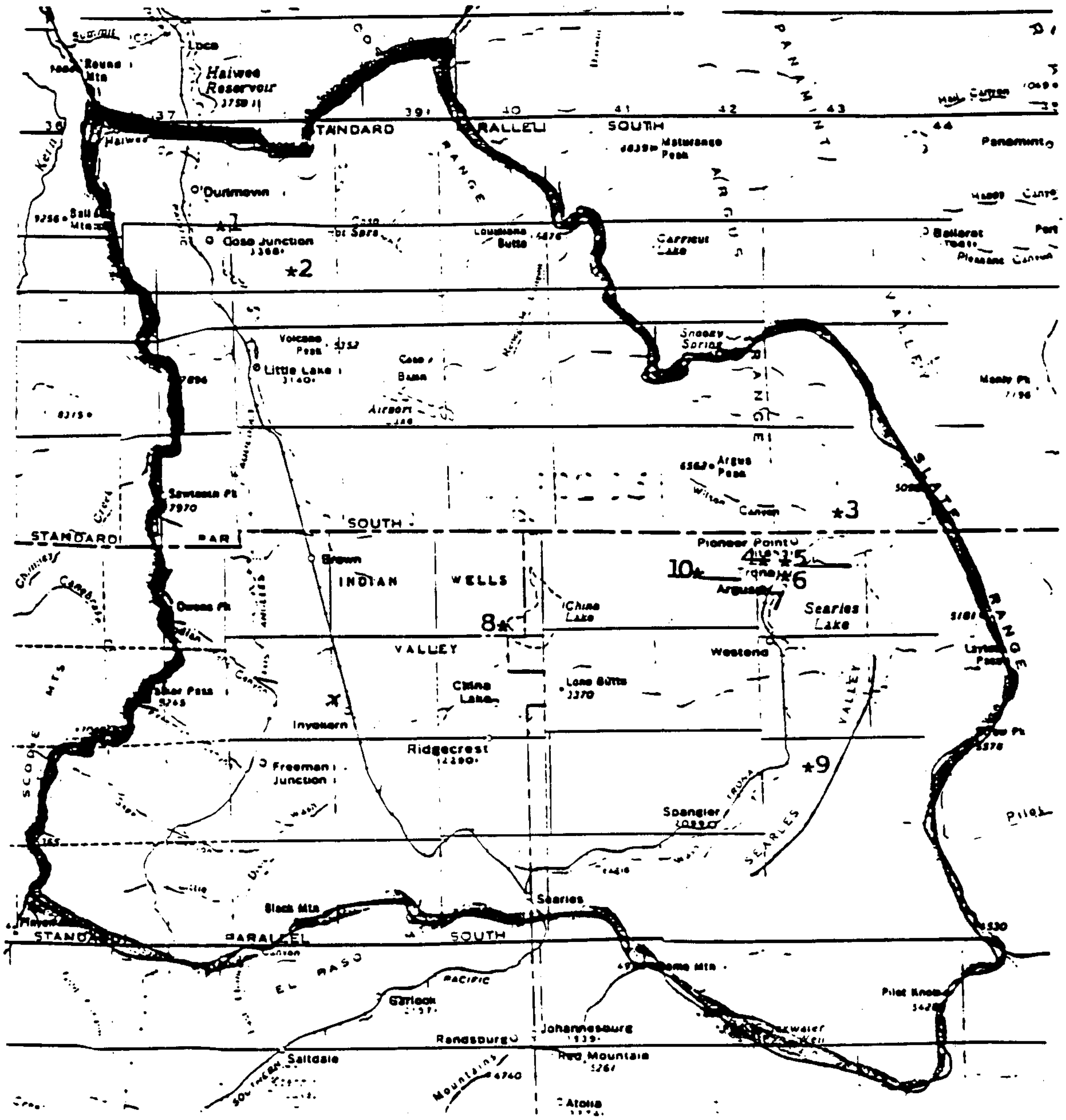
Roads

- *Pave, vegetate or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.*
- *Prohibit permanent unpaved roads, and parking or staging areas at commercial, municipal, or industrial facilities.*
- *Develop traffic reduction plans for unpaved roads.*
- *Pave or chemically stabilize unpaved roads.*
- *Pave, vegetate, or chemically stabilize unpaved parking areas.*
- *Provide for storm water drainage to prevent water erosion onto paved roads.*
- *Provide rerouting or rapid cleaning of temporary sources of mud and dirt on paved roads.*
- *Develop traffic reduction plans for unpaved roads.*
- *Lower the vehicle speed limit on unpaved roads and implement a proactive enforcement program to monitor compliance with speed limits.*
- *Require curbing and pave or stabilize shoulders of paved roads.*

Map Showing NWC, the Surrounding Mountains, and the Major Air Flows.

FIGURE 13-1

AIR MONITORING STATIONS



#1	Coso Junction Station	#6	Trona Station
#2	Coso, 10 Miles East, Station	#7	ACE-2 Station
#3	ACE-6 Station	#8	China Lake Station
#4	ACE-4 Station	#9	ACE-5 Station
#5	ACE-3 Station	#10	ACE-1 Station (inactive)

FIGURE 13-2

SYNOPTIC CONDITIONS LEADING TO VISIBILITY DEGRADATION IN THE CALIFORNIA DESERTS

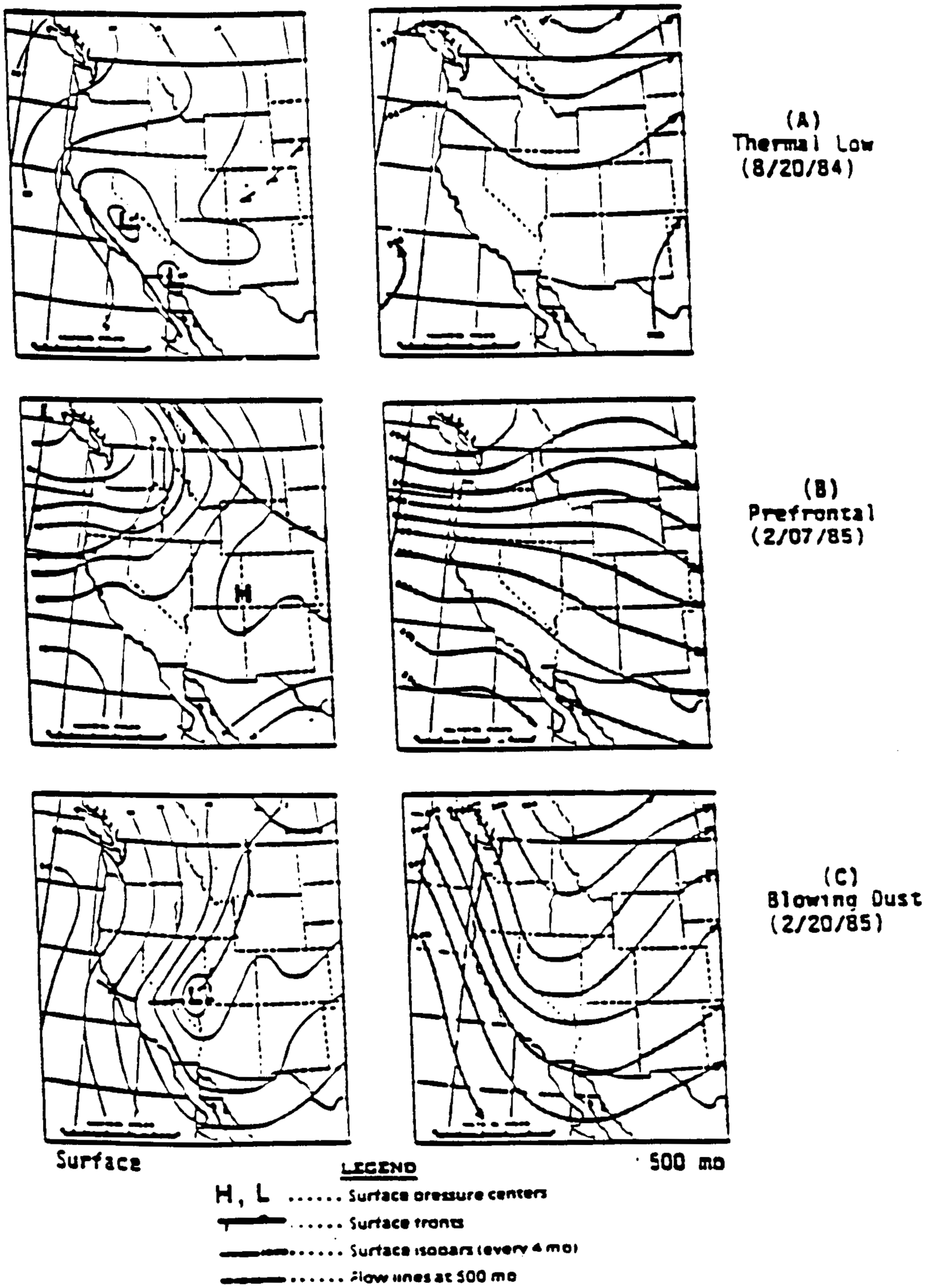


FIGURE 13-3

SECTION II

Chapter 14.0

GEOLOGY AND SOILS

14.1 SETTING

The City of Ridgecrest is located within the Indian Wells Valley, which is an approximately 480 square mile basin which extends about 35 miles in a north-south direction and 25 miles in an east-west direction. The average elevation of the valley is 2300 feet above mean sea level. It is estimated that the Indian Wells Valley has upwards of 6,000 feet of alluvial fill. The valley is surrounded by mountain blocks characterized by interior drainage. This depression is a local expression of the greater Basin and Range geologic province of the western United States. The basin consists of unconsolidated alluvium that has been eroded from the surrounding mountains, lacustrine deposits, windblown sands, playa silts and clays, with possible estuarine and marine sediments of depth. The major geologic feature within the study area is the many playas, such as Mirror Lake, Satellite Lake, Airport Lake and the largest being China Lake.

The Indian Wells Valley is characterized as consisting of four geologic units. The deepest unit is the basement complex which is pre-Tertiary and is composed of igneous and metamorphic rocks that underlie the valley. This unit is considered to be generally non-water bearing.

The next unit is made up of lake deposits, of Pleistocene and Holocene age and includes the playa and lacustrine deposits. The playa deposits are composed of unconsolidated silts and clays and occur at China Lake, Mirror Lake and Satellite Lake. The lacustrine deposits are composed of cemented sand, silt and clay. These deposits were formed by an ancestral lake much larger than the present China Lake. These units are of low permeability and do not yield water of high quality. (Warner, June 1975)

The third unit is the alluvium of Pleistocene and Holocene age which is exposed in most of the valley. This unit is comprised of unconsolidated younger and older alluvium, stream deposits, fan deposits and dune sands which are derived by erosion from the surrounding mountains.

This unit overlies the basement complex and the lake deposits. The alluvium is of particular importance as it constitutes the principal recharge area for the Indian Wells Valley.

The playa and sand dune deposits are of Holocene Age and are comprised of windblown sand and small interdune playas. These deposits overlie the lake deposits and the alluvium. The playa and sand dune deposits yield small quantities of poor quality water and are not significant hydrologically as the sand is mostly above the water table.

This section identifies the geologic issues that may potentially impact the planning area.

a. Geologic Hazards. the planning area lies within an active earthquake region of Southern California and is subject to such geologic hazards as fault displacement, earthquakes and ground shaking, earthquake-induced flooding, landslides/mudslides, liquefaction, soil subsidence, expansive soils, and flooding. As the City of Ridgecrest is an inland desert community with no surface water bodies within the Indian Wells Valley, the following geologic hazards are not found to be of concern: lurching, tsunamis and, seiches. The discussion of each geologic hazard in this section will encompass: nature and effects of the hazard, general areas potentially subject to the hazard, and comments on the probability of occurrence and relative severity of the hazard. Existing hazard policies and management programs as they relate to each hazard shall also be described.

14.1.1 Geologic Hazards

a. Fault Displacement. A fault is a plane or surface of earth materials along which failure has occurred and materials on opposite sides have moved relative to one another in response to the accumulation of stress. A fault is considered to be active if it has moved during the last 12,500 years or if it occurs within an identified seismic gap. Active faults represent the greatest risk for future movement and the greatest risk to life and property from a land use planning perspective. Faults which displace deposits less than 2 million years old but show no evidence of movement in the last 12,500 years are generally considered to be potentially active and represent a lesser risk of future movement.

Ground surface displacement along a fault, although more limited in area than the ground shaking associated with it, can have disastrous consequences when structures are located straddling the fault or near the fault zone. Fault displacement involves forces so great that generally it is not practically feasible (structurally or economically) to design and build structures to accommodate rapid displacement and remain intact. Amounts of movement during a single earthquake can range from several inches to tens of feet.

Another aspect of fault displacement is not the result of violent movement associated with earthquakes, but the barely perceptible movement along a fault called "fault creep." Damage by fault creep is usually expressed by the rupture or bending of buildings, fences, railroads, streets, pipelines, curbs, and other such linear features.

Permanent effects of ground displacement include abrupt elevation changes (up or down) of the ground surface along the fault, alteration of surface drainage patterns, changes in groundwater levels, dislocations of street alignments and property lines, and a permanent change in grade of sewer and water utilities. Secondary effects of ground displacement could include the disruption of traffic and emergency vehicle service because of road and bridge destruction, and the disruption of vital utilities and community services.

Areas on and around "active" and potentially active fault traces are potentially subject to surface rupture. Please refer to Figure 14-1 for the approximate location of fault traces in the planning area.

The valley floor is a very seismically active area. Fault systems lying within or near the valley are the main sources of this seismic activity (See Figure 14-1). The major source of fault activity is the Sierra Nevada frontal fault which extends visibly along the majority of the Sierra Nevada Range. This fault forms the west border of the Indian Wells Valley. It is characterized as a right lateral fault and its inception is likely pre-Tertiary.

The Little Lake Fault branches eastward from the Sierra Nevada frontal fault and continues southeast across the valley floor to the Garlock Fault. It is typified as a steeply southwest dipping right-lateral fault and is thought to be an extension of the Owens Valley fault. This fault has exhibited minor ground cracking with a M5.2 earthquake occurring in 1982 and has an average indicated slip rate of 0.6 mm per year. The Little Lake Fault has been identified as part of the Alquist-Priolo Special Studies Fault Zone by the State Division of Mines and Geology in January of 1990.

The third local source of seismic activity is the right slip Airport Lake Fault which strikes north/south approximately 22 miles through the Coso Range to terminate at the Little Lake Fault. The Airport Lake Fault is described as a "well defined zone of north-south trending nested grabens" (Zellmer, 1987). This fault is considered to be active, with activity occurring regularly within the last 10,000 years and known displacement within the past 100 years.

The fourth local source is the Argus Fault. This zone appears as a series of splays located on the eastern edge of the valley at the base of the Argus Range. Its trace is lost as it continues north.

The final local source is the Garlock Fault which extends northeast and east-northeast for about 150 miles from its junction with the San Andreas Fault near Gorman to Death Valley. It has expressed left lateral movement in the past and is considered active with a general slip rate of 0.3 inches per year. The Garlock Fault shows evidence of six Holocene events with no major earthquakes having been evidenced in the past 500 years.

In addition, there are numerous northwesterly trending faults which subdivide the basin into a series of groundwater subunits. Most, but not all, of the latter faults are concealed beneath the shallow alluvium and data are not generally available to determine the effectiveness of the faults as groundwater barriers (Dutcher and Moyle, 1973).

b. Earthquakes and Ground Shaking. Ground shaking or ground motion is caused by the release of accumulated energy during an earthquake. The energy is released in the form of seismic waves which travel outward in all directions from the earthquake center. The intensity of groundshaking at a particular site is a function of several factors, including: maximum ground acceleration, magnitude of the earthquake, near surface amplification, distance from earthquake center, duration of strong shaking, and natural vibration period.

The primary effect of ground shaking is the damage or destruction of buildings and infrastructure, and the potential for loss of life. Building damage can range from minor cracking of plaster to total collapse. Disruption of infrastructure facilities could include damage to utilities, pipelines, roads, bridges, etc. Slope failure, liquefaction, tsunamis, seiches, and dam failure are other geologic hazards that can be triggered by earthquakes and ground shaking. Fires may also occur. Secondary effects include damage caused by these hazards.

Available geologic information indicates that the potential for strong ground shaking in the Indian Wells Valley is high. There is a potential for severe ground shaking to occur as a result of movement along one of the major Valley faults (e.g., Garlock, Sierra Frontal).

The year 1981 ended a 20-year period of seismic quiescence. Recently the months of June and July, 1992 ground shaking occurred when the Indian Wells Valley experienced 21 quakes of ≥ 3.0 magnitude on the Richter scale. No surface expressions of these events have been located. Estimates of ground shaking intensity vary depending on various assumptions about the type of earthquake generating fault movement, attenuation, geologic characteristics of the seismic wave travel paths, and local soil conditions. The U.S.G.S. Open File Report 76-416, 1976, estimates that the horizontal acceleration in rock with 90 percent probability of not being exceeded in 50 years will be about 0.4 g in the Ridgecrest region. It is expected that there will be accelerations in the order of 0.4 to 0.6 g from a magnitude 7-7.5 earthquake on the Sierra Nevada fault. (Data supplied by NAWS from the CAL-TECH/USGS Broadcasting System for Earthquakes.)

Ground shaking from earthquakes is generally characterized by expressing the vibratory ground motion in terms of its acceleration, velocity and displacement parameters in the form of a response spectrum, and by the duration of the shaking. The frequency of the vibration is also very important since high frequencies are generally less damaging than low frequencies. The most damaging frequency band extends between 1 and 10 cycles per second (periods of 0.1 and 1, respectively)

Developing generalized response spectra for the City of Ridgecrest does not appear to be a responsible approach. Each structure to be built should be evaluated individually considering site-specific soil conditions, expected life and use, and acceptable risk factors.

No historically active faults have been recognized in Ridgecrest. However, several faults which have prehistoric movements thought to have occurred in the last 10,000 years pass through the area and could experience displacements in the future. The Little Lake Special Studies Zone is a "sufficiently active" fault zone that warrants special study based on geologic evidence in this area. Seismic activity in the region cannot be entirely ignored. It is estimated that there are 3000 to 5000 small earthquakes (Richter magnitude of ≤ 2) a year in the Valley.

The ground rupture that might be anticipated depends on the nature of the fault movement. The faults in the Ridgecrest area are known, from geologic evidence, to have moved in the past both horizontally and vertically. The movement on any one of these faults during a single displacement episode might be close to one foot, both horizontally and vertically.

Damage from such a movement would include ruptured water, sewage, and gas lines, and ruptured foundations and roadways. In addition, changes in elevation could disrupt hydraulic gradients, thus affecting gravity sewer lines. The width of the zone of ground rupture could reach between a few inches and several feet.

c. Liquefaction Liquefaction is a process by which relatively soft, watery sediments ("soil") may liquefy (lose their solidity) during moderate to intense earthquake shaking. The potential for liquefaction to occur is greatest in areas with loose, granular, low-density soils, where the water table is within the upper 40 to 50 feet of the ground surface.

Liquefaction may manifest itself by the development of cracks in the ground surface, followed by the emergence of water from the ground in the form of sand boils, sand volcanoes, and sand ridges. If quicksand conditions develop as the soil liquefies, buildings and other objects on the ground surface may tilt or sink, and lightweight buried structures may float to the surface.

Extreme settling or subsidence of the ground may result from liquefaction. Ground settlement often occurs differentially because sand and water are seldom removed evenly over broad areas. If the ground surface slopes even very gently, liquefaction may lead to lateral spreading or low angle landsliding of soft saturated soils. This can result in the rapid or gradual loss of strength in the foundation materials so that structures built upon them gradually settle or break up as the foundation soils flow out from beneath them. If liquefaction occurs in a layer of soil below the ground surface, the liquefied layer can act as a slip-plane, similar to ball bearings, and cause large, destructive landslides. This can occur on slopes as gentle as 2.5 percent (U.S. Geological Survey, 1974).

In the Ridgecrest area, the area underlain by ground water at depths of up to about 50 feet should be considered as susceptible to liquefaction. The effects of liquefaction depend on the volume, depth, and extent of the liquefied deposit. Thus, a very deep sand lens that liquified would have less effect than a shallow, thick, liquified layer. Liquefaction may result in ground rupture, differential settlement, and lateral spreading.

The potential liquefaction zone is illustrated in Figure 14-1 for the planning area.

d. Landslides/Mudslides. A landslide is the perceptible downslope movement of earth masses. It is part of the continuous, natural process of the downhill movement of soil, rock, and rock debris. The term is used loosely to encompass downslope creep of soil and rock material to sudden mass movement of an entire hillside. Included as common types of landslides are rockfalls, slumps, block glides, mudslides and earth flows such as debris flows and mud flows. Landslides or slope instability resulting in landslides may be caused by several natural factors including broken or weak bedrock, heavy rainfall, erosion, gravity, earthquake activity, fire, and by human alteration of topography and water content in the soil.

Slope instability that results in landslides can cause substantial damage and disruption to buildings and infrastructure. Some of these losses can include possible loss of life; displacement and destruction of buildings, roadways, and other improvements; blockage of drainage channels; disruption of transportation and communication systems; and the loss and disruption of utilities and pipelines. A secondary effect of the landslide hazard that could have significant impacts in the future are lawsuits initiated against the developers and owners of properties that gave rise to landslides and the governmental review agencies that approved development.

The hillside areas located at the south end of the City and commonly referred to as the "College Heights area" come to mind when discussions of this nature arise. However, the soil conditions and the angle of repose of the slopes in this area are not of the nature associated with this geologic hazard.

e. Subsidence. Subsidence is the sinking of ground surface caused by compression or collapse of earth materials. In addition to those forms of the hazard that occur naturally, four types of subsidence caused by human activity have been identified in California. These are groundwater withdrawal subsidence, oil or gas withdrawal subsidence, peat oxidation subsidence, and hydro-consolidation subsidence. Groundwater withdrawal subsidence, which generally occurs in valley areas underlain by alluvium, is the most extensive and the impacts most costly (California Division of Mines and Geology, 1973).

Groundwater withdrawal subsidence results from extraction of a large quantity of water from an unconsolidated aquifer. As water is removed from the aquifer, the total weight of the overburden, which the water used to help support, is placed on the alluvial structure and it is compressed. If fine-grained silts and clays make up portions of the aquifer, the additional load can squeeze the water out of these layers and into the coarser grained portions of the aquifer. All of this compaction produces a net loss in volume and hence a subsidence of the land surface. Hydroconsolidation subsidence is a peculiar property of some dry unconsolidated porous, semiarid and arid deposits to lose their dry strength and to develop spontaneous settling, slumpage or cracking after wetting.

Damage caused by subsidence is generally not of an immediate or violent nature. The consolidation of alluvium and settling of the land surface is a process that often occurs slowly over many years, except when prompted by seismic shaking or wetting of highly collapsible soils.

Subsidence that results from groundwater withdrawal can be responsible for numerous structural effects. Most seriously affected are long surface infrastructure facilities that are sensitive to slight changes in gradient. Such facilities include wells, canals, sewers, and drains. Hydroconsolidation is one of the most destructive forms of subsidence. Over a relatively short period of time, it can cause severe damage to pipelines, roads, buildings, etc.

In the planning area, no measurable evidence of regional subsidence exists. However the regional water decline in the Ridgecrest area between 1921 and 1987 has been about 80 feet. Ground subsidence can result from soil compaction due to ground water withdrawal and is an irreversible process.

f. Expansive Soils. Expansive soils are soils that are generally clayey, swell when wetted and shrink when dried. Wetting can occur naturally in a number of ways (i.e., absorption from the air, rainfall, groundwater fluctuations, lawn watering, broken water or sewer lines, etc.).

In hillside areas, as expansive soils expand and contract, a gradual downslope movement or creep of the soil material may occur. This downward soil movement may eventually result in a landslide. Clay soils also retain water and may act as a lubricated slippage plane between other soil-rock strata, resulting in a landslide. These types of landslides are often triggered by earthquakes or by unusually moist conditions. Expansive soils are also often prone to excessive erosion.

When structures are placed on expansive soils, foundations may rise each wet season and fall with the succeeding dry season. Movements may vary under different parts of a structure with the result that foundations, walls, and ceilings crack, various structural portions of the building are distorted, and doors and windows are warped so they do not function properly. Signs of soil creep can be seen in such features as curved trees, and tilted fences and telephone poles.

There are no known areas of expansive soils in the hillsides of the planning area. There may be some very local areas of these soil types. (U.S.D.A., Oral Communication, June 1992)

i. Earthquake-Induced Flooding. There are no bodies of water within Ridgecrest and its planning area. The nearest body of water is the North Haiwee Reservoir (NHR) that is maintained by the Los Angeles Department of Water & Power (LADWP). The South Haiwee Reservoir (SHR) was drained as a result of a Seismic Stability Evaluation Report. If the NHR or the SHR earth dams, constructed by the semi-hydraulic-fill method with a clay core, were to be damaged, the flood inundation maps indicate that this would have no effect on the City nor the planning area. (personal communication, Duane D. Buchholz, LADWP)

The Governor's Office of Emergency Services states that if inundation maps do not indicate flood waters reaching a community, the community does not need to prepare a Dam Failure Evacuation Plan, as required by the California Dam Safety Act.

A flood may be defined as a temporary rise in stream flow that results in water overtopping its banks and inundating areas adjacent to the channel not normally covered with water. The flood plain is the relatively flat or lowland area adjoining the stream that is subject to periodic inundation by floodwater.

Floods are usually described in terms of their frequency of occurrence. For example, the 100-year flood is the flood magnitude that has a one-percent chance of being equalled or exceeded in any given year. This type of designation is based on probability and an element of chance is involved. According to statistical averages, a 25-year flood should occur on the average of once every 25 years, but two 25-year floods could conceivably occur in any one year. For planning purposes, the flood magnitude most often used to delineate flood plain boundaries is the 100-year flood.

Flooding is basically a direct response to the amount, distribution, and intensity of precipitation. Most storms are relatively small and do not seriously disrupt people and the land on which they live. Occasionally, however, a storm of great magnitude will occur, causing serious damage and disruption to the landscape and its inhabitants. Historically floods in the area have resulted from local storms. These storms can occur at any time and produce high intensity rainfall for peak durations of approximately six hours or less. Floods have occurred in the Indian Wells Valley in 1961, 1963, 1964, 1969, 1983 and 1984. All have resulted from high intensity local storms.

The magnitude and frequency of flooding events can be influenced by many factors. Natural and artificially-induced changes to the characteristics of the drainage basin and flood plain of a stream or river can have profound effects on the extent and severity of any particular flood. Such changes include the growth of brush, denuding of brush followed by heavy rainfall, impervious surfaces constructed in urbanizing areas and piecemeal channelization.

The primary effect of flooding, where urban encroachment on floodplains has occurred, is the threat to life and property. Floods may also create health and safety hazards and disruption of vital public services. Economic costs may include a variety of flood relief expenses, as well as investment in flood control facilities to protect endangered development.

The extent of damage caused by any flood depends on many factors including: topography of the area flooded, depth, duration, and velocity of the flood-waters, the extent and type of development in the flood plain, and the effectiveness of forecasting, warning, and emergency operations.

As a result of the August 15, 1984 flood, numerous flood improvements have been made by different agencies. This flood was caused by an intense storm centered over southeast Ridgecrest. NAWS's (Naval Air Weapons Station) Engineering Division has estimated that this event was a 60- to 70- year flood. Damages to NAWS were estimated to be $30 million dollars. The City estimated the cost of damages to its facilities at $2.5 million and were reimbursed for $29,000 though FEMA and $145,000 from the State office of Emergency Services. Private property damages in the City limits were reported by residents as $1.7 million.

CalTrans in 1984 placed flood control improvements beneath Highway 178 as part of the road widening program for that highway. They increased the number of 36" culverts from three to five at El Paso Wash approximately 2 miles west of the intersection of North China Lake Blvd and Inyokern Road. Dixie Wash which is 6 miles west of this intersection has three 48-inch culverts. These culverts have been designed for roughly 5-year storms.

As a result of the 1984 floods, the NAWS put into place MILCON P-414 (Military Construction Contract), a drainage correction project, that will divert flood waters from their main facility sites. This includes the diversion of water from the Ridgecrest Wash through a diversion channel at their main entrance. Other on-center flood improvements were done to correct damage from the 1984 flood. These drainage improvements and repairs were completed at an estimated cost of $33 million in 1986. (Oral Communication, Barry Kenady, NAWS, August 1992)

The City of Ridgecrest has constructed one major flood control project and is constructing one temporary project as well. The "Downs Storm Drain Project" that was constructed in mid-1991, is a buried maximum 60" conduit that carries waters from Dolphin Avenue to Bowman Road and from Langley Street to Bowman Road. This project was designed to carry a 25-year storm. Begun in 1990 and continuing to mid 1992, the "Bowman Temporary Retention Basin" project is designed upon completion to consist of 14 basins. The basins were to extend between Downs Street and China Lake Boulevard in the Bowman Road R.O.W with a design storage capacity of 25-30 acre feet. An objective of the series of basins was to capture and retain storm drainage to lessen the downstream impact during a storm event. As typical of a small desert city, the City relies heavily on its system of streets to contain and carry storm and nuisance waters away from residential areas.

The City adopted the "Master Drainage Plan" prepared by James M. Montgomery, Consulting Engineers, Inc in May 1989 (City Council Resolution 89-35), which addresses a watershed area of 135 square miles. This document's information is hereby incorporated by reference and is available for review at Ridgecrest City Hall, 100 W. California Avenue until an EIR is completed that addresses its environmental consequences.

1. Legal Setting. The following Federal, State, and local laws and programs pertain to specific geologic hazards or hazard zones in the City of Ridgecrest. The purpose and plans of each are briefly outlined below.

Alquist-Priolo Special Studies Zones Act. In 1972, the California Legislature enacted the Alquist-Priolo Special Studies Zones Act. The purpose of this Act is to ensure that structures for human occupancy are not built on active faults. It requires a geological investigation for new development meeting specific criteria within designated special studies zones. The Act also requires the State Geologist to delineate special studies zones around all potentially and recently active traces of major faults in California.

The regulation of the State Mining and Geology Board, which governs the Alquist-Priolo Special Studies Zones, provides that:

> "No structure for human occupancy, identified as a project under Section 2621.6 of the Act, shall be permitted to be placed across the trace of an active fault. Furthermore, the area within fifty (50) feet of an active fault shall be assumed to be underlain by active branches of that fault unless and until proven otherwise by an appropriate geologic investigation and submission of a report by a geologist registered in the State of California. This 50-foot standard is intended to represent minimum criteria only for all structures. it is the opinion of

the Board that certain essential or critical structures, such as high-rise buildings, hospitals, and schools should be subject to more restrictive criteria at the discretion of cities and counties. Moreover, it is recommended that a geologic report by a geologist registered in the State of California be required for a single-family dwelling otherwise exempted under Section 2621.6, if that structure lies on or within 100 feet of the trace of a historically active or other known active fault as shown on Special Studies Zone Maps or by more precise or detailed information known to the approving authority."

Section 2621.6 of the Act defines a project as:

"(1) Any subdivision of land which is subject to the Subdivision Map Act, Division 2 (commencing with Section 66410) of Title 7 of the Government Code, and which contemplates the eventual construction of structures for human occupancy.

(2) Structures for human occupancy, with the exception of:
- (A) Single-family wood frame dwellings to be built on parcels of land for which geologic reports have been approved pursuant to the provisions of paragraph (a) of this subdivision.
- (B) A single-family wood frame dwelling not exceeding two stories when such dwelling is not part of a development of four or more dwellings.
  - (b) For the purposes of this chapter, a mobile home, whose body width exceeds eight feet shall be considered to be a single-family wood frame dwelling not exceeding two stories."

(Title 14, California Administrative Code Section 3602 (a)).

A special study zone has been designated in the City. This zone is located on a northwest trend entering the City at the north in the vicinity of the 600 block of East Inyokern Road and follows a southeast trend to the intersection of Dolphin Avenue and Sunland Street where all traces are lost in the desert alluvium. The zone varies in width from approximately 900 to 2000 feet. The boundary of the special study zone is depicted in Figure 14-1; however, this figure is for reference purposes only. The official study zone maps published by the California Division of Mines and Geology depict the precise location of the zone. Development permits are withheld in this zone until a geologic investigation demonstrates that a site is not threatened by surface displacement from future fault movement.

Flood Plain Management

- o Federal Flood Insurance Program. The standards and criteria of the National Flood Insurance Program (NFIP) are directed toward the protection of structures and facilities from flood hazard and the protection of existing development from the effects of new development. Participation in the NFIP requires implementation of the following minimum flood plain management standards. Under the NFIP, residential structures (including basements) are required to be elevated to or above the base flood level (the 100-year flood level). Non-residential structures may be elevated above or floodproofed watertight to or above the base flood level.

For the protection of existing development, the NFIP standard and criteria rely on a regulatory floodway (floodway is the channel of a river or stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100 year flood can be conveyed without substantial increases in flood height). Under the NFIP, no actions are allowed that would have the cumulative effect of increasing the water surface elevation of the base flood more than 1 foot at any point within the community (Federal Register, 1978).

The Federal Emergency Management Agency has designated the flood plain areas on Flood Insurance Rate Maps (FIRM) and Floodway Maps that may be periodically amended by the Federal Flood Insurance Administration. The City of Ridgecrest currently qualifies for and participates in the NFIP.

California Building Standards. Building safety and construction in the City of Ridgecrest is regulated by the requirements set forth by the California Buildings Standards Commission. These building code requirements are periodically updated by the California Buildings Standards Commission and are subsequently amended and adopted by the City as required by §17958 and §18941.5 of the Health & Safety Code. California Building Standards represent the minimum requirements for building safety and construction of earthquake-resistant structures. The City Building Inspection Department requires that in conformance with Code requirements, soil reports be prepared for most new structures used for human occupancy. These soil reports are needed to assess on-site soil conditions for potential geologic hazards. Soil reports for areas where the soils are known to be uniform are sometimes waived upon the determination of the Director of Public Works. For major development projects, such as the construction of critical facilities or uses that will have large occupant loads, geologic investigations are required to assess the potential impacts of earthquake-related ground shaking at the site. (City of Ridgecrest, Chief Building Official)

Disaster Preparedness Plans. The City of Ridgecrest has adopted and maintains a comprehensive Emergency Preparedness Plan that addresses the City's planned response to extraordinary emergency situations associated with natural disasters, hazardous material incidents, and nuclear defense operations. It provides operational concepts relating to the various emergency situations (i.e., earthquake, airplane crash, flood), identifies components of the Local Emergency Management Organization, and describes the overall responsibilities of the organization for protecting life and property and assuring the overall well-being of the population. The plan also identifies the sources of outside support which might be provided (through mutual aid and specific statutory authorities) by other jurisdictions, State and Federal agencies, and the private sector. This plan has been reviewed and approved by the California Office of Emergency Services. Regional and State-wide coordination of disaster relief operations and resources would be the responsibility of the County Office of Emergency Preparedness and the California Office of Emergency Services.

14.2 MINERAL RESOURCES

The primary mineral resource in the planning area is aggregate (sand and gravel). Clay and expansible shale and other minerals may also be present. However, because they are not recognized as being of statewide or countywide significance, they are not specifically addressed in this document.

Aggregate is a significant type of mineral resource extracted within the county. Aggregate includes sand, gravel and rock material and comprises the basic ingredients for a large variety of rock products including fill, construction-grade concrete and riprap. There are no extraction sites in the planning area.

The Surface Mining and Reclamation Act (SMARA) of 1975 has two basic objectives. One is to safeguard access to mineral resources of regional and statewide significance in the face of competing land uses and urban expansion, and the other is to ensure the proper reclamation of surface mining operations. The SMARA references mineral resources in general; however, the only resources that the State has surveyed are aggregate resources. The survey process involved two phases. The first phase consisted of the "Classification" of areas containing significant mineral deposits which are threatened by land uses incompatible with or which would preclude mining. The second phase of the survey process if referred to as "designation" and is the formal recognition by the State Mining and Geology Board of areas containing mineral deposits of regional or statewide significance which should be protected from land uses incompatible with mineral extraction. To ensure proper reclamation of mining sites, the SMARA requires all jurisdictions in which mining occurs to adopt a reclamation ordinance and have it certified by the State Mining and Geology Board (Sec. 2774.3(a) SMARA).

SMARA also mandates that:

> "Within 12 months of the designation of an area of statewide or regional significance within its jurisdiction, every lead agency shall, in accordance with state policy, establish mineral resource management policies to be incorporated in its general plan which will:

a. Recognize mineral information classified by the State Geologist and transmitted to the Board.

b. Assist in the management of land use which affects areas of statewide and regional significance.

c. Emphasize the conservation and development of identified mineral deposits." (Section 2762(a) SMARA)

14.3 IMPACT ANALYSIS

14.3.1 Significance Thresholds for Geologic Hazards

a. First Tier Impact Analysis. A geologic hazard is determined to have a significant impact when an unacceptable number of people and facilities are exposed to the hazard in an identified hazard zone. In other words, when the level of risk to people and structures is perceived to be too high, the threshold is exceeded. Local, state and federal government hazard policies and regulations for development in hazard zones provide the general definitions of what acceptable levels of risk are presently perceived to be.

Specific thresholds cannot be identified in this analysis because the data upon which this study is based are highly generalized. It is not possible to determine whether acceptable levels of risk are exceeded because the specific type of development and population density that could occur in each hazard zone cannot be identified from the data and maps available from the City for each alternative. Also, the hazard potential maps and descriptions are extremely generalized. Therefore, in this analysis, areas of proposed development that are within the generalized high hazards zones will be identified as areas where potentially significant impacts may occur. Activities associated with the proposed development that could have potentially significant impacts on geologic hazards (i.e., subsidence, fault displacement) will also be identified.

b. Second Tier Impact Analysis. Significance thresholds are most appropriately identified during detailed studies and during the site specific project planning and review stages of the development process. More detailed and accurate hazard information should be gathered at that time. It could then be determined if an acceptable level of risk is exceeded by development of a specific project in a particular hazard area. The threshold would be exceeded if the project did not meet the development criteria or standards defined for that type of hazard zone by local, state or federal hazard policies or regulations.

14.3.2 Geologic Hazards

a. Construction-Related Soil Erosion (Short-Term Impact). During the construction phase of development for all of the alternatives, vegetation removal and disruption of soil cover by vehicle movements and excavations is expected to cause an increase in temporary soil erosion and siltation of drainage areas and retention basins. Local weather, topographic and soil conditions will all affect the extent to which erosion occurs.

Hillsides are particularly prone to erosion during construction due mainly to steep slope conditions. Under Alternatives 1, 2, and 3, erosion in the hillside areas may occur during development resulting in loss of soil, siltation of channels and basins and property damage.

Construction-related soil erosion is a short-term impact. As development continues to cover over the soil the rate of erosion is expected to decrease to approximately the same order as prior to development.

b. Fault Displacement

Common Impacts. The Alquist-Priolo Special Studies Zone encompasses the Little Lake fault zone, which exhibited minor ground cracking with a M5.2 earthquake occurring in 1982 and has an average indicated slip rate of 0.6 mm per year. Much of the northern portions of this zone have been previously overbuilt. However, Alternatives 1, 2 and 3 would result in new residential development within the Alquist-Priolo Fault Rupture Special Studies Zone. All new development in this zone is subject to the constraints of the Alquist-Priolo Special Studies Zones Act.

Development under each alternative is also proposed in areas atop fault traces of active or potentially active faults. (Refer to 14-1 in the Safety Element for approximate location of fault traces.) A fault displacement hazard exists in these general areas. It is impossible to accurately identify zones of risk at this time because the location and activity of the potentially active faults are primarily conjectural in alluvium.

Permanent effects of fault displacement include abrupt elevation changes (up or down) of the ground surface along the fault, alteration of surface drainage patterns, changes in groundwater levels in wells, dislocations of street alignments and property lines, and a permanent change in grade of sewer and water utilities. Secondary effects of ground displacement could include the disruption of traffic and emergency vehicles due to road and bridge destruction, flooding due to the disruption of surface drainage, and the disruption of vital utilities and community services.

Alternative 1 and 2. Development of low density residential lands is proposed in the Little Lake Alquist-Priolo Special Studies Zone in the vicinity of Sunland Street and Upjohn Avenue.

The geologic report submitted for the southeast corner of this intersection has stated that no trace of the Little Lake Fault could be found. The majority of this zone has been developed.

Alternative 3. This alternative would see all lands within the present City limits and its sphere of influence completely developed. Lands to be developed within the Little Lake Alquist-Priolo Special Studies Zone will be subject to geologic studies prior to development.

No Project. This no-project alternative would see limited additional growth and development proposed within the Little Lake Alquist-Priolo Special Studies Zone.

c. Earthquakes and Groundshaking. Groundshaking resulting from a strong earthquake is a substantial regional hazard potentially affecting the entire planning area. It is one of the most difficult seismic hazards to predict and quantify. Groundshaking is also considered to pose a greater threat to the City than fault displacement.

The primary effect of groundshaking is damage or destruction to buildings and infrastructure and thus the potential for loss of life. Secondary effects are damages caused by earthquake triggered hazards such as landslides, dam failure, and fires.

The actual impact groundshaking would have on the proposed development is dependent on several factors including: number of people exposed, the density distribution of the population, local intensity and ground vibration conditions, and building/infrastructure design and structural integrity. The increase in population proposed under each alternative increases the hazard potential because more people are potentially exposed to the hazard.

Available geologic information indicates that the potential for strong ground shaking in the planning area is high. The potential for severe ground shaking to occur as a result of movement along one of the major California faults (e.g., the San Andreas and the Garlock) could result in significant ground shaking related damage throughout the City.

Table 14-1 lists the major faults within 100 km of Ridgecrest which either have been historically active or show evidence of Quaternary (within last 2 million years) movements and are considered to pose a groundshaking hazard to Ridgecrest.

The Ridgecrest Planning area has felt ground shaking from earthquakes in Yucca Valley, Big Bear, and Whittier to name a few over the past five years. The Indian Wells Valley experienced earthquakes to a magnitude of 4.7 as a result of the events of June/July 1992. There has been no evidence of surface expression of these latest quakes and no reports of structural damage. Table 14-2 gives a listing of Earthquakes felt in the Ridgecrest Planning Area, their magnitude and their locations. (Data supplied by NAWS from the CAL-TECH/USGS Broadcasting System for Earthquakes [CUBE].)

Alternativea 1 and 2. Development of low density residential lands is proposed in the Little Lake Alquist-Priolo Special Studies Zone in the vicinity of Sunland Street and Upjohn Avenue. The geologic report submitted for the southeast corner of this intersection has stated that no trace of the Little Lake Fault could be found. The majority of this zone has been developed.

Alternative 3. This alternative would see all lands within the present City limits and its sphere of influence completely developed. Lands to be developed within the Little Lake Alquist-Priolo Special Studies Zone will be subject to geologic studies prior to development.

Alternative 4. This no-project alternative would see limited additional growth and development proposed within the Little Lake Alquist-Priolo Special Studies Zone.

d. Liquefaction. Under each of the alternatives little development is proposed within the generalized boundaries of the liquefaction zone. The liquefaction hazard zone approximate location is shown in Figure 14-1 This area is generally underlain by groundwater at a depth of up to 50 feet. The affects of liquefaction depend on the volume, depth, and extent of the liquified deposit. The alluvial and lake deposits of this area contain sand and silt layers, which if relatively clean and loose could liquefy when subjected to strong ground shaking.

The primary impact of liquefaction is destruction of property. Buildings and other objects on the ground surface sink, tilt, and collapse as the foundations beneath them liquefy, and lightweight buried structures may float to the surface. In general, the taller the structure the more susceptible it is to damage.

The proposed development in the liquefaction for each alternative is described below. The type and density of proposed development is also mentioned where possible.

Alternatives 1, 2 and 3. Proposed development in the liquefaction zone consists of: commercial development, low-density residential and medium density residential in the area north of Drummond Avenue and east of China Lake Boulevard which is within the City planning boundaries. The majority of the identified liquefaction zone is located within the boundaries of the Naval Air Weapons Station, China Lake over which the City has no planning jurisdiction.

Alternative 4. The no project alternative would likely see no development within the liquefaction zone.

TABLE 14-1

SIGNIFICANT FAULTS WITHIN 100 KM OF RIDGECREST

NAME	DISTANCE AND DIRECTION FROM RIDGECREST	ACTIVITY LEVEL	HISTORICAL SEISMICITY	MAXIMUM CREDIBLE EARTHQUAKE
Owens Valley	75 km NNW	Active 1872	1872 M=>8.0	> 8.0
Panamint Valley Fault Zone	50 km ENE	Quaternary	-	7.5
Death Valley Fault Zone	90 km NE	Quaternary	-	7.5
Garlock	18 km SE	Quaternary	1974 M=4.3?	8.0
Blackwater	30 km SE	Quaternary	-	6.8
Harper Fault Zone	35 km S	Quaternary	-	7.0
Lockhart	46 km SSW	Quaternary	-	7.5
Cantil Valley	37 km SE	Active	1971(?)	6.5
Helendale	87 km SSE	Quaternary	-	-
White Wolf	81 km SW	Active	1952 M=7.7	8.0
Kern Canyon	70 km WNW	Quaternary	-	6.8
Sierra Nevada	19 km W	Active	-	≥ 8.0
Little Lake Fault	0 km	Active	1982	6.5
Airport Lake Fault Zone	3 km N	Active	-	7.4
Faults in Indian Wells Valley	0 to 30 km	Quaternary to Active	Numerous 1992 M≤5.4	7.0 to 7.5

TABLE 14-2

EARTHSHAKING EXPERIENCED IN THE INDIAN WELLS VALLEY

Date	Richter Magnitude	Location
July 4, 1972	4.0	NAWS
January 2, 1974	4.2	NAWS
June 14, 1979	4.6	NAWS
April 19, 1981	4.4	NAWS
March 1, 1982	4.2	NAWS
March 7, 1982	4.5	NAWS
March 8, 1982	4.0	NAWS
April 25, 1982	4.0	NAWS
September 29, 1982	4.2	NAWS
September 30, 1982	4.1	NAWS
October 1, 1982	4.9	NAWS
August 16, 1985	4.2	NAWS
May 23, 1986	4.1	NAWS
December 20, 1991	4.1	NAWS
January 12, 1992	4.1	NAWS
February 19, 1992	4.1	NAWS
April 27, 1992	4.0	NAWS
June 10, 1992	4.1	NAWS
June 28, 1992	7.5	Landers
June 28, 1992	6.6	Big Bear
June 30, 1992	4.7	NAWS
July 1, 1992	4.4	NAWS
July 2, 1992	4.1	NAWS
July 2, 1992	4.0	NAWS
August 22, 19924.5 NAWS	4.5	NAWS

• (CUBE)

g. Landslides/Mudslides

Common Impacts. Landslides/slope failures are probably the single most important hazard affecting potential development in hillside areas. Soil, geologic and engineering studies of the College Heights development indicate that conditions do not exist for landslides or mudslides.

The impacts of landslides and other forms of slope failure may include substantial damage and disruption to buildings and infrastructure. If the movement of earth and debris is rapid, unexpected loss of life could result.

Alternative 1,2 and 3. Over 640 acres of land in the College Heights Area would be developed as residential within the planning area for the community.

Alternative 4. This alternative would result in little or no development in the College Heights area.

h. Soil Subsidence

Common Impacts. There are currently no visible signs of subsidence within the planning area. Continued extraction of fluids from this general area may increase the likelihood of subsidence. The Indian Wells Valley Water District has not pumped the "Ridgecrest Field" since the early 1980's. This area is located in the vicinity of Ridgecrest Boulevard and Norma Street.

Damage caused by subsidence occurs over a long period of time except when prompted by seismic shaking or wetting of highly collapsible soils. Loss of life would probably occur only as a secondary effect of subsidence, possibly the result of flooding. Drainage courses, wells, and utility lines are potentially the most vulnerable to damage.

Alternative 1,2 and 3. The Ridgecrest Field is currently overcovered with residential development. No further development would occur in this area.

Alternative 4. This alternative would see little or no development within the planning area.

i. Expansive Soils. Expansive soils may contribute to downslope creep, landslides and erosion. the seasonal expansion and contraction of soil may cause foundations, walls, and ceilings to crack and various structural portions of buildings to warp and distort.

Soil and geologic studies of the planning area indicate that there are no expansive soils in the area.

j. Flooding. Primary effects of flooding include injury and loss of life, damage to structures caused by swift currents, debris, and sediment, disruption of communication and transportation facilities, severe erosion, loss of vegetation and crops from sediment deposition, health hazards from ruptured sewage lines and damaged septic tanks, and the disruption of utilities and vital public services.

Secondary effects of flooding place a burden on local and national taxpayers and resources. Evacuation relief and flood-fighting services, clean-up operations, and the repair of public facilities are paid for by the public. The construction and maintenance of flood prevention and control facilities are also paid for by taxpayers.

The extent of damage caused by any flood depends on the topography of the area flooded, depth and duration of flooding, velocity of flow, rate of water rise, the extent of development and land use on the flood plain, the sediment load deposited by the flood, and the effectiveness of forecasting, warnings, and emergency operations.

The 100-year flood hazard in the planning area is located within areas that have been identified in all planning efforts as not to contain structures for human domicile or work activity.

The 100-year to 500-year flood inundation area covers the majority of the planning area. Development is usually not restricted in this zone because the level of risk is considered extremely low.

No property located within the 100-year flood plain is proposed for residential or commercial development under any of the alternatives. Any proposed development within the City's 100-year flood plain has been designated for future park and recreation use. These uses significantly reduce the damage potential of floods.

1. Dam Inundation. There is only one dam that upon failure, could bring flood waters within the vicinity of the planning area. As has been noted earlier this dam (South Haiwee Reservoir) has not been utilized by LADWP for several years.

The dam inundation maps prepared by the dam operators are intended as a worst-case scenario for use by local agencies for emergency preparedness in the event of an unlikely disaster causing dam failure. Although such a catastrophic event is in the realm of possibility, it is not considered a probable occurrence.

14.3.4 Significance Thresholds for Mineral Resources

a. First Tier Impact Analysis. No significant impact on primary mineral resources will result if development occurs within the planning area. There are no mineral resources currently being actively developed or extracted. As such any impact by proposed development under each alternative has no effect upon mineral resources.

b. Second Tier Impact Analysis. No potentially significant impacts to mining activities on the surrounding environment, existing land use and future land use will occur in the resource areas proposed for urban development. No known active mineral resources occur on the area, therefore impacts to potential mining operations are not likely to occur. If mineral resources were to be discovered in the future the specific impacts would need to be determined on a case-by-case basis at the time specific permit applications, for mining activities and other projects that would be reviewed by the City and/or county, are submitted.

14.3.5 Mineral Resources

No known vital and valuable mineral resources exist within the planning area. There are no foreseen potential impacts associated with mineral resources. Development activities would not obstruct or hamper access to the resources. No environmental impacts would result from mineral extraction and processing.

Pursuant to the objectives of SMARA, the City would be required to adopt policies that would prohibit additional development of incompatible uses adjacent to or within mineral resource, except in those areas already committed to other uses. The objectives of SMARA are to safeguard access in the face of competing land uses and ensure proper reclamation of mineral land. Because there is already incompatible existing development from mining operations would be addressed on a project specific basis. Implementation of the SMARA objectives would prevent incompatible land uses from being developed in the mineral resource area. Therefore, direct obstruction of access to aggregate resources is not a potentially significant impact.

Any mineral extraction activities that may occur or be proposed outside the planning area should be addressed on a project specific basis. Mineral resource extraction and processing may cause adverse environmental impacts during and after extraction operations on the environment and nearby land uses. Appropriate regulation through environmental safety and reclamation laws or policies should mitigate or prevent many of the impacts of extraction activities. Specific impacts associated with individual mining projects should be identified and mitigated, in accordance with CEQA, during the environmental review and permitting process.

14.4 MITIGATION MEASURES

14.4.1 Geologic Hazards

a. Construction-Related Soil Erosion. As a condition of approval of a development permit, the City Building and Public Works Division and/or Planning Division should require the developer to implement the pertinent erosion control measures below or other erosion control measures where appropriate for development projects (Alternatives 1,2 and 3) and any other project sites where an erosion problem is identified.

- o Use of approved dust palliatives on areas not to be constructed immediately after grading;
- o Seeding and mulching of bare surfaces;
- o Building permits must be drawn within 30 days of issuance of a grading permit; and
- o Soil must be wet prior to grading;
- o Grading must cease during wind conditions that exceed 30 mph.

Residual Impact. The potential impacts of construction-related soil erosion would be reduced to an acceptable level for all the development alternatives by implementation of the above mitigation measures.

b. Fault Displacement

Alquist-Priolo Special Studies Zone. The fault rupture hazard within the Alquist-Priolo Special Studies Zone for Alternatives 1, 2 and 3 is mitigated by the following measures:

- o Continued enforcement of the requirements set forth in the Alquist-Priolo Special Studies Zone Act of 1972. The City requires the developer of any structure (except where narrow exemption standards are met) proposed within the Alquist-Priolo Special Studies Zone to have a geologic investigation as part of the development review process. The structure(s) proposed must be shown to be at least 50 feet from any trace of the fault and development within 50 feet of the fault trace must be limited to outdoor uses and to structures not intended for human occupation.
- o The City should require the developer to pay for a review of the required geologic investigation by a certified expert chosen by the City in order to determine the

sufficiency of the evaluation prior to project approval.

- Continued cooperation by the City with State officials (California Division of Mines and Geology) regarding ongoing studies and redefinition of the Alquist-Priolo Special Studies Zone(s) located in the City. For example, have site specific geologic investigations on file and available to researchers.

- City promotion and encouragement of additional pertinent geologic and seismic investigations in the City by Federal, State, and local agencies.

Residual Impact. Implementation of the above mitigation measures would reduce the risk of fault rupture under any of the development alternatives to an acceptable level.

Active Faults and Potentially Active Faults Without Alquist-Priolo Designations. The fault rupture hazard to proposed development in the vicinity of inferred potentially active faults is currently considered to be acceptable. However, the following additional mitigation measures are recommended.

- City should require the developer of critical service structures (hospitals, fire stations, police stations, etc.) to have geologic investigation conducted by geotechnical or engineering geologist to show structures are 50 feet from active (not currently designated as Alquist Priolo Special Studies Zones) and potentially active fault traces.

- City should cooperate with and encourage federal, state and local seismic and geological studies in the City to better define level of risk and location of faults in the City. This could possibly include having the City geologist coordinate information and act as liaison between researchers and the City.

- City should require all development within areas of active or potentially active fault zones to complete a geologic investigation conducted by geotechnical or engineering geologist to determine extent and remedies required of geologic hazards.

Residual Impact. The hazard level associated with potentially active faults is currently acceptable, and would continue to be acceptable under the development alternatives.

c. Earthquakes and Groundshaking. The following mitigation measures would reduce the potential impacts of groundshaking.

- The City should review and update its Emergency Preparedness Plan and undertake periodic disaster preparedness exercises in cooperation with appropriate state and federal agencies.

- o The City should identify all hazardous buildings in the community.

- o The City should develop a hazardous building abatement ordinance, and retrofit older structures to improve seismic safety or demolish the structures if retrofitting is not feasible. This should be imposed gradually, encouraging or requiring those structures that are the most dangerous and have the highest occupancies to undergo retrofitting first.

- o The City should require, as part of the permit review and approval process, that critical service structures be able to withstand groundshaking from the maximum credible earthquake and still be operational.

- o The City should adopt building and grading ordinances that are as stringent or more stringent than those contained in the most up-to-date Uniform Building Code for groundshaking and other related hazards.

- o Initiate a program where City and Kern County provide mutual aid building inspector services after an earthquake or other major disaster. This program establishes a means to provide rapid and efficient evaluations of structures after a disaster to determine if buildings are safe for occupancy.

Residual Impact. The above mitigation measures would reduce the potential impact of groundshaking under the development alternatives to an acceptable level for this seismically active region. The hazardous building abatement ordinance to retrofit or demolish seismically unsafe structures could have potential adverse impacts on the historical integrity of historic structures, such as the tufa stone structures or " Old Kern County Fire House".

d. Liquefaction. The following mitigation measures would reduce the hazard potential associated with liquefaction.

- o The City should continue to require that adequate geologic and geotechnical engineering evaluation reports are prepared where deemed appropriate during planning and environmental review or by the Building Official. All reports should be prepared by registered geotechnical engineers or engineering geologists and reviewed by an expert selected by the City prior to project approval. The reports should demonstrate that hazardous conditions such as liquefaction do not exist or can be overcome by site preparation work or engineering design.

Residual Impact. The above measures would reduce the risk of this hazard under the development alternatives to an acceptable level.

e. Landslides/Mudslides. No lands within the planning area have been discovered to be subject to this hazard. If lands subject to this hazard are discovered the following mitigation measures should be applied.

- o Adopt policies and standards for drainage, grading, site design and landscaping requirements as a set of development guidelines and/or incorporate them in the City zoning ordinances "Hillside Management Program", where appropriate. Economic feasibility and aesthetic acceptability of guidelines and measures must be evaluated prior to adoption.

- o Building and grading ordinances as or more stringent than those contained in the Uniform Building Code should be adopted by the City for identified slope failure hazard areas. The ordinances should be periodically reviewed to ensure application of current state-of-the-art policies.

- o Geologic and geotechnical engineering reports for hillside construction should be prepared as required by a "Hillside Management Program" and submitted to the Building Official. They should demonstrate that all identified hazards can and will be mitigated. The mitigation measures should also be shown to be economically feasible. Reports should be reviewed by the City at the applicant's expense for technical adequacy and any aesthetic implications the project or mitigation measures may have on the area.

- o Whenever a landslide moves significantly or damages a foundation or structure, the City should prepare, or cause to be prepared, a detailed study of the geologic materials, foundations, or structures involved. This information should be made available to the general public for future use.

- o After a major earthquake, inspections of hillside areas should be conducted by a registered geologist to identify any potential landslides that could be triggered by aftershocks.

- o The City should implement a Geologic Hazard Abatement District in the hillsides in which the cost of studies and corrective work is shared by all affected property owners and prospective developers.

Residual Impact. Implementation of the above mitigation measures should reduce the hazard potential under the development alternatives to an acceptable level.

f. Soil Subsidence. The following mitigation measures should be implemented by the City.

- o Establish a program as soon as feasible to identify subsidence rates within the City and monitor extraction of fluids. Limit extraction if it is perceived to increase the rate of subsidence.

- o The building official should require special provisions be made in foundation design and construction for high risk structures (i.e., high density residential development, structures of high foundation and lateral pressure such as tall buildings, and critical facilities) in areas with hazardous subsidence rates.

- o Routine required site specific geotechnical engineering studies should identify the presence of collapsible soils and identify appropriate mitigation measures for potential hydrocompaction.

Residual Impact. The above mitigation measures would reduce the potential subsidence impact under the development alternatives to a level generally considered acceptable.

g. Expansive Soils. The following mitigation measures should be implemented by the City upon the discovery of expansive soil types.

- o Continue to require that adequate soils, geologic and structural evaluation reports are prepared when deemed appropriate by the Building Official. All reports should demonstrate that all identified hazards can and will be mitigated. They should be prepared by registered soils engineers, engineering geologists and/or structural engineers. The report should be reviewed by the City at the applicant's expense.

- o Continued enforcement of relevant ordinances contained in the Uniform Building Code. Adopt updated versions as appropriate.

Residual Impact. The above mitigation measures would reduce the potential impact of expansive soils under the development alternatives to a level of insignificance.

j. Flooding. the following mitigation measures should be implemented by the City:

- o Prepare and adopt an E.I.R. for the City Master Drainage Plan prepared by

Montgomery & Associates so that this technical document can be utilized to its fullest capacity.

- o Require implementation of the flood control designs proposed by the City Master Drainage Plan in all new development.

- o Enter into a Joint Powers Agreement (JPA) with Kern County to develop a valley wide flood control program.

- o Enter into a Joint Powers Agreement (JPA) with Kern County to develop a valley storm drainage control program.

- o Continued participation in the Federal Emergency Management Agency's National Flood Program to qualify for federal insurance and relief programs.

- o Review and update the City Emergency Preparedness Plan annually or semi-annually and undertake periodic disaster preparedness exercises in cooperation with appropriate state and federal agencies as soon as feasible.

Residual Impact. The above mitigation measures would reduce the flooding hazard under the development alternatives to an acceptable level.

k. Dam Inundation. As the only reservoir that could have dam failure is empty the following mitigation measure is only for future use.

- o Continue emergency preparedness planning by the City to provide evacuation plans, improve response to disaster, and provide disaster recovery measures.

Residual Impact. Impacts are reduced to an acceptable level by the mitigation measure above.

14.4.2 Mineral Resources

a. Obstruction of Access. The potential for obstruction of access to mineral resources by buildout under any alternative would be mitigated by implementation of the following measures by the City:

- o For aggregate or mineral resources:

  -- If the City were to annex a resource area, then the City should adopt a

Mineral Resource Management Program and implement the basic objectives of SMARA. The intent of SMARA includes allowing only compatible land uses in or adjacent to resource areas and providing sufficient access for equipment.

Residual impact. The above mitigation measure should reduce the potential impacts of obstructed access to mineral resources to less than significant. However, the level of impact would ultimately be determined by the actual mineral resource protection policies and regulations adopted, the effectiveness of implementation and enforcement, and City action to prohibit incompatible land uses in or adjacent to resource areas.

b. Resource Extraction. The City should implement the following measures to mitigate potential adverse environmental impacts associated with resource extraction:

- o Prior to the annexation and development of any mineral resource areas, the City should adopt goals, policies, programs, and ordinances regulating mineral resource extraction.

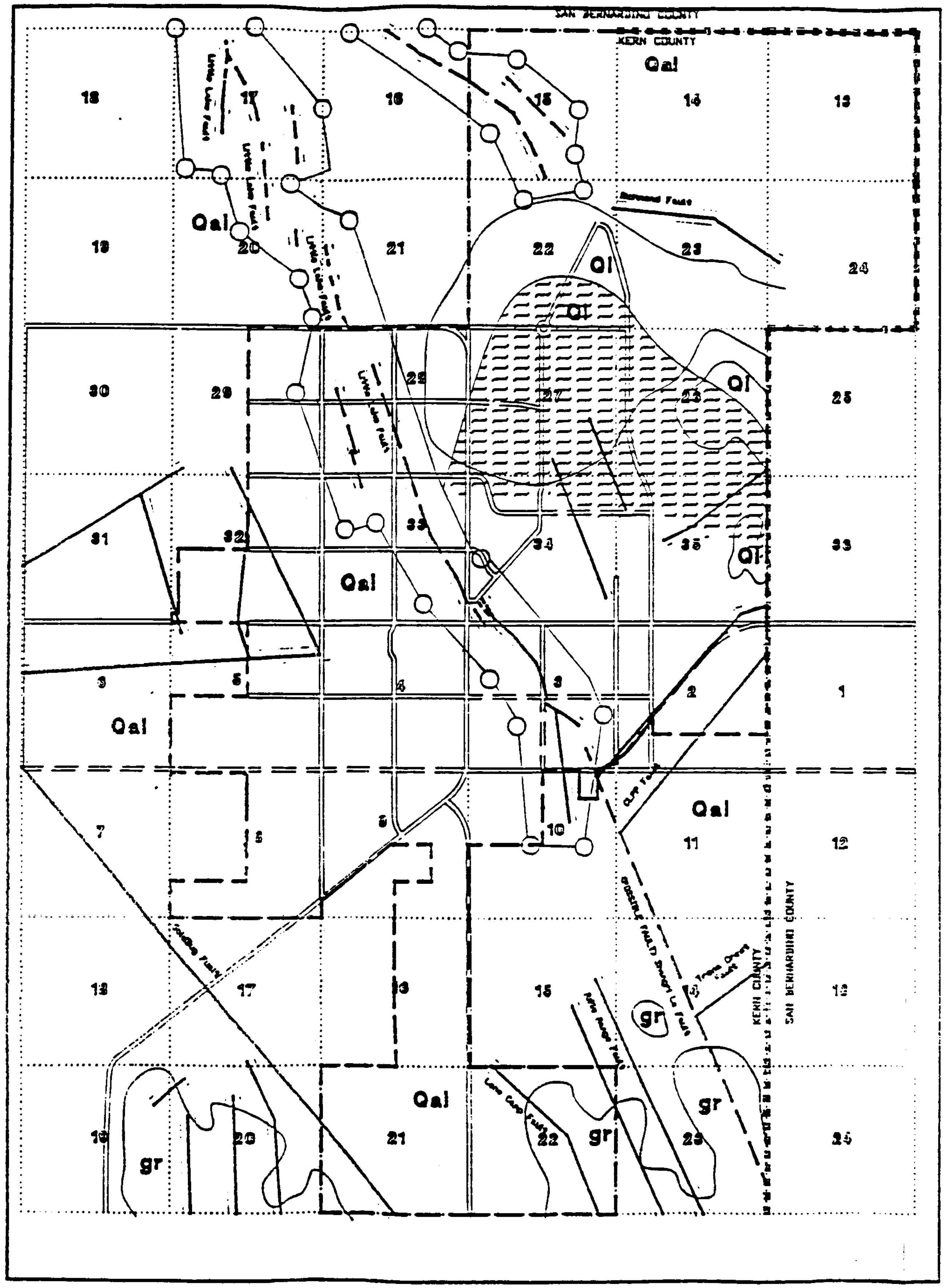
- o A major objective of SMARA is to achieve proper reclamation of mining sites. If mineral resource areas are annexed to the City, the City should implement goals, policies and programs that satisfy this objective.

- o All new mining development projects should be reviewed for their specific environmental impacts in accordance with CEQA.

- o The City should require an applicant for a specific project to locate any on-site or nearby abandoned well sites as a condition of approval of a development permit.

- o Any project or structure to be located over or in the proximity of an abandoned well must be approved by the State Division of Oil and Gas. Reabandonment may be required. If construction over an abandoned well is unavoidable, an approved gas venting system over the well is recommended by the State Division of Oil and Gas.

Residual Impact. Implementation of the above mitigation measures is anticipated to reduce impacts associated with mineral extraction to less than significant.



RIDGECREST GENERAL PLAN

Ridgecrest, California

GEOLOGY AND SEISMIC HAZARD

LEGEND

SEISMIC FACTORS

- Active or Potentially Active Fault Trace(Approximate Location)
- 200 - Foot Study Zone
- Possible Fault Extention
- Potential Liquefaction Hazard

GEOLOGIC FACTORS

- Qal Recent Alluvium
- Ql Quaternary Lake Deposit
- gr Mesozoic Granitic Rock
- Alquist Priolo Special Study Zone

Sources:

- -St. Amand and Roquemore, 197?
- -Earth Sciences Associates Inc., 1979.
- -U.S.G.S., Warner, 1975.
- -DMG, Trona Sheet, 1965.
- -Updated May 1981 Using Geologic Reports on File With The City.
- -DMG, Fault Rupture Hazard Zones in California, 1988

SCALE

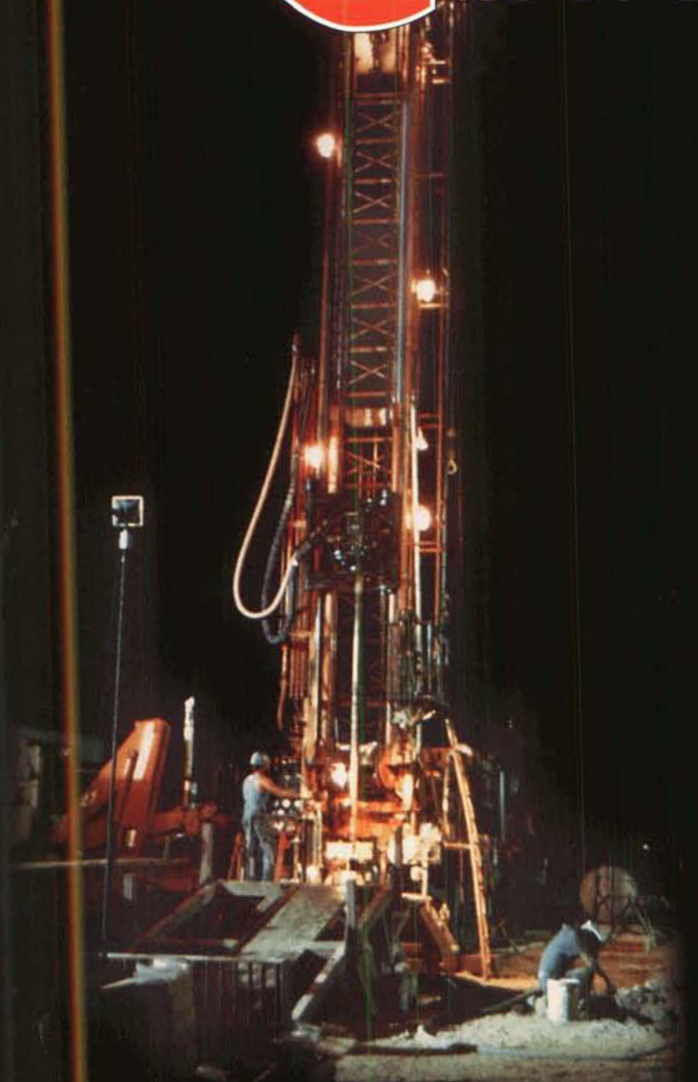
FEET 0 500 1000 2000 4000

NORTH

Drafted By
Data Map Systems, Inc.
100 E. Dolphin AVE.
Ridgecrest CA 93555
(619) 375-7798

FIGURE 14-1

INDIAN WELLS VALLEY GROUNDWATER PROJECT



VOLUME I

SUMMARY REPORT

DECEMBER 1993

WATER RESOURCES MANAGEMENT ...FOR THE FUTURE

Department of the Interior
Bureau of Reclamation

OUR MISSION

To manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Indian Wells Valley Water District
P.O. Box 399
Ridgecrest, CA 93556
1-619-375-5086

DISCLAIMER

Publication of the study results presented herein should not be construed as representing either the approval or disapproval of the commissioner of the Bureau of Reclamation or the Secretary of the Interior.

The purpose of this document is to provide the Indian Wells Valley community with information concerning groundwater resources and to provide optional implementation plans for future development.

INDIAN WELLS VALLEY GROUNDWATER PROJECT

A cooperative effort among
the Bureau of Reclamation,
the Indian Wells Valley Water District,
the North American Chemical Company,
and the Naval Air Weapons Station

SUMMARY REPORT

Prepared By
Bureau of Reclamation
Lower Colorado Region

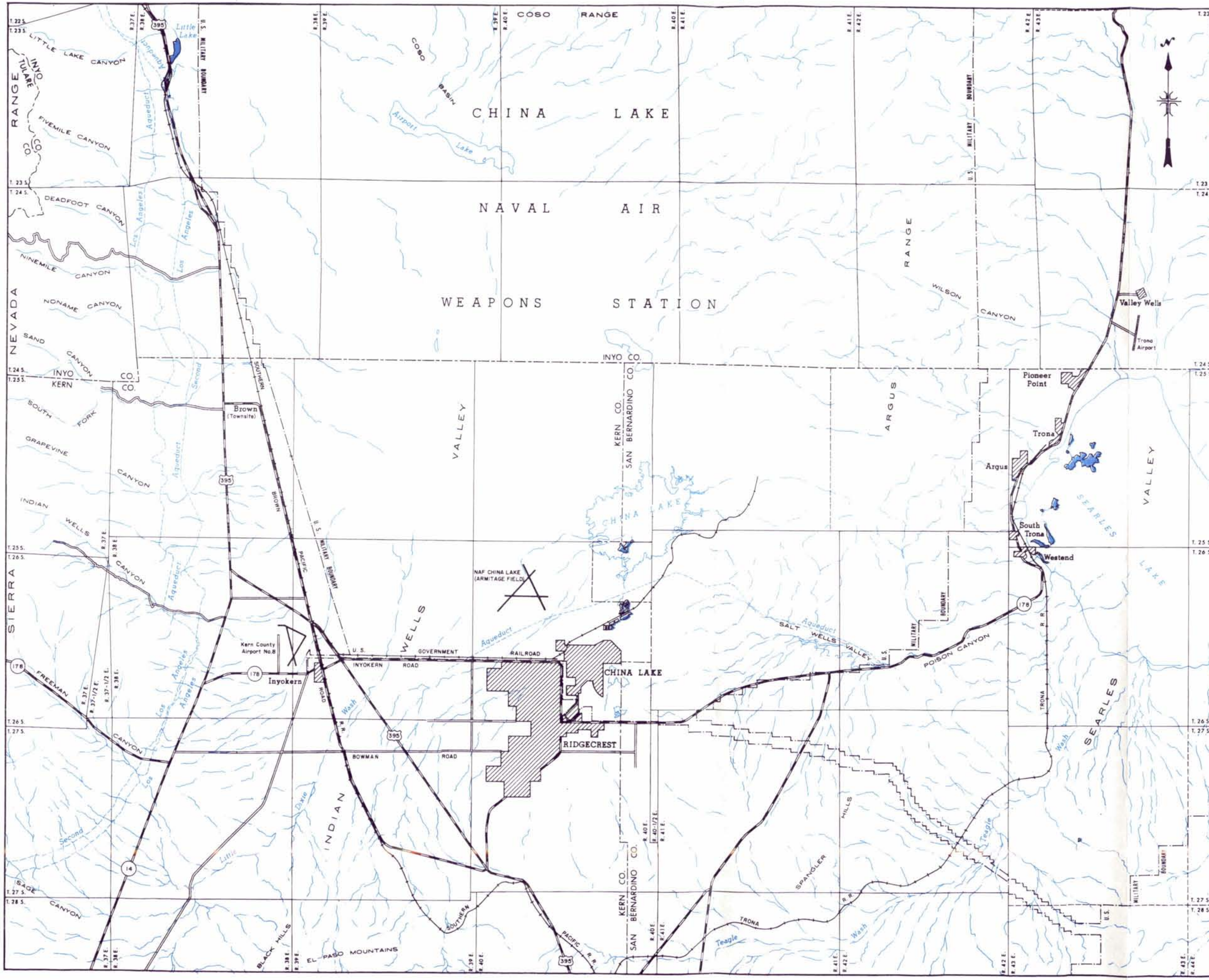
December 1993

PREFACE

Documentation of the Indian Wells Valley Groundwater Project is contained in two report volumes. Volume I, the Summary Report, is intended for a general audience. It contains an explanation of the administrative, institutional, and financial aspects of the Project; a description of Project activities; and a non-technical presentation of Project activity results, conclusions, and recommendations.

Volume II, the Technical Report, is intended for a technical audience. It provides all of the technical details concerning the test wells, data collected, data analysis, groundwater modeling, and recommendations for future investigations. Technical discussion on groundwater recharge quantities, recharge distribution, pneumatic slug testing, and a hypothesis for the anomalously low transmissivites found in many of the shallow piezometers are appended to this volume. Also included in this volume, are all of the data collected as part of this Project.

Mr. John A. Johnson, civil engineer in the Bureau of Reclamation's Lower Colorado Regional office in Boulder City, Nevada, was the primary author of Volume I, while Mr. Dennis E. Watt, hydrologist for the Bureau of Reclamation in Boulder City, was the principal contributor to Section A of Volume II. Section B of Volume II was done by personnel in the Bureau of Reclamation's Denver office in Denver, Colorado. Mr. Leslie Pehrson, an engineering intern in the Bureau of Reclamation's Boulder City office, performed the calculations in Section C of Volume II. Mr. Gail F. Moulton, chief geologist for the North American Chemical Company of Trona, California; Mr. Michael D. Stoner, geologist with the Naval Air Weapons Station at China Lake, California; and Dr. Don Decker, a physicist with the Naval Air Weapons Station, reviewed drafts of both volumes and provided significant technical and editorial suggestions.



KEY MAP

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

INDIAN WELLS VALLEY
GROUNDWATER PROJECT

CALIFORNIA

GENERAL LOCATION MAP

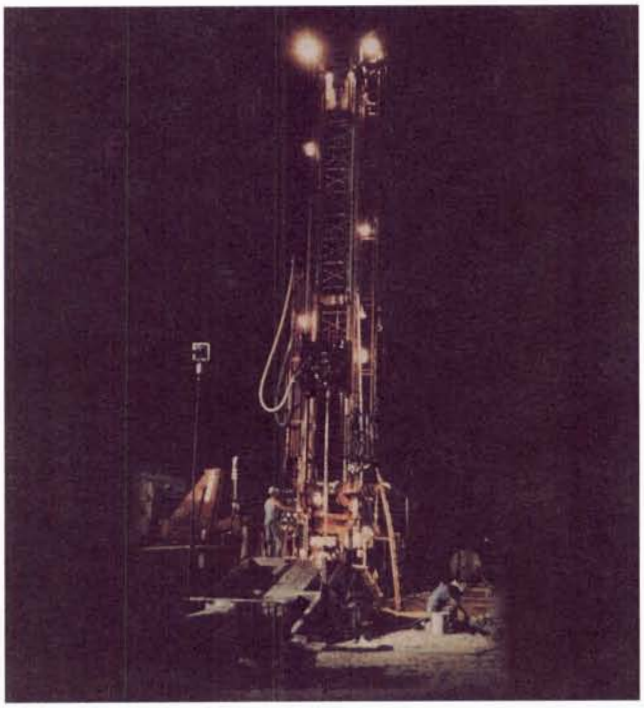
MAP NO. 1539-300-1

0 5 10
KILOMETERS

5000 0 5000 15000 25000
FEET

SEPTEMBER 1992

EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

PROJECT OBJECTIVE

The primary objective of the Indian Wells Valley Groundwater Project (Project) was to refine estimates of the life of the natural groundwater resource in the Indian Wells Valley (Valley) and to identify management concepts to conserve and extend the useful life of this resource.

APPROACH

In the Memorandum of Understanding which established the Project, the participants agreed on the goals to be achieved:

- ✓ Refine groundwater resource quantity and quality
- ✓ Refine recharge quantities and locations to the extent possible
- ✓ Model aquifer performance under pumping scenarios that meet future demands
- ✓ Develop future water resource management options, including conservation

To accomplish these goals, the following approach was taken:

- ✓ Summarize existing data and findings
- ✓ Obtain additional information by drilling test wells and collecting data from those wells
- ✓ Evaluate existing recharge and aquifer performance studies
- ✓ Analyze all data and integrate all information into potential water resource utilization plans for the future

PROJECT DESCRIPTION

Ten monitoring wells were drilled during the Project—seven were funded under the Project and three were funded separately by individual Project participants. All wells, irrespective of funding source, were designed and constructed in a similar manner. These wells were located to provide critical water quality and recharge data in areas of the Valley where such information was sparse. Areas of greatest need were in the Southwest, West, and

Northwest Areas. All wells were completed with multiple piezometers or sampling tubes within a given bore hole to obtain water samples and water table elevations at selected zones down as deep as 2,000 feet. Data collected and analyzed during the Project included drilling logs; electric, gamma ray, and down-hole temperature logs; stratigraphic interpretations of drill cuttings; static water table levels; water quality at selected depths; and measurements of aquifer transmission characteristics. It was specifically intended that these wells be located and constructed to allow convenient monitoring in the future.

MAJOR FINDINGS

- The Valley fill consists predominantly of sands and fine gravels in the heavily pumped area west of Ridgecrest, in the southwest, and along the extreme western boundary of the Valley.

- Chemical analyses indicate a predominate sodium bicarbonate water in most areas of the Valley.

- Water quality patterns imply that the Sierra Nevada watershed contributes a major portion of the groundwater recharge into the Valley.

- Poor water quality was found in the northwest and north central portions of the Valley associated with a thick organic-bearing clay layer.

- Good quality water was found down to the 2,000-foot drilling depth in the Intermediate and Southwest Areas.

- The west-to-east groundwater surface gradient in the Leliter area (about 4 miles north of Inyokern) indicates minimal recharge into this area from the west.

- A very steep apparent groundwater surface gradient exists in the extreme south and southwest portion of the Valley. This is probably a result of either faults or structural features which restrict groundwater flow.

- A fairly steep groundwater surface gradient exists in the northwest corner of the Valley (Louisiana Pacific Sawmill site), which implies groundwater recharge from the Sierran watershed to the northwest or north (Rose Valley).

- In most cases, aquifer transmission properties, which were computed from measurements made in each piezometer, are consistent with drill log data.

- Temperature profiles indicate the presence of geothermal sources underlying the Valley at depth.

CONCLUSIONS AND RECOMMENDATIONS

Three very important major discoveries were made during the course of this Project:

- A greater quantity of high quality water is in storage at depth in the Intermediate and Southwest Areas than previously known.

- Data concerning recharge into the Southwest Area is contradictory and will require additional exploration to reconcile data obtained during this Project with earlier results from the southwest. Some earlier work implies a very low recharge rate.

- Much of the west and northwest parts of the Valley have relatively poor water at depth associated with a very thick and extensive clay layer.

There are three major avenues for extending the life of the groundwater resources in the Indian Wells Valley:

- Blend good quality water with poorer quality water

- Expand pumping to "new" areas, such as the southwest

- Treat poorer quality water

Either blending or treatment would be governed by the appropriate water quality standards for the application (potable, industrial, or agricultural).

From a technical perspective the near-term recommended approach to extend the life of the groundwater resource is to immediately begin to blend water from the northwest part of the Valley with water from the Intermediate Area. In the long-term, the Southwest Area should be further studied to better define availability of groundwater in that area. Water quality treatment technology and costs should also be studied further.

While this Project made significant contributions to the water resource data base in the Valley, there are still many areas of uncertainty. In order to accommodate this uncertainty in data, a probable data range from a worst or conservative case to an optimistic case was established. An intermediate case within those limits was then determined. Table 1 presents the assumptions used to develop the intermediate case. More detailed information on these values and how they were selected can be obtained in Volume II, Technical Report, Section C.

Table 1. Data used to determine intermediate case water resource life projections

Demand Projections	NAWS, NACC, and agricultural users continue to pump current levels; pumping from Water District, Inyokern CSD, and private residential wells increases by 50% by the year 2010
Specific Yield	20% or 0.20
Saturated Thickness That Can be Dewatered	200 feet
Natural Recharge	3,000 acre-ft/yr into the Southwest Area, 3,000 acre-ft/yr into the Northwest Area, 0 acre-ft/yr into the Intermediate Area
Migration of Surrounding Water Into Pumped Areas	Constant 5% of pumped volume
Water Quality	250 mg/L in the Southwest and Intermediate Areas and surrounding the Southwest Area; 1,000 mg/L in the Northwest Area and area surrounding the Northwest and Intermediate Areas

Using the assumptions in table 1, the following calculated projections can be made to guide future water production management:

- Implementation of blending Intermediate Area and Northwest Area water could extend the life to the Intermediate Area resource by 13 years, to a total of 42 years.

- Expanding pumping into the Southwest Area and continued pumping from the Intermediate Area could provide acceptable quality water for 68 years.

- Blending Northwest Area water with water from both the Intermediate Area and Southwest Area could provide acceptable quality water for 92 years.

- Because the Northwest Area appears to contain zones of water with high concentrations of specific ions, treatment of Northwest Area water may be necessary in order to do any blending.

Additional resource life would be obtained by not only practicing conservation through pumping/blending management of the aquifer, but also through continued and effective conservation at consumption.

Willingness to dewater a thickness greater than 200 feet would also substantially increase the life of the water resources in the Intermediate and Southwest Areas. For each 100 feet of additional dewatering in those areas, the resource life would be extended about 30 years.

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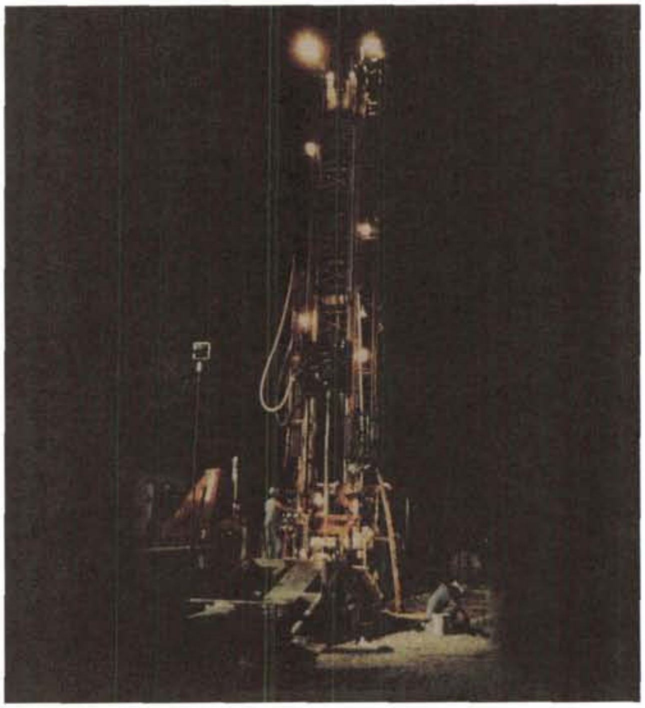
About the cover: *This nighttime photo of the Bureau of Reclamation drill rig at well site #4 was taken by Don Decker. Once started, drilling at all wells proceeded around the clock. Some hours after this shot, the well was "bottomed out" at 2,020 feet.*

CHAPTER I

INTRODUCTION



I. INTRODUCTION

DESCRIPTION OF AREA

Indian Wells Valley (Valley) is located just east of the southern Sierra Nevada about 150 miles north of Los Angeles. Prior to World War II human activity in the Valley was largely confined to Indians, miners, pioneers, and adventurers. Significant military presence began during and immediately after the war when the Navy established the Naval Ordnance Test Station at China Lake. This facility later became the Naval Weapons Center and now is called the Naval Air Weapons Station. Establishment of a military base in the Valley resulted in rapid development of an active on-base community. The town of Ridgecrest—the outside-the-gate community—was little more than a crossroads and general store in 1943 but began to grow rapidly in the 1950's as the influx of military personnel demanded goods and services beyond what the Navy offered on base.[1] Today Ridgecrest has a population of about 30,000 with a "trade area" of about 65,000.[2]

U.S. 395 is the main route between population centers of southern California and recreational opportunities in the eastern Sierra Nevada range and the high desert. Located just a few miles east of U.S. 395, Ridgecrest offers food and lodging opportunity for travelers. In addition to the Navy and tourism, employment by the North American Chemical Company, a mining facility located 25 miles to the east in Searles Valley, also makes a significant contribution to the economic activity in the Valley.

At an elevation of about 2,300 feet, Ridgecrest has a climate typical of the high desert area. Summers are hot and normally very dry. Winters are cool, but not unpleasant. Average annual precipitation ranges between 4 and 6 inches, with most of that coming as rainfall between October and March. Occasional short duration thundershowers occur during summers.[3]

Grant Bowman, a pioneering farmer in the Valley, recorded in his diary pumping 500 miner inches (approximately 12.5 cubic feet a second) to irrigate 260 acres of alfalfa between the years 1910 and 1925. He pumped from two 24-inch diameter wells. Static water levels were 90 feet below ground surface.[4] The first farming activity was along Bowman Road in the southeastern part of the Valley, but in the early 1950's farming expanded to

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[1] Ridgecrest & Inyokern, California STREET MAP, 1990, Marcoa Publishing Incorporated.

[2] Ibid.

[3] Draft *Indian Wells Valley Water District Domestic Water System 1990 Water General Plan*, Krieger & Stewart, August 1990, p. II-2, II-3.

[4] Personal communication with Mr. Jim Bosanko, Grant Bowman's grandson, November 5, 1993.

the northwest. Groundwater pumping for agricultural purposes has been estimated at an annual average of 1,000 acre-feet from 1920 to 1951, increasing to about 1,400 acre-feet a year from 1951 to 1968. Farming in the Bowman Road area ceased in 1969, but pumping of 300 to 800 acre-feet a year to support farming along Brown Road in the Northwest Area (see figure 12 for the location of specific areas) continued until 1976 when the major expansion of agricultural pursuits occurred.[5] Early pumping for domestic needs was from the Ridgecrest Area. Between 1930 and 1985 pumping gradually increased to about 3,500 acre-feet a year. Then, as water quality worsened to unacceptable levels, wells were abandoned and pumping volumes declined in that Area.[6] Extraction of water from the Valley for industrial purposes also began in the early 1920's when West End Chemical Company (later Stauffer Chemical Company) began pumping up to 1,000 gallons a minute for transfer to their facilities in Searles Valley. American Potash and Chemical Company, the predecessor to North American Chemical Company, began pumping about 750 gallons a minute from the Valley in the early 1940's.

PROJECT PURPOSE

Groundwater aquifers are the sole source of water for the Valley, and pumping has concentrated in areas where aquifer characteristics, water quality, and water elevations are known. For domestic and industrial use, this has been in an area immediately west of the city of Ridgecrest. Agricultural pumping has been concentrated in the northwest portion of the Valley.

Data show a gradual, continuing rate of decline in water elevations in these areas of most heavy pumping. This decline not only results in increasing pumping heads and requires adjusting pumps to lower elevations, but it also may signal a depletion of the groundwater resource.

For many years local water experts have been debating the natural recharge quantity and safe yield from the groundwater aquifers underlying the Valley. Average **published** recharge numbers range from 10,000[7] to 15,800[8] acre-

[5] "The Ground-Water Flow System in Indian Wells Valley, Kern, Inyo, and San Bernardino Counties, California," Charles Berenbrock and Peter Martin, U.S. Geological Survey Water-Resources Investigations Report 89-4191, 1991, pp. 15-17.

[6] Ibid., figure 6

[7] *Water Supply of Indian Wells Valley*, California, Pierre St.-Amand, NWC TP 6404, April 1986.

[8] *Hydrogeologic Conditions in Indian Wells Valley and Vicinity*, Robert T. Bean, February 1989.

feet a year. Suggestions of recharge up to 30,000 acre-feet have been made.[9] With current withdrawals from the groundwater of about 30,000 acre-feet a year (see chapter III), it appears from the **published** reports that the Valley is in a state of overdraft and pumping groundwater to meet expected future demands will result in continued depletion of the resource.

Resolution of the disparity in recharge estimates would be very difficult under any data collection program and, even with unlimited funding, answers may never be obtained to everyone's satisfaction. In the meantime, water purveyors must make plans for serving their customers' needs in the future. Therefore, the Indian Wells Valley Groundwater Project (Project) was designed to obtain as much practical additional information on the groundwater resource as possible within funding and temporal constraints. This additional information would then be used, along with existing data, to:

- Help define the groundwater resource extent in terms of both volume and quality
- Help define recharge quantities and locations to the extent possible
- Help define groundwater performance under pumping scenarios that match future demands
- Develop future water development plans, including conservation of existing resources

PROJECT FORMULATION

Groundwater is the sole source of supply for meeting the increasing water needs of the Valley. Groups responsible for nearly all utilization of the groundwater resources include:

- Indian Wells Valley Water District (Water District), major water purveyor to residents of the city of Ridgecrest, California
- North American Chemical Company (NACC), which extracts water for use in its facilities and to serve domestic needs in Searles Valley
- Naval Air Weapons Station (NAWS), which provides water for military use and residents on the base

[9] *The Daily Independent*, July 22, 1988.

- Inyokern Community Services District (CSD), which serves the town of Inyokern, California

- Agricultural interests and individual well owners

The importance of the groundwater resource led many of these entities to actively seek additional information on the extent and quality of the resource. Through individual data collection efforts and financial participation with the U.S. Geological Survey (USGS), Soil Conservation Service, and Kern County Water Agency, local entities have attempted to increase knowledge of the resource so they could make better future water management decisions. However, many of these efforts were limited by funding constraints or institutional considerations, such as access to well sites and jurisdictional responsibilities.

The absence of hard data in many areas of the Valley and at depth has contributed to differences of opinion over the expected life of the groundwater resource. This debate and the necessity to make long-term plans for continued provision of future water delivery service resulted in the Water District and the Bureau of Reclamation (Reclamation) initiating discussions in 1988 on a joint groundwater investigation. Those discussions were then expanded to include all local entities with an interest in water issues and eventually led to the development of a work plan for a $1-million data collection and analysis effort.

Although all local entities with an interest in water issues had input into the work plan, three entities elected to provide financial contributions to the investigation—Indian Wells Valley Water District, North American Chemical Company (formerly Kerr-McGee Chemical Corporation), and the Naval Air Weapons Station (formerly Naval Weapons Center). These three entities agreed to provide half of the funding for the effort on an equal basis, with the other half coming from Reclamation.

With the investigation having been defined to the satisfaction of participating entities and the funding commitments having been made, the work plan was initiated in March 1990.

PROJECT PARTICIPANTS

The Project was a cooperative effort among Reclamation and local entities. As pointed out above, while a number of local entities expressed interest in and provided input to the Project, three entities participated financially. The Kern County Water Agency could not provide funding for the Project, but that agency did contribute the expertise of a staff geologist to help formulate Project activities and assist in data collection and interpretation.

The original Project budget was $1,050,000 over a 3-year period. Commitments for Project financing were:

Bureau of Reclamation	$ 525,000
Indian Wells Valley Water District	175,000
North American Chemical Company	175,000
Naval Air Weapons Station	175,000
TOTAL	$1,050,000

Under the original agreement among the participating parties, Reclamation would conduct the investigation, and the local entities would transfer their funding commitment to Reclamation for use in Project activities. However, early in the Project it became apparent that more efficient use would be made of Project funds by contracting for test well drilling locally. Consequently, local entities used their funds for contract drilling, while Reclamation funds were used for data collection and analysis activities, as well as for drilling.

Because information obtained from the early drilling activity were so valuable in helping define the groundwater resource, the Water District and NAWS determined that funding additional wells would be of benefit to their respective agencies and to the Project. In order to ensure compatibility of data from all wells, the design, drilling, installation, and data collection procedures were made consistent among all the wells, irrespective of funding source. Contributions to the drilling program by each of the participating entities is shown below.

Bureau of Reclamation	• Drilled Test Well BR-4 with in-house drilling crews • Partially funded Test Well BR-10.

Indian Wells Valley Water District	• Fully funded Test Wells BR-1, BR-3, NR-1, NR-2, and MW-32.
North American Chemical Company	• Fully funded Test Well BR-2 • Partially funded BR-10.
Naval Air Weapons Station	• Fully funded Test Wells BR-5 and BR-6 and partially funded BR-10.

The final identifiable contributions to the Project are given below:

Bureau of Reclamation	$525,000.00
Indian Wells Valley Water District	635,247.56
North American Chemical Company	175,000.00
Naval Air Weapons Station	298,000.00
TOTAL	$1,633,247.56

In addition to the increased funding for drilling shown above, each of the local participants provided professional services and equipment that have not been recorded separately as services to the Project. Local participants contributed personnel and equipment necessary for contract administration, compilation of information required to develop an estimate of future water demands for the Valley, surveying services, environmental field inspection and evaluation in support of access permit applications, drilling administration and logging the drill holes, installation of security devices on the wells, and obtaining temperature profiles at each of the wells. In addition, many hundreds of hours of volunteer labor were offered. The total value of these activities is no doubt in the range of tens of thousands of dollars.

COMMUNICATION WITH THE PUBLIC

During the course of the Project, aggressive efforts were made to maintain contact with the general public in order to provide information on Project progress and solicit input on Project direction. Presentations were made at public meetings in Ridgecrest and at briefings to the Water District board of directors. Communication was established early in the Project with local residents having multiple views on water issues in the Valley in order to obtain a wide perspective of how the Project might be formulated. Frequent technical briefings were made to local groups with interest in the progress of the Project. Local newspapers covered Project activities and published press releases concerning the Project.

PROJECT MANAGEMENT

In order to ensure appropriate direction and progress of the Project, an administrative structure was implemented that established clear responsibilities and accountability. Figure 1 illustrates the structure that was employed. Each of the participating entities named a manager from its organization as a representative to a Steering Committee. This committee acted as the executive group that provided overall direction and guidance to the Project effort. The committee met on an approximate monthly basis to review Project progress, approve technical activities, approve budgets, and make any other executive decisions necessary. Reclamation's representative to the Steering Committee chaired the meetings.

Day-to-day management of the Project was the responsibility of a program manager, employed by Reclamation, who tracked technical activities, expenditures, and schedules. Deviations from the program were taken to the Steering Committee for action or adjustments.

Photo by J. Johnson

Technical Subcommittee in session. From left to right: Dennis Watt, Gail Moulton, Don Decker, Ken Turner, Mike Stoner, Frank Monastero and Mike Lovejoy.

A Technical Subcommittee was established to develop technical requirements, determine appropriate data collection techniques, provide quality assurance during drilling and sampling, evaluate data as it became available, and provide technical advice to the Steering Committee. Technical experts from each of the participating entities and the Kern County Water Agency made up this subcommittee. The Technical Subcommittee often solicited input from technical specialists within other interested organizations.

PROJECT ADMINISTRATION

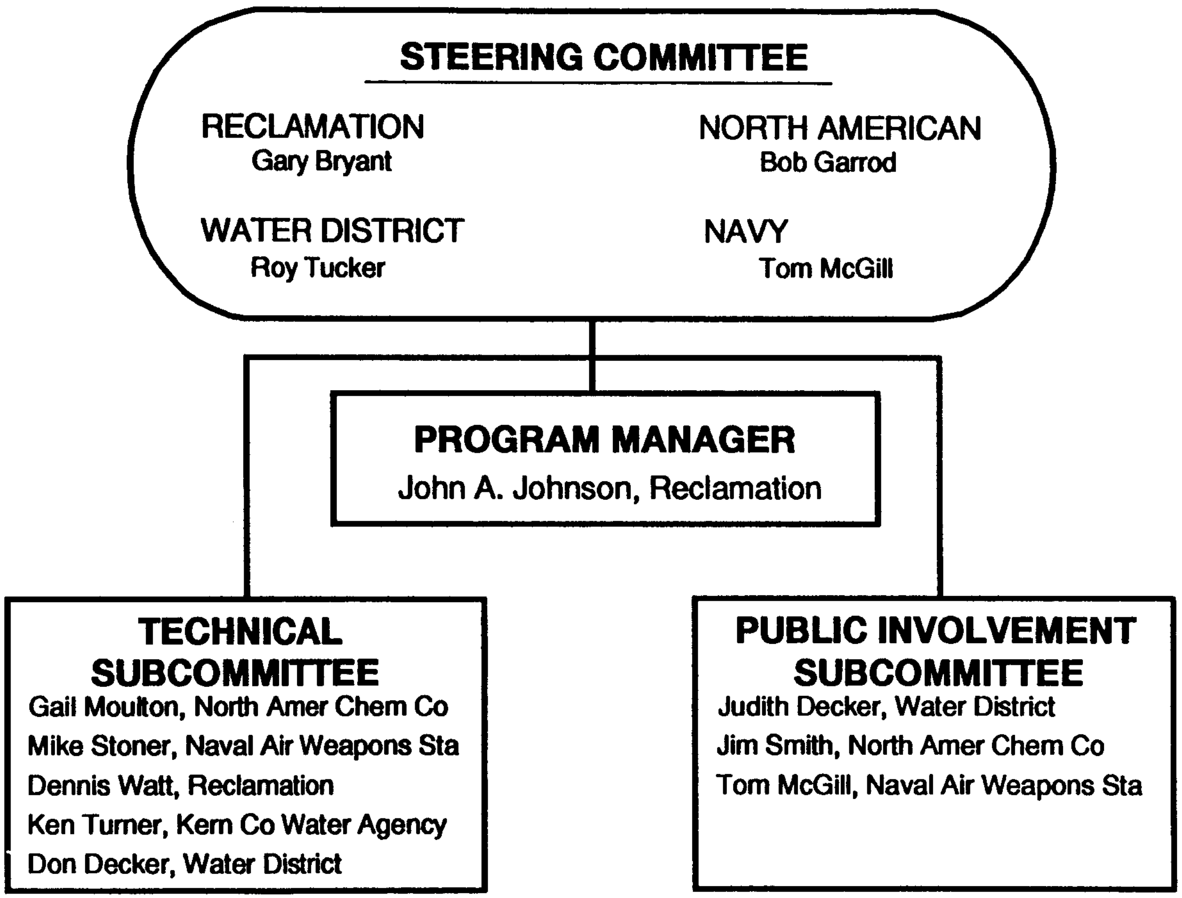

Figure 1: Project Administrative Structure

A Public Involvement Subcommittee was established to provide a link between the Project and interested publics and news media. This subcommittee was responsible for hosting public forums and producing news releases that kept the public informed of Project progress and solicited public comment and input.

AUTHORITY

This Project was undertaken by Reclamation under the authority of the Act of June 17, 1902 (32 Stat. 388) and its amendments and the Contributed Funds Acts of 1921 (41 Stat. 1404, 43 U.S.C. 395). First year Federal funding was provided by Public Law 100-371, the Energy and Water Development Appropriations Act of 1989. Remaining Federal funding was provided by subsequent appropriations acts.

ACKNOWLEDGMENTS

Bureau of Reclamation: Reclamation personnel in the Lower Colorado Regional office located in Boulder City, Nevada, were responsible for overall accomplishment of the Project. Project management was performed by Mr. John A. Johnson. Mr. Gary L. Bryant, Planning and Loans Officer, was responsible for administrative supervision and management. Mr. Dennis Watt performed major portions of the geohydrologic research and analysis. Ms. Shirley Nutter, Ms. Sierra Slentz, Ms. Christina Robinson, and Ms. Tina Bellis provided the graphic, editorial, and layout expertise required to produce this report.

While Reclamation personnel were responsible for Project oversight and many of the technical aspects of the investigation, the enthusiastic technical and management support of personnel from local participating entities was crucial to successful accomplishment of Project objectives.

Naval Air Weapons Station: Mr. Michael D. Stoner, geologist with NAWS, provided not only technical capability in the field of geology, but also many hours of field work and local coordination. He played a critical role in doing the necessary field work in siting the wells, advising the drilling contractors, obtaining environmental clearance for drilling, surveying, and many other tasks that were necessary for smooth accomplishment of the Project. When Dr. Francis C. Monastero became head of the NAWS Geothermal Project Office late in the Project, he immediately saw a cooperative opportunity and followed up on that opportunity by providing his staff, particularly Mr. Michael A. Hasting, for technical consultation and contract administration. He also provided funding from his budget for mutually beneficial activities, as well as invaluable technical advice.

Dr. Thomas J. McGill, head of the Environmental Project Office, provided management support from the NAWS.

<u>**Indian Wells Valley Water District**</u>: The Water District Board of Directors' support for the Project went beyond normal expectations. They consistently supported the Project by providing funding beyond contractual requirements. Several hundreds of thousands of dollars worth of test well construction and other Project features would not have been possible without the funding approval of the Water District board. Mrs. Judith A. Decker, one of the board members, took a special interest in the Project, and her staunch advocacy position was of frequent help. Dr. Don Decker represented the Water District as technical expert. His depth of knowledge in many relevant technical areas, his willingness to listen to and consider different points of view, and his ability to present Project accomplishments with aplomb were irreplaceable benefits to the Project. The Project was actively supported by former General Manager, Mr. Joe B. Mont-Eton; present General Manager, Mr. Warren McGowen; and Mr. LeRoy O. Tucker, Assistant General Manager, who also represented the Water District in providing management direction to the Project. Mr. Tucker contributed further to the Project by successfully arguing the merits of designing and completing the Water District monitoring wells using Project well specifications.

<u>**The North American Chemical Company**</u>: NACC was also generous in providing top quality personnel and equipment to support the Project. Mr. Gail F. Moulton, chief geologist, was actively involved in providing input to all technical aspects of the Project and was instrumental in obtaining company equipment for collecting water samples, measuring water levels, and measuring down-hole temperatures. Mr. Moulton also served as chairman of the Technical Subcommittee. Technical expertise, including much of the logging of the drill cuttings, was provided by Mrs. Dipti Barari, staff geologist. Mr. Robert R. Garrod provided the management link between the Project and NACC. His committed support was responsible for the active financial and technical involvement by the company. The Project was also the beneficiary of the creative and thoughtful mind of Mr. Thomas S. Bunn III, legal counsel for NACC.

<u>**Kern County Water Agency**</u>: This agency, represented by Mr. Darrell D. Sorenson, graciously extended the services of Mr. Ken Turner, staff hydrogeologist. Mr. Turner helped develop the work plan, logged some of the drill cuttings, and provided technical expertise throughout the investigation.

<u>**Other**</u>: Many people and organizations contributed to the Project by providing background information, a forum for discussing Project activities and new ideas, or previously published data. These include Mr. Leroy Marquardt of the East Kern County Resource Conservation District, the San Diego office of the USGS, and Ms. Peggy Breeden, past president of the local Well Owners' Association.

Data used to develop the water demand projections of figure 2 were based on information available through the late 1980's. High population growth rates in the Valley during the 1980's have more recently moderated or even declined, and agricultural use has not expanded as anticipated. These conditions led to consideration of revising the future water demand projections. This was not done, however, because the altered conditions are so recent that a trend cannot be established and it is possibly only a temporary phenomenon.

Except for pumping by large agricultural users, which is confined to the northwest portion of the Valley, most of the pumping occurs in an area known as the intermediate pumping zone, Intermediate Area, or intermediate wellfield. This is an area immediately west of Ridgecrest with good quality groundwater at fairly shallow depths. Figure 12 (following page 94) shows the boundaries of the Intermediate Area, as well as other areas referred to later. These are not precise boundaries determined by well defined hydrogeologic parameters, but rather by generally accepted practices or assumptions.

Since 1921, groundwater elevations have been declining. The water table has declined about 80 feet in the Intermediate Area, 70 feet in the Ridgecrest Area, 30 feet in Inyokern, and 15 feet or more in the agricultural area. Declining water table elevations in the Intermediate Area has introduced a reverse gradient potential for poor quality water to backflow into the Intermediate Area from the surrounding brackish and salty water areas, although no noticeable degradation has occurred at this time.[13] Poor quality water surrounding the Intermediate and Southwest Areas could, therefore, pose a threat to existing and additional wells in those areas.

Because of the projected increases in pumping requirements and concerns over the ability of the Intermediate Area to tolerate this increased pumping without potential adverse impacts, water purveyors needed additional information on the quality and availability of groundwater in other areas of the Valley so that expansion could occur in the most appropriate way.

This need for additional information on groundwater resources in the Valley led to discussion among local water purveyors and Reclamation on ways of addressing the future water supply problem. Those discussions, in turn, led to the development of the Project.

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[13] *Draft Environmental Impact Report, Proposed Southwest Well Field and Transmission System Program, SCH #87082401*, Krieger & Stewart, Incorporated, February 1988, sec. 1.3.

II. PROBLEM DEFINITION

Prior to establishment of a military base in 1943, population in the Valley was sparse. As much as 10 years later, in 1953, the population of Ridgecrest was only about 2,000, and Inyokern had a population of about 800, while the base itself had a population of about 10,000.[10] Through the 1950's and early 1960's, the population of Ridgecrest grew slowly—about 3 percent a year.[11] During the late 1960's more and more employees at the Naval facility chose to reside outside the base. Increasing population caused construction of tract and custom houses and shopping centers with chain "anchor" stores. Policy established by the NAWS in the 1970's encouraged employees to live off base, resulting in accelerated growth in Ridgecrest. Irrigation of larger parcels of agriculture, primarily alfalfa, also began in the 1970's. Population growth of Ridgecrest continued to accelerate until annual growth rates reached 8 to 10 percent in the late 1980's.[12] Data from the 1980 and 1990 census show a population in Ridgecrest of 15,929 and 27,725, respectively. Population in the Valley outside the city boundaries grew in parallel with Ridgecrest.

Increasing population has resulted in increasing demands on the groundwater as a source of domestic, industrial, and agricultural use. Major users of water from the groundwater aquifer underlying Indian Wells Valley include the agricultural sector, consisting primarily of the Brown Road Land and Farming Company; the Indian Wells Valley Water District, serving the city of Ridgecrest and surrounding county areas; the North American Chemical Company, serving domestic water to the town of Trona, as well as industrial needs of the company; the Inyokern CSD, serving the town of Inyokern; the NAWS, serving the needs of base residents and providing water for military purposes; and private wells, serving individual houses or small groups of houses.

Estimates of water produced by each of these segments in 1990 and estimated pumping requirements through the year 2010 are shown in figure 2. It is obvious from this graph that the future water needs of the Valley are being driven by the Indian Wells Valley Water District. Future water production by other entities are expected to remain fairly constant, relative to the total Valley-wide pumping quantity. An exception is the Community Services District where future water demand is projected to increase significantly. However, the CSD's total water projection is small enough that it does not substantially impact the total future demand curve. More detail on future water use projections is contained in section B of volume II.

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[10] *Geology and Ground Water in Indian Wells Valley, California*, Fred Kunkel and G.H. Chase, U.S. Geological Survey, January 23, 1969, p.13.

[11] Marcoa Publishing Inc., op. cit.

[12] Krieger & Stewart, op. cit.

CHAPTER II

PROBLEM DEFINITION

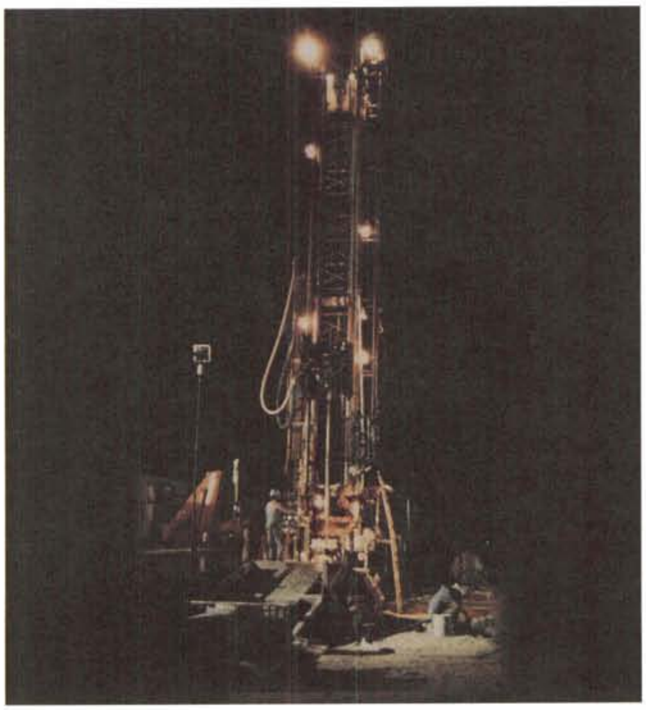
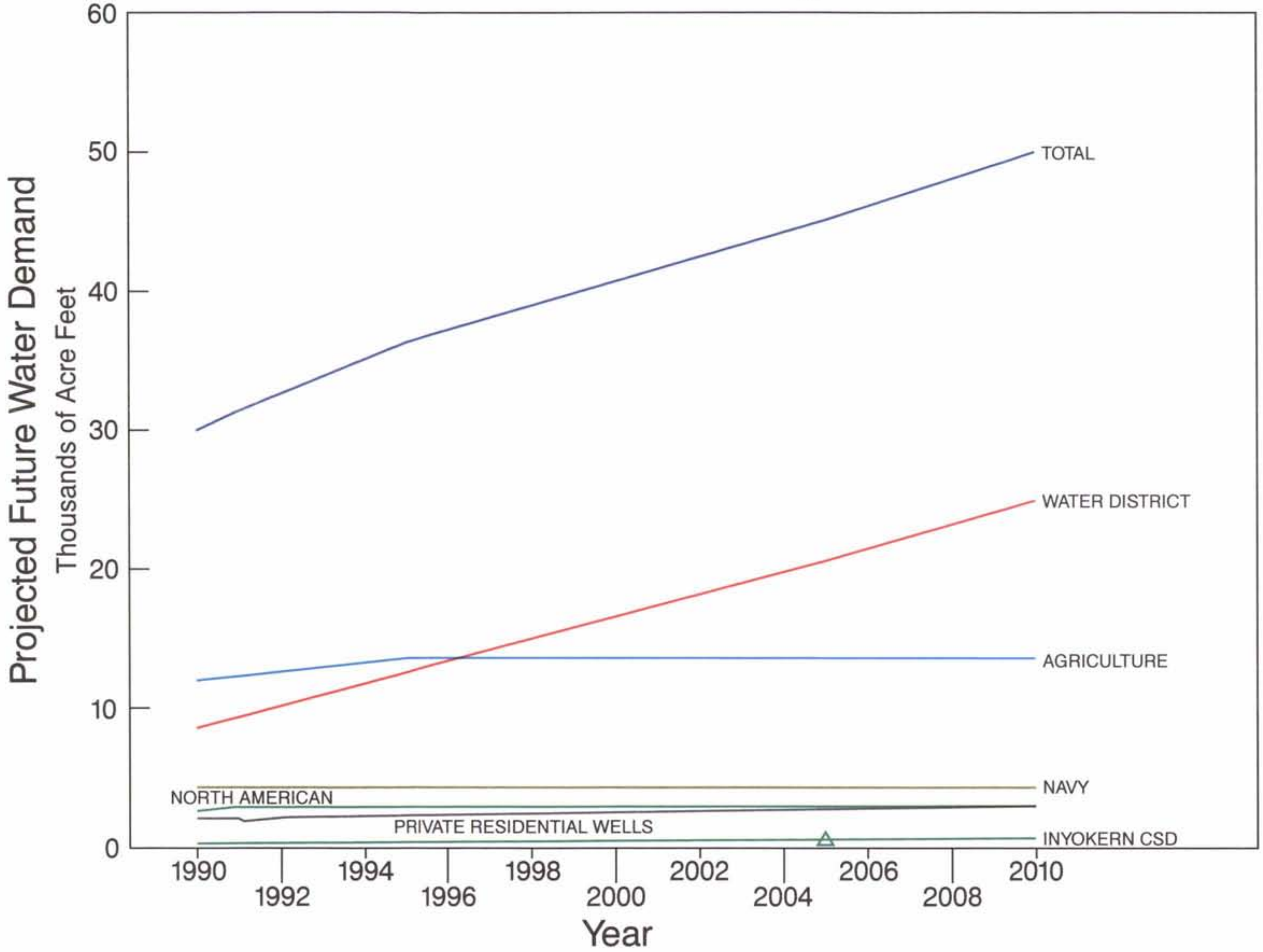
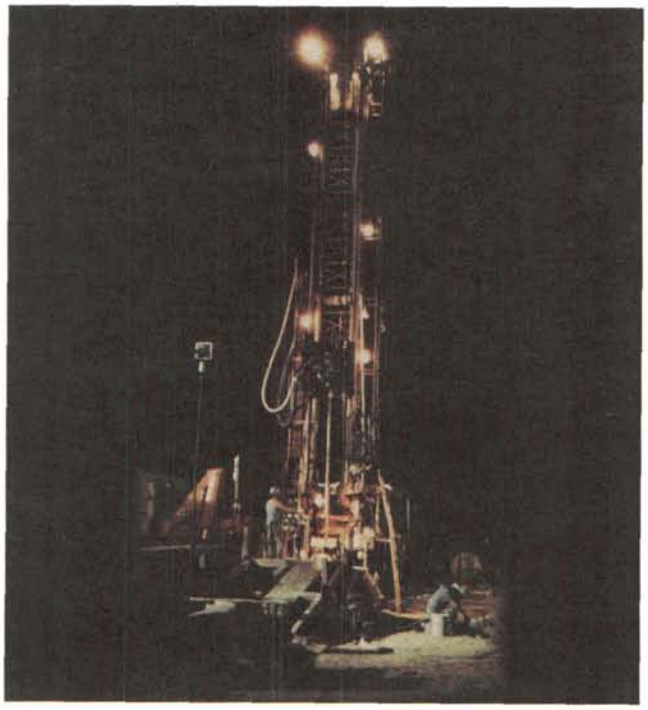


Figure 2: Projected Future Water Demands Indian Wells Valley, California



CHAPTER III

PROJECT DESCRIPTION



III. PROJECT DESCRIPTION

The Project was originally designed to be completed in three phases—compilation of existing data, collection of additional data, and development of implementation plans for future development of the groundwater resource. However, there was an understanding that the plan was open to adjustment as additional information became available.

Compilation, evaluation, and display of existing data was essentially completed during the first 6 months of the Project. During that time, a field data collection program was defined.

The nucleus of the field data collection program was a drilling strategy involving up to 10 multi-piezometer test wells. Location of those wells, along with their priorities, are shown on figure 3. Figure 4 shows a generic design of the test wells. The number of well pipes, called piezometers, and the location of the screened sections were determined by technical experts after review of the drilling and geophysical logs. Actual completion information for each well is given in a following chapter.

Ten wells were installed under this Project. BR-4 was drilled first with Reclamation drill crews; all other wells were drilled by contract. Table 2 shows the order of drilling, the funding source, and the contracting entity for each well installed under the Project. In addition to the wells shown on table 2, the NAWS's Geothermal Project Office drilled a very deep well (7,400 feet) between the proposed location of BR-7 and BR-8 to test for geothermal potential in the middle of the Valley.

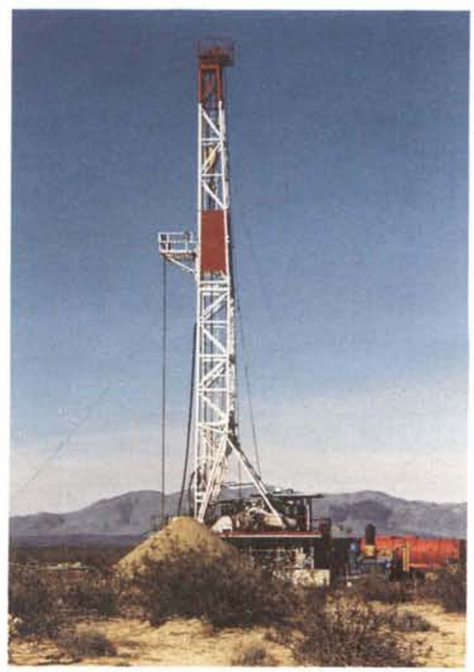


Photo by Mike Stoner

Indian Wells Valley Groundwater Project well drilling in progress at BR-6.

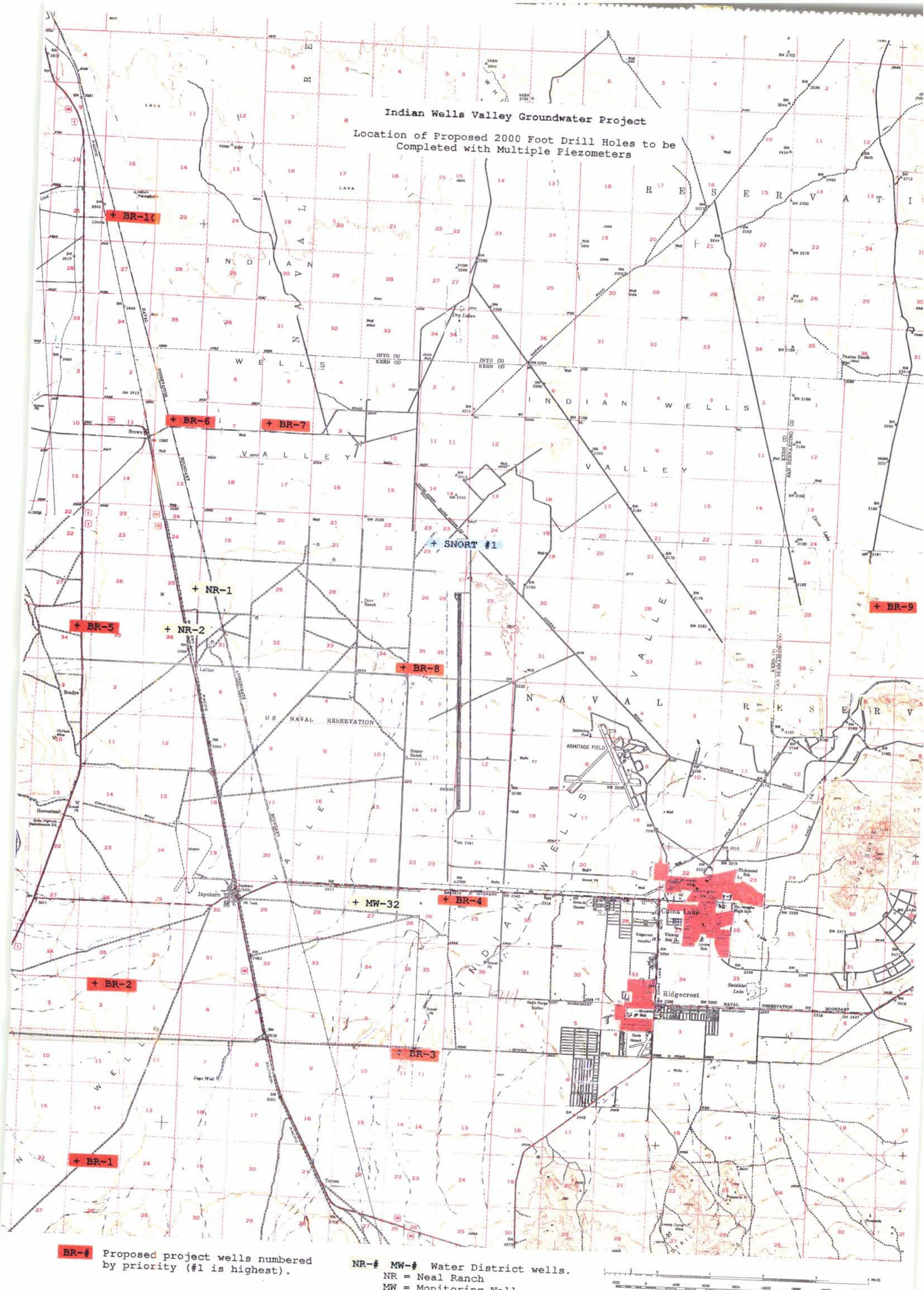
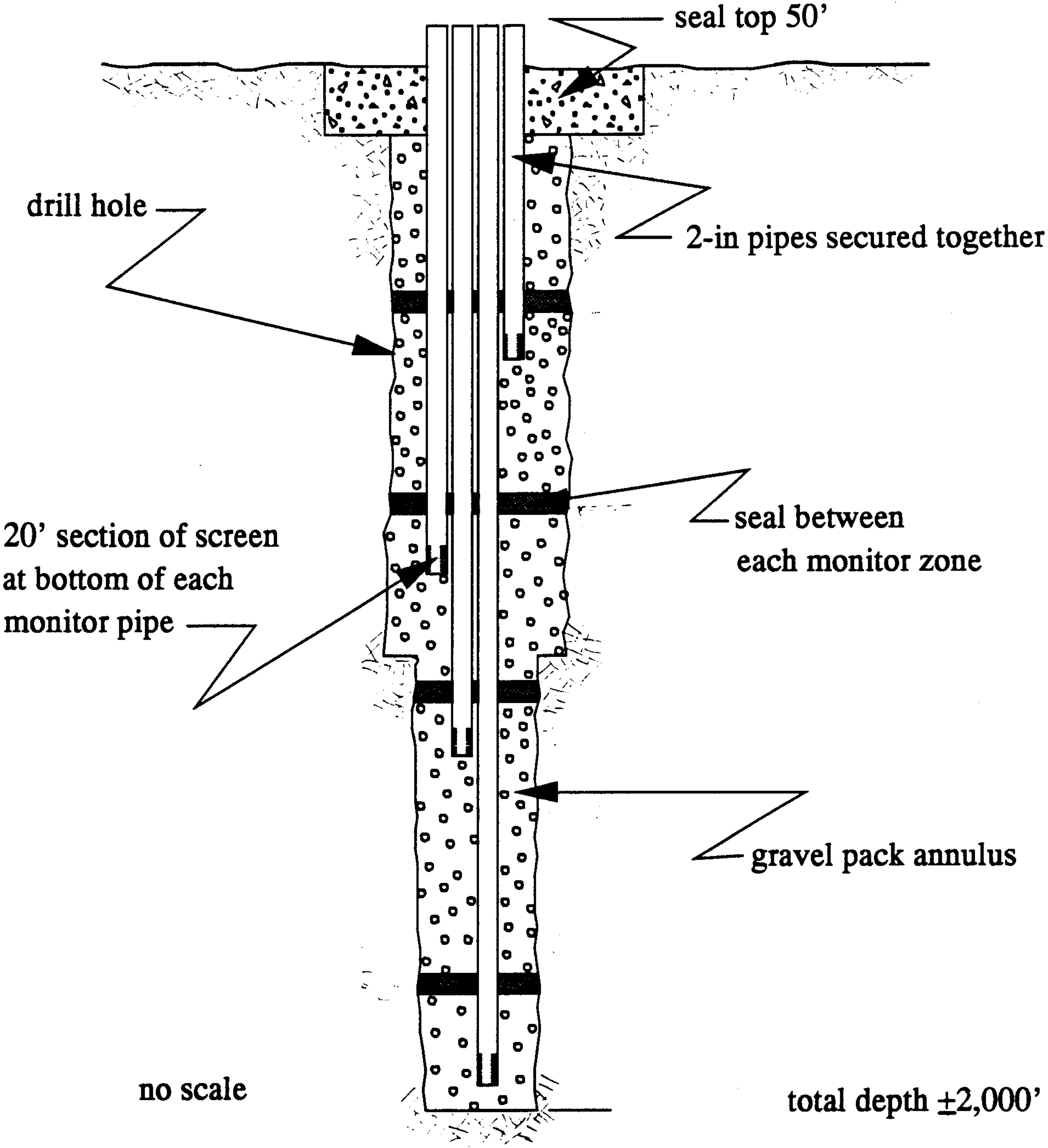


Figure 3: Sites for Installation of Monitoring Wells by Order of Priority

Figure 4: Sketch of Monitoring Well



Designated SNORT-1, this well offered groundwater data unavailable from other sources. Adjustments in the location of BR-5 and BR-6 and the installation of SNORT-1 reduced the priority of BR-7 and BR-8. After installation of the casing in SNORT-1, perforations at appropriate levels were made under Project funding contributed by the NAWS. After review of all data obtained prior to drilling the last well, the decision was made to increase the priority of BR-10 and drill at that site rather than at BR-7, BR-8, or BR-9.

Table 2. Test wells drilled under Project

TEST WELL	FUNDING SOURCE	CONTRACTING ENTITY
BR-4	Project	Reclamation Force Account
BR-2	Project	NACC
NR-1	Water District	Water District
NR-2	Water District	Water District
BR-1	Project	Water District
BR-3	Project	Water District
MW-32	Water District	Water District
BR-5	Project	NAWS
BR-6	Project	NAWS
BR-10	Project	NAWS
SNORT-1[14]	NAWS/Project	NAWS

Construction costs for Project wells contracted by both the NAWS and the Water District exceeded those participants' cost share under the Project agreement. Those additional costs were contributed by the respective entity.

Water level measurements, temperature gradients, and aquifer characteristics were obtained from each piezometer at each well. Those data and information on how those data were obtained are given in later chapters.

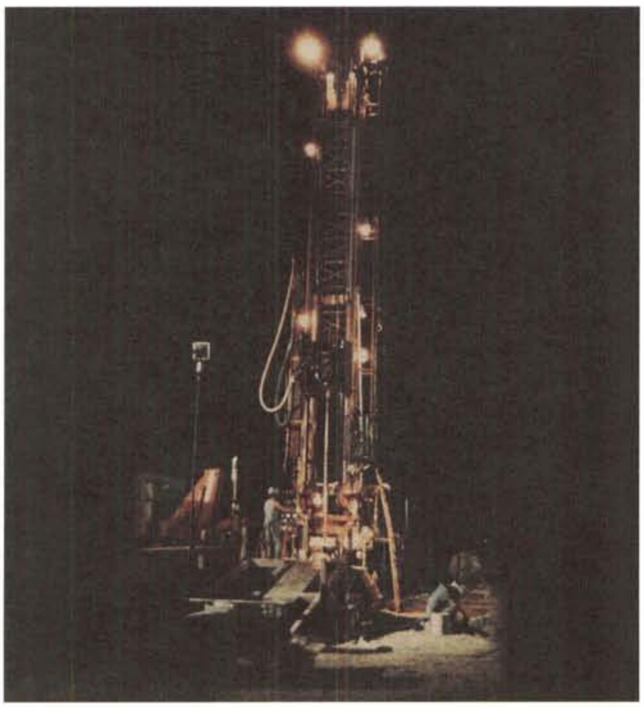
The USGS has done considerable work on modeling the groundwater aquifer in Indian Wells Valley. The USGS provided Reclamation with the

[14] The hole designated as SNORT-1 was drilled by NAWS under a geothermal program. Perforations in the casing at higher elevations in the hole were funded under the Project.

MODFLOW model they developed so it could be used under the Project in generating and evaluating various groundwater resource management options. However, concerns with respect to recharge distribution and the method used to estimate total recharge (see Volume II, Section A, "Aquifer Modeling" for a description of these concerns) led to a decision to postpone revision and application of the model to a future time.

CHAPTER IV

PREVIOUS GROUNDWATER DATA



IV. PREVIOUS GROUNDWATER DATA

The USGS has been the most comprehensive collector and compiler of groundwater and water well related data in the Valley. Their data base for 131 wells includes physical attributes of the wells, water levels, hydrographs, and, for many wells, at least one water quality analysis. These data are occasionally published in open-file reports. The latest open-file report was published by Berenbrock[15] and presents data collected between 1977 and 1984.

Groundwater quality data has also been recently compiled and published by Whelan and others[16] under contract to the East Kern County Resource Conservation District (EKCRCD). Under this contract, nearly 1,200 analyses were compiled from over 370 sites and 23 new sites were analyzed. Since these analyses included sample sites in Rose Valley, the Coso Range, the Argus Range, and Salt Wells Valley, many of the more than 370 sites are outside the Indian Wells Valley. Of the 23 new sites, 8 are wells in the Valley. Other sites are springs, seeps, and wells in the consolidated rock surrounding the Valley.

Cornerstone Engineering of Bakersfield, California, also under contract to the EKCRCD, has compiled water well related data for the Valley. Their database consists of data for about 785 wells. However, only location, type, and depth is given for most of the wells. Even though there is only minimal data for most of the wells, this database is valuable in that it is a fairly complete list of all wells in the Valley that were drilled prior to 1986 and that were drilled under county permit.

In addition to the published information from the sources described above, a list of wells in the Valley was provided by Ms. Peggy Breeden, a local resident active in groundwater issues.

Figure 5 provides a visual depiction of the distribution of wells in the Valley that existed prior to Project initiation. Red dots represent wells drilled to a depth shallower than about 1,000 feet, while green dots represent wells deeper than about 1,000 feet.

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[15] *Ground-Water Data for Indian Wells Valley, Kern, Inyo, and San Bernardino Counties, California, 1977-84*, Charles Berenbrock, U.S. Geological Survey Open File Report 86-315, 1987.

[16] *A Water Chemistry Study of Indian Wells Valley, Inyo and Kern Counties, California*, J.A. Whelan, R. Baskin, and A.M. Katzenstein, Naval Weapons Center, China Lake CA, Publication NWC TP 7019 (2 volumes), 1989.

From figure 5, it can be seen that to a large extent wells have been constructed in clusters. Concentration of these clusters reflect either areas of better quality water, areas of higher groundwater elevations, or areas of higher water use densities. Figure 5 also provides graphic evidence that most of the wells existing prior to the Project were less than 1,000 feet deep.

Figures 6 and 7 provide locations of wells that have water surface elevation and water quality analysis data, respectively, published by the USGS. Each dot represents one well. It is immediately apparent that while there are many wells in the Valley, water elevations are available on only a portion of them, and consistent water quality data are published on fewer yet. Detailed information on well locations and data available from each well are contained in Volume II, Section A, "Test Wells".

In order to assure that wells were neither double counted nor left out, a comparison was made between each of the data sources. Since the only common information recorded in all the sources was location and depth, these were the parameters compared. Although there were some discrepancies, they were not significant, and it was concluded that there were no significant duplications or exclusions. Data presented in figures 5, 6, and 7, then, can be confidently presented as an accurate depiction of well information available for the Valley.

Knowledge of existing well information provided the basis for establishing a drilling program under the Project. Well locations and design were heavily influenced by the availability of groundwater data from existing wells.

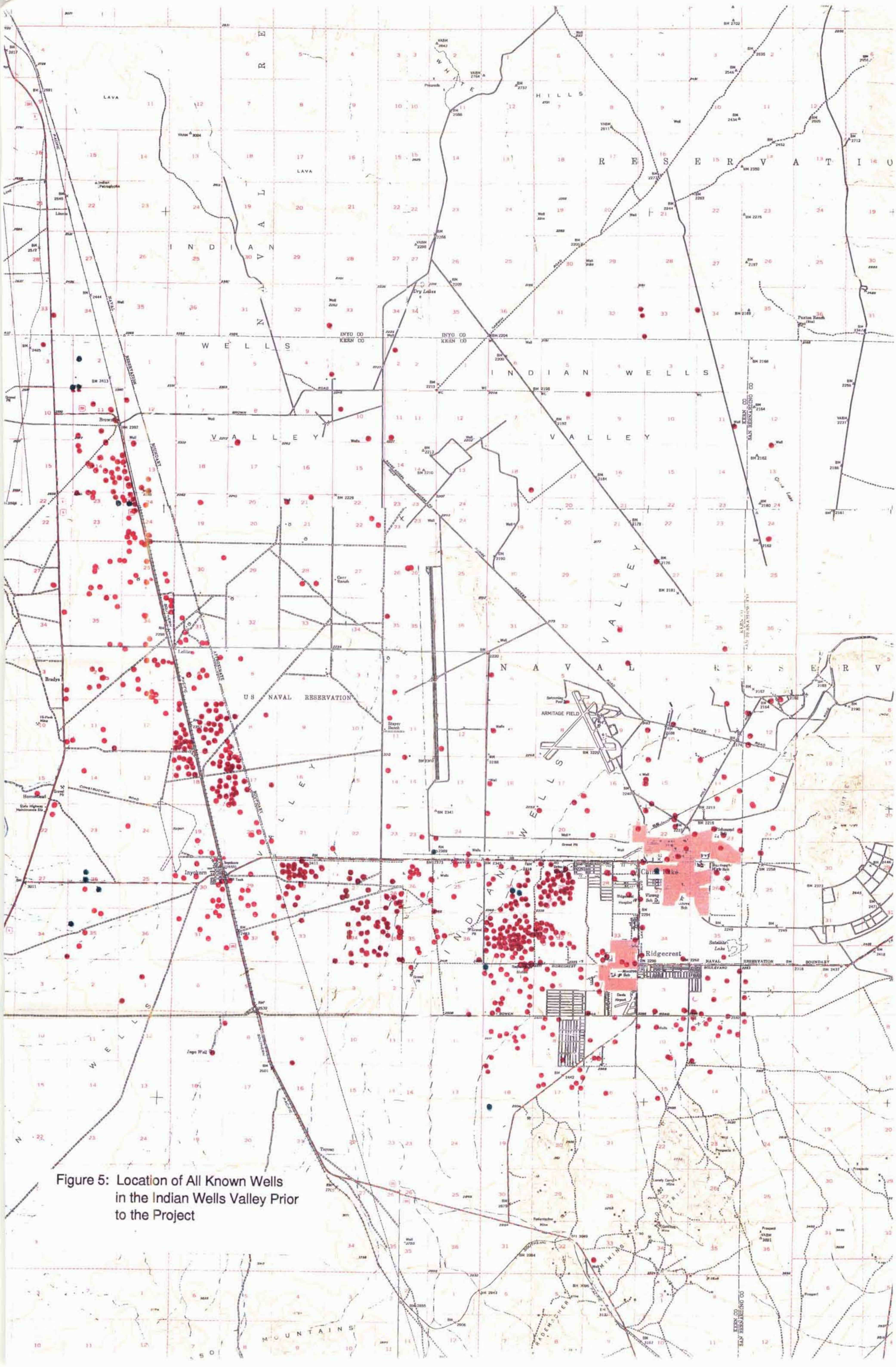


Figure 5: Location of All Known Wells in the Indian Wells Valley Prior to the Project

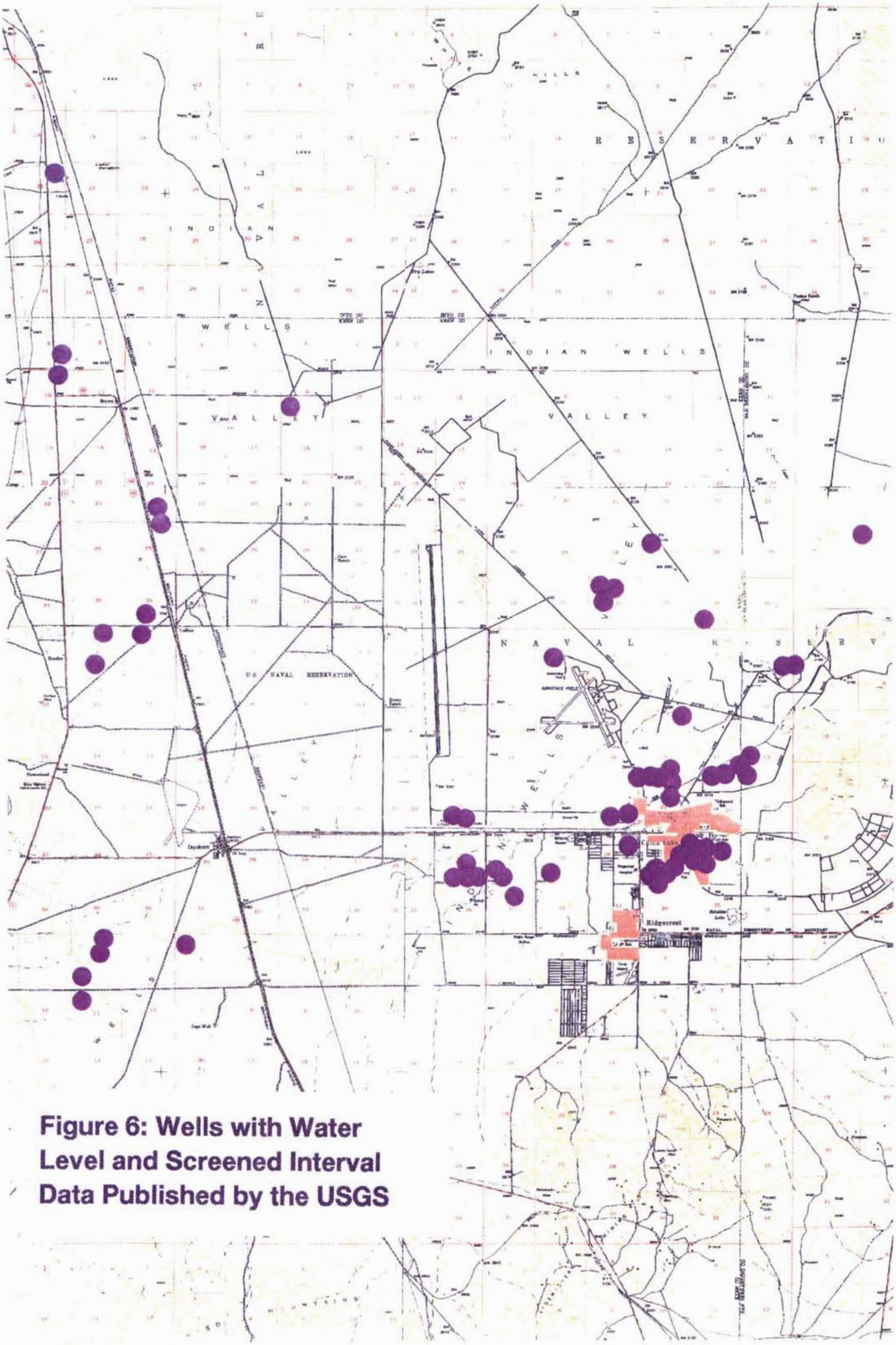


Figure 6: Wells with Water Level and Screened Interval Data Published by the USGS

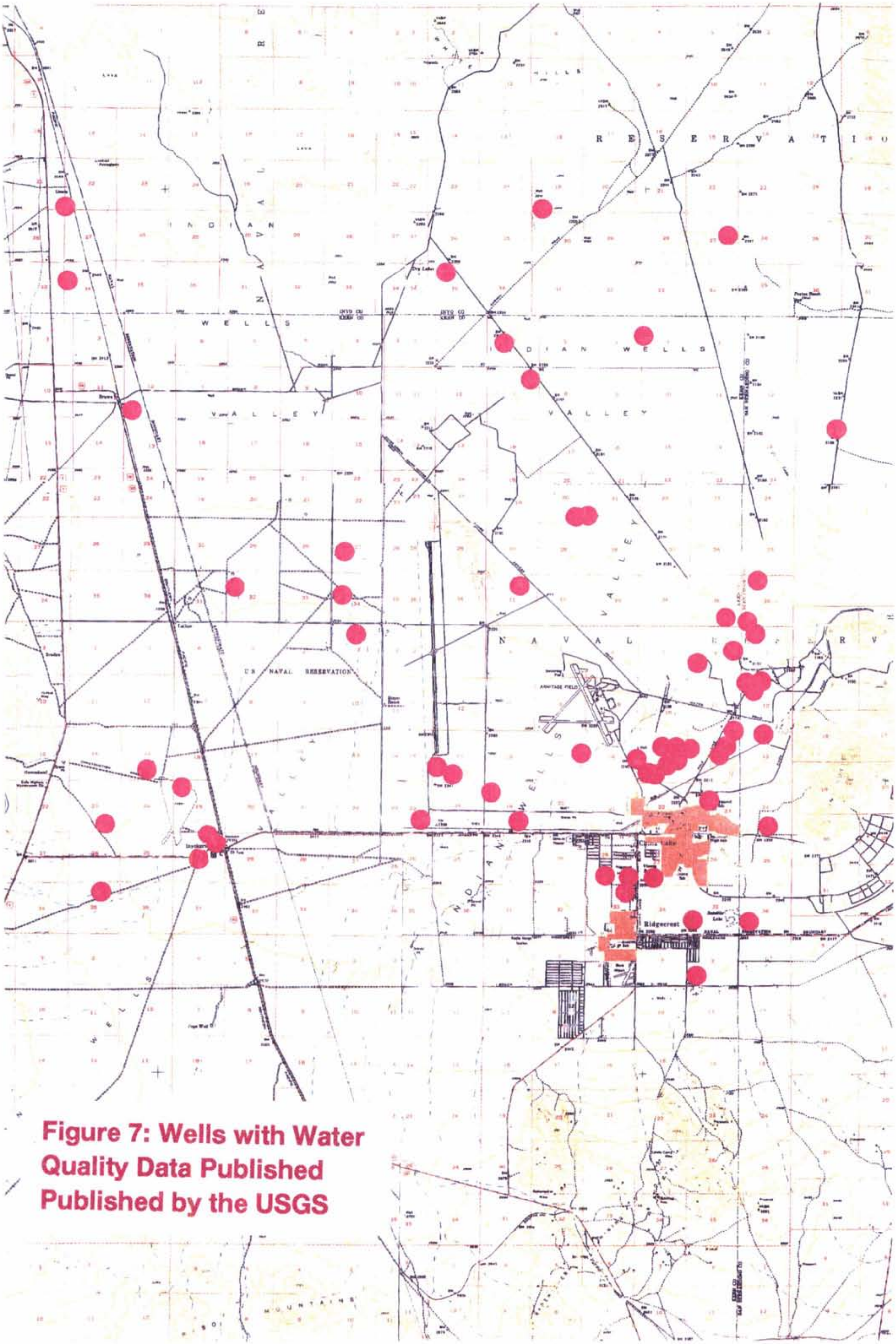
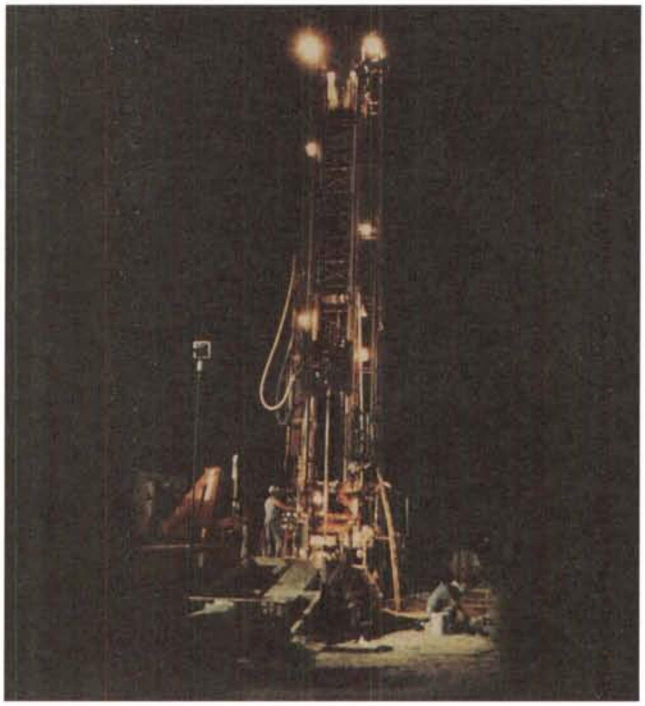


Figure 7: Wells with Water Quality Data Published Published by the USGS

CHAPTER V

TEST WELLS



V. TEST WELLS

WELL DESIGN

Members of the Project Technical Subcommittee collaborated on the design of the test wells and solicited input from other technical experts in the Valley. Design parameters included depth, drilling method, number and diameter of piezometers at each well, screen length, screen location, and standard considerations such as gravel pack, development procedures, plug installation, and concrete seal at the surface.

After considering existing well information in the Valley, costs, drill rig availability and mobility, and the desire to maximize both depth and number of wells, a drilling depth of 2,000 feet was selected. This depth allowed use of a mobile drill rig, providing groundwater data from depths not previously available, and kept costs at a level that allowed construction of up to seven wells under the Project budget.

Two general casing designs were considered—one large diameter casing and multiple small diameter casings. The single casing design consisted of a 6-inch-diameter casing screened at selected depth intervals. The multi-casing design consisted of installation of more than one small diameter pipe (piezometer) in a common drill hole. Each piezometer would be screened at a different depth. In each case, appropriate size filter pack would be used to fill the annular space. Bentonite (or other non-permeable material) seals would be set between the screens to prevent vertical flow in the annulus during pumping.

Photo by Don Decker

Nighttime photo of Bureau of Reclamation drill rig at well site #4.

After considering the advantages and disadvantages of each design, the multi-casing completion was selected as the design that would be used on Project wells. Two inches was selected as the diameter for each of the piezometers in the nested completion. This diameter allows use of a submersible pump capable of lifting water from a depth of 300 to 400 feet. A screen length of 20 feet was used. Figure 4 presents an illustration of the well design.

All of the holes for the test wells were drilled by conventional circulation mud rotary. The hole diameter of the first pass to total depth was at the drillers discretion. Most chose to drill the hole to completion diameter on one pass as opposed to reaming a smaller diameter pilot hole.

Drillers were required to maintain a complete log. Cuttings, retained in clear zip-lock bags for later description by a geologist, were sieved from the mud return every 10 feet during the drilling process. Electric and geophysical logs were run immediately after the hole was drilled.

The number of piezometers to be placed in each hole and the depth of the screen were determined by a consensus among Technical Subcommittee members at the drill site when the electric logging was completed. The screens were set opposite sandy intervals, and the annular seals were set opposite significant clay layers, if available.

Each well was developed by air lifting for about 12 hours at an estimated flow rate of 5-10 gallons per minute.

WELL LOCATIONS

Locations of the test wells were established by a process that required each Technical Subcommittee member to independently develop a prioritized list of 10 locations. The rationale of the individual lists was then considered collectively by the entire Technical Subcommittee. After these deliberations and consultation with other local experts, the Technical Subcommittee settled upon the locations and priorities (one being the highest priority, ten the lowest) shown on figure 3. Although locations and priorities were established before the drilling program began, there was an agreement among the technical experts and managers that the program would be reviewed after each hole was drilled. Changes in both locations and priorities could be made, depending upon data previously obtained during the drilling activity.

A description of each site location and the reason for that location is given below (some of the locations were adjusted to accommodate access or environmental considerations):

Site 1 T27S/R38E Section 23 Well BR-1

Surface geology and geophysical studies indicate the potential for a groundwater divide and/or a structural high in the Southwest Area of the Valley. Hydraulic conductivity in this unit could be much lower than in the valley fill. In addition, the apparent location of this feature could impact the estimate of recharge to the Valley from the southwest watersheds.

Site 2 T27S/R38E Section 11 Well BR-2

The relationship of water levels, water quality, and the geologic log of this well as compared to those same attributes in BR-1 may lend insight into this area that has been modeled as the largest recharge source to the Valley. There may be distinct water quality and water level differences between sites 1 and 2 which may be based on the subsurface configuration or the potential structural high. [This well was actually located in section 2.]

Site 3 T27S/R39E Section 10 Well BR-3

This site was selected to explore the southern "boundary" area of the Intermediate Area wellfield. Water quality at depth could bear on long-term operation of the Intermediate Area wellfield. Subsurface geology may contribute to a notable difference in hydraulic conductivity at this location as compared to the wells on the west side of the Valley. [This well was actually located in section 11.]

Site 4 T26S/R39E Section 26 Well BR-4

This site is in the middle of the Intermediate Area wellfield. Water quality and stratigraphy below the current pumping level of the wellfield is of particular interest because of the potential to affect wellfield water quality. This site could also be used to test the suggestion of an upwelling of deep water in this area.

Site 5 T25S/R38E Section 34 Well BR-5

Previous geotechnical work in this area indicates unique subsurface geologic features that could have a bearing on the groundwater resource. A well would verify the groundwater conditions and geology. Water quality data are lacking in this area. Water table elevations at this site could provide an indication of recharge gradients.

Site 6 T25S/R38E Section 10 Well BR-6

The Sierra Nevada watersheds west of this site have been modeled as one of the larger recharge sources for the Valley. A well here could provide data that would help evaluate recharge quantities. Comparison of water table elevations with other wells will indicate recharge gradient. A well at this site would also extend knowledge of water quality.

Site 7 T25S/R39E Section 8 Well BR-7

This site would provide information on the extent of fine-grained subsurface deposits, if any. Used with data from site 6, this well could help answer questions on water quality variation with depth and steepness of the groundwater gradient.

Site 8 T25S/R39E Section 34 Well BR-8

Selection of this site was also based on previous geophysical surveys. Those surveys suggest deposits that typically yield low quantities of poor quality water—a condition that has significant impact on the long-term pumping potential of the area. A well here would help define the existence and extent of those deposits.

Site 9 T25S/R39E Section 30 Well BR-9

A deep well in the China Lake Playa area would give insight into the depositional history of the Valley and the existence of subsurface fine-grained material in this area. It would provide an indication of potential for groundwater production at depth below the playa.

Site 10 T24S/R38E Section 22 Well BR-10

Nine-mile Canyon in the Sierra Nevada west of this site is estimated to be a relatively large contributor of recharge in the Valley. Water quality differences with depth may yield insight as to the depth of section through which the recharge flows. This well also had the potential for providing data on migration of fine-grained deposition during recent geologic time. [This well was actually completed in section 21.]

Although 10 drilling sites were selected, it was understood from the beginning of the Project that budget constraints would not allow installation of wells at each of the 10 sites unless drilling costs were very favorable. As the drilling program progressed, it became apparent that drilling costs would not allow construction of 10 wells, and some of the sites would have to be eliminated. A determination was made to eliminate sites 7, 8, and 9. These sites were selected for elimination for two reasons. First, the NAWS completed a deep geothermal exploration well (SNORT-1) in the center of the Valley. After the NAWS made the upper section of this well available to the Project for completion and data collection, it was determined that this well would generally substitute for sites 7 and 8. Second, the discovery of thick sections of clay in NR-1, NR-2, and BR-6 made site 10 more important than site 9 because site 10 would provide additional information on the extent of the thick subsurface clay.

WELL COMPLETION

Except for BR-4, each of the wells were installed by private drilling companies through contract with one of the local participants. While the holes were drilled in a similar manner, each well was different with respect to the number of 2-inch piezometers installed and the depth of screen. This section briefly describes how each well was completed. Additional information on the well completions are available in Volume II, Section A, "Test Wells".

Well BR-1

Drilling by Southern California Drilling of Lancaster, California, began on February 15 and was completed on March 5, 1991. A 12¼-inch hole was drilled to 1,910 feet. The drilling rate was a fairly consistent 30 feet per hour to about 1,700 feet. From 1,700 to 1,830 feet the drilling rate was about 15 feet per hour. The drilling rate decreased until the last 30 feet took 6 hours, a rate of 5 feet per hour. Four 2-inch piezometers were set in the hole, with the bottom of the 20-foot screens at 1,700; 1,520; 1,060; and 635 feet.

Well BR-2

Drilling by Southern California Drilling of Lancaster, California, began on October 1 and was completed on October 24, 1990. A 12¼-inch hole was drilled to 2,020 feet. The penetration rate was relatively consistent for the entire hole depth. Three 2-inch piezometers were set in the hole, with the bottom of the 20-foot screens at 1,960; 1,480; and 640 feet.

Well BR-3

Drilling by Southern California Drilling of Lancaster, California, began on March 6 and was completed on March 19, 1991. A 12¼-inch hole was drilled to 2,024 feet. The penetration rate was relatively consistent for the entire hole depth. Three 2-inch piezometers were set in the hole, with the bottom of the 20-foot screens at 1,870; 1,340; and 670 feet.

Well BR-4

Drilling by Reclamation crews from Sacramento, California, and Phoenix, Arizona, began on August 28 and was completed about September 27, 1990. The hole was drilled to 2,020 feet and electric logged. Difficulty in placing the 2-inch pipe resulted in setting only one piezometer in the hole, with the bottom of the 10-foot screen at 1,200 feet.

Well BR-5

Drilling by Welch and Howell Drilling of El Centro, California, began on December 19, 1991, and was completed on January 3, 1992. The hole was drilled to 1,014 feet with a 14¾-inch bit; a 12¼-inch bit was used to drill the remainder of the hole to 2,013 feet. The drilling rate, through coarse alluvial fill, was consistent for the entire hole depth. Three 2-inch piezometers were set in the hole, with the bottom of the 20-foot screens at 1,980; 1,610; and 870 feet.

Well BR-6

Drilling by Welch and Howell Drilling of El Centro, California, began on January 6 and was completed on January 17, 1992. The hole was drilled to 1,008 feet with a 14¾-inch bit; a 12¼-inch bit was used to drill the remainder of the hole to 2,012 feet. Most of the material encountered from a depth of 510 feet to about 1,480 feet was clay. Three 2-inch piezometers were set in the hole, with the bottom of the 20-foot screens at 1,660; 1,210; and 350 feet.

Well BR-10

Drilling by Welch and Howell Drilling of El Centro, California, began on August 24 and was completed on September 2, 1992. The hole was drilled to 591 feet with a 17½-inch bit; a 14¾-inch bit was used to drill the hole from 591 to 1,002 feet; the remainder of the hole to 2,005 feet was drilled with a 12¼-inch bit. Four 2-inch piezometers were set in the hole, with the bottom of the 20-foot screens at 1,950; 1,580; 1,200; and 660 feet.

Well NR-1

This well was drilled on Water District property in the Northwest Area of the Valley to provide information on a potential future production site. Drilling by Southern California Drilling of Lancaster, California, began on January 7 and was completed on February 6, 1991. The hole was drilled to 2,012 feet with a 12¼-inch bit. A continuous clay and black organic mud section was encountered between 340 feet and 1,810 feet. Three 2-inch piezometers were set in the hole, with the bottom of the 20-foot screens at 1,980; 1,190; and 270 feet.

Well NR-2

Because of the unexpected thickness of the clay encountered at Well NR-1, the Water District drilled this well on the opposite corner of their northwest property to determine the extent of the clay layer. Drilling by Southern California Drilling of Lancaster, California, began on February 4 and was completed on February 15, 1991. The hole was drilled to 1,994 feet with a 12¼-inch bit. A continuous clay layer was encountered between 445 feet and 1,490 feet. Three 2-inch piezometers were set in the hole, with the bottom of the 20-foot screens at 1,930; 1,560; and 350 feet.

Well MW-32

This well was drilled west of the Intermediate Area on property the Water District was contemplating purchasing. Drilling by Rottman Drilling Company of Lancaster, California, began on September 23 and was completed on October 8, 1991. The hole was drilled to 1,968 feet with a 12¼-inch bit. The entire hole was through a sandy alluvial fill with very little silt or clay. Four 2-inch piezometers were set in the hole, with the bottom of the 20-foot screens at 1,920; 1,260; 900, and 360 feet.

SNORT-1

This hole was drilled to obtain data on the nature of the entire sedimentary column in the Valley and the nature of the basement rocks. Drilling by Welch and Howell Drilling Company of El Centro, California, began on September 8 and reached a total depth of 7,394 feet on September 30, 1991. A 7-inch casing was installed. Two intervals in the upper part of the hole were completed under the Project by perforating the casing between 840 and 880 feet and between 1,430 and 1,470 feet. Additional data are available from deeper perforations completed as part of the NAWS geothermal program.

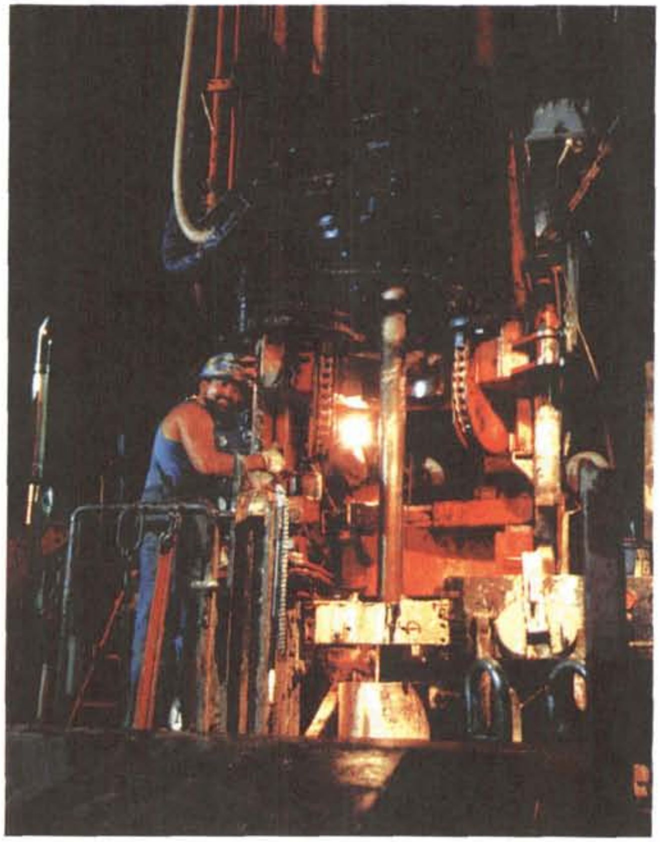
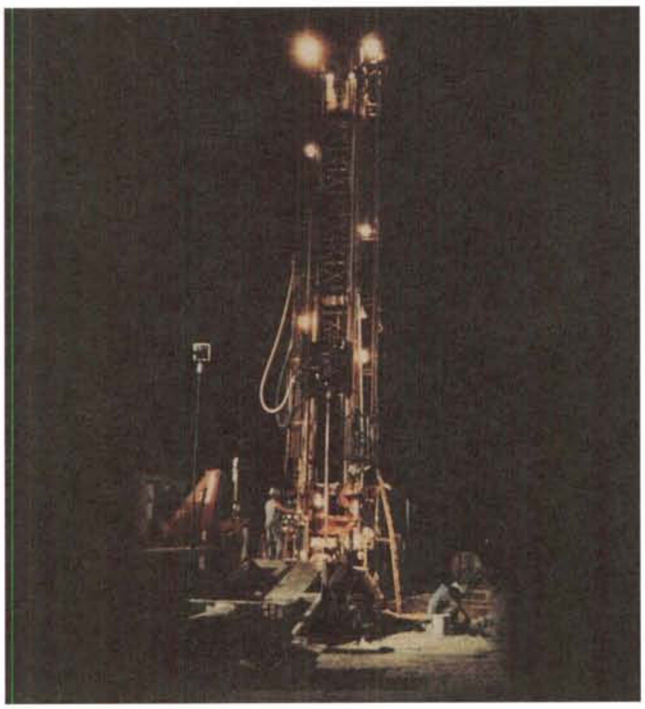


Photo by Don Decker

This available light photo was taken at BR-4 shortly after "bottoming out" at 2,020 feet in the early morning hours of September 13, 1990. Bureau of Reclamation driller Kevin Herrman is shown with a happy "thumbs up" smile. At daybreak, Gail Moulton, Don Decker, and other Technical Committee Members supervised electric logging of the well and immediately analyzed the results to provide instruction as to the number and location of the individual sampling tubes (piezometers) to be installed in the well.

CHAPTER VI

DATA COLLECTION PROCEDURES



VI. DATA COLLECTION PROCEDURES

During actual drilling of each well and after installation of each piezometer, data on the geologic formation, aquifer characteristics, groundwater elevations, and groundwater quality were obtained.

During the drilling operation, a log of the rate at which drilling progressed was maintained by the driller, and samples of the drill cuttings were collected. Electric logs were run after the hole reached total depth. These data provided information about the formation penetrated by the drill hole.

After each well was completed, data on the groundwater were collected. Depth to groundwater was measured immediately after each well was completed and about every 2 months thereafter. Water samples were collected after each well completion and sent to a laboratory for chemical analysis. Transmissivities were estimated by performing rising head slug tests. These tests involved depressing the water level within the 2-inch piezometers with air pressure, then measuring the rate of recovery after the pressure was released.

Detailed presentations of all data collected are included in Volume II, Section A, "Data Collected". This chapter summarizes the methodology for obtaining the data.

DRILL HOLE CUTTINGS

As part of the hole drilling process, a thick drilling mud was circulated through the drill stem, bit, and up the open hole. During every 10 feet of drill bit penetration, a sample of the cuttings was collected by straining the mud returning from the hole. These cuttings were placed in a zip-lock plastic bag marked with the drill hole depth. Cutting samples from each hole were packed into wood boxes for storage and later description by an experienced geologist.

ELECTRIC LOGS

Subcontracts were awarded to Welenco of Bakersfield, California, on BR-4; Schlumberger, also of Bakersfield, on BR-10; and Barbour Well Surveying of Camarillo, California, on all other wells to complete electric logs. Immediately after the hole was drilled to total depth and before the 2-inch piezometers were installed, an electric probe was lowered down the hole. The electric potential between the down-hole probe and a probe on the surface was measured continuously as the down-hole probe was gradually lowered. Varying potential, recorded on a strip chart, provided an indication of the geologic formation the down-hole probe passed through.

WATER QUALITY

In order to remove any drilling mud from the wall of the drill hole and further develop the well so the screens and formation are not artificially constrained, each 2-inch piezometer was pumped immediately after installation. An air-lift method was used to develop each piezometer. Pumping was continued for 12 hours or until clear water was obtained.

Water samples were collected from each piezometer near the end of the air-lift development pumping. For all wells except BR-10, these samples were analyzed by Clinical Laboratories of San Bernardino, California; BC Laboratories of Bakersfield, California, analyzed water samples from BR-10; for many wells, North American Chemical Company laboratories also completed a separate analysis. The analysis by Clinical and BC Laboratories included constituents identified in Title 22 of the California Health Code of Regulations.

WATER ELEVATIONS

Depth to water in each piezometer was generally measured whenever Reclamation's technical expert was in the Valley. This occurred about every 2 months. All measurements were made with a 1,000-foot electric water level sounder. A cable similar to 300-ohm, twin-lead, TV antenna wire with measurement marks at 0.05-foot intervals was lowered down each piezometer. When the end of the cable reached the water, a meter at the surface indicated completion of an electric circuit through the twin leads in the cable. Depth to water was then determined by the mark on the cable at the top of the piezometer.

Actual elevations of the top of the well casings were established by a third order survey completed by a Reclamation survey crew from Yuma, Arizona. The survey began and ended at a bench mark established by the Coast and Geodetic Survey. Allowable closure error for third order accuracy was a function of the survey distance. Actual survey data are included in Volume II, Section A, "Data Collected".

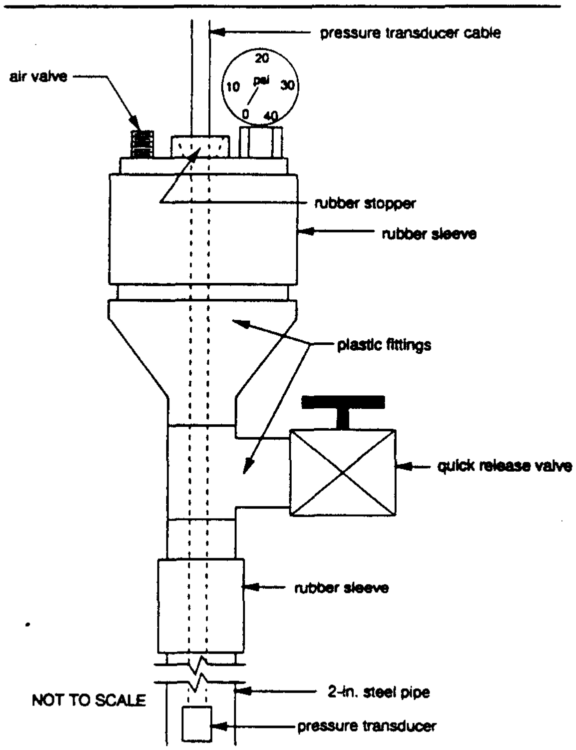
An oil coating on the inside of the medium-depth piezometer at BR-3 and the shallow piezometer at MW-32 hampered accurate water elevation measurements by the electric sounder. Application of bleach to the shallow piezometer at BR-3 and various mechanical attempts to remove the coating were unsuccessful. The water elevation in the shallow piezometer at BR-3 was finally obtained by a North American Chemical Company temperature probe.

This probe was relatively heavy and had no problem overcoming the friction of the coating. Analysis of a sample of the coating material taken off the temperature probe indicated that it consisted of lubricating oil and magnetic particles. The oil apparently originated from the air compressor used during the airlifting procedure.

TRANSMISSIVITY ESTIMATES

A pneumatic slug test was conducted on each piezometer installed in Project wells, and the recorded recovery rate was used to estimate the transmissivity of the formation opposite the screened interval. This pneumatic technique—a recent advancement in slug testing—involves either injecting air into a sealed well to lower the water level[17] or applying a partial vacuum to a sealed well to raise the water level.[18] The injection method used in this Project required developing the specifically adapted pipe assembly shown in figure 8. A commonly available electric data logging device used in conjunction with down-hole pressure transducers was adapted to the pipe assembly. The assembly also provided a connection for a compressed air source that allowed pressurizing air in the piezometer to about 10 pounds per square inch and a valve that allowed releasing the pressure very quickly. SCUBA tanks worked well as a compressed air source. Ten pounds per square inch pressure in the piezometer depressed the water level about 23 feet. After release of the pressure, the water

Figure 8: Pneumatic Slug Test Assembly



[17] "A Sample Pneumatic Device and Technique for Performing Rising Water Level Slug Tests," Darrell I. Leap, *Ground Water Monitoring Review*, Fall 1984, pp. 141-146.

[18] "Vacuum and Pressure Test Methods for Estimating Hydraulic Conductivity," Jeffrey P. Orient, Andrzej Nazar, and Richard C. Rice, *Ground Water Monitoring Review*, Winter 1987, pp. 49, 50.

level recovered, eventually to the original level. The data logger recorded the recovery rate over time.

Both the Cooper method[19] and AQTESOLV (AQuifer TEst SOLVer) computer software from Geraghty and Miller Modeling Group in Reston, Virginia, were used to estimate transmissivity of the screened aquifer.

HYDRAULIC CONNECTION

Some of the slug test equipment was also used to test for hydraulic conductivity between the screens of nested piezometers. To conduct the test the electric sounder probe was lowered to about 0.02 feet above the water level in the next to the deepest piezometer. The pneumatic slug pipe head assembly was secured to the deep piezometer, and the piezometer was pressurized to about 15 pounds per square inch, displacing about 34 feet of water. Any upward movement detected by the sounder would have indicated a hydraulic connection between the two piezometers. No indications of an open hydraulic connection between piezometers were observed.

TEMPERATURE PROFILES

Temperature profiles were obtained in each drill hole by using a ComProb/Gearhart Owens International temperature tool on a North American Chemical Company wire line rig. Each hole was logged by lowering the temperature tool down the hole at a rate of 5 feet a minute. Data were recorded by computer on a floppy disk and later printed out in tabular or graphic form. Data are accurate to within .5 degrees Fahrenheit. Temperature profiles are included in Volume II (Appendix XII). The temperature gradients reported in the following chapters are mostly from logging by the NAWS Geothermal Projects Office.

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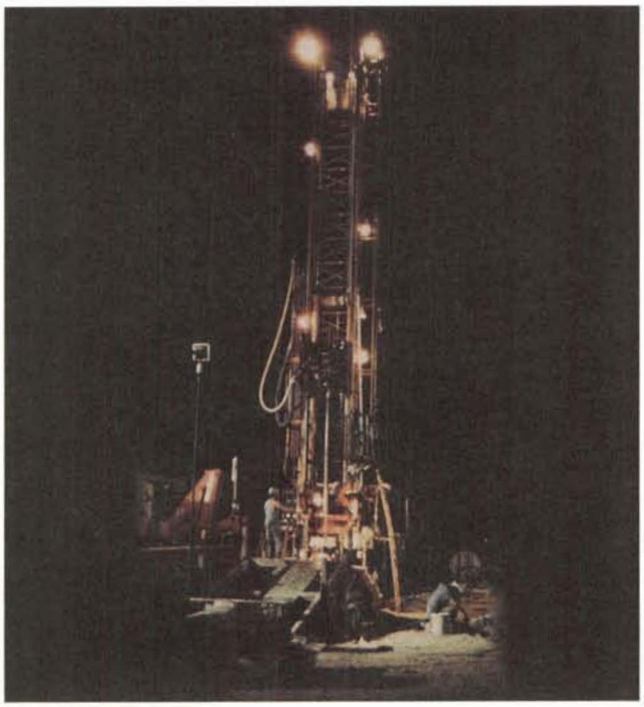
[19] "Response of a Finite-Diameter Well to an Instantaneous Charge of Water," H.H. Cooper, J.D. Bredehoeft, and I.S. Papadopulos, *Water Resources Research*, v. 3, No. 1, p.#263-269, 1967.

CHAPTER VII

DATA AND DATA ANALYSIS



VII. DATA AND DATA ANALYSIS

DATA COLLECTED

Data collected during the Project included stratigraphy developed from drill cuttings and electric logs, water surface elevations, water quality analyses, temperature profiles, and aquifer transmissivities. Figure 9 presents in graphic form most of the data obtained during the Project. Each vertical line below the well designation represents one piezometer. The length of the line is scaled to the piezometer depth (1 inch = 1,000 feet). Horizontal bars represent depths to groundwater relative to each other but not at the piezometer depth vertical scale. Table 3 shows much of the same information in a different format. More detailed information is available in Volume II, Section A, "Data and Data Analysis".

Table 3. Data collected from Project test wells

WELL	WATER ELEVATION feet (9/10/92)	WATER QUALITY mg/L	TRANS-MISSIVITY ft^2/min	NOTES
BR-1				Mostly sand with some clay. Water from each piezometer is sodium bicarbonate. Temperature gradient is 2.0 °F per 100 feet.
Shallow	2666.72	212	0.21	
Medium-shallow	2669.03	243	0.24	
Medium-deep	2664.42	353	0.01	
Deep	2656.77	285	0.004	
BR-2				Mostly sand. Iron and manganese above recommended regulatory maximum contaminate level (MCL) in medium and deep piezometers. Temp. gradient is 2.3 °F per 100 feet.
Shallow	2382.50	NA	0.01	
Medium	2386.06	240	0.19	
Deep	2376.94	354	0.016	
BR-3				Mostly sand and fine gravel; clay between 1,380 and 1,740 feet. Chloride levels higher than bicarbonate in 2 lower aquifers. Temp. gradient is 2 °F per 100 feet.
Shallow	2183.40	360	0.06	
Medium	2200.71	955	NA	
Deep	2201.48	6,634	0.006	
BR-4	2112.69	183	0.28	Fine to coarse sand. Water is sodium bicarbonate; iron exceeds MCL. Temp. gradient is 2.1 °F per 100 feet.

Table 3. Data collected from Project test wells

BR-5 Shallow Medium Deep	 2186.02 2178.86 2177.04	 534 837 891	 0.23 0.15 0.18	Medium to coarse sand. All water is sodium bicarbonate; iron and manganese are higher than MCL; higher sulfate and chloride compared to BR-1, BR-2, and BR-4. Temp. gradient information is not available.
BR-6 Shallow Medium Deep	 2189.90 2188.55 2203.75	 596 481 540	 0.02 0.25 0.20	Medium to coarse sand to 370 ft; clay from 370 to 1,700 feet; clayey to silty, medium sand 1,700 feet to bottom. All water is sodium bicarbonate with sulfate and chloride higher than BR-1, BR-2, and BR-4; arsenic, iron, manganese, and aluminum exceed MCL. Temp. gradient is 2.22 °F per 100 feet.
BR-10 Shallow Medium- shallow Medium- deep Deep	 2253.51 2239.38 2198.50 2196.09	 1,000 580 1,220 1,330	 0.19 0.02 0.14 0.09	Medium to coarse sand to 680 feet; light gray/green clay with interbedded sand from 680 to 1,440 feet; medium to coarse sand from 1,440 to bottom. Water is predominately sodium bicarbonate; iron and manganese exceeded secondary MCL in lower aquifers. Temp. gradient is 1.7 °F per 100 feet.
NR-1 Shallow Medium Deep	 2176.49 2208.78 2165.87	 2,406 3,660 3,251	 0.004 NA 0.05	Medium to coarse sand to 340 feet; clay from 340 to 1,820 feet; medium sand from 1,820 to bottom; fossils and methane gas were encountered in the hole. Water in shallow aquifer is sodium sulfate with high concentrations of calcium and magnesium; water in lower aquifers are sodium bicarbonate; Nitrate exceeded MCL in the shallow piezometer. Temp. gradient is 2.75 °F per 100 feet.

Table 3. Data collected from Project test wells				
NR-2 Shallow Medium Deep	 2184.31 2176.08 2177.45	 808 1,367 3,305	 0.48 0.14 0.12	Fine to coarse sand to 440 feet; clay from 440 to 1,480 feet; sand from 1,440 to 1,620 feet; interbedded sand and clay from 1,620 to bottom. Shallow and deep waters are sodium bicarbonate with high sulfate in shallow aquifer; middle aquifer is sodium sulfate with high bicarbonate, chloride, and nitrate; arsenic is above MCL. Temp. gradient is 2.7 °F per 100 feet.
SNORT-1 Shallow Deeper	 N/A N/A	 9,890 N/A	 N/A N/A	No flow in the deeper (1,430- to 1,450-foot) interval.
MW-32 Shallow Medium-shallow Medium-deep Deep	 2176.76 2175.50 2176.58 2177.85	 252 169 176 526	 0.009 0.31 0.23 0.11	Mostly fine to medium sand. All waters are sodium bicarbonate. No constituents exceed MCL. Temp. data was not obtained.

DATA ANALYSIS

Considerable data have been obtained during the Project. The primary reason for collecting data, of course, is to learn something about the groundwater resource in Indian Wells Valley that will help in its future development. This requires interpretation of the data, a somewhat courageous venture when dealing in the geohydrologic realm. This section provides some interpretive inferences that can be made from data collected during the Project. These data and their analysis provided a significant expansion of knowledge in the groundwater resource of the Valley. It must be recognized, however, that knowledge is progressive and future work will build upon the results of this Project. Isotopic analyses, future water surface elevation data, seismic surveys, and additional well construction will add to the general knowledge of the groundwater resource and may provide a basis for re-evaluation of the inferences drawn here.

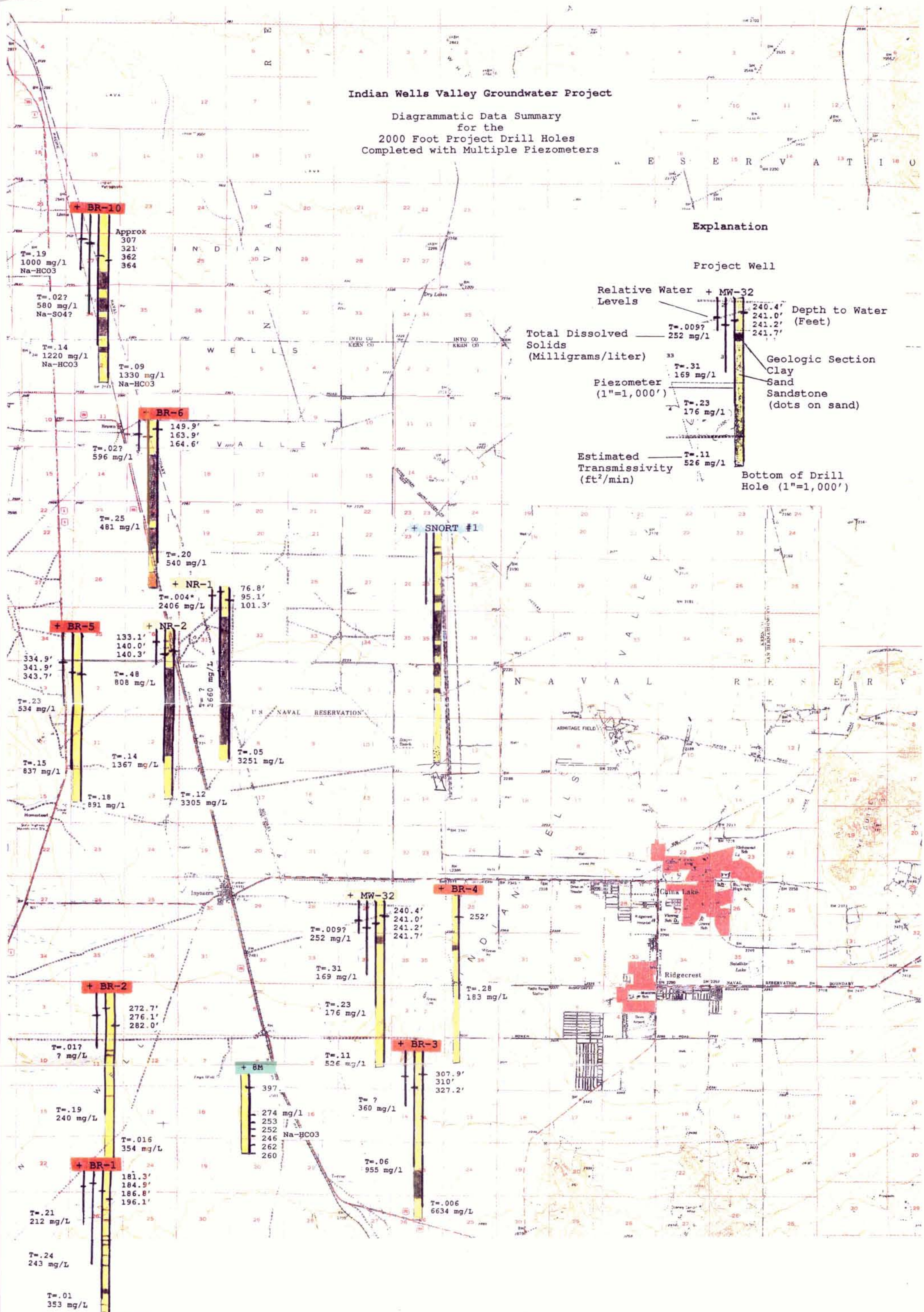


Figure 9: Data Obtained from Wells Constructed Under the Project

Sodium and bicarbonate are the predominant cation and anion, respectively, found in nearly all water samples taken from Project wells. The primary source of sodium in natural water is from the release of soluble products from igneous rock and its weathering products.[20] This suggests that the source of recharge is runoff from the surrounding mountains, which are of igneous composition. In most cases carbonate and bicarbonate ions in groundwater are derived from carbon dioxide in the atmosphere and soil and from the solution of carbonate rocks;[21] although in the southern Sierra Nevada and Coso areas, the carbonate ions could also have a geothermal source.[22] However, water surface measurements obtained during the Project generally indicate downward water movement, providing further evidence of recharge from surrounding mountains.

Stratigraphic analyses revealed a thick layer of clay in the northwest portion of the Valley. While the full expanse and origin of this clay is not known, it appears to extend over much of the north half of the Valley. Clay encountered in a NACC well 2 miles north of Inyokern and the lack of clay in a Community Service's District well in the middle of Inyokern indicates that the clay pinches out somewhere north of Inyokern Road. Figure 12 (following page 94) shows the approximate location of the clay layer. While existing data provide a reasonable definition of the west boundary of the clay, the location of the east boundary is much less conclusive. The clay seems extensive enough to impact the estimates of good quality water available for municipal and industrial use. Except for the clay, sand is the predominate material in the Valley fill.

Earlier estimates of good quality retrievable water in storage varied between 587,000 and 3,200,000 acre-feet.[23] The presence of poor quality water associated with the extensive clay stratum discovered in the northwest part of the Valley decreases the estimate of good quality groundwater in storage in that area. However, good quality water found at depth in the Intermediate and Southwest Areas increases the estimate of water in storage in those areas. Using information on the extent of the clay in the Northwest Area and the depth of the good quality water in the Intermediate and Southwest Areas, good quality water in storage is re-estimated as 5,600,000 acre-feet. Table 4 gives the factors used in calculating this new estimate.

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[20] *Groundwater Hydrology*, H. Bouwer, McGraw-Hill, New York, 1978.

[21] *Hydrogeology*, S.N. Davis and R.J.M. DeWiest, John Wiley and Sons, New York, 1966.

[22] Personal communication with Dr. Frank Monastero, January 27, 1993.

[23] *Water Supply of Indian Wells Valley*, California, Pierre St.-Amand, Naval Weapons Center, April 1986, pp. 41, 42.

Table 4. Estimated good water in storage in the Indian Wells Valley

UNIT	AREA acres	DEPTH feet	SATURATED VOLUME acre-feet	EFFECTIVE SPECIFIC YIELD[24] Percent	WATER IN STORAGE acre-feet
Intermediate Area	15,360	1,700	26,112,000	10	2,600,000
Southwest Area	17,920	1,700	30,464,000	10	3,000,000
TOTAL					5,600,000

The main difference between this estimate and the estimate given by St.-Amand is the area and depth of good quality water. Project data indicate a much greater depth of good quality water than that used by St.-Amand. It should be recognized, however, that physical and economic factors may limit the retrievable depth of water. It is hard to imagine pumping to a depth of 2,000 feet under today's conditions. In the next chapter where calculations of water resource life are made, additional dewatering thicknesses of 100, 200, and 300 feet are used.

Water in the northwest part of the Valley is not included as useable water in table 4 because it is consistently of poor quality. Except for the medium zone in BR-6, all water samples were higher than 500 mg/L in total dissolved solids. While the water may be adequate for agricultural use, it does not meet Environmental Protection Agency suggested minimum water quality parameters. Analytical results from water samples taken from SNORT-1 substantiate that this poor quality water exists in much of the north half of the Valley. In order for this water to be used for potable purposes, it would probably have to be treated or blended with better quality water.

Well NR-1 is in an area of historic agricultural use. Analysis of a water sample from the upper zone indicates total dissolved solids of 2,406 mg/L. This is too high for normal agricultural practices and crops. Analysis of water from other shallow wells in the area show better quality water. An abnormally low transmissivity measurement in the shallow piezometer at NR-1 may indicate ineffective well cleaning after installation of the piezometer, creating suspicion of the accuracy of the water quality reading from this piezometer. Future work should be done to validate water quality in this piezometer.

[24] Effective specific yield is defined here as the percentage of water that can come out of a soil formation by gravity drainage.

Water surface elevation readings indicate a flat gradient eastward from BR-5. This may indicate limited recharge from the Sierra Nevada in this region.

In contrast to the flat gradient east from BR-5, the gradient east, northeast, and north from BR-1 appears quite steep. Some researchers suggest[25] a fault or boundary of some type running in a northwest direction somewhat east of BR-1. The Water District's southwest Monitoring Well No. 3, as well as BR-2, may be influenced by this boundary.

Water surface elevations in all the piezometers have remained relatively constant during the Project with the exception of the piezometers at BR-1. As shown in figure 10, water elevations dropped significantly over a year and a half. No compelling reason has been offered for this change, but future measurements in BR-1 and Water District wells in the Southwest Area may help provide a clearer picture of water surface changes in this area.

Looking at the data as a whole, the opportunity for obtaining a significant amount of water for municipal use from the north half of the Valley is not very encouraging. Although the thick clay layer may contain large quantities of water, the quality is poor, and this may limit the long-term availability of sufficient quantities for large scale agriculture or municipal and industrial uses. There is also the potential for significant subsidence in this area.

Good quality water in the Intermediate and Southwest Areas is apparently available not only near the surface but also to depths not previously explored. These areas, then, present opportunities for further utilization of the groundwater resource.

SUMMARY OF DATA ANALYSIS BY AREA

Southwest Area

The discovery of good quality water to a depth of at least 2,000 feet is probably the most significant Project finding in the Southwest Area. Total dissolved solids (TDS) in the groundwater samples collected from the Project piezometers ranged from about 200 mg/L in the upper part of the aquifer to about 350 mg/L in the deeper part. A substantial volume of groundwater is in storage in this area.

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[25] "A Geophysical Investigation of Indian Wells Valley, California: U.S. Naval Ordnance Test Station, China Lake, California", R.T. Zbur, NOTS Technical Publication 2795, 1963.

The estimated transmissivity in the upper part of the aquifer is nearly as high as those estimated in the Intermediate Area Project piezometers. Estimated transmissivity at depth is much lower.

The groundwater gradient between well 8M (see figure 9) and the Intermediate Area is about the same as that between the deeper Northwest Area Project piezometers (BR-10 and BR-6). This suggests that the recharge from the southwest and northwest is about the same.

The groundwater gradient between the Intermediate Area and both well 8M and the shallow BR-3 piezometer could suggest equal recharge to the Valley from the south (El Paso Mountains) and the southwest. However, recharge must be much less from the El Paso Mountains because the lack of a pinyon-juniper woodlands on the El Paso Mountains indicates much less annual precipitation.

Northwest Area

The massively thick clay section discovered under much of the Northwest Area is probably the most significant finding of the Project regardless of area. The thickness of this clay in the Project drill holes ranged from about 800 to 1,300 feet. Depth to the top of the clay in the Project drill holes ranged from about 350 feet to about 700 feet.

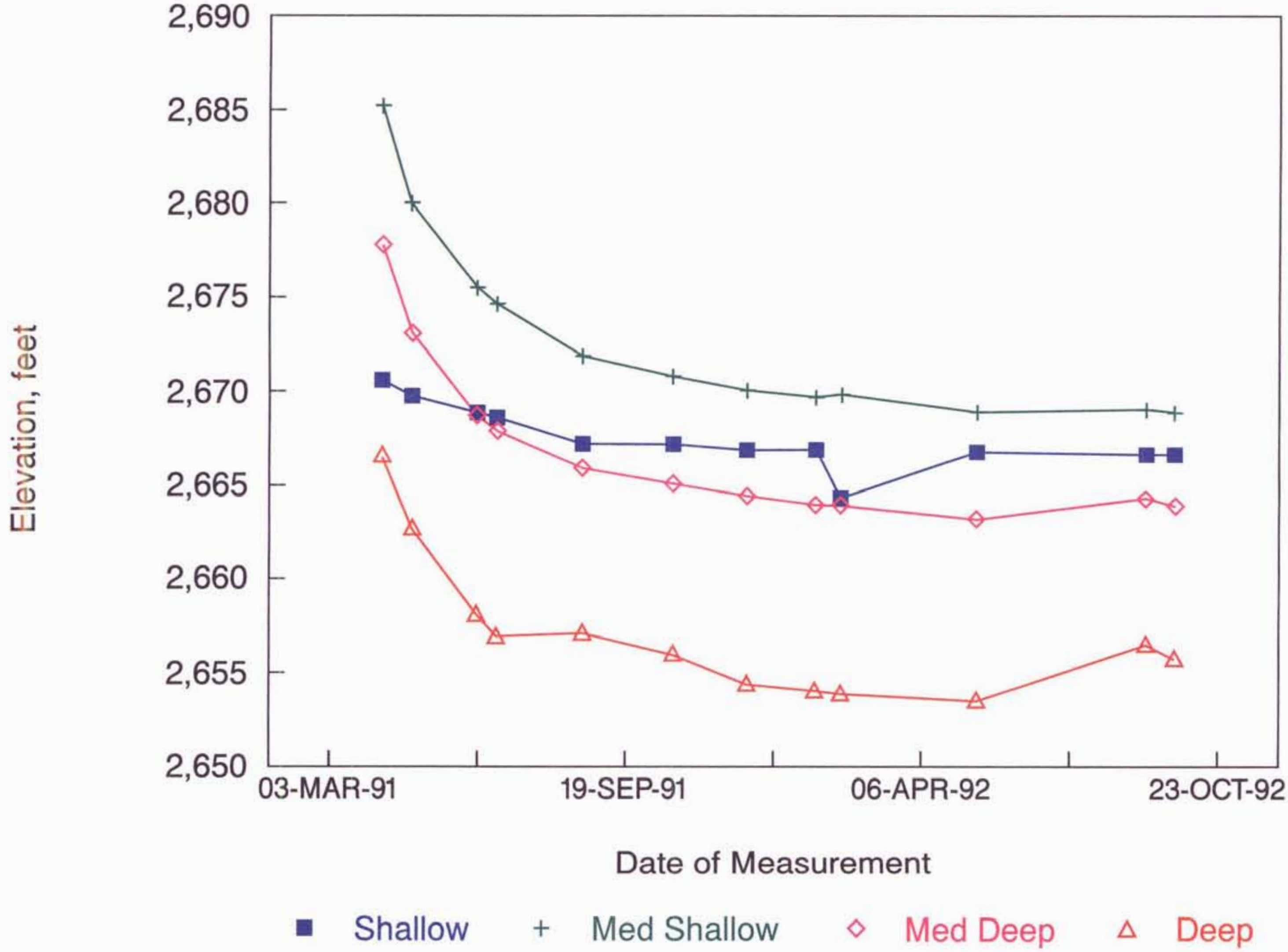
In general, the Northwest Area is characterized by poor quality water at depth. Shallower water, while acceptable for agricultural use, would have to be treated or blended with better quality water in order to make it acceptable for domestic use. High concentrations of certain water constituents could further limit blending in the absence of treatment.

Estimated transmissivities in the aquifer above the clay are about the same as those estimated for the upper aquifer in the Intermediate Area. The relatively thin "aquifers" interbedded in the massive clay and the aquifer below the clay are generally less transmissive.

The groundwater gradient between the deep BR-10 and BR-6 piezometers is about the same as the gradient in the lower elevations of the Southwest Area. This suggests that recharge from each area is about the same, if the aquifer transmissivity and cross-sectional area are equal.

Low groundwater surface gradients in the central part of the Northwest Area indicate little recharge; while steeper gradients in the north reflect recharge from the northerly watersheds.

Figure 10: Water Elevations for BR-1



Intermediate Area

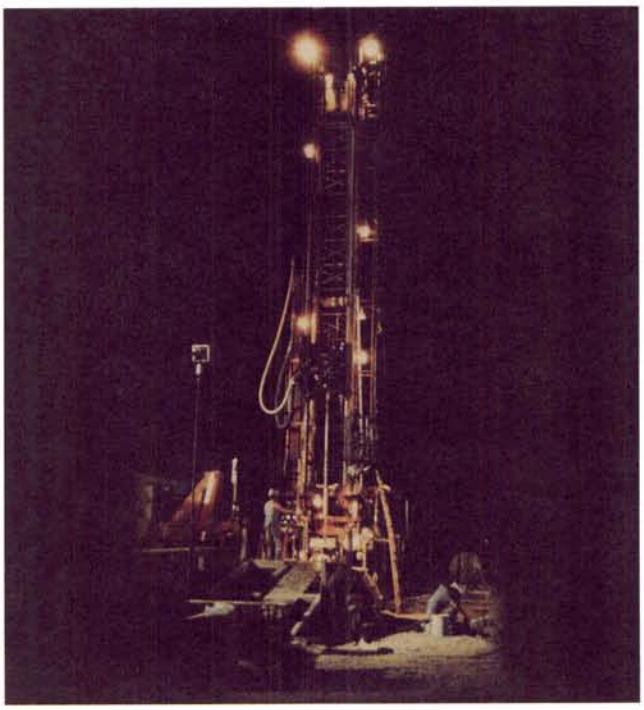
Discovery of relatively good quality water (526 mg/L) at 1,900 feet in the deep piezometer of Project well MW-32 is probably the most significant Project finding in the Intermediate Area. Even at a depth of 1,250 feet, the total dissolved solids is only 176 mg/L. This suggests that the Intermediate Area resource can be utilized to a greater extent than originally thought. The relative water levels in the MW-32 piezometers indicate an upward potential which is probably induced by the moderate depth pumping in the Intermediate Area.

The threat of water quality degradation from surrounding poor quality water remains the greater concern for more extensive utilization in the Intermediate Area. Project data indicate that water quality at depth deteriorates to the south.

Estimated transmissivity at depth is fairly high for a depth of nearly 2,000 feet. The estimated deep transmissivity is about one-half of that in the shallower aquifer.

CHAPTER VIII

RECOMMENDATIONS FOR FUTURE STUDIES



VIII. RECOMMENDATIONS FOR FUTURE STUDIES

INTRODUCTION

Data collected under the Project contributed to significant gains in knowledge of the groundwater resource in the Valley. However, as is typical with most data collection programs with finite funding and temporal constraints, areas were discovered where additional investigations would be extremely useful. This chapter documents these investigations so that they can be pursued in the future should capability become available.

Regardless of whether or not any of the recommendations contained in this chapter are implemented, it may be quite useful to convene the Technical Subcommittee members on a periodic basis. The Technical Subcommittee could evaluate any additional data that becomes available in the future, review current groundwater trends, and recommend groundwater programs local entities may consider for the future.

BLENDING STUDIES

As presented in the next chapter, blending of northwest water with intermediate and/or southwest water would increase the usable groundwater volume available for use in the Valley. The interplay between water treatment method and cost, specific pumping locations, and ion concentrations influences the optimum future development strategy. In order to evaluate the impact of those elements on future decisions, the following additional studies should be considered.

Water Treatment

Because of the wide range in possible treatment costs, it would be necessary to refine those costs prior to making decisions that would commit to treatment activities. Studies to refine these costs should commence at an early date, not only to provide better data upon which to base future decisions, but also to provide optional methods of handling any individual constituent that may limit the blending possibilities.

A study of treatment possibilities and costs should include definition of water to be treated, a literature search of possible treatment methods, laboratory analyses of viable treatment methods, field tests to verify laboratory results, and documentation of all activities. Costs for such a study would depend upon the specific work plan developed, but could be done for between $150,000 and $200,000 over a period of 15 to 18 months.

Location of Pumping

Specific sites for future production in the Northwest Area should be carefully considered since there is some variation in water quality, clay extent, and existing improvements. The general potential for subsidence and, if necessary, implications of pumping at specific locations on subsidence should be studied.

Because of the real potential for substantial surface subsidence resulting from pumping water from or beneath the clay layer, only pumping from above the clay layer was considered. Even with pumping from the aquifer above the clay, subsidence is a possibility that needs further exploration.

Individual Ion Concentrations in Northwest Area Water

The effects of specific ionic concentrations on potential blending strategies warrant further investigation. Only TDS was considered in developing strategies for blending northwest water with better quality water from the Intermediate and Southwest Areas. No consideration was given to the concentration of individual ions. However, some ions may approach or exceed established maximum concentrations for municipal and industrial use. This could limit or prohibit blending possibilities.

GENERAL STUDIES

There are opportunities to further the understanding of the general water resource in the Valley by continued monitoring and completing additional studies. This section contains suggestions on future studies that would provide data helpful for making long-term water management decisions.

Periodic Water Level Measurements

Water levels in Project piezometers have been measured every 1 to 2 months during the course of the Project. These measurements should continue on a regular basis. Several District monitoring wells in the Southwest Area of the Valley were added to the water level measuring itinerary because of the significant drop in BR-1 water levels. Water levels in these wells should continue to be measured on the same schedule as the Project piezometers.

Some consideration should be given to consistency in personnel and equipment used in the measuring effort. This will eliminate measurement errors introduced by individual differences in measuring techniques and equipment idiosyncracies.

Frequent water level measurements in the four MW-32 piezometers should be taken during the first year of pumping from District production wells 30 and 31. These measurements could yield insight into short- and long-term aquifer dynamics. Initial and long-term water level responses in these piezometers would probably make an excellent model calibration set. Installation of an electric logger may be the best method for collecting the initial water level changes and should be considered.

The water level in all of the Neal Ranch piezometers should be monitored if one of the Neal Ranch production wells is pumped for a 30-day test, as has been suggested. An electric data logger would probably be the most efficient method for recording water levels.

Water Sampling for Isotope Analysis

Analyzing water for isotopes can provide information on the age and origin of water. Groundwater age could provide additional evidence with respect to the previously accepted estimate of about 10,000 acre-feet of recharge a year.

Serious consideration should be given to analyzing all Project wells for isotopes. Because of the recharge delineation potential, wells of most interest for isotope analysis sampling would be those closest to the mountain front recharge watersheds. These would include wells BR-1, BR-2, BR-3, BR-5, BR-6, and BR-10. Other wells should be sampled and analyzed as funding permits.

Playa Investigations

One of the most difficult, yet most consequential, groundwater issues in the Valley concerns the amount of natural recharge to the Valley. Current estimates of recharge rely on calculations made in the 1950's by USGS researchers Kunkel and Chase.[26] One of these calculations involved an empirical estimate of evapotranspiration from the China Lake playa.

Recent work on playa evaporation rates using more direct measurement techniques on bare soil suggest that the earlier Kunkel and Chase estimates may be too high. Ullman[27] notes that the empirical technique used by many investigators may greatly overestimate the true value of evaporative loss from

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[26] *Geology and Ground Water in Indian Wells Valley, California*, F. Kunkel and G.H. Chase, U.S. Geological Survey Open-File Report, 1969.

[27] "Evaporation Rate From a Salt Pan: Estimates From Chemical Profiles in Near-Surface Groundwaters," W.J. Ullman, *J. Hydrol.*, 79: 365-373, 1985.

the water table in arid and semi-arid environments. Refinement of the annual recharge to the Valley may be possible by using more direct measurements of evapotranspiration for the playa.

The "Australian tube" method or weighing lysimeters could be used to make these measurements. Both offer relatively inexpensive ways to obtain field measurements of evaporation from a playa. In order to provide a comparison with Kunkel and Chase numbers, however, the weighing lysimeter method would require placement of lysimeters only in areas of the playa with the same water level as at the time of the Kunkel and Chase estimate. The Australian authors suggest that water levels are not critical for their soil tube method.[28]

Watershed Investigations

Installation of relatively permanent, yet inexpensive, surface flow gauges in the lower drainage of several watersheds in the Sierra Nevada would help refine recharge distribution estimates and total recharge to the Valley. Previous watershed recharge estimates could be compared to actual average annual long-term base flow (most of which becomes recharge) from the gauged watersheds. In addition, the relatively long-term annual base flow from several watersheds may correlate with some watershed attribute, such as area covered with juniper/pine vegetation, and allow a better estimate of recharge from the non-gauged watersheds.

Canyon constrictions formed by bedrock just upstream of the alluvial fan apex are ideal locations for stream gauging. The bedrock constriction forces most of the water draining from the watershed to the surface and most of this water becomes aquifer recharge when it reaches the alluvial fan apex. Perennial flow in Sand Canyon at the lower wilderness study area boundary indicates a bedrock constriction which probably allows little underflow. This location appears to be ideal for a gauging station. An inspection of other canyons on the west side of the Valley may reveal other potential locations for a gauging station. The Haiwee Spring area may offer a gauging opportunity for Coso Mountain runoff. Gauge sites should be selected by consensus of Technical Subcommittee members.

The USGS is a good source for ideas on the type of gauge best suited to the requirements and on construction techniques. In addition, they could estimate annual monitoring costs and provide help in developing monitoring procedures.

[28] "Estimate of Evaporation From the Normally 'Dry' Lake Frome in South Australia," G.B. Allison and C.J. Barnes, *J.Hydrol.*, 78:229-242, 1985.

Aquifer Modeling

The USGS had developed a model of the Indian Wells Valley groundwater aquifer based on the MODFLOW computer program.[29] One objective originally contemplated for the Project was a revision of the USGS model to accommodate new data obtained during the Project. The model would have been used to predict impacts of various future groundwater pumping possibilities. Time and fiscal constraints and questions regarding recharge quantity, recharge distribution, and distribution of aquifer transmissivity prohibited realization of this objective.

Recalibration of the USGS model is recommended subsequent to refinement of recharge to the Valley as covered under the "Playa Investigations" and "Watershed Investigations" sections of this chapter. Transient calibration is recommended should recharge quantity and recharge distribution remain uncertain.

Water Quality Analyses

Additional water samples should be taken from all Project piezometers and analyzed for constituent concentrations. These samples should be collected from a relatively steady discharge, displacement pump after electrical conductivity, pH, and temperature have stabilized (as required by standard EPA and USGS procedures). This will assure that the sample is reasonably representative of the aquifer water and reduce the uncertainty about any anomalous constituent concentrations. Consistency in electrical conductivity, pH, and temperature after several pumping episodes would instill even more confidence in subsequent water samples being representative.

This activity should receive high priority because some constituent concentrations in some of the air-lifted samples collected at the end of piezometer development suggest less than total development. Poor development in some piezometers is also suggested by less than expected transmissivity values in some of the aquifers.

SOUTHWEST AREA STUDIES

While Project data provided evidence of a significant resource in the southwest that could be utilized in the future, there are still areas of uncertainty. These areas should be explored further, as outlined below.

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[29] *The Ground-Water Flow System In Indian Wells Valley, Kern, Inyo, and San Bernardino Counties, California*, Berenbrock, Charles and Peter Martin, U.S. Geological Survey Water-Resources Investigations Report 89-4191, 1991.

Additional Water Elevation Data

The number of wells in the Southwest Area measured for water surface elevation should be expanded. Unexpected values of water surface elevation in Project piezometers and implications of these values create the need to expand the measurement of water levels to all available wells in the area. Acquisition and analysis of additional water surface elevation information may provide a more complete picture of the distribution of water level changes and recharge into the area.

Aquifer Testing

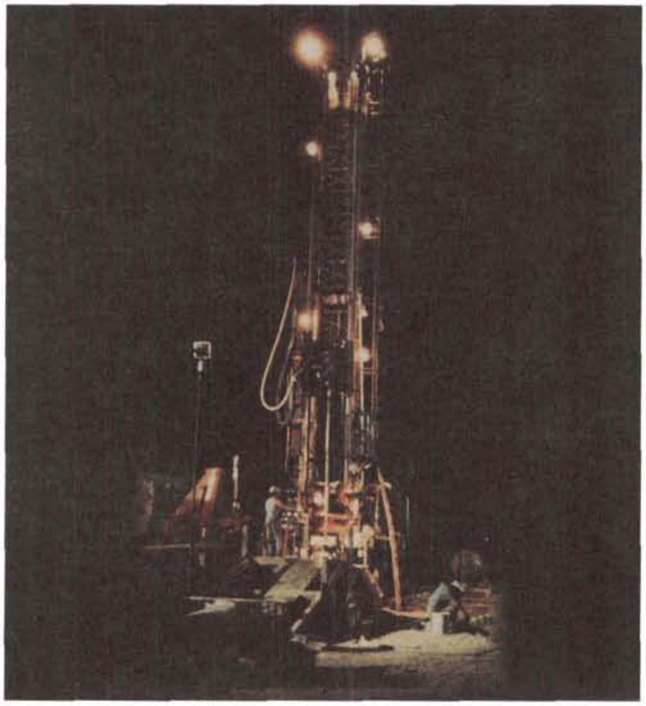
The Water District test well in the Southwest Area should be pumped for an extended period of time, preferably in excess of 7 days. This test will provide verification of aquifer characteristics, such as transmissivity and, especially, water storage.

Water Elevation Fluctuations

Short-term continuous water surface elevation measurement in BR-1 should be considered. During the Project, water surface elevations were measured at approximate 2-month intervals. Water level changes in the four BR-1 piezometers have been especially interesting because declining water surface elevations (see figure 10) may represent the ebb of a recharge pulse from the southwest watersheds. Short-term continuous water level monitoring with a data logger may reveal an informative short-term pattern of water level variation.

CHAPTER IX

FUTURE DEVELOPMENT ALTERNATIVES



IX. FUTURE DEVELOPMENT ALTERNATIVES

INTRODUCTION

This chapter presents a description of future groundwater development possibilities identified during the Project. The alternatives are essentially combinations of different ways to use the three areas of existing groundwater resources in the Valley—the Intermediate Area, the Southwest Area, and the Northwest Area. Six combinations emerge:

- Continue pumping from the Intermediate Area only
- Continue pumping from the Intermediate Area and expand into the Southwest Area
- Continue pumping from the Intermediate Area and blend water from the Northwest Area
- Continue pumping from the Intermediate Area, expand into the Southwest Area, and blend water from the Northwest Area
- Continue pumping from the Intermediate Area and blend **treated** water from the Northwest Area
- Continue pumping from the Intermediate Area, expand into the Southwest Area, and blend **treated** water from the Northwest Area

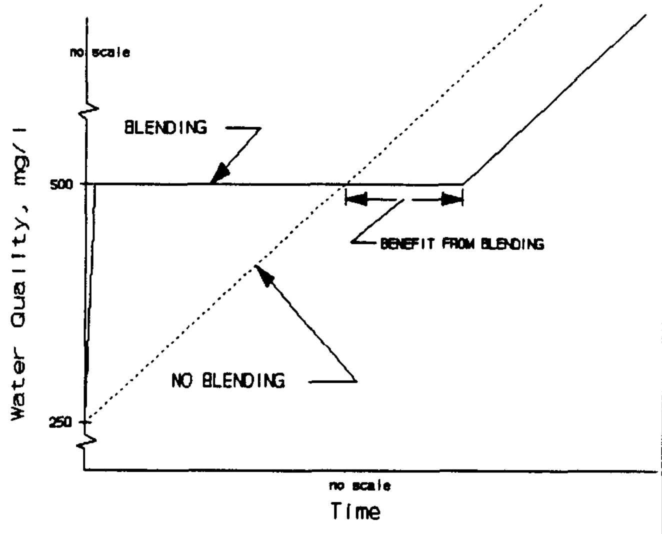
There are two prime considerations in determining a strategy for future water development—volume of water available and water quality. Because groundwater is available in finite quantities, decisions on future water development must include an estimate of available water volume and implications of heavy pumping in one area as opposed to spreading the pumping over a larger area.

Selection of a future groundwater development strategy will also depend upon the approach to water quality. Continued pumping from the good quality sources will result in an accelerated decline of water quality. Once the water quality of those sources has declined to the point where TDS content reaches 500 mg/L, no further opportunity is available for use of poorer quality water by blending. A level of 500 mg/L was used because it is the Environmental Protection Agency's **recommended** maximum TDS level for domestic use.[30]

[30] Water supplies delivered to many people in southern California, Nevada, Arizona, and other parts of the country contain TDS in excess of 500 mg/L.

Early pumping from both good and poorer quality water sources and blending those two water streams will result in a rapid (but scarcely perceptible) decline in water quality, but the total water volume available to the Valley at or less than 500 mg/L will be expanded. Another way of looking at the water quality impacts of blending is illustrated in figure 11. Blending early will result in a more rapid increase to 500 mg/L, but that level will be sustained for a longer period of time before TDS levels go above 500 mg/L.

Figure 11. Water Quality Impacts of Blending



While the conceptual water quality concern expressed above is valid, the condition in which resource life is limited by water quality (as represented by TDS) was never reached in the analyses used here. As described later in this chapter under "Other Assumptions and Considerations", the reasons are that 1) retrievable water volumes are much smaller than the total volume of good quality water in storage and 2) migration of poor quality surrounding water into the Intermediate Area is assumed to be a small percentage of the pumped quantity. This means that although water in the Intermediate Area will degrade over time, the degradation rate is small enough that the TDS never reaches 500 mg/L.

Each alternative presented here provides a different way of meeting future water demands from existing groundwater resources. The alternatives are described in somewhat general terms because knowledge of groundwater parameters is not sophisticated enough to allow more specific depictions.

Along with alternative descriptions, some subjective observations of advantages and disadvantages are provided.

This is not expected to be the last word in options for groundwater development in the Valley. Additional subsurface investigations, a longer time span of data from piezometers installed under this Project, age dating of water samples, and refinement of groundwater computer models will provide additional information useful for adjusting these options or developing new ones. In the meantime, however, information presented herein provides the basis for current decisions and the foundation for future data collection programs.

DEVELOPMENT ALTERNATIVE SUMMARY

Table 5 presents a summary of each future development alternative. More detailed information is provided in the following sections.

Table 5. Summary of future water resource development alternatives

ALTERNATIVE	LIFE OF RESOURCE	WATER QUALITY	INCREMENTAL COST
ALTERNATIVE 1 Continue pumping from the Intermediate Area	Resource life ranges between 14 and 52 years, with a best estimate of 29 years.	Start at present 250 mg/L TDS, gradually decline to 264 mg/L under the intermediate case.	Base condition, $0 cost.
ALTERNATIVE 2 Continue pumping from the Intermediate Area and expand into the Southwest Area	Resource life ranges between 26 and 134 years, with a best estimate of 68 years.	Start at present 250 mg/L TDS, negligible decline.	$7,250,000 capital incremental cost.
ALTERNATIVE 3 Continue pumping from the Intermediate Area and blend water from the Northwest Area	Resource life ranges between 19 and 77 years, with a best estimate of 42 years.	Immediately decline to 500 mg/L.	$4,700,000 capital incremental cost.
ALTERNATIVE 4 Continue pumping from the Intermediate Area, expand into the Southwest Area, and blend water from the Northwest Area	Resource life ranges between 33 and 169 years, with a best estimate of 92 years.	Immediately decline to 500 mg/L.	$12,000,000 capital incremental cost.
ALTERNATIVE 5 Continue pumping from the Intermediate Area and blend **treated** water from the Northwest Area	Same as Alternative 3, since resource is not limited by water quality.	Water quality could be adjusted to meet specific needs.	$23,700,000 capital incremental cost; $6,800,000 annual cost for treatment.
ALTERNATIVE 6 Continue pumping from the Intermediate Area, expand into the Southwest Area, and blend **treated** water from the Northwest Area	Same as Alternative 4, since resource is not limited by water quality.	Water quality could be adjusted to meet specific needs.	$31,000,000 capital incremental cost, $6,800,000 annual cost for treatment.

ALTERNATIVE 1
Continue Pumping from the Intermediate Area Only

Under this option the current pumping patterns would continue in the future. Additional water demands would be met by construction of more wells in the Intermediate Area. Advantages of this alternative include dealing with a known, good quality water source. This source meets current user's needs satisfactorily. The source is relatively close to the user and an existing distribution system is in place. This source of good quality water is, however, finite. Over time, the good quality water will be pumped out and as the pumping depression expands, poorer quality water in surrounding areas will gradually migrate into the Intermediate Area.

Under the assumptions made in the analysis presented in this chapter, water quality in the Intermediate Area never reaches the 500 mg/L level before the resource is depleted. However, actual conditions may differ. In any case, inflow from surrounding areas presents a natural water quality blending process that is, to a large extent, uncontrollable. The amount, timing, and constituent makeup of neither the poor quality water coming from surrounding areas nor the blended water produced in the well field can be controlled. This leaves water purveyors at risk for water quality declines much faster than expected, variations in water quality, and certain ions exceeding standards.

Heavy drawdown in the Intermediate Area will also increase pumping head and costs associated with pumping water from deeper levels. In addition to large production wells constructed by major purveyors, the Intermediate Area is the location of a number of wells serving individual houses or groups of houses. As the drawdown curve drops and expands, these private wells may have to be deepened and/or the pumps will have to be reset to a lower elevation. Pumping costs will also increase for these wells, and these wells will pump poorer quality water over time.

This alternative will constitute the base direct cost level against which other alternatives are compared. Other alternatives, then, may incur incremental costs over and above expansion costs incurred under this alternative. New wells would be drilled, existing wells deepened, distribution systems enlarged as demands dictate. These costs, however, will be incurred irrespective of which alternative is pursued.

ALTERNATIVE 2
Continue Pumping from the Intermediate Area and Expand into the Southwest Area

This option anticipates the continued use of the Intermediate Area wellfield in combination with pumping from the Southwest Area. Data collected under the Project revealed a good quality water source in that Area. Pumping heads would be reasonable, and aquifer transmissivities are favorable. Conveyance and power facilities would have to be extended into the Area.

This option would prolong the period of excellent quality water being available. High transmissivities in the Southwest Area would result in low drawdown at expected pumping rates. There are few private wells in the area that would be impacted by drawing down the water surface.

There may be some negative impacts to developing a well field in the southwest. The remoteness of the area would require capital expenditures for collection and power facilities. If most recharge to the Intermediate Area comes from the southwest as some of the data indicate, then pumping in the southwest could intercept a portion of this recharge, resulting in a faster decline in the groundwater surface in the Intermediate Area. It should be recognized however, that the estimates of aquifer "life" given in this analysis already assume no recharge in the Intermediate Area. Although data from the Project and other sources provide an indication of a satisfactory resource in the Southwest Area, there is no production history in this area to confirm the data. Recharge into this area has yet to be estimated satisfactorily.

In addition to the base costs associated with Alternative 1, costs would be incurred for extending the water conveyance system to the Southwest Area and providing power to the area. Installation of a 30-inch pipe from Ridgecrest to the Southwest Area, a distance of about 10 miles, is estimated to cost $7,000,000 (see Volume II, Appendix XV for more detail on the cost estimates). A 30-inch pipe would be capable of carrying over 25,000 acre-feet a year. A wood-pole, 34.5-kV transmission line built over the 5 miles between Inyokern and the Southwest Area would cost about $250,000.

ALTERNATIVE 3
Continue Pumping from the Intermediate Area and Blend Water from the Northwest Area

Under this option, water would be pumped from the aquifer in the northwest part of the Valley and blended with water pumped from the Intermediate Area. Blending is necessary because the water quality in the northwest is poorer than the maximum recommended TDS level of 500 mg/L. For purposes of analysis of this alternative, a representative water TDS of 1,000 mg/L was used for the northwest water, and a TDS of 250 mg/L was used as the current quality of water in the Intermediate Area. Blending would occur at a rate that resulted in a final water quality of 500 mg/L.

This option has the advantage of prolonging the availability of good quality water in the Intermediate Area by spreading out the pumping over a larger area of the Valley. As some current pumping in the Intermediate Area is shifted to the northwest, pumping heads in the Intermediate Area would temporarily stabilize or decline.

A disadvantage of this alternative is that water quality delivered to the consumer will decline more rapidly than if blending didn't occur. It should be noted, however, that there is a risk with implementing any option that exclusively uses sources of good quality water. **The risk is that although good—even excellent—quality water will be available for a period of time; once those resources are depleted the only other sources available are of much poorer quality, and blending opportunities would no longer be available.** The result is that water quality delivered to the consumer may degrade to a level greater than 500 mg/L within a shorter time than if blending were implemented (see figure 11). This assumes that good quality recharge into the Valley is much smaller in volume than total pumping and other withdrawals, a situation that seems quite reasonable considering all available data.

In order to make this option work, additional capital expenditures would be necessary. A pipeline would have to be constructed to the Northwest Area to collect water pumped from that area. Mixing facilities would be necessary to assure that water collected from the northwest was not unequally distributed. A 20-inch pipeline would be required to transport 12,333 acre-feet a year, an amount that would allow a blend of 1,000 mg/L northwest water and 250 mg/L intermediate water to result in a 37,000 acre-feet a year 500 mg/L composite. If this pipeline discharged to mixing facilities in Ridgecrest, the cost for the 14-mile feature is estimated at $5,400,000; if the pipe is tied into an existing 30-inch pipeline on Inyokern Road, its length would be about 7 miles and it would cost about $2,700,000.[31] Existing power facilities are available to serve the new wells. Mixing facilities are estimated to cost $2,000,000.[32]

[31] See Volume II, Appendix XV for calculations.

[32] Personal communication with Mr. Roy Tucker, Assistant Manager, Indian Wells Valley Water District, January 12, 1993.

ALTERNATIVE 4
Continue Pumping from the Intermediate Area, Expand into the Southwest Area, and Blend Water from the Northwest Area

Under this option, better quality water from both the Intermediate and Southwest Areas would be blended with water pumped from the Northwest Area. Since water quality in the Intermediate and Southwest Areas are similar, the quantities pumped from each of these areas would be determined by factors other than water quality. Just enough water would be pumped from the Northwest Area to provide a 500 mg/L blend.

As with Alternative 3, use of the blending process would stretch the available usable water resource of the Valley by making use of the poor quality water in the northwest while still providing adequate quality of water delivered to the consumer. This option would also provide the ability to control the delivered water quality and would avoid possible dramatic declines in water quality in the future as discussed earlier. There would be an immediate decline in the quality of water delivered to customers served by the District and to perhaps other Valley water pumpers. Since the blending is controlled, however, this decline could be phased in gradually so it would not be perceptible; and it could be adjusted to accommodate varying conditions. Since additional pumping would occur in the northwest, existing wells in that area may see some declines in pumping levels.

Additional capital expenditures required for this alternative would also include a pipeline to the Northwest Area and mixing facilities. In addition, a pipeline and power transmission facilities to the Southwest Area would have to be constructed. Using costs from Alternatives 2 and 3, total incremental costs are about $12,000,000, assuming the 20-inch pipeline tied into the existing 30-inch pipeline at Inyokern Road and mixing facility costs would remain about the same.

ALTERNATIVE 5
Continue Pumping from the Intermediate Area and Blend Treated Water from the Northwest Area

This option is similar to Alternative 3 except under this option water pumped from the northwest would be treated prior to blending with intermediate water. Blending with untreated water from the northwest may be limited by the presence of high concentrations of specific toxic ions—for example, arsenic in BR-6. Treatment would avoid that limitation, allowing full use of the blending possibilities. Treatment could also be used to lower the total dissolved solids concentrations to further manage blended water quality or quantity of water that could be used from the Northwest Area. Using either approach, life of the total water resource in the Valley could be significantly extended in time.

Treatment could allow full use of all water sources in the Valley, depending upon the level of treatment used. For purposes of estimating costs, it was assumed that the quantity pumped from the northwest will never exceed 12,333 acre-feet a year. This quantity is consistent with the approximate amount now being pumped from that area for agricultural purposes and with the assumed size of the pipeline installed to that area.

Treatment costs could be high. Depending upon the method of treatment and amount of water treated, construction and operating costs could significantly increase the cost of water to the user. Without a detailed study of water chemistry, laboratory tests, knowledge of power and chemical costs, brine disposal requirements, etc., treatment costs can only be roughly approximated. Based on water treatment and desalting applications at other locations, costs could range between $200 and $900 an acre-foot. For purposes of this analysis, a cost of $550 an acre-foot was used. This includes amortization of the $21 million capital investment (to treat 12,333 acre-feet a year) at 8 percent over 20 years and operation, maintenance, and power costs of $1.39 a 1,000 gallons.[33]

Assuming a 20-inch pipeline extending to the northwest from the 30-inch pipeline at Inyokern Road, incremental costs for this alternative are $2,700,000 for the pipeline and $6,800,000 a year for treatment costs.

ALTERNATIVE 6
Continue Pumping from the Intermediate Area, Expand into the Southwest Area, and Blend Treated Water from the Northwest Area

This option is similar to Alternative 4 except under this option water pumped from the northwest would be treated prior to blending with intermediate and southwest water.

Again, this alternative could allow use of all water resources in the Valley irrespective of quality, limited only by technology and economics.

In addition to pipeline and transmission line requirements, incremental costs would include treatment of the poorer quality water. Assuming a 20-inch pipe extending to the Northwest Area from the existing 30-inch pipe at Inyokern Road, a 30-inch pipe extending to the Southwest Area from Ridgecrest, a 34.5-kV transmission line extending to the Southwest Area from Inyokern, incremental costs for these facilities are nearly $10,000,000. Treatment of 12,333 acre-feet a year would add $6,800,000 to the annual cost.

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[33] Figures adapted from "West Basin Desalter Demonstration Project, Draft Progress Report", U.S. Bureau of Reclamation, January 1993.

OTHER OPTIONS

Each of the options discussed above could be adjusted as local conditions change and more data become available. There are also opportunities to combine some of the features of several options, particularly treatment. In any case, the options discussed here should not be viewed as definitive or final, but rather as the options considered most viable at the completion of the Project.

ASSUMPTIONS USED IN RESOURCE LIFE CALCULATIONS

In estimating the life of the water resource in Indian Wells Valley, major assumptions have to be made for three parameters—projected future withdrawals from the groundwater, extractable groundwater volume, and recharge volume and distribution. The assumptions made for those three parameters are summarized here; additional information on and rationale for these assumptions are presented in Volume II, Section C.

Recognizing that adequate information is not available to be precise in calculating expected water resource life, ranges were established for each parameter. Reasonable extremes were developed in an effort to bracket the parameters. Three scenarios were evaluated. A "worst case" condition was developed by using conservative values for all evaluation parameters. More optimistic values were used to develop a scenario at the other extreme of the range. Intermediate values based on interpretation of available data and professional judgement were then established to define a scenario that is considered to be a realistic representation of future conditions.

Future Groundwater Withdrawals

Future demands for groundwater withdrawals were estimated in 1990 by consolidating projections made by each of the major pumpers in the Valley. Those projections were made at the end of a period of high population growth in the Valley and commensurate increasing demands on the groundwater resource. Since it would be quite unusual for those growth rates to be sustained over the long term, those projections were taken as the worst or conservative case.

Soon after the 1990 projection effort was completed, growth rates flattened or even declined. The low side of the future withdrawal range, then, was assumed to be a constant withdrawal rate equal to the pumping rate in 1990.

A future pumping rate that may be more realistic than either of the range extremes was derived by assuming that pumping for the Naval Air Weapons Station, North American Chemical Company, and agriculture will remain at current levels in the future and that the other entities will increase pumping quantities in a straight line so that by the year 2010 the pumping volume by these other entities will increase 50 percent. After 2010, pumping is assumed the remain constant.

Retrievable Water Volumes

Three specific areas that could be used to provide future water resources for the Valley were identified from Project data--the Intermediate Area, the Southwest Area, and the Northwest Area (see figure 12). In order to determine the extractable water from each of these areas assumptions were made on specific yield and amount of saturated thickness that would reasonably be expected to be dewatered during pumping.

Specific yield is defined as the amount of water that can be removed from a soil formation by gravity drainage. This accounts for soil pore volume and molecular attraction between water and the soil particles. For this analysis, a specific yield of 20 percent, or 0.20, was used.

While data obtained during the Project indicate good quality water in the Intermediate Area and Southwest Area to a depth of at least 2,000 feet, dewatering the aquifer to that depth is not considered reasonable for both physical and economic reasons. However, given the high economic value of municipal and industrial water as compared to agricultural water, pumping from depths of 500 to 600 feet is not unreasonable for those purposes.

Current groundwater table depths in the Intermediate Area are near 250 feet below ground surface. While the groundwater table in other areas of the Valley is shallower, the assumption will be made here that for all areas under consideration in this analysis the depth to groundwater is 250 feet. In order to bracket reasonable dewatering thicknesses, dewatering values of 100, 200, 300 feet are used. A dewatering thicknesses of 100 feet will be considered the low side of the range since this would apparently not be hard to achieve with known transmissivities and stratigraphy. A 300-foot dewatering thickness will be used as the high end of the range. At this thickness, the 550-foot total static pumping head may be reaching the current edge of the economic pumping range. For this analysis, 200 feet will be considered the intermediate value of dewatering thickness. A 200-foot dewatering thickness will always be the maximum limit for the Northwest Area because of the thick clay layer in that area.

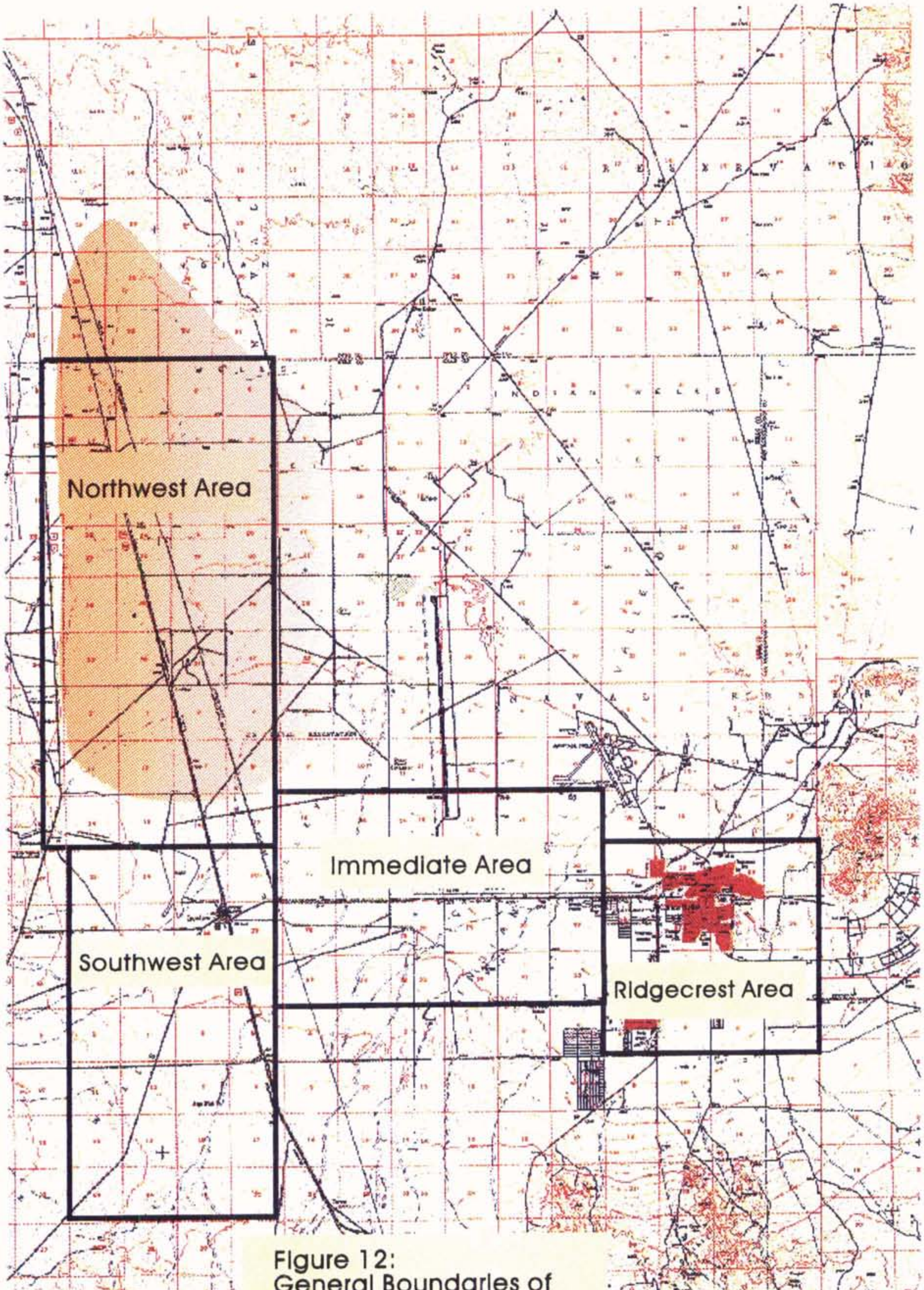


Figure 12:
General Boundaries of Groundwater Areas and Approximate Extend of the Subsurface Northwest Clay Layer.

With the assumptions given above, the retrievable water volumes in millions of acre feet are about:

Area	100-foot dewatering thickness	200-foot dewatering thickness	300-foot dewatering thickness
Intermediate	0.31	0.61	0.92
Southwest	0.36	0.72	1.06
Northwest	0.52	1.04	1.04
TOTAL	1.19	2.37	3.02

Recharge Quantity and Distribution

Recharge quantity and distribution has long been the subject of speculation and discussion among local water experts. Resolution of the various viewpoints continues to be elusive. However, calculation of a resource life demands making recharge assumptions.

Recent research suggests that the previous quantitative estimate of Valley recharge may be too high (see Volume II, Appendix II). Based on that possibility, the low estimate for recharge quantity used here was 3,000 acre-feet a year from the east slope of the Sierra Nevada. Based on the assumption that recharge distribution is proportional to watershed vegetation distribution, (see Volume II, Section A, "Aquifer Modeling" for a discussion of this distribution methodology) 1,000 acre-feet would be applied to the Southwest Area and 2,000 acre-feet would be applied to the Northwest Area.

Previous researchers[34] have estimated a recharge from the Sierra Nevada of about 6,000 acre-feet a year, with half coming into the Northwest Area and half into the Southwest Area, and none into the Intermediate Area. That estimate was used here for the intermediate recharge case.

The high end of the recharge range was obtained by adding 3,000 acre-feet a year into the Northwest Area to the intermediate case, making a total of 9,000 acre-feet a year.

[34] Berenbrock and Martin, op. cit.

The major assumptions used to calculate resource life are summarized in table 6.

Table 6. Major assumptions used to calculate resource life

Evaluation parameter	Conservative case	Intermediate case	Optimistic case
Future withdrawals	1990 projections	50% increase in 18 years for some pumpers	No change from current pumping volumes
Extractable water volume	100-foot dewatering depth	200-foot dewatering depth	300-foot dewatering depth
Total recharge	3,000 acre-ft/yr	6,000 acre-ft/yr	9,000 acre-ft/yr

Other Assumptions and Considerations

There are other considerations that must be made when analyzing various resource development alternatives. Declining water tables in the Intermediate Area will induce poorer quality water in surrounding areas to migrate into that area. Based on the historic total water production from the Intermediate Area, and a simple analysis of the resulting water level depression, it is apparent that recharge into this area is small compared to the rate of extraction. It is estimated that inflow from surrounding areas is about 5 percent of the extracted volume. While that percentage will undoubtedly increase as the water table drops further, no attempt was made to estimate that change over time.

In calculating water quality changes in the Intermediate Area, surrounding water was assumed to have a representative TDS of 1,000 mg/L. Water quality in neither the Southwest nor Northwest Areas will change in response to surrounding water migrating into those areas because the surrounding water quality is assumed to be the same as water within those areas.

One of the considerations that is not addressed in this analysis is the existence of or potential for ground surface subsidence. This concern is especially applicable to the Northwest Area where pumping from either above or beneath the extensive clay layer could result in subsidence. This issue should be the subject of study prior to implementation of water withdrawals from the Northwest Area.

Another area that needs additional attention is specific water quality parameters. In the analyses presented herein, it was assumed that blending alternatives are not limited by specific ions; i.e., blending proportions are determined by TDS only. In some cases these proportions may be limited by high concentrations of specific ions. This possibility and its consequences will have to be considered under more detailed analyses.

For the assumptions of future increases in groundwater withdrawal, the District is the only major water purveyor in the Valley expected to experience significant increases (see figure 2) and would thus likely bear the impacts of decreasing water quality resulting from the blending alternatives. However, there may be opportunities--through water transfers or exchanges--to spread the impacts to other entities who are major groundwater pumpers.

Pumping for agricultural purposes was assumed to be concentrated in the Northwest Area. Annual pumping volumes of either 12,000 (for the low and realistic future pumping cases) or 13,000 acre-feet (for the high case) were assumed to continue until the resource was depleted. At that time municipal and industrial pumping in the Northwest Area would cease, and agricultural pumping would continue at a rate equal to recharge.

GROUNDWATER RESOURCE LIFE

The model used to estimate the life of the groundwater resource in the Valley is neither sophisticated nor complex. A simple approach was used because uncertainty in available data would not have allowed additional accuracy even with a more rigorous mathematical approach. This approach will also allow easy and quick adjustments to the resource life estimates as additional information becomes available in the future. In order to compensate for uncertainties in assumptions and simplicity in the modeling effort, the extremes described above were developed to provide a reasonable range of the resource life estimates.

A detailed description of the model used to calculate resource life and an example of the calculation are given in Volume II, Section C.

Since there are three major evaluation parameters (recharge, dewatering thickness, and future pumping volumes), each with three possible values (low or conservative, intermediate, and high), there are 27 possible combinations of resource life for each potential development alternative. Instead of calculating a resource life for each combination, calculations were made only using low, high, and intermediate values for each of the evaluation parameters.

Resource life estimates for each resource development alternative are given in table 7.

Table 7. Estimated resource life

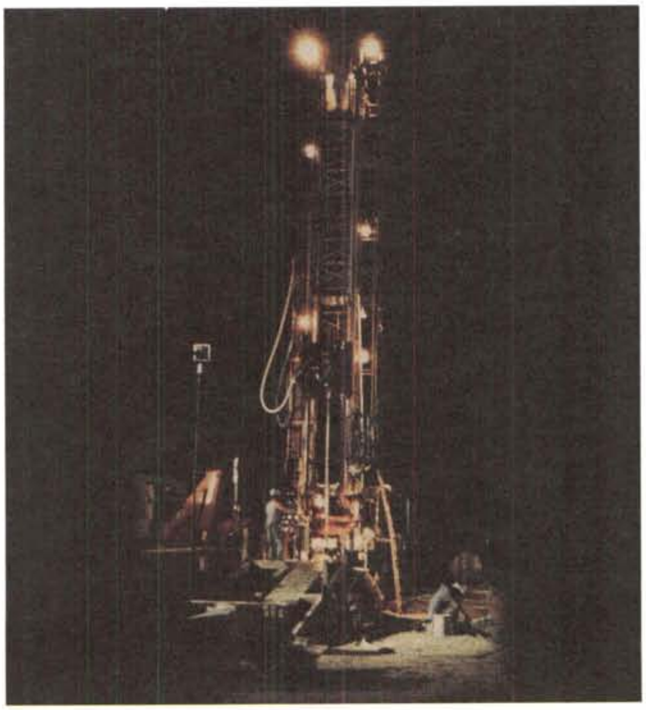
Resource development alternative	Resource life, years		
	Conservative case	Intermediate case	Optimistic case
No. 1—Pump Intermediate Area only	14	29	52
No. 2—Pump Intermediate Area, expand into the Southwest Area	26	68	134
No. 3—Pump Intermediate Area, blend Northwest Area water	19	42	77
No. 4—Pump Intermediate Area, expand into the Southwest Area, blend Northwest Area water	33	92	169
No. 5—Pump Intermediate Area, blend treated water from the Northwest Area	19	42	77
No. 6—Pump Intermediate Area, expand into the Southwest Area, blend treated water form the Northwest Area	33	92	169

For alternatives that included pumping from both Intermediate and Southwest Areas, the pumping distribution between those areas was adjusted to maximize resource life.. This distribution ranged from 55 percent being pumped from the Southwest Area and 45 percent from the Intermediate Area to 61 percent being pumped from the Southwest Area and 39 percent from the Intermediate Area.

In this analysis, water quality never became a limiting factor. Water volume in the Intermediate or Southwest Area became depleted before the water quality reached the Environmental Protection Agency recommended TDS concentration of 500 mg/L. That is why the resource life for Alternatives 5 and 6 are the same as for Alternatives 3 and 4, respectively. This also means that, if assumptions of water quality decline in the Intermediate Area are reasonable, treatment of the Northwest Area water for blending purposes is unnecessary when TDS is the only consideration. Elevated concentrations of individual ions, however, may make treatment necessary in order to implement any of the blending alternatives.

CHAPTER X

RECOMMENDED ALTERNATIVE



X. RECOMMENDED ALTERNATIVE

Based on the data obtained and analyses performed during this Project, the recommended alternative for meeting the objective of conserving and extending the usable life of the resource is:

1) Blend water from the Northwest Area with water from the Intermediate Area. This would immediately relieve drawdown pressures on the Intermediate Area well field and extend its life.

2) Undertake a study to better define the quantity, quality, and availability of groundwater from the Southwest Area.

Adoption of this strategy would immediately extend the useable life of the groundwater in the Valley by approximately 13 years (the difference between Alternative No. 1 and Alternative No. 3 for the intermediate case in table 7), with the potential of ultimately doubling the life of the groundwater resource.

This recommendation is made from a technical perspective only and it must be viewed in conjunction with socio-political and financial considerations. Such evaluation must be done by the appropriate water producers in the Valley.

Document Separator

INDIAN WELLS VALLEY GROUNDWATER PROJECT

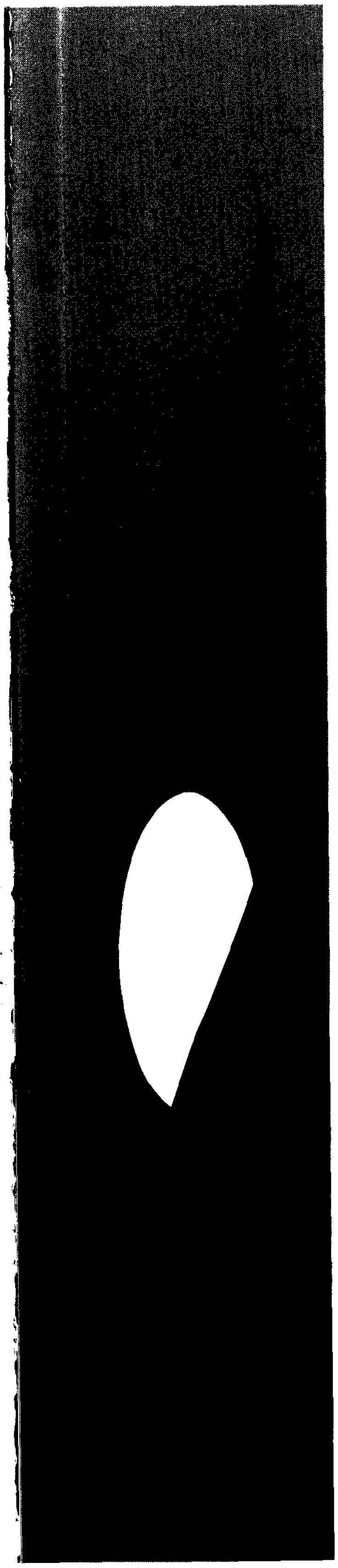
VOLUME II

TECHNICAL REPORT

DECEMBER 1993

WATER RESOURCES MANAGEMENT... ...FOR THE FUTURE

Department of the Interior
Bureau of Reclamation



OUR MISSION

To manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Indian Wells Valley
Water D[illegible]
P.O. Box [illegible]
Ridgecrest, C[illegible]656
1-619-375-5086

DISCLAIMER

Publication of the study results presented herein should not be construed as representing either the approval or disapproval of the commissioner of the Bureau of Reclamation or the Secretary of the Interior.

The purpose of this document is to provide the Indian Wells Valley community with information concerning groundwater resources and to provide optional implementation plans for future development.

INDIAN WELLS VALLEY GROUNDWATER PROJECT

A cooperative effort among
the Bureau of Reclamation,
the Indian Wells Valley Water District,
the North American Chemical Company,
and the Naval Air Weapons Station

TECHNICAL REPORT

Prepared By
Bureau of Reclamation
Lower Colorado Region

December 1993

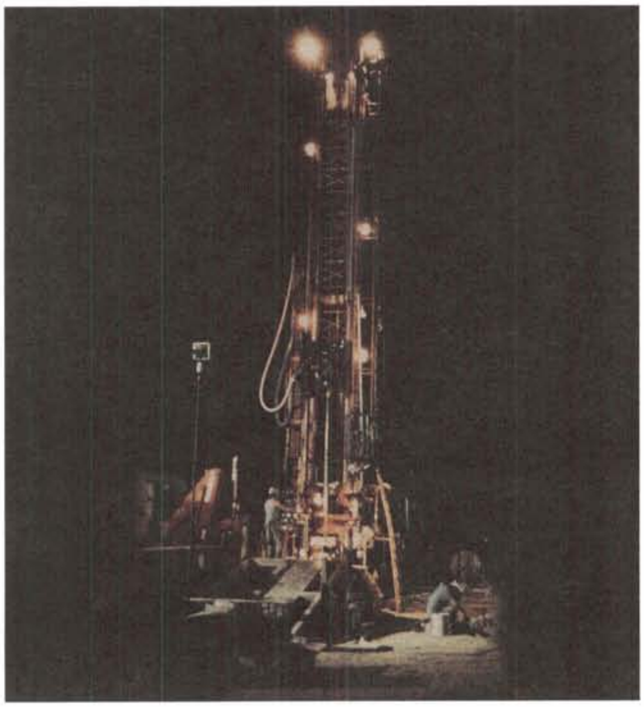
PREFACE

Documentation of the Indian Wells Valley Groundwater Project is contained in two report volumes. Volume I, the Summary Report, is intended for a general audience. It contains an explanation of the administrative, institutional, and financial aspects of the Project; a description of Project activities; and a non-technical presentation of Project activity results, conclusions, and recommendations.

Volume II, the Technical Report, is intended for a technical audience. It provides all of the technical details concerning the test wells, data collected, data analysis, groundwater modeling, and recommendations for future investigations. Technical discussion on groundwater recharge quantities, recharge distribution, pneumatic slug testing, and a hypothesis for the anomalously low transmissivites found in many of the shallow piezometers are appended to this volume. Also included in this volume, are all of the data collected as part of this Project.

Mr. John A. Johnson, civil engineer in the Bureau of Reclamation's Lower Colorado Regional office in Boulder City, Nevada, was the primary author of Volume I, while Mr. Dennis E. Watt, hydrologist for the Bureau of Reclamation in Boulder City, was the principal contributor to Section A of Volume II. Section B of Volume II was done by personnel in the Bureau of Reclamation's Denver office in Denver, Colorado. Mr. Leslie Pehrson, an engineering intern in the Bureau of Reclamation's Boulder City office, performed the calculations in Section C of Volume II. Mr. Gail F. Moulton, chief geologist for the North American Chemical Company of Trona, California; Mr. Michael D. Stoner, geologist with the Naval Air Weapons Station at China Lake, California; and Dr. Don Decker, a physicist with the Naval Air Weapons Station, reviewed drafts of both volumes and provided significant technical and editorial suggestions.

EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

PROJECT OBJECTIVE

The primary objective of the Indian Wells Valley Groundwater Project (Project) was to refine estimates of the life of the natural groundwater resource in the Indian Wells Valley (Valley) and to identify management concepts to conserve and extend the useful life of this resource.

APPROACH

In the Memorandum of Understanding which established the Project, the participants agreed on the goals to be achieved:

- ✓ Refine groundwater resource quantity and quality
- ✓ Refine recharge quantities and locations to the extent possible
- ✓ Model aquifer performance under pumping scenarios that meet future demands
- ✓ Develop future water resource management options, including conservation

To accomplish these goals, the following approach was taken:

- ✓ Summarize existing data and findings
- ✓ Obtain additional information by drilling test wells and collecting data from those wells
- ✓ Evaluate existing recharge and aquifer performance studies
- ✓ Analyze all data and integrate all information into potential water resource utilization plans for the future

PROJECT DESCRIPTION

Ten monitoring wells were drilled during the Project—seven were funded under the Project and three were funded separately by individual Project participants. All wells, irrespective of funding source, were designed and constructed in a similar manner. These wells were located to provide critical water quality and recharge data in areas of the Valley where such information was sparse. Areas of greatest need were in the Southwest, West, and

Northwest Areas. All wells were completed with multiple piezometers or sampling tubes within a given bore hole to obtain water samples and water table elevations at selected zones down as deep as 2,000 feet. Data collected and analyzed during the Project included drilling logs; electric, gamma ray, and down-hole temperature logs; stratigraphic interpretations of drill cuttings; static water table levels; water quality at selected depths; and measurements of aquifer transmission characteristics. It was specifically intended that these wells be located and constructed to allow convenient monitoring in the future.

MAJOR FINDINGS

- The Valley fill consists predominantly of sands and fine gravels in the heavily pumped area west of Ridgecrest, in the southwest, and along the extreme western boundary of the Valley.

- Chemical analyses indicate a predominate sodium bicarbonate water in most areas of the Valley.

- Water quality patterns imply that the Sierra Nevada watershed contributes a major portion of the groundwater recharge into the Valley.

- Poor water quality was found in the northwest and north central portions of the Valley associated with a thick organic-bearing clay layer.

- Good quality water was found down to the 2,000-foot drilling depth in the Intermediate and Southwest Areas.

- The west-to-east groundwater surface gradient in the Leliter area (about 4 miles north of Inyokern) indicates minimal recharge into this area from the west.

- A very steep apparent groundwater surface gradient exists in the extreme south and southwest portion of the Valley. This is probably a result of either faults or structural features which restrict groundwater flow.

- A fairly steep groundwater surface gradient exists in the northwest corner of the Valley (Louisiana Pacific Sawmill site), which implies groundwater recharge from the Sierran watershed to the northwest or north (Rose Valley).

- In most cases, aquifer transmission properties, which were computed from measurements made in each piezometer, are consistent with drill log data.

- Temperature profiles indicate the presence of geothermal sources underlying the Valley at depth.

CONCLUSIONS AND RECOMMENDATIONS

Three very important major discoveries were made during the course of this Project:

- A greater quantity of high quality water is in storage at depth in the Intermediate and Southwest Areas than previously known.

- Data concerning recharge into the Southwest Area is contradictory and will require additional exploration to reconcile data obtained during this Project with earlier results from the southwest. Some earlier work implies a very low recharge rate.

- Much of the west and northwest parts of the Valley have relatively poor water at depth associated with a very thick and extensive clay layer.

There are three major avenues for extending the life of the groundwater resources in the Indian Wells Valley:

- Blend good quality water with poorer quality water

- Expand pumping to "new" areas, such as the southwest

- Treat poorer quality water

Either blending or treatment would be governed by the appropriate water quality standards for the application (potable, industrial, or agricultural).

From a technical perspective the near-term recommended approach to extend the life of the groundwater resource is to immediately begin to blend water from the northwest part of the Valley with water from the Intermediate Area. In the long-term, the Southwest Area should be further studied to better define availability of groundwater in that area. Water quality treatment technology and costs should also be studied further.

While this Project made significant contributions to the water resource data base in the Valley, there are still many areas of uncertainty. In order to accommodate this uncertainty in data, a probable data range from a worst or conservative case to an optimistic case was established. An intermediate case within those limits was then determined. Table 1 presents the assumptions used to develop the intermediate case. More detailed information on these values and how they were selected can be obtained in Volume II, Technical Report, Section C.

Table 1. Data used to determine intermediate case water resource life projections

Demand Projections	NAWS, NACC, and agricultural users continue to pump current levels; pumping from Water District, Inyokern CSD, and private residential wells increases by 50% by the year 2010
Specific Yield	20% or 0.20
Saturated Thickness That Can be Dewatered	200 feet
Natural Recharge	3,000 acre-ft/yr into the Southwest Area, 3,000 acre-ft/yr into the Northwest Area, 0 acre-ft/yr into the Intermediate Area
Migration of Surrounding Water Into Pumped Areas	Constant 5% of pumped volume
Water Quality	250 mg/L in the Southwest and Intermediate Areas and surrounding the Southwest Area; 1,000 mg/L in the Northwest Area and area surrounding the Northwest and Intermediate Areas

Using the assumptions in table 1, the following calculated projections can be made to guide future water production management:

- Implementation of blending Intermediate Area and Northwest Area water could extend the life to the Intermediate Area resource by 13 years, to a total of 42 years.

- Expanding pumping into the Southwest Area and continued pumping from the Intermediate Area could provide acceptable quality water for 68 years.

- Blending Northwest Area water with water from both the Intermediate Area and Southwest Area could provide acceptable quality water for 92 years.

- Because the Northwest Area appears to contain zones of water with high concentrations of specific ions, treatment of Northwest Area water may be necessary in order to do any blending.

Additional resource life would be obtained by not only practicing conservation through pumping/blending management of the aquifer, but also through continued and effective conservation at consumption.

Willingness to dewater a thickness greater than 200 feet would also substantially increase the life of the water resources in the Intermediate and Southwest Areas. For each 100 feet of additional dewatering in those areas, the resource life would be extended about 30 years.

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APPENDIXES

Appendix

About the cover: *This nighttime photo of the Bureau of Reclamation drill rig at well site #4 was taken by Don Decker. Once started, drilling at all wells proceeded around the clock. Some hours after this shot, the well was "bottomed out" at 2,020 feet.*

INTRODUCTION

I. INTRODUCTION

DESCRIPTION OF AREA

Indian Wells Valley (Valley) is located just east of the southern Sierra Nevada about 150 miles north of Los Angeles. Prior to World War II human activity in the Valley was largely confined to Indians, miners, pioneers, and adventurers. Significant military presence began during and immediately after the war when the Navy established the Naval Ordnance Test Station at China Lake. This facility later became the Naval Weapons Center and now is called the Naval Air Weapons Station. Establishment of a military base in the Valley resulted in rapid development of an active on-base community. The town of Ridgecrest—the outside-the-gate community—was little more than a crossroads and general store in 1943 but began to grow rapidly in the 1950's as the influx of military personnel demanded goods and services beyond what the Navy offered on base (Marcoa, 1990). Today Ridgecrest has a population of about 30,000 with a "trade area" of about 65,000 (Marcoa 1990).

U.S. 395 is the main route between population centers of southern California and recreational opportunities in the eastern Sierra Nevada range and the high desert. Located just a few miles east of U.S. 395, Ridgecrest offers food and lodging opportunity for travelers. In addition to the Navy and tourism, employment by the North American Chemical Company, a mining facility located 25 miles to the east in Searles Valley, also makes a significant contribution to the economic activity in the Valley.

At an elevation of about 2,300 feet, Ridgecrest has a climate typical of the high desert area. Summers are hot and normally very dry. Winters are cool, but not unpleasant. Average annual precipitation ranges between 4 and 6 inches, with most of that coming as rainfall between October and March. Occasional short duration thundershowers occur during summers (Krieger and Stewart, 1990).

Grant Bowman, a pioneering farmer in the Valley, recorded in his diary pumping 500 miner inches (approximately 12.5 cubic feet a second) to irrigate 260 acres of alfalfa between the years 1910 and 1925. He pumped from two 24-inch diameter wells. Static water levels were 90 feet below ground surface.[1] The first farming activity was along Bowman Road in the southeastern part of the Valley, but in the early 1950's farming expanded to the northwest. Groundwater pumping for agricultural purposes has been estimated at an annual average of 1,000 acre-feet from 1920 to 1951, increasing to about 1,400 acre-feet a year from 1951 to 1968. Farming in the Bowman Road area ceased in 1969, but pumping of 300 to 800 acre-feet a year to support farming along Brown Road in the Northwest Area

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[1] Personal communication with Mr. Jim Bosanko, Grant Bowman's grandson, November 5, 1993.

(see figure 2 of Section C, page C6 for the location of specific areas) continued until 1976 when the major expansion of agricultural pursuits occurred (Berenbrock and Martin, 1991). Early pumping for domestic needs was from the Ridgecrest Area. Between 1930 and 1985 pumping gradually increased to about 3,500 acre-feet a year. Then, as water quality worsened to unacceptable levels, wells were abandoned and pumping volumes declined in that Area (Berenbrock and Martin, 1991). Extraction of water from the Valley for industrial purposes also began in the early 1920's when West End Chemical Company (later Stauffer Chemical Company) began pumping up to 1,000 gallons a minute for transfer to their facilities in Searles Valley. American Potash and Chemical Company, the predecessor to North American Chemical Company, began pumping about 750 gallons a minute from the Valley in the early 1940's.

PROJECT PURPOSE

Groundwater aquifers are the sole source of water for the Valley, and pumping has concentrated in areas where aquifer characteristics, water quality, and water elevations are known. For domestic and industrial use, this has been in an area immediately west of the city of Ridgecrest. Agricultural pumping has been concentrated in the northwest portion of the Valley.

Data show a gradual, continuing rate of decline in water elevations in these areas of most heavy pumping. This decline not only results in increasing pumping heads and requires adjusting pumps to lower elevations, but it also may signal a depletion of the groundwater resource.

For many years local water experts have been debating the natural recharge quantity and safe yield from the groundwater aquifers underlying the Valley. Average **published** recharge numbers range from 10,000 (St.-Amand, 1986) to 15,800 (Bean, 1989) acre-feet a year. Suggestions of recharge up to 30,000 acre-feet have been made.[2] With current withdrawals from the groundwater of about 30,000 acre-feet a year (see chapter III, Summary Report), it appears from the **published** reports that the Valley is in a state of overdraft and pumping groundwater to meet expected future demands will result in continued depletion of the resource.

Resolution of the disparity in recharge estimates would be very difficult under any data collection program and, even with unlimited funding, answers may never be obtained to everyone's satisfaction. In the meantime, water purveyors must make plans for serving their customers' needs in the future.

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[2] *The Daily Independent*, July 22, 1988.

designed to obtain as much practical additional information on the groundwater resource as possible within funding and temporal constraints. This additional information would then be used, along with existing data, to:

- Help define the groundwater resource extent in terms of both volume and quality
- Help define recharge quantities and locations to the extent possible
- Help define groundwater performance under pumping scenarios that match future demands
- Develop future water development plans, including conservation of existing resources

PROJECT FORMULATION

Groundwater is the sole source of supply for meeting the increasing water needs of the Valley. Groups responsible for nearly all utilization of the groundwater resources include:

- Indian Wells Valley Water District (Water District), major water purveyor to residents of the city of Ridgecrest, California
- North American Chemical Company (NACC), which extracts water for use in its facilities and to serve domestic needs in Searles Valley
- Naval Air Weapons Station (NAWS), which provides water for military use and residents on the base
- Inyokern Community Services District (CSD), which serves the town of Inyokern, California
- Agricultural interests and individual well owners

The importance of the groundwater resource led many of these entities to actively seek additional information on the extent and quality of the resource. Through individual data collection efforts and financial participation with the U.S. Geological Survey (USGS), Soil Conservation Service, and Kern County Water Agency, local entities have attempted to increase knowledge of the resource so they could make better future water management decisions. However, many of these efforts were limited by funding constraints or institutional considerations, such as access to well sites and jurisdictional responsibilities.

The absence of hard data in many areas of the Valley and at depth has contributed to differences of opinion over the expected life of the groundwater resource. This debate and the necessity to make long-term plans for continued provision of future water delivery service resulted in the Water District and the Bureau of Reclamation (Reclamation) initiating discussions in 1988 on a joint groundwater investigation. Those discussions were then expanded to include all local entities with an interest in water issues and eventually led to the development of a work plan for a $1-million data collection and analysis effort.

Although all local entities with an interest in water issues had input into the work plan, three entities elected to provide financial contributions to the investigation—Indian Wells Valley Water District, North American Chemical Company (formerly Kerr-McGee Chemical Corporation), and the Naval Air Weapons Station (formerly Naval Weapons Center). These three entities agreed to provide half of the funding for the effort on an equal basis, with the other half coming from Reclamation.

With the investigation having been defined to the satisfaction of participating entities and the funding commitments having been made, the work plan was initiated in March 1990.

PROJECT PARTICIPANTS

The Project was a cooperative effort among Reclamation and local entities. As pointed out above, while a number of local entities expressed interest in and provided input to the Project, three entities participated financially. The Kern County Water Agency could not provide funding for the Project, but that agency did contribute the expertise of a staff geologist to help formulate Project activities and assist in data collection and interpretation.

The original Project budget was $1,050,000 over a 3-year period. Commitments for Project financing were:

Bureau of Reclamation	$ 525,000
Indian Wells Valley Water District	175,000
North American Chemical Company	175,000
Naval Air Weapons Station	175,000
TOTAL	$1,050,000

Under the original agreement among the participating parties, Reclamation would conduct the investigation, and the local entities would transfer their funding commitment to Reclamation for use in Project activities. However, early in the Project it became apparent that more efficient use would be made of Project funds by contracting for test well drilling locally. Consequently, local entities used their funds for contract drilling, while Reclamation funds were used for data collection and analysis activities, as well as for drilling.

Because information obtained from the early drilling activity were so valuable in helping define the groundwater resource, the Water District and NAWS determined that funding additional wells would be of benefit to their respective agencies and to the Project. In order to ensure compatibility of data from all wells, the design, drilling, installation, and data collection procedures were made consistent among all the wells, irrespective of funding source. Contributions to the drilling program by each of the participating entities is shown below.

Bureau of Reclamation	• Drilled Test Well BR-4 with in-house drilling crews • Partially funded Test Well BR-10.
Indian Wells Valley Water District	• Fully funded Test Wells BR-1, BR-3, NR-1, NR-2, and MW-32.
North American Chemical Company	• Fully funded Test Well BR-2 • Partially funded BR-10.
Naval Air Weapons Station	• Fully funded Test Wells BR-5 and BR-6 and partially funded BR-10.

The final identifiable contributions to the Project are given below:

Bureau of Reclamation	$525,000.00
Indian Wells Valley Water District	635,247.56
North American Chemical Company	175,000.00
Naval Air Weapons Station	298,000.00
TOTAL	$1,633,247.56

In addition to the increased funding for drilling shown above, each of the local participants provided professional services and equipment that have not been recorded separately as services to the Project. Local participants contributed personnel and equipment necessary for contract administration, compilation of information required to develop an estimate of future water demands for the Valley, surveying services, environmental field inspection and evaluation in support of access permit applications, drilling administration and logging the drill holes, installation of security devices on the wells, and obtaining temperature profiles at each of the wells. In addition, many hundreds of hours of volunteer labor were offered. The total value of these activities is no doubt in the range of tens of thousands of dollars.

COMMUNICATION WITH THE PUBLIC

During the course of the Project, aggressive efforts were made to maintain contact with the general public in order to provide information on Project progress and solicit input on Project direction. Presentations were made at public meetings in Ridgecrest and at briefings to the Water District board of directors. Communication was established early in the Project with local residents having multiple views on water issues in the Valley in order to obtain a wide perspective of how the Project might be formulated. Frequent technical briefings were made to local groups with interest in the progress of the Project. Local newspapers covered Project activities and published press releases concerning the Project.

PROJECT MANAGEMENT

In order to ensure appropriate direction and progress of the Project, an administrative structure was implemented that established clear responsibilities and accountability. Figure 1 illustrates the structure that was employed. Each of the participating entities named a manager from its organization as a representative to a Steering Committee. This committee acted as the executive group that provided overall direction and guidance to the Project effort. The committee met on an approximate monthly basis to review Project progress, approve technical activities, approve budgets, and make any other executive decisions necessary. Reclamation's representative to the Steering Committee chaired the meetings.

Photo by J. Johnson

Technical Subcommittee in session. From left to right: Dennis Watt, Gail Moulton, Don Decker, Ken Turner, Mike Stoner, Frank Monastero and Mike Lovejoy.

Day-to-day management of the Project was the responsibility of a program manager, employed by Reclamation, who tracked technical activities, expenditures, and schedules. Deviations from the program were taken to the Steering Committee for action or adjustments.

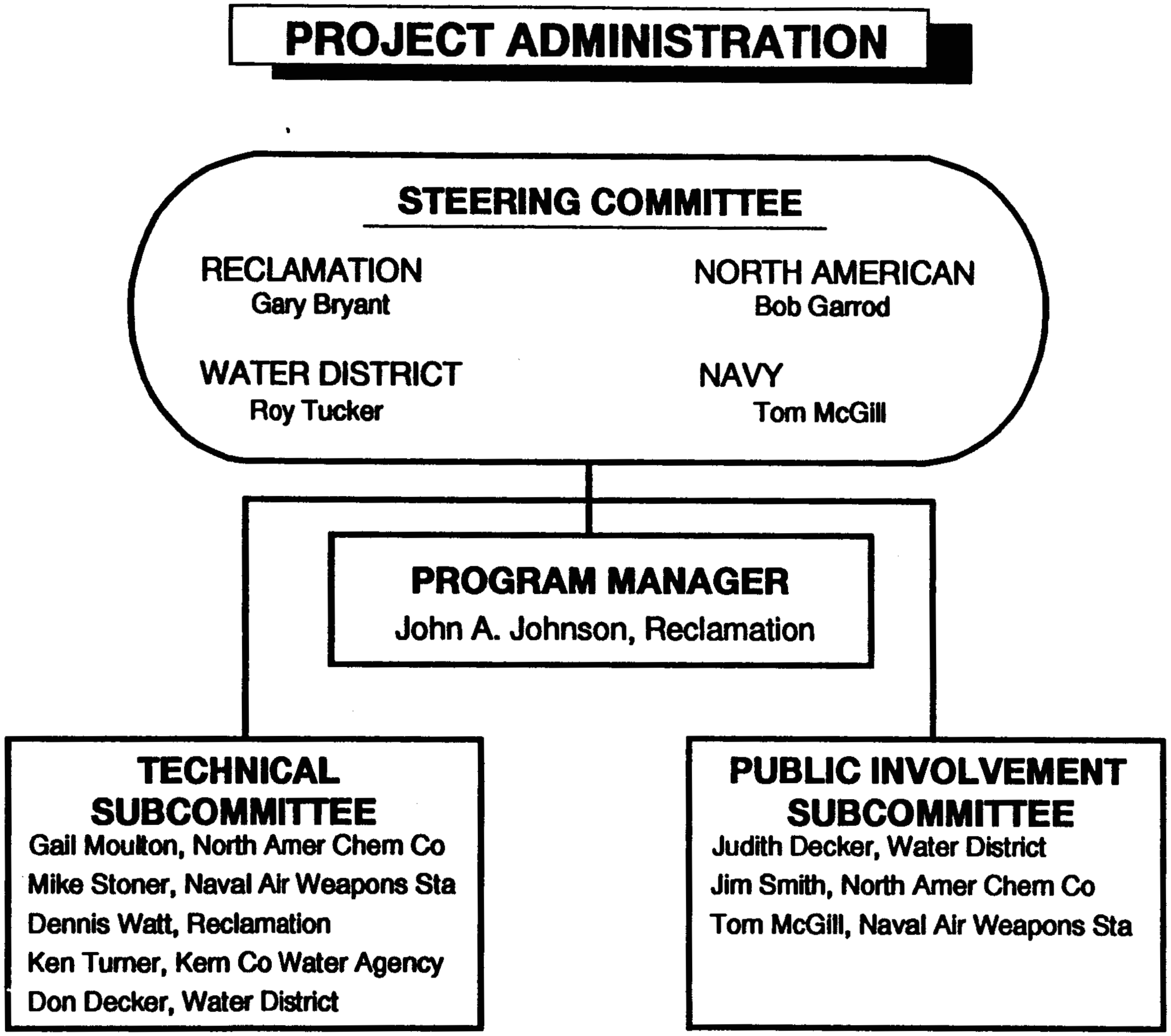


Figure 1: Project Administrative Structure

A Technical Subcommittee was established to develop technical requirements, determine appropriate data collection techniques, provide quality assurance during drilling and sampling, evaluate data as it became available, and provide technical advice to the Steering Committee. Technical experts from each of the participating entities and the Kern County Water Agency made up this subcommittee. The Technical Subcommittee often solicited input from technical specialists within other interested organizations.

A Public Involvement Subcommittee was established to provide a link between the Project and interested publics and news media. This subcommittee was responsible for hosting public forums and producing news releases that kept the public informed of Project progress and solicited public comment and input.

AUTHORITY

This Project was undertaken by Reclamation under the authority of the Act of June 17, 1902 (32 Stat. 388) and its amendments and the Contributed Funds Acts of 1921 (41 Stat. 1404, 43 U.S.C. 395). First year Federal funding was provided by Public Law 100-371, the Energy and Water Development Appropriations Act of 1989. Remaining Federal funding was provided by subsequent appropriations acts.

ACKNOWLEDGMENTS

Bureau of Reclamation: Reclamation personnel in the Lower Colorado Regional office located in Boulder City, Nevada, were responsible for overall accomplishment of the Project. Project management was performed by Mr. John A. Johnson. Mr. Gary L. Bryant, Planning and Loans Officer, was responsible for administrative supervision and management. Mr. Dennis Watt performed major portions of the geohydrologic research and analysis. Ms. Shirley Nutter, Ms. Sierra Slentz, Ms. Christina Robinson, and Ms. Tina Bellis provided the graphic, editorial, and layout expertise required to produce this report.

While Reclamation personnel were responsible for Project oversight and many of the technical aspects of the investigation, the enthusiastic technical and management support of personnel from local participating entities was crucial to successful accomplishment of Project objectives.

Naval Air Weapons Station: Mr. Michael D. Stoner, geologist with NAWS, provided not only technical capability in the field of geology, but also many hours of field work and local coordination. He played a critical role in doing the necessary field work in siting the wells, advising the drilling contractors,

obtaining environmental clearance for drilling, surveying, and many other tasks that were necessary for smooth accomplishment of the Project. When Dr. Francis C. Monastero became head of the NAWS Geothermal Project Office late in the Project, he immediately saw a cooperative opportunity and followed up on that opportunity by providing his staff, particularly Mr. Michael A. Hasting, for technical consultation and contract administration. He also provided funding from his budget for mutually beneficial activities, as well as invaluable technical advice.

Dr. Thomas J. McGill, head of the Environmental Project Office, provided management support from the NAWS.

<u>Indian Wells Valley Water District</u>: The Water District Board of Directors' support for the Project went beyond normal expectations. They consistently supported the Project by providing funding beyond contractual requirements. Several hundreds of thousands of dollars worth of test well construction and other Project features would not have been possible without the funding approval of the Water District board. Mrs. Judith A. Decker, one of the board members, took a special interest in the Project, and her staunch advocacy position was of frequent help. Dr. Don Decker represented the Water District as technical expert. His depth of knowledge in many relevant technical areas, his willingness to listen to and consider different points of view, and his ability to present Project accomplishments with aplomb were irreplaceable benefits to the Project. The Project was actively supported by former General Manager, Mr. Joe B. Mont-Eton; present General Manager, Mr. Warren McGowen; and Mr. LeRoy O. Tucker, Assistant General Manager, who also represented the Water District in providing management direction to the Project. Mr. Tucker contributed further to the Project by successfully arguing the merits of designing and completing the Water District monitoring wells using Project well specifications.

<u>The North American Chemical Company</u>: NACC was also generous in providing top quality personnel and equipment to support the Project. Mr. Gail F. Moulton, chief geologist, was actively involved in providing input to all technical aspects of the Project and was instrumental in obtaining company equipment for collecting water samples, measuring water levels, and measuring down-hole temperatures. Mr. Moulton also served as chairman of the Technical Subcommittee. Technical expertise, including much of the logging of the drill cuttings, was provided by Mrs. Dipti Barari, staff geologist. Mr. Robert R. Garrod provided the management link between the Project and NACC. His committed support was responsible for the active financial and technical involvement by the company. The Project was also the beneficiary of the creative and thoughtful mind of Mr. Thomas S. Bunn III, legal counsel for NACC.

Kern County Water Agency: This agency, represented by Mr. Darrell D. Sorenson, graciously extended the services of Mr. Ken Turner, staff hydrogeologist. Mr. Turner helped develop the work plan, logged some of the drill cuttings, and provided technical expertise throughout the investigation.

Other: Many people and organizations contributed to the Project by providing background information, a forum for discussing Project activities and new ideas, or previously published data. These include Mr. Leroy Marquardt of the East Kern County Resource Conservation District, the San Diego office of the USGS, and Ms. Peggy Breeden, past president of the local Well Owners' Association.

PROBLEM DEFINITION

Prior to establishment of a military base in 1943, population in the Indian Wells Valley was sparse. In 1953, the population of Ridgecrest was only about 2,000 and Inyokern had a population of about 800, while the base itself had a population of about 10,000 (Kunkel and Chase, 1969). Through the 1950's and early 1960's the population of Ridgecrest grew slowly--about three percent a year (Marcoa, 1990). During the late 1960's more and more employees at the Naval facility chose to reside outside the base. Growth in Ridgecrest accelerated in the 1970's due to a NAWS policy which encouraged employees to live off base. Irrigation of larger parcels of agriculture, primarily alfalfa, also began in the 1970's. Population growth of Ridgecrest continued to accelerate until annual growth rates reached 8 to 10 percent in the late 1980's (Krieger and Stewart, 1990); since then, however, rates have declined somewhat. Data from the 1980 and 1990 census show a population in Ridgecrest of 15,929 and 27,725, respectively. Population in the Valley outside the city boundaries grew in parallel with Ridgecrest.

Increasing population has resulted in increasing demands on the groundwater as a source of domestic, industrial, and agricultural use. Major users of water from the groundwater aquifer underlying Indian Wells Valley include the agricultural sector, consisting primarily of the Brown Road Land and Farming Company; the Indian Wells Valley Water District, serving the city of Ridgecrest and surrounding county areas; the NACC, serving domestic water to the town of Trona as well as industrial needs of the company; the Inyokern Community Services District, serving the town of Inyokern; the Naval Air Weapons Station, serving base residents and providing water for military purposes; and private wells, serving individual houses or small groups of houses.

Estimates of water produced by each of these segments in 1990 and estimated pumping requirements through the year 2010 are shown in figure 2. It is obvious from this graph that the future water needs of the Valley are being driven by the Indian Wells Valley Water District. Future water production by other entities are expected to remain fairly constant, relative to the total Valley-wide pumping quantity. An exception is the Community Services District where future demand is projected to increase significantly. More detail on future water use projections are contained in Section B of this volume.

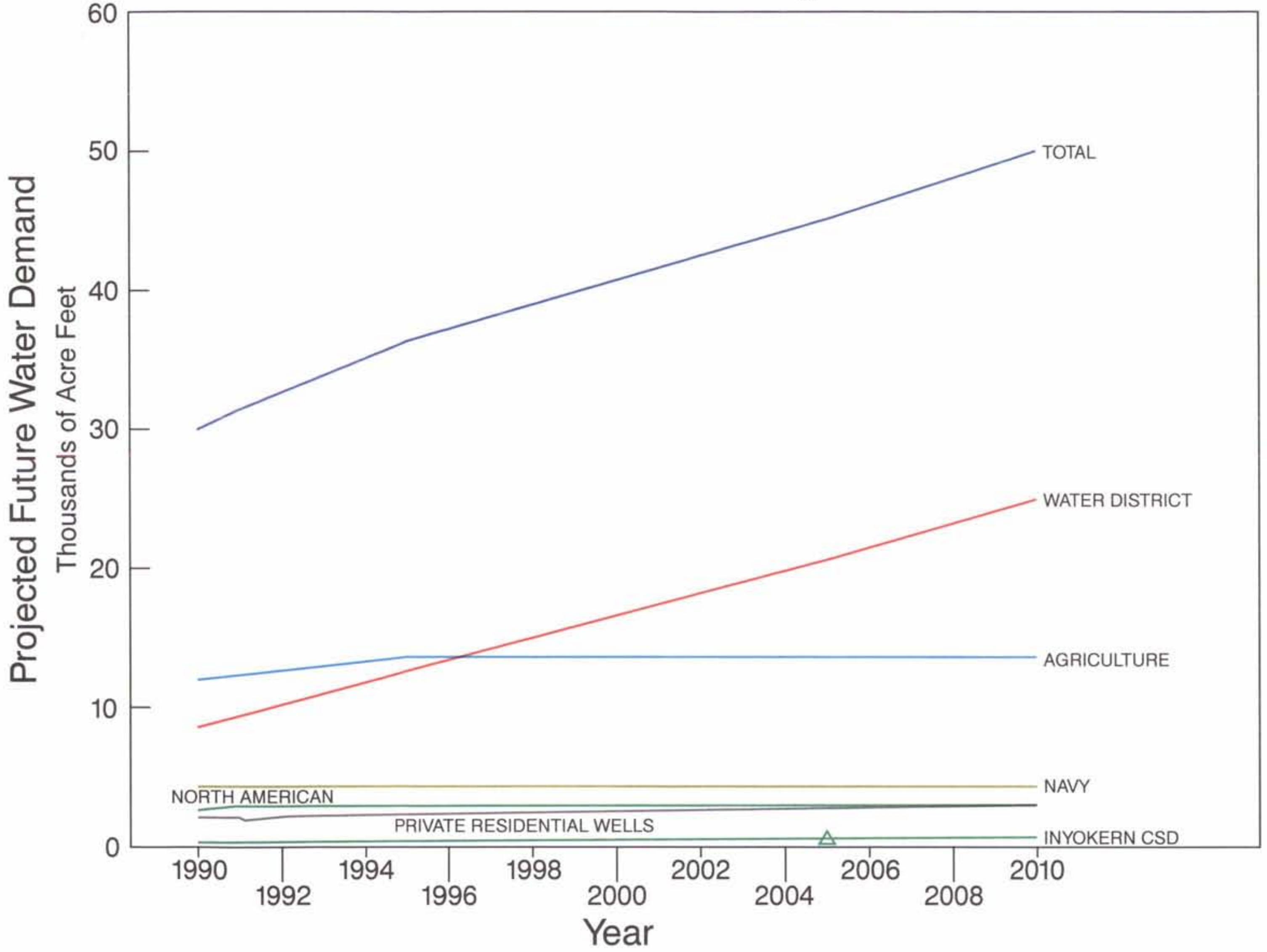
Data used to develop the water demand projections on figure 2 were based on information available through the late 1980's. High population growth rates in the Valley during the 1980's have more recently moderated or even declined and agricultural use has not expanded as anticipated. These conditions led to consideration of revising the future demand projections. This was not done, however, because the altered conditions are so recent that a trend cannot be established and it is possibly only a temporary phenomenon.

Except for pumping by large agricultural users, which is confined to the northwest portion of the Valley, most of the pumping occurs in an area known as the intermediate pumping zone, Intermediate Area, or Intermediate Wellfield. This is an area immediately west of Ridgecrest with good quality groundwater at fairly shallow depths. Since 1921 groundwater elevations have been declining. The water table has declined about 80 feet in the Intermediate Area, 70 feet in the Ridgecrest area, 30 feet in Inyokern, and 15 feet or more in the agricultural area. Declining water table elevations in the Intermediate Area has introduced a reverse gradient potential for poor quality water to backflow into the Intermediate Area from the brackish and salty water areas, although no noticeable degradation has occurred at this time (Krieger and Stewart, 1988). Poor quality water surrounding the Intermediate and Southwest Areas could, therefore, pose a threat to existing and additional wells in those areas.

Because of the projected increases in pumping requirements and concerns over the ability of the Intermediate Area to tolerate this increased pumping without potential adverse impacts, water purveyors needed additional information on the quality and availability of groundwater in other areas of the Valley so that expansion could occur in the most appropriate way.

This need for additional information on groundwater resources in the Valley led to discussion among local water purveyors and Reclamation on ways of addressing the future water supply problem. Those discussions, in turn, led to the development of the Indian Wells Valley Groundwater Project.

Figure 2: Projected Future Water Demands Indian Wells Valley, California



PROJECT DESCRIPTION

The Project was originally designed to be completed in three phases--compilation of existing data, collection of additional data, and development of implementation plans for future development of the groundwater resource. However, there was an understanding that the plan was open to adjustment as additional information became available.

Compilation, evaluation, and display of existing data was essentially completed during the first six months of the Project. During that time a field data collection program was defined.

The nucleus of the field data collection program was the installation of up to ten multi-piezometer test wells.

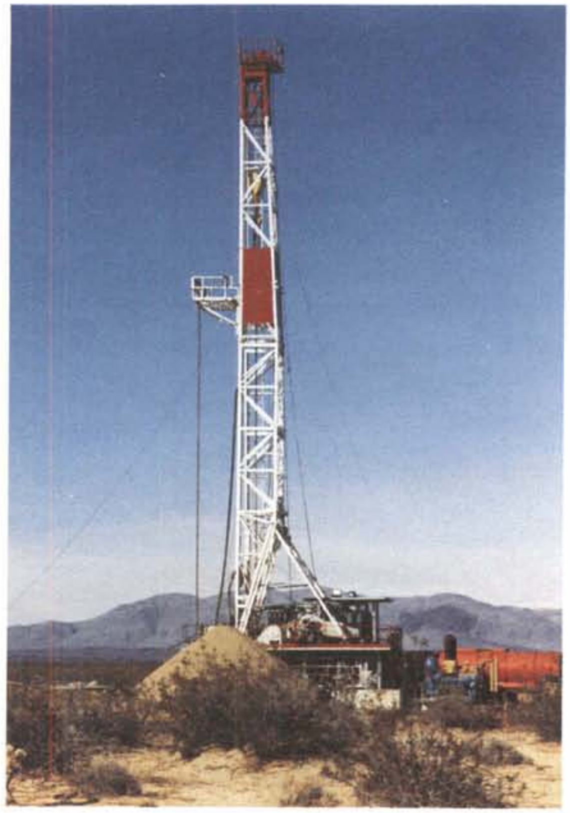


Photo by Mike Stoner

Indian Wells Valley Groundwater well drilling in progress.

Ten wells were eventually installed under this project, but not necessarily in the original priority order or original location. Details concerning the design of the test wells can be found in the Test Wells chapter of Section A in this volume.

BR-4 (number is the priority, 1 being the highest priority) was drilled first with Reclamation drill crews; all other wells were drilled by contract. Table 1 shows the order of drilling, the funding source, and the contracting entity for each well installed under this Project. In addition to the wells shown on table 1, the Navy's Geothermal Project Office drilled a very deep well (7,400 feet) between the proposed location of BR-7 and BR-8 to test for geothermal potential in the middle of the Valley.

Designated SNORT-1, this well offered groundwater data unavailable from other sources. Adjustments in the location of BR-5 and BR-6 and the installation of SNORT-1 eliminated the need to drill BR-7 and BR-8. After installation of the casing in SNORT-1, perforations at appropriate levels were made under Project funding contributed by the Navy. After review of all data obtained prior to drilling the last well, the decision was made to construct BR-10 rather than complete a well at one of the BR-7, BR-8, or BR-9 sites. Construction costs for Project wells contracted by both the NAWS and the Water District exceeded those participant's cost share under the Project agreement. Those additional costs were contributed by the respective entity.

Table 1. Wells drilled under Project

WELL	FUNDING SOURCE	CONTRACTING ENTITY
BR-4	Project	Reclamation Force Account
BR-2	Project	NACC
NR-1	Water District	Water District
NR-2	Water District	Water District
BR-1	Project	Water District
BR-3	Project	Water District
MW-32	Water District	Water District
BR-5	Project	NAWS
BR-6	Project	NAWS
BR-10	Project	NAWS
SNORT-1	NAWS/Project	NAWS

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SECTION A - GEOHYDROLOGY

GROUNDWATER SYSTEM

GROUNDWATER SYSTEM

Berenbrock and Martin (1991) note that the geohydrology of the Valley is discussed in detail in reports by Von Huene (1960), Zbur (1963), Kunkel and Chase (1969), and Dutcher and Moyle (1973). The reader is referred to these reports for a more complete description of the geology and hydrology of the Valley. Only a brief summary of the geohydrology from Berenbrock and Martin (1991) is given below.

DESCRIPTION OF AQUIFER SYSTEM

All of the following summary description of the valley geohydrology is from Berenbrock and Martin (1991); however, it is not their complete description. See figure 2 for the surface distribution of most of the features described below.

"Indian Wells Valley is a structural and topographic depression in the southwestern part of the Basin and Range province. The lithologic units mapped by Von Huene (1960), Zbur (1963), and Kunkel and Chase (1969) can be grouped into two categories: (1) consolidated rocks, which commonly have low porosity and permeability and do not readily transmit water, except where highly fractured, and (2) unconsolidated deposits, which generally transmit water readily."

CONSOLIDATED ROCKS

"The consolidated rocks include the basement complex, continental deposits, and volcanic rocks. The basement complex consists of pre-Tertiary igneous and metamorphic rocks and underlies the younger rocks and deposits of the Valley and composes the surrounding mountains and hills. The continental deposits of Tertiary age overlie the basement complex. Kunkel and Chase (1969) reported that the continental deposits are indurated and poorly sorted and they considered the deposits to be virtually non-water bearing. The volcanic rocks include the Miocene Black Mountain Basalt near the El Paso Mountains (Diggles and others, 1985) and the Quaternary unnamed volcanic rocks described by Kunkel and Chase (1969). The volcanic rocks are nearly impermeable except where weathered or fractured and are not considered an important source of groundwater."

UNCONSOLIDATED BASIN FILL

"The unconsolidated basin fill deposits include alluvium, and lacustrine, playa, and sand-dune deposits. The alluvium of Pleistocene and Holocene age includes older alluvium, younger alluvium, alluvial fans, and elevated pediment veneers and stream-terrace deposits. These deposits consist of unconsolidated moderately to well-sorted gravel, sand, silt, and clay and generally are highly permeable. The percentage of silt and clay increases toward the central part of the Valley and China Lake. The lacustrine deposits consist predominantly of silt and silty clay of Pleistocene age (Kunkel and Chase, 1969). The lacustrine deposits are interbedded with and overlie the alluvial deposits in the central part of the Valley. The playa deposits, of Holocene age, also generally are of low permeability, consisting of silt and clay with occasional sand lenses. The sand-dune deposits, of Holocene age, consist of a thin veneer of windblown sand (100 feet or less in thickness) covering the underlying deposits (Warner, 1975). These sand deposits are not considered a source of ground water because they generally are above the water table."

"On the basis of lithologic logs from wells, previous investigators have divided the unconsolidated deposits in the Valley into two main aquifers: (1) the shallow aquifer (shallow water body of Kunkel and Chase, 1969) and (2) the deep aquifer (main water body of Kunkel and Chase, 1969)."

SHALLOW AQUIFER

"The shallow aquifer includes (from land surface to the top of the deep aquifer) sand-dune deposits, playa deposits, younger lacustrine deposits, shallow alluvium where underlain by lacustrine deposits, and probably some older lacustrine deposits. The shallow aquifer as defined by Kunkel and Chase (1969) extends from China Lake westward to the center of the Valley and from the area south of Airport Lake southward to the community of China Lake. The base of the shallow aquifer is poorly defined. For the purpose of this study, however, the base was assumed to slope from an altitude of 1,950 feet above sea level on the west to an altitude of 1,850 feet on the east beneath China Lake. This assumption was based in part on the geologic and electric logs of several wells that were drilled through the shallow aquifer near the community of China Lake."

"The water-bearing deposits in the shallow aquifer consists primarily of fine sand, silt, and clay of low permeability. These deposits confine or partly confine the underlying deep aquifer in the eastern part of the Valley. The shallow aquifer does not yield water freely to wells and contains water of poor quality (dissolved-solids concentration greater that 1,000 milligrams per liter (mg/L)) (Warner, 1975; Berenbrock, 1987)."

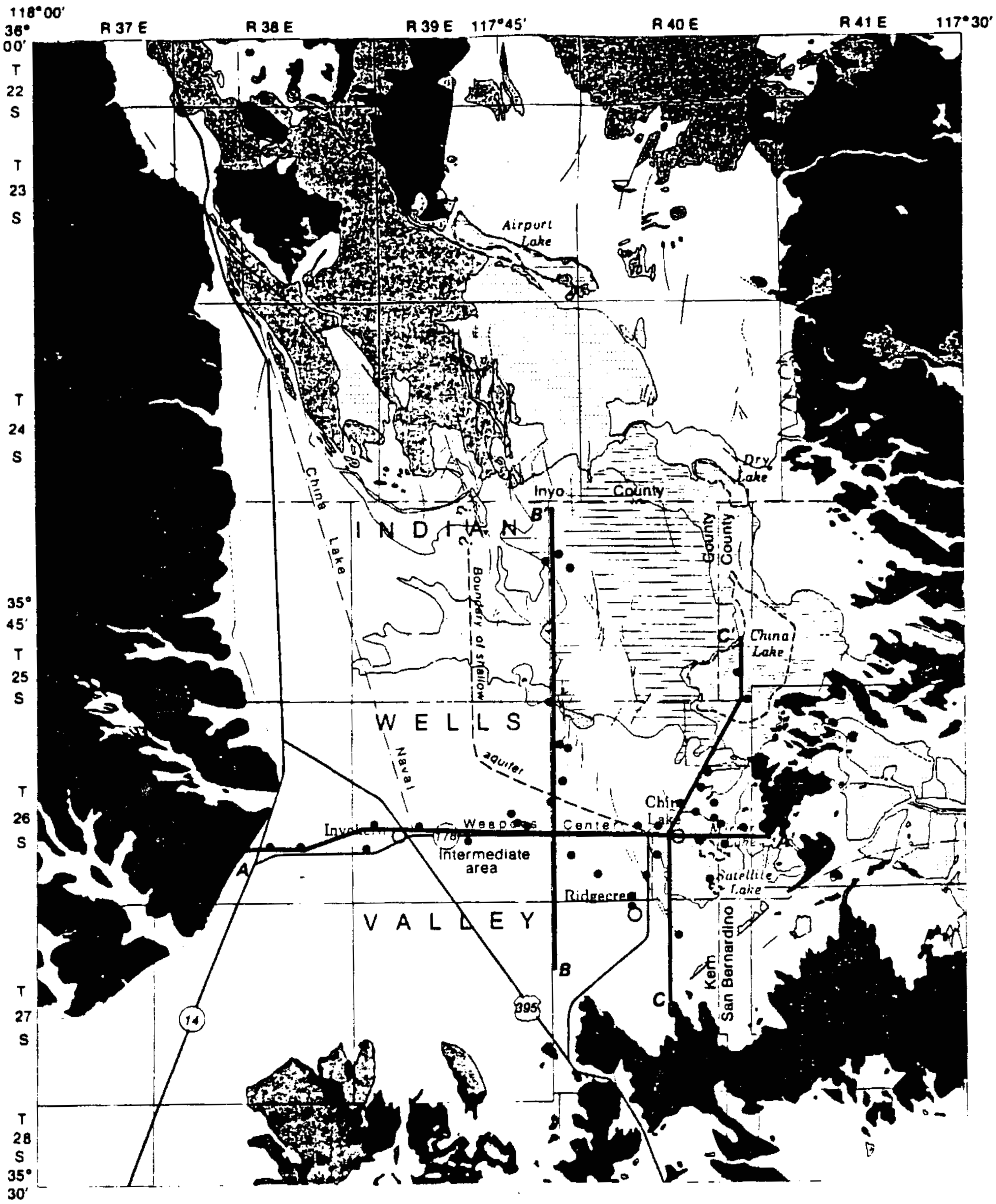

Figure 2. Generalized geology, from Berenbrock and Martin (1991), of Indian Wells Valley. Geologic sections along the lines (B---B') are included in Berenbrock and Martin (1991). The dots are the wells shown in the geologic sections.

GEOLOGIC UNITS

UNCONSOLIDATED DEPOSITS --

Quaternary

- Sand dunes (Holocene)
- Sand dunes and playa deposits (Holocene)
- Playa deposits (Holocene)
- Alluvium (Holocene and Pleistocene)
- Lacustrine deposits (Pleistocene)

CONSOLIDATED ROCKS --

Quaternary and Tertiary

- Volcanic rocks (Pleistocene and Miocene)

Tertiary

- Continental deposits (Pliocene and Miocene)

Pre-Tertiary

- Basement complex

FAULTS--Dashed where approximate

BOUNDARY OF SHALLOW AQUIFER (Kunkel and Chase, 1969)

DEEP AQUIFER

> "The deep aquifer includes the total saturated thickness of the alluvium and lacustrine deposits where the shallow aquifer is not present and the alluvium and lacustrine deposits that underlie the shallow aquifer in the eastern part of the Valley. The base of the deep aquifer is the base of the alluvium. Beneath most of the central part of the Valley, the saturated thickness of the deep aquifer is estimated to be at least 1,000 feet (Kunkel and Chase, 1969)."

At Project well MW-32, completed in the center of the Valley as part of this project, the saturated thickness was found to be at least 1,700 feet.

> "The deep aquifer in most places is unconfined; however, in the eastern part of the Valley the deep aquifer is confined by silt and clay lenses of the lacustrine and playa deposits. This aquifer consists of medium-to-coarse sand and gravel of high permeability and is the main source of water to wells in the Valley. The deep aquifer commonly yields more than 1,000 gal/min to wells, and some wells in the Intermediate and Inyokern areas yield more than 2,000 gal/min. The dissolved-solids-concentration in samples from wells perforated in the deep aquifer generally is less than 1,000 mg/L (Warner, 1975). Wells perforated in the deep aquifer near Inyokern; in the Intermediate Area; and in the southwest part of the Valley near the Little Dixie Wash have dissolved-solids concentration less than 400 mg/L (Berenbrock, 1987)."

NATURAL RECHARGE AND DISCHARGE

> "Natural recharge to the groundwater system in the Valley consists almost entirely of runoff from the surrounding mountains. Because infiltration of the runoff occurs near the mountain front where the runoff first crosses the unconsolidated deposits of the Valley, the natural recharge is termed mountain-front recharge. Little, if any, direct infiltration of precipitation recharges the Valley groundwater system. Precipitation averages only 4 to 6 in/yr on the Valley floor, and most is lost to evaporation, which averages about 80 in/yr from ponded water (Farnsworth and others, 1982)."

> "Prior to extensive pumping in the Valley, recharge to the groundwater system was balanced by natural discharge. Except for a small amount of groundwater outflow to Salt Wells Valley, natural discharge occurred almost entirely by evapotranspiration from the shallow aquifer in the vicinity of China Lake in the eastern part of the Valley. By mapping areas of phreatophytes and moist lands present in 1912 in and around China Lake and multiplying the areas by assigned evapotranspiration rates, Lee

(1912) estimated evapotranspiration in the Valley to be 31,600 acre-feet per year."

"Kunkel and Chase (1969) considered Lee's estimate to be inaccurate because when the estimate was made in 1912, maps of the area were poor, aerial photographs were not available, and little work had been done on the evapotranspiration rates for the various phreatophytes. Using modern maps, Kunkel and Chase (1969) classified 33,000 acres of moist lands in and around China Lake as areas of evapotranspiration. They then assigned evapotranspiration rates to the area on the basis of a nonlinear relation between a maximum evapotranspiration rate when the water table is at land surface and zero evapotranspiration when the depth to water approaches 10 feet below land surface. The nonlinear relation was based on research in other desert basins since Lee's work in 1912 (Smith and Skarn, 1927; Young and Blaney, 1942; Blaney, 1952)."

"Using the revised values for area and evapotranspiration rates, Kunkel and Chase (1969) estimated the total groundwater discharge by evapotranspiration for 1912 to be 11,000 acre-feet per year, about 20,600 acre-feet less than Lee's (1912) estimate. The main reason for the difference in the estimates is that Kunkel and Chase used a nonlinear relation between evapotranspiration and depth to water. The maximum evapotranspiration rates used by both Lee and Kunkel and Chase are about the same; however, the nonlinear relation between evapotranspiration and depth to water (used by Kunkel and Chase) predicts much lower evapotranspiration rates than the linear relation (used by Lee) as the depth to water increases."

"In addition to revising Lee's estimate of evapotranspiration for 1912, Kunkel and Chase (1969) estimated the total evapotranspiration for 1953. The total area of evapotranspiration for 1953 was assumed to be the same as in 1912; however, different evapotranspiration rates were assigned to areas according to the measured depth to water in 1953. Total groundwater discharge by evapotranspiration in 1953 was estimated by Kunkel and Chase to be 8,000 acre-feet per year, about 3,000 acre-feet less than their revised estimate of evapotranspiration for 1912. Kunkel and Chase attributed the decrease in evapotranspiration to an increase since 1912 in groundwater pumpage from the deep aquifer. They suggested that the increased pumpage caused a net decline in water levels in the shallow aquifer near China Lake, thereby reducing evapotranspiration."

"Bloyd and Robson (1971) used the 1912 and 1953 estimates of average annual evapotranspiration by Kunkel and Chase as initial estimates of natural recharge and discharge for the model that they developed. In calibrating the model, Bloyd and Robson determined the natural recharge and discharge to be 9,850 acre-feet per year."

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PREVIOUS GROUNDWATER DATA

PREVIOUS GROUNDWATER DATA

INTRODUCTION

Compilation and display of water well data from pre-Project databases were the first technical tasks of the Project. This information was used to assist in the selection of sites for the proposed Project deep aquifer exploration wells.

The U.S. Geological Survey (USGS) has by far been the most comprehensive collector and compiler of groundwater and water well related data for the Valley. Their data base for 131 wells includes physical attributes of the wells, water levels, hydrographs, and for many at least one water quality analysis. This data is occasionally published in open-file reports. The latest open-file report is by Berenbrock (1987) and presents data collected between 1977 and 1984.

Groundwater quality data has also been recently compiled and published by Whelan and others (1989) under contract to the East Kern County Resource Conservation District (EKCRCD). Of the nearly 1200 analyses reported for over 370 sites, all but 23 were previously available. Of the 23 sites, 8 are wells in the Valley. Many of the other sites are springs, seeps and wells in the consolidated rock bounding the Valley.

Cornerstone Engineering of Bakersfield, also under contract to the EKCRCD, has compiled water well related data for the Valley. Their database consists of data for about 785 wells. However, only location, type, and depth is given for most of them. Even though there is only minimal data for most of the wells, this database is valuable in that it is probably a fairly complete list of all the wells in the Valley.

U.S. GEOLOGICAL SURVEY DATA

The various USGS open-file reports for the Valley list much data for their observation wells and is by far the most complete database for the wells included. The USGS did not include all wells in the Valley; however, that was not their intent.

The latest open-file report (Berenbrock) gives data for 131 wells and includes records of water levels at selected wells along with long-term hydrographs for four wells. A well description is included in the water level record which includes, but is not limited to, location (legal and descriptive), use, diameter, depth, date drilled, altitude of land surface, highest water level and date, and lowest water level with the date.

Water quality analyses for 85 wells are also reported in the latest USGS report. These should be representative of the water in the aquifer because the samples were usually collected after the well had been pumped. Berenbrock (1987) reports:

> "Where possible, samples were collected from pumped wells. Where pumped wells were not available, wells were pumped with a portable submersible pump. Specific conductance of discharge water was monitored, and sampling was delayed until after specific conductance had stabilized and a least 1.5 times the casing volume had been pumped. Water samples were not collected after pressure tanks or treatment apparatus had been used. If untreated water could not be obtained from a well, that well was not sampled".

All water quality analyses reported by Berenbrock were performed at the USGS's Water-Quality Laboratory in Denver, Colorado. The water quality section also lists the number of wells that equaled or exceeded primary and secondary maximum contaminant levels for selected chemical constituents as set by the U.S. Environmental Protection Agency.

EAST KERN COUNTY RESOURCE CONSERVATION DISTRICT DATA (Whelan)

Whelan and others (1989) used nearly 1200 water quality analyses from previous studies (representing over 370 sites) and analyses from their 23 new sites to make various kinds of water chemistry plots and diagrams. The previously available analyses appear to be from the USGS based on the format of a computer print-out. Since the analyses include sample sites in Rose Valley, the Coso Range, the Argus Range, and Salt Wells, many of the more than 370 sites do not represent the Valley. Of the 23 newly sampled sites, only 8 are wells in the Valley. Many are springs and wells from the consolidated rock surrounding the Valley.

Water quality analyses reported by Whelan should be representative of the local groundwater since the samples appear to have been collected from sources (wells and springs) actively producing groundwater. Flow estimates are reported for most of the sites. It is assumed that the wells were pumping at the time of sample collection because the reported collection point for the samples is the wellhead. On-site measurements at the sampled source included temperature, pH, and electrical conductivity. It appears that the water quality samples were collected following USGS procedures.

EAST KERN COUNTY RESOURCE CONSERVATION DISTRICT DATA (Cornerstone Engineering)

Cornerstone Engineering of Bakersfield (Conerstone), under contract to EKCRCD, has also compiled water well related data for the Valley. Their data base consists of data for about 785 wells in the Valley. Location, type, and depth is given for most of the wells. Some of the wells have a value for temperature listed. The rest of the data for some of the wells such as ground elevation, test (pumping?) date, and water quality analysis availability appear to be from the USGS.

This data set is valuable in that it is an attempt to document all the wells in the Valley. However, it is difficult to determine the method Cornerstone used in compiling the data base because the text is not yet available. Since almost all the wells listed have a location, owner, type (domestic, agricultural, public), depth, and permit number, it is surmised that they used various county records for information sources. It appears that they field checked some of the locations based on the "yes" or "no" tabulated under the column headed "Located." Only location and depth is given for many of the wells.

MAPS SHOWING PRE-PROJECT WATER WELL DATA

Maps (figures) were prepared to visually display the water well related data from existing databases. All the figures described below are in Appendix V of this volume. Except for Details A, B, and C, they are all one half the size of the originals.

The first set of figures--1 and 1a--display the data from the Cornerstone Engineering Data Base for the northwest area of the Valley. The numbered figure is the Cornerstone map showing the location of the wells and the "underlying" figure (with the figure number followed by an "a") shows the "stick" representation of the wells. The horizontal scale on the stick map is the same as the overlying location map and the point at the top of each "stick" underlies the well location on the map. The length of the stick is proportional the total depth of the well per the vertical scale shown.

Each of the other figure sets--2 and 2a through 8 and 8a--are constructed as described above. The first figure set (1 and 1a) covers the northwest part of the Valley. The following figure sets are sequenced from west to east and tiered from north to south. The last figure set (8 and 8a) covers the extreme southwest part of the Valley.

Figure sets 9 and 9a through 11 and 11a cover Details A, B, and C as shown on figures 3 and 4. The detail maps were constructed by Cornerstone to clearly show well locations in high density areas.

Figure sets 12 through 12d are constructed as described above using USGS data from Open-File Report 86-315 (Berenbrock, 1987). Figure 12 is the location map from Open-File Report 86-315. The "a" figure shows all the USGS observation wells with a reported total depth. The figures lettered "b," "c," and "d" show the wells from the preceding figure that have a measured water elevation, known screen interval(s), and a water quality analysis, respectively. The "e" figure shows all the water quality analyses without regard for missing well data, i.e. water elevation, screen interval(s), and total depth.

Water quality analyses are shown as bar-type Stiff diagrams with each bar representing the constituent shown in the legend. Any constituent over 1000 parts per million (ppm) is represented by a one-half inch bar with the actual concentration listed. If there is more than one water quality analysis for the well, the most recent is shown.

The "f" figure shows a colored ball (will not show on black and white copies) at the top of each well from figure "e". The colors are coded as shown in the legend. The colors were selected so as to intuitively convey the relative water quality to the viewer.

Figures 13 through 13f represent the detail area shown on figure 12 and are constructed the same as the figure 12 set described above.

CONCLUSIONS

The intent of the well attribute displays (the appended figures) is not to portray all known well data, although most is, but to visually portray most of the known data in simulated three dimensions. Data deficient zones (location and depth) are readily apparent from inspection of the figures. As can be seen, there are relatively few wells in the Valley with a known depth, screen interval(s), water elevation, and water quality. Many of the wells with many known attributes are in the Intermediate Area. Many of the wells with a water quality analysis are missing one or more of the other attributes. Although there are many wells (mostly domestic) surrounding the Naval Air Weapons Station, most are relatively shallow.

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TEST WELLS

TEST WELLS

INTRODUCTION

The overall Project goal was to determine aquifer and groundwater related parameters in areas where little data had been previously collected and to depths not usually explored for groundwater production. Maximizing future usability and the number of parameters that could be determined while minimizing the short and long-term costs was the general design criteria for the test wells. The following narrative section explains the process used to develop the test well design. Data collected from the wells is discussed in the following chapter.

TEST WELL DESIGN

The first design consideration was depth. Two thousand feet was selected as a compromise between the desire for collecting groundwater related data to as deep as possible but at the same time from as many locations as possible. Furthermore, the drill rig needed to drill a 2,000 foot hole of the required diameter is relatively mobile compared to the rig needed to drill the required diameter to much beyond 2,000 feet. For holes much deeper than 2,000 feet, rig mobility generally decreases and the need for additional equipment increases such that the marginal cost increases at a higher rate.

Two general well design types were considered for completion of Project test wells. One proposed completion consists of a single casing "string" from the ground surface to depth with a variable number of like diameter screens at selected depth intervals. The annular space would be filled with the appropriate size filter pack. Bentonite (or some other non-permeable material) seals would be set at appropriate intervals between the screens to prevent vertical flow in the annulus during pumping. Six inches was selected as the casing diameter so as to easily accommodate widely available submersible electric pumps. The advantages of this type of well are: any number of screens can be set at zones of interest; the relatively large diameter will accommodate off-the-shelf submersible electric pumps; flow during pumping with submersible electric pumps is constant and easily measured; head can be measured below, in, and above the packer isolated screen during pumping; and specific capacity can be determined for each screened interval.

The disadvantages of the single string, large diameter completion are: a packer above and below the pump is required to isolate pumping to one screen and likewise the head at each screen can only be determined by packer isolation of the screen. Packer installation requires some type of rig. This means that any time a water quality sample or a head measurement is desired, a rig and crew would be needed to set the packer equipment for the measurements.

Measurements after the departure of the drilling and well completion drill rig would clearly be very time consuming and expensive.

The other well completion design considered for the Project drill holes is commonly called a "nested well" completion. A nested well refers to a drill hole completed with more than one small diameter well with screens at different intervals.[1] Because of the small diameter of the individual wells, the drill hole diameter for this type of completion would be about the same as for the larger diameter single string well completion. As in the single string well completion, the annular space would be filled with filter pack and bentonite seals would be set between the screens at appropriate intervals to prevent inter-screen flow during pumping.

The ability to make water level measurements and collect water samples without packer isolation equipment is the advantage of a nested completion. The only equipment needed to measure head at any time is a well sounder. The disadvantages of the nested completion are: specific capacity can not be determined during pumping because measurements of depth to water are not possible during air-lift pumping from a small diameter well, and a maximum of about 4 wells (4 screened intervals) can be installed in the same diameter hole as would be needed for the "large" diameter single string completion.

After much discussion of the advantages and disadvantages of each completion, the subcommittee reached a consensus that the nested completion was more advantageous, especially in the long-term. Of particular advantage would be the ability to sample water and measure depth to water in the nested completion without a rig (to install screen isolation packers). The cost of a packer setting rig would be a major hindrance to any potential future research use of the wells. In addition, the nested completion allows easy installation of pressure transducers for depth to water measurements by a data logger.

Two inches was selected as the diameter for each of the piezometers in the nested completion because the minimum diameter of semi-off-the-shelf submersible pumps capable of lifting water from 300 to 400 feet is about 1-7/8 inches. This allows water samples to be pumped instead of air-lifted. Pumped samples (non-aerated) may be required for some future investigation. Obviously more piezometers (more screened intervals) can be installed in a given diameter drill hole as the diameter of the individual piezometers is decreased, however the smaller the diameter the higher the probability of limiting some future research.

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[1]According to Nielsen (1991), nested wells can also mean closely spaced wells, installed in separate drill holes, with screens at different depths. As used herein, "well" refers to the full drill hole completion and "piezometer" refers to one of the three or four individual small diameter wells in the nested completion.

All of the screens were 20 foot long except in well BR-4. Twenty feet was a trade-off between the desire for a long screen, so that aquifer parameters determined from slug test would represent more of an aquifer "average," and a short screen so that the head would not be an average of a large aquifer thickness.

DRILLING AND COMPLETION SEQUENCE

All of the holes for the test wells were drilled by conventional circulation mud rotary. The diameter of the first pass to total depth was at the drillers discretion. Most chose to drill the hole to completion diameter on one pass to total depth as opposed to reaming a smaller diameter pilot hole.

The drillers were required to maintain a complete drillers log which included "joint" number, drilling start time, drilling stop time, circulation time, joint length, total drill string length, and formation and construction notes. Cuttings, retained in clear zip-lock bags for later description by one of the subcommittee members, were sieved from the mud return every 10 feet during the drilling.

Electric and natural gamma logs were run immediately after the hole was drilled. The electric logs included spontaneous potential, 16-inch normal, 64-inch normal, and the 6-foot lateral. A long spaced sonic log (acoustic velocity) was run in the BR-10 drill hole. Temperature logs were run in the deep piezometer one to two months after completion by personnel from the Navy's Geothermal Programs Office. The temperature logs in Appendix XII were run by NACC.

The intervals to be screened were selected by a consensus among the subcommittee members at the drill site when the electric logging was completed. In many cases, if not most, this impromptu subcommittee meeting was in the pre-dawn hours. The screens were set opposite sandy intervals and the annular seals were set opposite significant clay layers if available. A typical completion is shown in figure 3.

The piezometers were developed by air-lift pumping. Most of the piezometers were air-lifted for about 12 hours (from drillers report) and the estimated flow rate on most was 5-10 gallons/minute. Poor development, however, is suspected in some of the piezometers. Slug test water level recovery in a number of the shallow piezometers was unexpectedly slow. Poor development, as opposed to the aquifer, is believed to be the cause of the slow

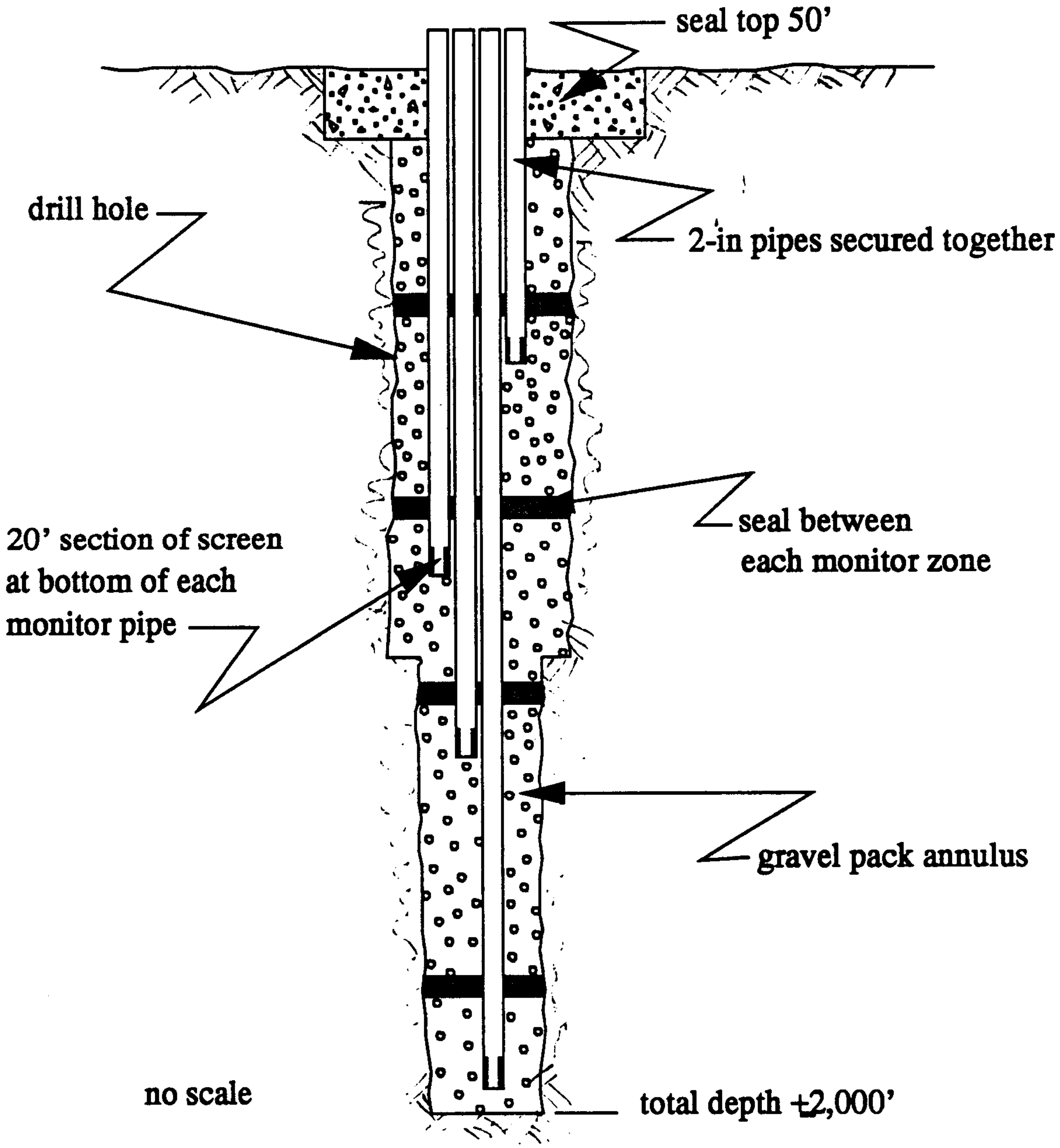

Figure 3. Schematic of typical drill hole completion with four piezometers. Some drill holes were completed with three piezometers.

recovery rate. Although the wells were designed to provide recommended submergence, the poor development was probably caused by too little air line submergence. See Appendix IV for a detailed explanation of the diagnosis. Less than complete development is suspected as the cause of the lower concentrations of some constituents in the filtered sample water quality analyses from the MW-32 piezometers as compared to the unfiltered samples.

A sample for water analysis was collected just before the air-lifting was stopped. The water quality samples were sent to Clinical Laboratory of San Bernardino or BC Laboratories of Bakersfield for a Title 22 Chemical Analysis. The Title 22 analysis covers all of the constituents and attribute standards for water in California. All of the analyses are included in Appendix VIII.

TEST WELL LOCATION SELECTION PROCESS

Each member of the subcommittee submitted a prioritized list of 10 potential test well locations with a short rationale for each location. The 10 sites were selected from a preliminary list of 16 well sites which were selected by the subcommittee members based on existing geohydrologic conditions, interpretations of geophysical surveys (seismic, gravity, and magnetic), likely depth to water, potential recharge zones, and the density of existing well related data in the area. Each member developed his priority list based on the criteria the member believed to be important and without consultation with the other members.

The final Project prioritized list of general locations (township, range, and section) for the test holes evolved from the individual priority lists after lengthy discussions of the location rationales. The exact location was guided by ease of equipment access, environmental concerns, safety, and land ownership. All wells were located on public land so as to eliminate potential future access problems due to change of ownership.

The locations and priorities developed by each member were remarkably similar, especially the high and low priority locations. The highest priority locations selected by most members were in the Southwest Area (SW) along with one well in the middle of the Intermediate Area (Inter). Determination of the water quality at depth was the rationale for the Intermediate Area location. The Southwest Area of the Valley was, and is, of interest because of the paucity of existing wells and the indication from geophysical surveys that there may be a subsurface structural high. In addition, the watersheds in the Sierra Nevada upslope of the Southwest Area have been modeled as the area of greatest recharge to the Valley. There was general agreement that the east and northeast area was a lower priority. There was some disagreement on the specific intermediate priority locations; however, in general they were in the center of the Valley north of the Intermediate Area.

SELECTED PRIORITY LOCATIONS

The following is a list of the selected test well locations in decreasing order of priority. The number of the BR (Bureau of Reclamation) test well designation is the same as the priority. Ten sites were selected with the understanding that the sum of the actual well completion costs would probably not allow completion of all ten sites. The subcommittee agreed that the order of priority could change based on the findings as the wells were completed. The actual location of some of the wells may be as much as one section from the proposed location due to access considerations and the location of previously cleared areas. See figure 4 in the Data and Data Analysis chapter for actual well locations.

Site 1 (SW) T27S/R38E Section 23(BR-1)
Exposures of Pleistocene sediments coupled with Bouger gravity and refraction studies (Cal Tech and NWC) indicate the potential for a groundwater divide and or a structural high in the Southwest Area of the Valley. Hydraulic conductivity in this unit could be much lower than in the Valley fill. In addition, the apparent location of this feature could impact the estimate of recharge to the Valley from the southwest watersheds.

Site 2 (SW) T27S/R38E Section 11(BR-2)
The relationship of water levels, water quality, and the geologic log of this well as compared to those same attributes in BR-1 may lend insight into the area that has been modeled as the largest recharge source to the Valley. There may be distinct water quality and water level differences between sites 1 and 2 which may be based on the subsurface configuration of the potential structural high. To reduce disturbance of desert vegetation and increase the distance from BR-1, this well was completed in section 2 (the adjacent section to the north of 11) on an area already clear of vegetation.

Site 3 (South) T27S/R39E Section 10(BR-3)
This site was selected to explore the southern "boundary" of the Intermediate Area. Water quality at depth could bear on long-term operation of the Intermediate Area well field. As the Valley fill may consist of interfingered Sierra Nevada derived sediments and sediments from the El Paso Mountains, there

may be a notable difference in hydraulic conductivity as compared to the wells on the west side of the Valley. To reduce disturbance of desert vegetation, this well was completed in the northwest corner of section 11 (the adjacent section to the east of 10) on an area already clear of vegetation.

Site 4
(Inter)

T26S/R39E Section 26(BR-4)
This site is in the middle of the Intermediate Area. Water quality and stratigraphy below the pumping horizon of the wellfield is of particular interest because of the potential to affect wellfield water quality. A refraction survey (Charlie profile) shows a distinct velocity increase at a depth of approximately 1300 feet. This is thought to be the top of the Ricardo Formation. Some have suggested an upwelling of deep water in this area.

Site 5
(West)

T25S/R38R Section 34(BR-5)
Bouger gravity, magnetic and refraction surveys (NWC, EKCRCD, and Cal Tech) indicate a potential depositional basin (fine-grained deposits) to the east and northeast of this site. The geologic and geophysical logs from this site and the Neal Ranch sites (NR-1 and NR-2) should indicate the depositional history of the area and the extent of the apparent fine-grained deposits. The water quality data may have an impact on future pumping distribution. The water table elevation at this site compared to the Neal Ranch sites will indicate recharge gradient.

Site 6
(West)

T25S/R38E Section 10(BR-6)
The Sierra Nevada watersheds west of this site have been modeled as one of the larger recharge sources for the Valley. As mentioned under Site 5 the Bouger gravity, magnetic and refraction surveys (NWC, EKCRCD, and Cal Tech) indicate a potential depositional basin in this area. The geologic and geophysical logs from this site and Site 7 should indicate the depositional history of the area and the extent of the fine-grained deposits, if any. The water quality data should indicate the potential for future pumping distribution. The water table elevation at this site compared to Site 7 will indicate recharge gradient. This well was actually completed in section 12 after it became apparent that this would be the last Project well (BR-10 was completed with financial assistance from the NAWS Geothermal Office).

Site 7 (Cent)

T25S/R39E Section 8 (BR-7)[Not Completed]
This site is a "companion" to Site 6. Data from each site (sites 6 and 7) would have much more meaning when compared to the other. Questions raised from the data collected at Site 6 could be partly answered by the data from Site 7. These questions may include: how extensive are the fine grained deposits (if found), how representative is the water quality variation with depth, and how steep is the water table gradient.

Site 8 (Cent)

T25S/R39E Section 34(BR-8)[Not Completed]
Selection of this site was also based on the previously mentioned geophysical surveys by Cal Tech, NWC and EKCRCD. Here the southward extension of an indicated Pleistocene deposition basin (fine grained deposits) is of interest. The vertical and horizontal extent of these deposits can have an impact on the long-term pumping potential of an area because the groundwater yield from these deposits is low and in many cases the water quality is poor.

Site 9 (East)

T25S/R39E Section 30(BR-9)[Not Completed]
A deep well in the China Lake Playa area would give insight into the depositional history of the Valley. The indication that there may have been a (pleistocene) depositional basin in the northwestern section of the Valley suggests that the center of fine grained deposition was not always on the east side of the Valley. Is there potential for groundwater production at depth below the playa? The horizontal and vertical extent of these deposits in the aquifer horizon can have a significant impact on future pumping distribution decisions because the groundwater yield from these deposits is low and in many cases the water quality is poor.

Site 10 (NW)

T24S/R38E Section 22(BR-10)
By all estimates the Nine-Mile Canyon in the Sierra Nevada west of this site is a relatively large contributor of recharge to the Valley. Water quality differences with depth may yield insight as to the depth of section through which this recharge flows. In part, this site was also selected because of the potential depositional center migration during recent geologic time as mention above. This well was completed in section 21.

SITES DRILLED AND COMPLETED

Priority sites 1 through 6 and site 10 were drilled and completed with piezometers. Two wells, completed to Project specifications, were installed by the Water District on their Neal Ranch property. These wells are designated NR-1 and NR-2. The Water District also completed well MW-32 as a Project well. Here the Water District only needed a pilot hole for a soon to be constructed large diameter supply well. A normal pilot hole would have been drilled to about 1200 feet at most and would have been completed with a single observation well.

As the drilling and completion of the wells progressed, well drilling costs increased to the point that some sites could not be completed. Sites 7, 8, and 9 were skipped for two reasons. The first was that the upper section of the Navy's SNORT well was made available to the Project for completion. The subcommittee decided that the central Valley location of the SNORT well would in general substitute for central Valley sites 7 and 8. The second reason was the discovery of the thick sections of clay in NR-1, NR-2, and BR-6, which made the BR-10 location ever more important because the location offered the most potential for exploring the extent of the thick subsurface clay.

DRILL HOLE COMPLETION HISTORY

A short narrative of the drilling and completion is given below in the order of well location priority. Refer to figure 4 in the following chapter for the location of the Project test wells.

***Well BR-1**
This well is about 200 feet west of the Red Rock Inyokern Road at a point about 5.2 miles south of Inyokern. Drilling by Southern California Drilling of Lancaster, California, began on February 15, 1991, and was completed on March 5. The 12¼-inch hole was drilled to 1,910 feet. Drilling rate was relatively consistent in this hole to about 1,700 feet. Drilling time per 30-foot joint down to 1,700 feet was about one hour. From about 1,700 to 1,830 feet the time per joint was about two hours. Drilling of the last full 30-foot joint took 6 hours. Although the change in penetration rate per joint is characteristic of bit failure, the bit was reported by several subcommittee members to be in relatively good shape. Four piezometers were set with the bottom of the 20 foot screens at 1,770, 1,520, 1,060, and 635 feet.

***Well BR-2**
This well is about 1¼ miles south of Highway 178 at the south end of Sierra Vista Road (27S, 38E, 2C). Drilling by Southern California Drilling of Lancaster, California, began on October 1, 1990, and was completed on

October 24. The 12¼-inch hole was drilled to 2,020 feet and the penetration rate was relatively consistent in this hole. Three piezometers were set with the bottom of the 20 foot screens at 1,960, 1,480, and 640 feet.

***Well BR-3**
This well is about 100 feet south of Bowman Road and about 1,500 feet east of Highway 395 (27S, 39E, 11D). Drilling by Southern California Drilling of Lancaster, California, began on March 6, 1991, and was completed on March 19. The 12¼-inch hole was drilled to 2,024 feet and the penetration rate was relatively consistent. Three piezometers were set with the bottom of the 20 foot screens at 1,870, 1,340, and 670 feet.

***Well BR-4**
This well is about 600 feet south of Inyokern Road and about 300 feet west of the north-south dirt road on the eastern section line of section 26 (26S, 39E, 26A). Drilling by U.S. Bureau of Reclamation crews from Sacramento, California, and Phoenix, Arizona, began on August 28, 1990, and was completed on about September 27. The hole was drilled to 2,020 feet and electric logged. After the deep piezometer was set, the previously set filter pack tremie pipe could not be moved, either up or down. After removing the deep piezometer from the hole, many days were spent fishing out the tremie. Since it was coming out in ever shorter sections and the annulus appeared to be increasingly packed with sand, it was decided to install one piezometer in the remaining open hole. Only one piezometer was set with the bottom of the 10 foot screen at 1,200 feet.

***Well BR-5**
This well is about 200 feet west of Highway 395 at a point about one-half mile north of the Leliter Road intersection with Highway 395 (25S, 38E, 34G). Drilling by Welch and Howell Drilling of El Centro, California, began on December 19, 1991, and was completed on January 3, 1992. The hole was drilled to 1,014 feet with a 14¾-inch bit and a 12¼-inch bit was used to drill to total depth of 2,013 feet. The drilling rate was relatively consistent in this hole. Coarse alluvial fill, mostly sand, was penetrated to total depth. Three piezometers were set with the bottom of the 20 foot screens at 1,980, 1,610, and 870 feet.

***Well BR-6**
This well is just inside the Naval Air Weapons Station west boundary, which parallels Brown Road, along a dirt eastward extension of the east-west section (north end) of Brown Road (25S, 38E, 12F). Drilling by Welch and Howell Drilling of El Centro, California, began on January 6, 1992, and was completed on January 17. The hole was drilled to 1,008 feet with a 14¾-inch bit and a 12¼-inch bit was used to drill to total depth of 2,012 feet. Total

clay thickness penetrated by this hole was significant. From a depth of about 510 feet to about 1,480 feet the section is about 75 percent clay.

Curiously, the electric log of the section from about 1,815 feet to total depth (2,012 feet) looks like the indurated section at the bottom of BR-1. The description of the cuttings samples from this interval is consistently sand with some clay with no indication of cementation. Unfortunately the driller did not record drilling time for each joint. Three piezometers were set with the bottom of the 20 foot screens at 1,660, 1,210, and 350 feet.

***Well BR-10**
This well is about one tenth of a mile southeast of the intersection of Highway 395 and Ninemile Road in the northwest part of the Valley (24S, 38E, 21J). Drilling by Welch and Howell Drilling of El Centro, California, began on August 24, 1992, and was completed on September 2. The hole was drilled with a 17½-inch bit to 591 feet, a 14¾-inch bit to 1,002 feet, and a 12¼-inch bit to 2,005 feet. The cuttings from 680 feet to 1,440 feet are mostly described as clay, however, the electric logs indicate significant sand interbeds. Four piezometers were set with the bottom of the 20 foot screens at 660, 1,200, 1,580, and 1,950 feet.

WATER DISTRICT WELLS

The following wells were completed by the Indian Wells Valley Water District. The Neal Ranch (NR) wells were completed to explore the geology and water quality under their Near Ranch property. Monitoring Well 32 (MW-32) was a pilot hole and observation well for production well #30. All three of the holes were drilled and completed as a standard Project test well. A normal pilot and exploration hole would probably have been about 1,000 feet deep and most likely would have been completed with one small diameter well.

***Well NR-1**
This well is located in the northeast corner of the Water District's Neal Ranch property (25S, 38E, 25J). Drilling by Southern California Drilling of Lancaster, California, began on January 7, 1991, and the wells were completed on February 6. The 12¼-inch hole was drilled to 2,012 feet. An extremely thick and relatively continuous clay and peat section was penetrated by this hole. The top of the clay is at a depth of about 340 feet and the bottom is at about 1,810 feet. Three piezometers were set with the bottom of the 20 foot screens at 1,980, 1,190, and 270 feet.

***Well NR-2**
This well is located in the southwest corner of the southwestern block of the Water District's Neal Ranch property (25S, 38E, 36F). Drilling by Southern California Drilling of Lancaster, California, began on February 4, 1991, and was completed on February 15. The 12¼-inch hole was drilled to 1,994 feet. The thick clay section penetrated by the drill hole for NR-1 was also encountered in this drill hole. Here the top of the clay is at a depth of about 445 feet and the bottom is at about 1,490 feet. Three piezometers were set with the bottom of the 20 foot screens at 1,930, 1,560, and 350 feet.

***Well MW-32**
This well is about 600 feet west of Victor Street and about 1,200 feet south of Inyokern Road (26S, 39E, 27D). Drilling by Rottman Drilling Company of Lancaster, California, began on September, 23, 1991, and was completed on October 8. The 12¼-inch hole was drilled to 1,968 feet. The section penetrated was a sandy alluvial fill with very little silt or clay. Four piezometers were set with the bottom of the 20 foot screens at 1,920, 1,260, 900, and 360 feet.

NAVY GEOTHERMAL TEST WELL

The Geothermal Program Office of the China Lake Naval Air Weapons Station allowed the Project to complete two intervals in the upper part of their geothermal exploration well (SNORT-1) located in the center of the Valley. Based on the electric logs the subcommittee selected 840-880 feet and 1,430-1,470 feet as the intervals for completion. The perforation and completion of these intervals was included in the perforation and completion contract for the deeper intervals of interest to the Geothermal Programs Office.

SNORT-1 is located about one mile northwest of the north end of the SNORT (Supersonic Naval Ordinance Research Track). Drilling by Welch and Howell Drilling Company of El Centro, California, began on September 8, 1991, and reached a total depth of 7,394 feet on September 30.

REFERENCE

Nielsen, D., 1991, **Practical Handbook of Ground-Water Monitoring**, Lewis Publishers, Chelsea, Michigan.

DATA COLLECTED

DATA COLLECTED

INTRODUCTION

Information and data were collected during each phase of well construction and after completion. During drilling, a penetration rate log was maintained by the driller and samples of the formation cuttings were collected from the drilling mud return. Electric logs were run after the hole reached total depth.

Information collected from each piezometer after completion included: depth to groundwater measurements approximately every two months, laboratory analysis of water samples collected at the end of development, slug tests for transmissivity estimates, and pressure tests to check for hydraulic connection between the piezometer screens. Detailed logs and all of the data collected from the piezometers can be found in the Appendices. The appendix and data found therein are as follows:

Appendix III - Pneumatic Slug Test Procedure and Data Analysis
Appendix VI - Diagrammatic Piezometer Completion and Data Summary
Appendix VII - Drill Hole Completion and Data Logs (with Electric Logs)
Appendix VIII - Laboratory Water Quality Analyses (Title 22)
Appendix IX - Water Elevation Hydrographs
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Appendix XI - Slug Test Data
Appendix XII - "Down-Hole" Temperature Logs
Appendix XIII - Project Well Location Map
Appendix XIV - Well Site Elevations

DRILL HOLE CUTTINGS

A sample of the formation cuttings was collected every ten feet during drilling of the test well hole. The samples were collected from the drilling mud return stream with a "kitchen strainer" and placed in a clear zip-lock plastic bag marked with the drill hole depth. All of the cuttings samples from each hole were packed into wood boxes for storage and later description by one of the subcommittee members. These boxes are in storage at Water District facilities.

DRILL HOLE COMPLETION AND DATA LOGS

The "geologic" logs for this Project were designed to present essentially all of the information collected during drilling and testing of the completed wells. In some cases the electric logs as shown are a "trimmed" rendering of the original. In each of these cases the log trace was not altered and as much of it is shown as possible within the space limit.

The descriptive cuttings log in the right column of the Drill Hole Completion and Data Log (see Appendix VII) is a summary of the detailed cuttings description. An interpretive adjustment to fit the depths to the electric logs was not made. The depth to water shown on the log is only one set of the measurements made during the course of the Project. They are, however, representative of the relative water level differences consistently noted between the piezometers. The rest of the information and data is believed to be self-explanatory.

LABORATORY WATER QUALITY ANALYSES

Water samples were collected from each piezometer near the end of air-lift development pumping. Water was air-lifted about 12 hours at 5-10 gallons per minute based on the driller's report. Water samples were submitted to a California certified laboratory for Title 22 analysis.

The water samples were believed to be representative of aquifer water; however, poor development is suspected in some of the piezometers based on slow water level recovery rates during the slug test (see Appendix IV). Some constituent concentration differences between filtered and unfiltered water samples from MW-32 also suggest less than full development.

DEPTH TO WATER MEASUREMENTS

Depth to water in each piezometer was generally measured whenever the Reclamation member of the subcommittee was in the Valley. All measurements were made with a 1,000 foot electric water level sounder. The cable on this sounder is the same as 300 ohm, twin-lead, TV antenna wire with measurement marks at a 0.05 foot interval. Some piezometers have fewer depth to water measurements than others. The number of depth to water measurements is a function of the date the well was completed--the later the completion, the fewer the measurements. All depth to water measurements can be found in Appendix X and water elevation hydrographs are in Appendix IX.

All depth to water measurements were made from the top of each piezometer. The column headed by "TOC to TOP" on the depth to water data sheet is the distance (in feet) from the "top of casing (large diameter outer protective surface pipe) to top of piezometer." Water level elevation is the top of casing elevation minus the sum of depth to water and TOC to TOP.

The top of casing elevation was established at a mark on the casing by a Reclamation survey crew from the Yuma Projects Office, Yuma, Arizona (see Appendix XIV for well site elevations). The elevation survey was "closed" and the closure error and length of "run" was noted. A closed survey begins and ends at the same known elevation point. The difference between the starting elevation and the ending elevation at the know elevation point is an indication of the survey quality.

Two wells--BR-3 medium and MW-32 shallow--have an oil coating on the inside of the piezometer pipe above the water level. This coating is especially heavy in BR-3 medium. Based on an analysis, this oil probably came from the air compressor used for air-lifting. Water level measurements could only be made on a few occasions with the electric sounder in BR-3 medium. One of the water level measurements in this piezometer was made with the temperature probe on the NACC's logging van. The oil sample for analysis was retrieved from the logging cable squeegee. Several attempts to reduce or remove this coating have not been successful. However, later attempts to get an electric sounder probe down to the water level, were less difficult than early attempts.

SLUG TESTS AND TRANSMISSIVITY ESTIMATES

A pneumatic slug test was conducted on each of the Project piezometers and the recorded recovery rate was used to estimate the transmissivity of the formation opposite the screened interval. The pneumatic technique, with an electric data logging devices used in conjunction with down hole pressure transducers, is a recent advancement in slug testing because it increases the range and application of slug tests. This method involves either injecting air into a sealed well to lower the water level (Leap, 1984) or applying a partial vacuum to a sealed well to raise the water level (Orient and others, 1987). This equipment and procedure for conducting slug tests allows testing in deep water level, small diameter wells screened in highly conductive aquifers.

The Cooper (1967) method for analyzing slug test recovery data was used to derive the estimated transmissivity of the 20 foot aquifer opposite the screen. The mathematical solution by Cooper and others (1967) for the instantaneous injection (or removal) of a volume of water (the "slug") assumes that the well fully penetrates the aquifer and that the aquifer is perfectly confined. This is clearly not the case in the Project test wells. However, Cooper and others (1967) conclude their paper with the following:

> "Few wells completely penetrate an aquifer, but it is nevertheless possible under some circumstances for a hydrologist to derive useful information

> from a test on a partially penetrating well. Since the vertical permeabilities of most stratified aquifers are only small fractions of the horizontal permeabilities, the induced flow within the small radius of the cone that develops during the short period of observation is likely to be essentially 2-dimensional. Therefore, the determined value of T [transmissivity] would represent approximately the transmissibility of that part of the aquifer in which the well is screened or open, provided that the aquifer is reasonably homogeneous and isotropic in planes parallel to the bedding and provided that the effective radius can be estimated closely."

It is believed that the physical properties around the Project's piezometer screens are sufficiently close to the conditions for which the Cooper method was derived because the estimated transmissivities when prorated over the full aquifer thickness seem reasonable. The raw slug test data is in Appendix XI.

AQTESOLV (Aquifer Test Solver), software from the Geraghty and Miller Modeling Group in Reston, Virginia, was used to estimate the transmissivity of the screened aquifer. The traditional Cooper solution for transmissivity relies on judgement of the best fit (overlay) between a plot of the recovery data and one curve from a family of type curves. Although the solution procedure in the software is not known, it is believed to offer a more consistent solution than overlay fitting. As a check, the transmissivity estimated from visual curve fitting was compared to the software solution for BR-4. The software solution for transmissivity was .28 ft^2/min and the visual solution was .275 ft^2/min.

HYDRAULIC CONNECTION TESTS

Some of the slug test equipment was also used to test for an "open" hydraulic connection between the screens of each Project well. To conduct the test the electric sounder probe was lowered to about 0.02 feet above the water level in the next-to-the-deepest piezometer. The pneumatic slug test well head assembly was then secured to the deep piezometer and air from a SCUBA tank was used to bring the pressure in the piezometer up to about 15 pounds per square inch (psi). After noting any sounding from the sounder, testing continued by moving the electric sounder to the next piezometer up the hole and moving the well head assembly to the next piezometer up the hole.

It is assumed that an open connection between screens through the annulus would provide a conduit for pressure transmission. This condition would manifest itself by a rise in piezometer water level (which would sound the sounder) subsequent to pressurizing the next piezometer down the hole. Water level changes in the nearest up-hole piezometer were not observed during any of tests.

TEMPERATURE PROFILES

Temperature logs were run in each deep piezometer using a ComProb/Gearhart Owens International temperature tool on a NACC wire line logger. Each piezometer was logged by lowering the temperature tool down the piezometer at five feet a minute. Data are recorded on a floppy disc for later printing. The temperature profiles are included in Appendix XII of this volume. The temperature gradients reported in the following chapter are mostly from logging by the NAWS Geothermal Projects Office.

REFERENCES

Cooper, H.H., Bredehoeft, J.D., and Papadopulos, I.S., 1967, *Response of a Finite-Diameter Well to an Instantaneous Charge of Water*, Water Resources Research, v.3, no.1, p.263-269.

Leap, D.I., 1984 (Fall), *A Simple Pneumatic Device and Technique for Performing Rising Water Level Slug Tests*, Ground Water Monitoring Review, pp.141-146.

Orient, J.P., Nazar, A., and Rice, R.C., 1987 (Winter), *Vacuum and Pressure Test Methods for Estimating Hydraulic Conductivity*, Ground Water Monitoring Review, pp.49-50.

DATA AND DATA ANALYSIS

DATA AND DATA ANALYSIS

INTRODUCTION

In this chapter the data collected from each Project well is discussed. Relative water levels are discussed first followed by water quality, estimated aquifer transmissivities derived from slug tests, deposits penetrated during drilling, and the results from the temperature log. Some interpretations are also offered; however, data collected in the future, especially isotopic analysis, could suggest alternative interpretations.

Another round of water sampling with a submersible pump is recommended for isotopic and water quality analysis. Stable isotope ratios, used to estimate water age, may be significant with respect to recharge. The water quality analyses will either confirm what appear to be unusual constituent concentrations in the aquifer water or suggest potential bias in the first sampling round.

The only groundwater quality attribute common to all waters from the test wells, except the BR-3 medium and deep piezometers and the SNORT-1 "piezometers," is that the predominant cation is sodium and the predominant anion is bicarbonate. The primary source of sodium in natural water is from the release of soluble products during the weathering of igneous rock (plagioclase feldspars) and its weathering products in other material (Davis and DeWiest, 1996 and Bouwer, 1978). Most carbonate and bicarbonate ions in groundwater are derived from the carbon dioxide in the atmosphere and in the soil and solution of carbonate rocks. Below a pH of 8.2 most of the carbonate ions take on hydrogen to become bicarbonate ions and the ratio of bicarbonate to carbonate ions increases to more than 100 to 1 (Davis and DeWiest, 1966).

Figure 4 is a depiction of the most pertinent groundwater related data collected from the Project wells. Depth of piezometer (1" = 1000'), elevation of groundwater (feet), water quality (total dissolved solids, mg/L), and estimated transmissivity (ft^2/min) are shown. In the depiction, each vertical line below the Project well designation represents one piezometer. The length of the line is scaled to the piezometer depth (1" = 1,000'). The horizontal bars represent groundwater levels relative to each other but not at the piezometer depth vertical scale. Water elevation is shown to the right (except BR-5) of the piezometer cluster depiction.

The column representing geology exaggerates the thickness of thin clay layers (BR-1, BR-2, BR-5) however their location on the column is representative. Thick clay deposits, however, are to scale (BR-3, BR-6, NR-1, and NR-2). The single clay layer shown on BR-4 and MW-32 is somewhat vertically exaggerated in each case.

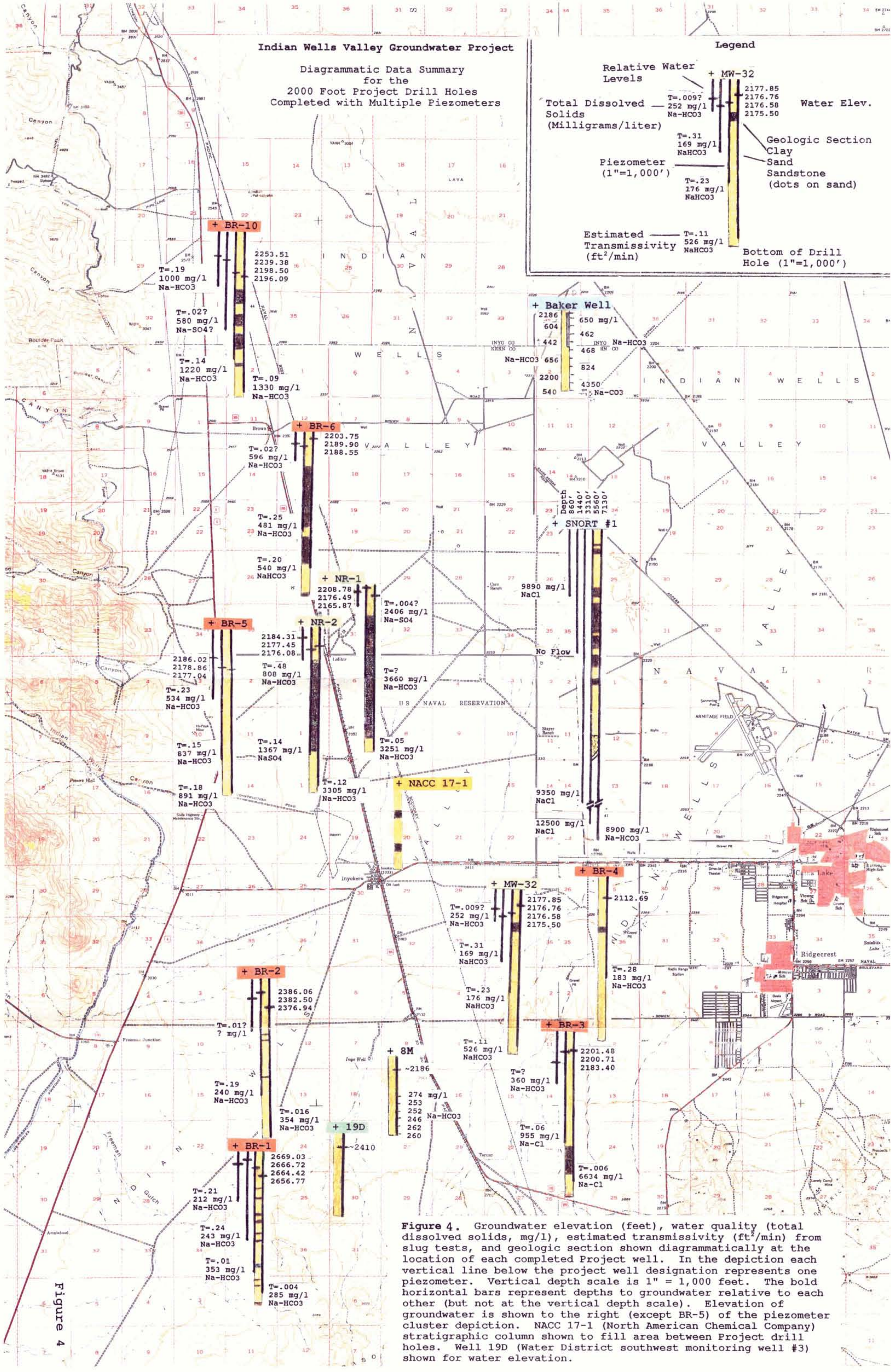

Figure 4. Groundwater elevation (feet), water quality (total dissolved solids, mg/l), estimated transmissivity (ft²/min) from slug tests, and geologic section shown diagrammatically at the location of each completed Project well. In the depiction each vertical line below the project well designation represents one piezometer. Vertical depth scale is 1" = 1,000 feet. The bold horizontal bars represent depths to groundwater relative to each other (but not at the vertical depth scale). Elevation of groundwater is shown to the right (except BR-5) of the piezometer cluster depiction. NACC 17-1 (North American Chemical Company) stratigraphic column shown to fill area between Project drill holes. Well 19D (Water District southwest monitoring well #3) shown for water elevation.

Reference to figure 4 will probably be helpful while reading the following discussion. Table 2 shows much of the same information in a different format. Detailed information for each well and individual piezometer can be found in the Appendices. The appendix and data found therein are as follows:

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Table 2. Data collected from Project test wells

WELL	WATER ELEVATION feet (9/10/92)	WATER QUALITY mg/L	TRANS-MISSIVITY ft^2/min	NOTES
BR-1				Mostly sand with some clay. Water from each piezometer is sodium bicarbonate. Temperature gradient is 2.0 °F per 100 feet.
Shallow	2666.72	212	0.21	
Medium-shallow	2669.03	243	0.24	
Medium-deep	2664.42	353	0.01	
Deep	2656.77	285	0.004	
BR-2				Mostly sand. Iron and manganese above recommended regulatory maximum contaminate level (MCL) in medium and deep piezometers. Temp. gradient is 2.3 °F per 100 feet.
Shallow	2382.50	NA	0.01	
Medium	2386.06	240	0.19	
Deep	2376.94	354	0.016	
BR-3				Mostly sand and fine gravel; clay between 1,380 and 1,740 feet. Chloride levels higher than bicarbonate in 2 lower aquifers. Temp. gradient is 2 °F per 100 feet.
Shallow	2183.40	360	0.06	
Medium	2200.71	955	NA	
Deep	2201.48	6,634	0.006	

Table 2. Data collected from Project test wells

BR-4	2112.69	183	0.28	Fine to coarse sand. Water is sodium bicarbonate; iron exceeds MCL. Temp. gradient is 2.1 °F per 100 feet.
BR-5 Shallow Medium Deep	 2186.02 2178.86 2177.04	 534 837 891	 0.23 0.15 0.18	Medium to coarse sand. All water is sodium bicarbonate; iron and manganese are higher than MCL; higher sulfate and chloride compared to BR-1, BR-2, and BR-4. Temp. gradient information is not available.
BR-6 Shallow Medium Deep	 2189.90 2188.55 2203.75	 596 481 540	 0.02 0.25 0.20	Medium to coarse sand to 370 ft; clay from 370 to 1,700 ft; clayey to silty, medium sand 1,700 ft to bottom. All water is sodium bicarbonate with sulfate and chloride higher than BR-1, BR-2, and BR-4; arsenic, iron, manganese, and aluminum exceed MCL. Temp. gradient is 2.22 °F per 100 feet.
BR-10 Shallow Medium-shallow Medium-deep Deep	 2253.51 2239.38 2198.50 2196.09	 1,000 580 1,220 1,330	 0.19 0.02 0.14 0.09	Medium to coarse sand to 680 feet; light gray/green clay with interbedded sand from 680 to 1,440 feet; medium to coarse sand from 1,440 to bottom. Water is predominately sodium bicarbonate; iron and manganese exceeded secondary MCL in lower aquifers. Temp. gradient is 1.7 °F per 100 feet.

Table 2. Data collected from Project test wells

NR-1 Shallow Medium Deep	 2176.49 2208.78 2165.87	 2,406 3,660 3,251	 0.004 NA 0.05	Medium to coarse sand to 340 feet; clay from 340 to 1,820 feet; medium sand from 1,820 to bottom; fossils and methane gas were encountered in the hole. Water in shallow aquifer is sodium sulfate with high concentrations of calcium and magnesium; water in lower aquifers are sodium bicarbonate; Nitrate exceeded MCL in the shallow piezometer. Temp. gradient is 2.75 °F per 100 feet.
NR-2 Shallow Medium Deep	 2184.31 2176.08 2177.45	 808 1,367 3,305	 0.48 0.14 0.12	Fine to coarse sand to 440 feet; clay from 440 to 1,480 feet; sand from 1,440 to 1,620 feet; interbedded sand and clay from 1,620 to bottom. Shallow and deep waters are sodium bicarbonate with high sulfate in shallow aquifer; medium aquifer is sodium sulfate with high bicarbonate, chloride, and nitrate; arsenic is above MCL. Temp. gradient is 2.7 °F per 100 feet.
SNORT-1 Shallow Deeper	 N/A N/A	 9,890 N/A	 N/A N/A	No flow in the deeper (1,430- to 1,450-foot) interval.
MW-32 Shallow Medium-shallow Medium-deep Deep	 2176.76 2175.50 2176.58 2177.85	 252 169 176 526	 0.009 0.31 0.23 0.11	Mostly fine to medium sand. All waters are sodium bicarbonate. No constituents exceed MCL. Temp. data was not obtained.

For convenience in the following discussion the term aquifer is used to denote only the twenty feet of formation at the screened interval of each piezometer. If there are three piezometers in a test well the aquifers are called shallow, medium, and deep. If there are four piezometers the two medium aquifers are called medium-shallow and medium-deep.

BR-1

The relative water levels in the piezometers, except the medium-shallow, are generally lower with increasing aquifer depth. In an area near surface recharge from mountain front runoff, water levels would be expected to be highest in the highest elevation aquifer and lowest in the lowest elevation aquifer. BR-1 is generally downslope of the watersheds which, by most estimates, are the largest source of recharge to the Valley. The higher water level in the medium-shallow piezometer, as compared to the shallow piezometer, is probably caused by clay layers confining the water in the aquifer screened by the medium-shallow piezometer. Figure 5 shows a physical arrangement in vertical section which could cause the relative water levels observed.

Total dissolved solids (TDS) of the water from the aquifers, based on the water samples collected at the end of air-lift development, ranged from 212 mg/L in the shallow aquifer to 353 mg/L in the medium-deep aquifer. All of the waters are sodium bicarbonate and none of the constituent concentrations exceeds a recommended limit.

The estimated transmissivity for the twenty foot screened interval in the upper two aquifers (0.21 and 0.24 ft/min) is nearly as high as those estimated for a like aquifer thickness in the Intermediate Area project wells (BR-4 and MW-32). The estimated transmissivity is an order of magnitude lower in the medium-deep aquifer and in the deep aquifer it is another order of magnitude lower.

The hole for these piezometers penetrated mostly alluvial sand with some clay. The dark brown clay noted at the bottom of the drill hole could be the continental deposits expected by some interpretations of geophysical surveys (see discussion under well location selection). The driller reported this clay to be hard and cemented. The Drillers Report shows the penetration rate slowing to six hours per 30 foot joint in this unit.

A temperature log was run in the deep well on June 5, 1991, three months after the well was pumped for development. The water temperature at the top of the water column (about 200 feet depth) was 75.5 degrees Fahrenheit (°F) and at a depth of 1,760 feet (bottom of the piezometer is 1,770 feet) the temperature was 106.9 °F. The rate of temperature increase is about 2.0 °F per 100 feet.

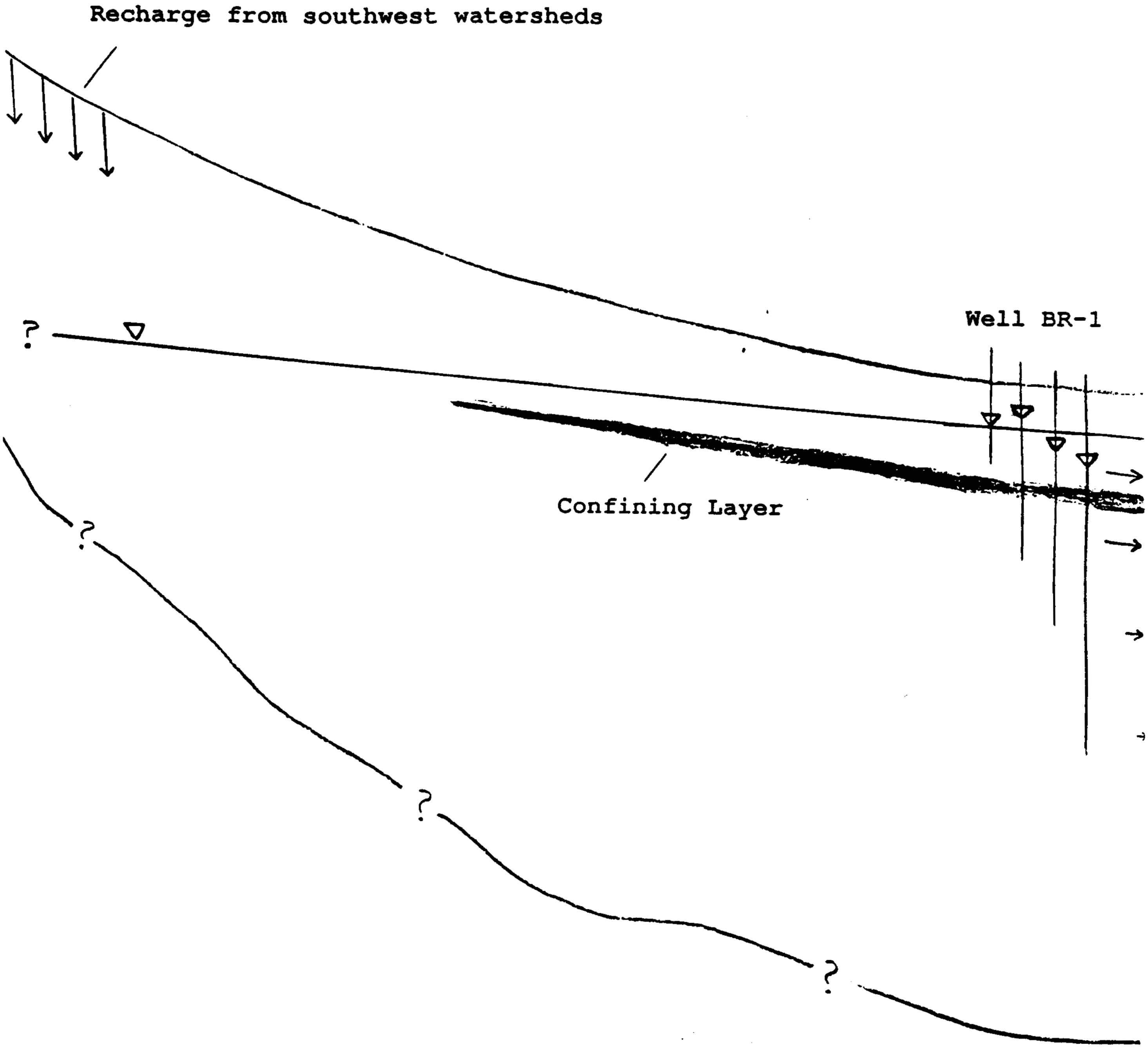

Figure 5. Hypothetical diagrammatic section between the southwestern recharge watersheds and Well BR-1. Confinement is probably the cause of the consistently higher water level in the shallow middle aquifer as compared to the water level in the shallow aquifer at well BR-1.

BR-2

Relative water levels in the BR-2 piezometers are the same as those in BR-1 in that the medium piezometer water level is higher than the shallow piezometer water level. In an area near surface recharge from mountain front runoff, water levels would be expected to be highest in the highest elevation aquifer and lowest in the lowest elevation aquifer. BR-2 is generally downslope of the watersheds which, by most estimates, are the largest source or recharge to the Valley. The higher water level in the medium piezometer is probably caused by confinement of the medium aquifer.

The TDS of the waters pumped from the BR-2 aquifers, based on the water samples collected at the end of air-lift development, ranged from 240 mg/L in the medium aquifer to 354 mg/L in the deep aquifer. The shallow aquifer escaped analysis due to an oversight. Both of the aquifer waters are sodium bicarbonate.

Although a water sample was not collected from the shallow aquifer, the TDS is probably less than 300 mg/L based on BR-1 shallow. The analysis suggests that iron is above the secondary maximum contamination level (SMCL) in both the medium and deep aquifer and manganese is above the SMCL in the deep aquifer but only slightly above in the medium aquifer. However, as mentioned in the introduction to this chapter, these concentrations may be a function of less-than-adequate development.

The estimated transmissivity of the medium aquifer is 0.19 ft^2/min and 0.016 ft^2/min in the deep aquifer. The medium aquifer transmissivity is nearly as high as those estimated in the Intermediate Area Project test wells (BR-4 and MW-32). The deep aquifer transmissivity is essentially the same as the estimate for the deep-medium aquifer at BR-1.

The low estimated transmissivity for the shallow aquifer (0.01) is believed to be a function of poor development. Insufficient airline submergence during air-lift development, although adequate by some texts, is thought to be the cause of inadequate development. See Appendix IV for a detailed explanation of the submergence hypothesis. Shallow aquifer transmissivity is probably about 0.20 based on the medium aquifer transmissivity and the BR-1 shallow and shallow-medium aquifer transmissivities.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. The alluvial fill is mostly subangular to subround, light gray to pale brown sand with scattered relatively thin clay layers.

A temperature log was run in the deep piezometer on November 15, 1990, about three weeks after the piezometer was air-lifted for development. The water temperature at the top of the water column (about 280 foot depth) was 79 °F and at a depth of 1,950 feet (bottom of the well is 1,960 feet) the temperature was 117 °F. The rate of temperature increase is about 2.3 °F per 100 feet.

BR-3

Confinement of the medium and deep aquifers at BR-3 is readily apparent based on piezometer water elevations. The lower elevation in the shallow piezometer, however, may be related to pumping in the Intermediate Area.

The laboratory reported TDS for the BR-3 aquifer waters are 955 mg/L in the shallow, 6,634 mg/L in the medium, and 360 mg/L in the deep. This aquifer depth water quality pattern is difficult to believe, especially since the 360 mg/L water is sodium bicarbonate and the others are sodium chloride bicarbonate. "Scrolling" each analysis to the next aquifer down yields a believable water quality versus aquifer depth trend. This hypothesis was confirmed by measuring the electrical conductivity of a water sample thieved from each of the piezometer screens by the NACC wire line logger. The electrical conductivities were found to increase with depth. This laboratory error is corrected in tabulated and graphical data.

Both of the lower aquifer waters have a greater concentration of chloride than bicarbonate. However, without the chloride the waters "look" the same as the waters from the rest of the test well piezometers. Primary sources of chloride in groundwater are evaporites, salty connate water, and marine water. Igneous rock materials contribute little chloride (Bouwer, 1978). The very high chloride concentration in the deep aquifer may be indicative of long residence time and little through-flow, connate water, or both.

The estimated transmissivity for the shallow aquifer is 0.06 ft^2/min and 0.006 ft^2/min for the deep aquifer. The shallow aquifer transmissivity is lower than those in the Intermediate Area and may be a function of poor development as mentioned in the chapter introduction. The deep aquifer transmissivity is much lower than in the Intermediate Area. Transmissivity was not estimated for the medium aquifer because the compressor oil film on the inside of the medium (depth) piezometer did not allow the slug test transducer to be set at an appropriate depth.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. The alluvial fill is mostly sand with scattered fine gravel; however, a significant clay section was penetrated in the lower part of the hole. The top of the clay section is about 1,380 feet deep and the bottom is at 1,740 feet.

A temperature log was run in the deep piezometer on December 12, 1991, nine months after the well was pumped for development. The water temperature at the top of the water column (about 310 feet depth) was 77.5 °F and at a depth of 1,170 feet (bottom of the piezometer is 1,870 feet) the temperature was 95 °F. The rate of temperature increase is about 2.0 °F per 100 feet. The temperature log was only run to 1,170 because of limited cable length.

BR-4

This well has only one piezometer due to completion difficulties as discussed in the Test Well chapter. The water level in this piezometer rises and falls in response to pumping of the nearby NACC well. A water elevation hydrograph for this well is in Appendix IX.

Total dissolved solids of the water pumped from the aquifer (1,200 feet depth), based on the water sample collected at the end of air-lift development, was 183 mg/L. The water is sodium bicarbonate. Iron, at 360 μ/l, slightly exceeds the 300 μ/l SMCL. All of the other analytes are below their respective maximum contaminant level (MCL).

The estimated transmissivity for the screened interval is 0.28 ft^2/min. The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. The alluvial fill is mostly light brown to gray brown, fine to coarse sand.

A temperature log was run in the piezometer on November 15, 1990, three months after the piezometer was pumped for development. The water temperature at the top of the water column (about 250 feet depth) was 77.5 °F and a depth of 1,200 feet (bottom of the piezometer is 1,200 feet) the temperature was 97.8 °F. The rate of temperature increase is about 2.1 °F per 100 feet.

BR-5

Relative water levels in the BR-5 piezometers fit the expected pattern in an area near surface recharge, in this case from mountain front runoff. Head is lost as water moves downward from the surface; therefore, the head is highest in the higher elevation aquifer and lowest in the lowest aquifer.

Total dissolved solids of the water pumped from the aquifers, based on the water samples collected at the end of air-lift development, ranged from 530 mg/L in the shallow to 890 mg/L in the deep. Total dissolved solids in the medium aquifer is 840 mg/L. The trend of increasing dissolved solids with increasing depth matches the expected trend for recharge from relative low TDS mountain watershed spring runoff. As the recharge water moves downward through the alluvium, the dissolved solids increase with increasing contact time with the alluvial sediments. It is interesting to note that these waters are not as low in dissolved solids as the waters in the BR-1 and BR-2 aquifers. If more spring runoff recharge is coming from the southwest watersheds than any of the other watersheds, then one could expect less dissolved solids in the southwest aquifers.

All of the waters are sodium bicarbonate; however, there are higher concentrations of sulfate and chloride as compared to the aquifer waters in BR-1, BR-2, and BR-4. The shallow aquifer water has especially notable sulfate (150 mg/L) and chloride (85 mg/L) concentrations. Sodium is 155 mg/L and bicarbonate is 227 mg/L in the shallow aquifer. Groundwater from igneous and metamorphic rocks or from sediments derived from them generally contain less than 100 ppm sulfate and may contain much less if sulfate reducing bacteria are active in the soil through which recharge water has percolated (Davis and DeWeist, 1966). However, Bouwer (1978) notes that in arid regions leaching of sulfate from the upper soil layers may be significant.

Iron and manganese concentrations are above their respective SMCL in each aquifer and arsenic is slightly above the MCL in the medium aquifer. These concentrations, however, may be influenced by development which is suspected to be less than complete.

Estimated transmissivity was 0.23 ft^2/min for the shallow aquifer, 0.15 ft^2/min for the medium aquifer, and 0.18 ft^2/min for the deep aquifer. The upper aquifers are nearly as transmissive as those estimated for the upper aquifers in MW-32 (the Intermediate Area) and the lower aquifer is somewhat higher than the lower aquifer in MW-32.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. The alluvial fill is a fairly well sorted, subround, off-white, generally medium to coarse sand.

BR-6

The relative water levels in the BR-6 piezometers suggest confinement of the deep aquifer whereas the shallow aquifer water level may be influenced by nearby agricultural groundwater pumping. The low water level in the medium piezometer, as compared to the other piezometers, is probably not related to pumping because the medium aquifer is under a thick clay section and local pumping is above the clay.

Total dissolved solids in the aquifer water, based on the water samples collected at the end of air-lift development, ranged from 596 mg/L in the shallow aquifer to 481 mg/L in the medium aquifer. Total dissolved solids in the deep aquifer is 540 mg/L.

All of the waters are sodium bicarbonate; however, like the BR-5 aquifer waters, there are higher concentrations of sulfate and chloride as compared to the aquifer waters in BR-1, BR-2, and BR-4. The shallow aquifer water has especially notable sulfate (168 mg/L) and chloride (76 mg/L) concentrations. Sodium is 199 mg/L and bicarbonate is 234 mg/L in the shallow aquifer.

Arsenic is above the MCL and iron and manganese are somewhat above the SMCL in all of the aquifer waters. Aluminum is above the SMCL in the shallow and deep aquifer. As in the other wells, these concentrations may be a function of less than total development.

Estimated transmissivity for the medium and deep aquifers are 0.25 ft^2/min and 0.20 ft^2/min respectively. The unexpectedly low transmissivity in the shallow aquifer is believed to be an artifact of poor development which was probably caused by insufficient air-line submergence during air-lift pumping (see Appendix IV). With full development the estimated transmissivity would probably be 0.20 to 0.25. These transmissivities are essentially the same as those in the Intermediate Area Project wells. However, the total thickness of the BR-6 aquifers is much less than the total thickness in the Intermediate Area.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. A thick clay section, with some sand interbeds, was penetrated from about 370 to 1,700 feet. Above the clay section the alluvial sediment is mostly a light brown, medium to coarse sand. Below the clay section is generally a gray-green, clayey to silty, medium sand.

BR-10

The relative water levels in the BR-10 piezometers are as would be expected near an area receiving recharge from the surface. Head is lost as water moves downward from the surface, therefore the head is highest in the higher elevation aquifer and lowest in the lowest aquifer.

Total dissolved solids in the aquifer water, based on the water samples collected at the end of air-lift development, ranged from 1,330 mg/L in the deep aquifer to 580 mg/L in the medium-shallow aquifer. Total dissolved solids in the shallow aquifer is 1,000 mg/L.

All of the waters are sodium bicarbonate except the medium-shallow aquifer. Like the BR-5 aquifer waters, there are higher concentrations of sulfate and chloride as compared to the aquifer waters in BR-1, BR-2, and BR-4. The shallow aquifer water has especially notable sulfate (225 mg/L) and chloride (176 mg/L) concentrations. Iron and manganese exceed SMCL in the lower aquifers, however, these concentrations may be a function of less than total development.

Estimated transmissivity for the four screened aquifers are (from shallow to deep) 0.19, 0.02, 0.14, and 0.09 ft^2/min respectively. The unexpectedly low transmissivity in the medium-shallow aquifer is believed to be an artifact of poor development which was probably caused by insufficient air-line submergence during air-lift pumping (see Appendix IV). With full development the estimated transmissivity would probably be around 0.20. The shallow and medium-deep transmissivities are similar to those in the Intermediate Area Project wells; however, the total thickness of the BR-10 aquifers is much less than the total thickness in the Intermediate Area.

The mud return formation samples and the drilling character indicate a non-cemented alluvial fill from the land surface to total depth. A thick light gray/green clay section, with some sand interbeds, was penetrated from about 680 to 1,440 feet. Above the clay section the alluvial sediment is mostly a light brown, medium to coarse sand. Below the clay section is generally a medium to coarse sand.

NR-1

The water level in the NR-1 shallow piezometer is higher than the water level in the deep piezometer. Both of these piezometers are screened in thick sand intervals. The water level in the medium piezometer is much higher than the other two piezometers. This interval produced some methane gas during development. The medium piezometer is screened in a relatively thin sand layer in a very thick organic bearing clay section. The high water level in the medium piezometer may be related to gas pressure.

Total dissolved solids of the water pumped from the aquifers, based on the water samples collected at the end of air-lift development, ranged from 2,406 mg/L TDS in the shallow to 3,660 mg/L in the medium. Total dissolved solids in the deep aquifer water is 3,251 mg/L. The deep aquifer quality is the same as in the deep aquifer at NR-2; however, the dissolved solids in the shallow aquifer is considerably higher than in the shallow aquifer at NR-2.

In irrigated arid areas, there can be a significant concentrating effect because plant roots take up only water and thereby concentrate the dissolved constituents in the remain soil water. With continued irrigation this "deep percolation" eventually reaches the water table. If groundwater is the source of the irrigation water, the salt concentration cycle is accelerated. The much higher shallow aquifer TDS may be related to "irrigation concentration". Neal Ranch was irrigated with groundwater for many years. The high TDS in the medium and deep aquifers may be a function of long residence time.

The estimated transmissivity for the lower aquifer is 0.05 ft^2/min. The very low estimated transmissivity from the slug test in the shallow aquifer is believed to be an artifact of poor development which was probably caused by insufficient airline submergence (see Appendix IV). Transmissivity of the shallow aquifer is probably about 0.30 ft^2/min or even a little greater based on the estimated transmissivity of the NR-2 shallow aquifer.

A slug test was not conducted on the piezometer screened in the medium aquifer because there was not enough room inside the outer casing to remove the pressure gauge reducer with readily available tools. During completion, a pressure gauge was installed on the medium piezometer. After several months the pressure dropped to zero and the gauge and all accessory plumbing except the reducer were removed.

A temperature log was run in the deep piezometer on February 12, 1991, one week after the well was pumped for development. The water temperature at the top of the water column (about 100 foot depth) was 73.5 °F and a depth of 1,980 feet (bottom of the piezometer is 1,980 feet), the temperature was 125.2 °F. The rate of temperature increase is about 2.75 °F per 100 feet.

NR-2

The relative water levels in these piezometers is confusing. The head in the deep aquifer is slightly higher than in the medium aquifer and the medium aquifer head is lower than the shallow. The relative water levels between NR-2 and BR-5 suggest very little recharge from the Sierra Nevada watersheds west of BR-5.

Total dissolved solids in the aquifer waters, based on the water samples collected at the end of air-lift development, ranged from 808 mg/L in the shallow aquifer to 3,305 mg/L in the deep aquifer. Total dissolved solids of the water retrieved from the medium aquifer was 1,367 mg/L. The deep water quality is the same as the deep water quality in NR-1. The shallow aquifer water quality is much better than in NR-1 shallow.

The shallow and deep waters are sodium bicarbonate, although sulfate is relatively high in the shallow aquifer. The medium aquifer is sodium sulfate with high bicarbonate, chloride, and nitrate. The high sulfate in the shallow aquifer may have been caused by evaporative concentration from long-term groundwater irrigation. See the discussion under NR-1. Arsenic is the only analyte above a MCL.

Estimated transmissivity for the shallow aquifer is very high, 0.48 ft^2/min. The water level rebounded rapidly during the slug test and displayed an "undampened" response--the water level oscillated above and below the static water level for several cycles. The amplitude of each succeeding cycle rapidly decreased. Figure 6 shows the response of the water level (NR-2 shallow) to the slug test.

The estimated transmissivity of the medium and deep aquifers are 0.14 ft^2/min and 0.12 ft^2/min respectively. These are nearly as high as those estimated for aquifer in the Intermediate Area project wells (BR-4 and MW-32).

A temperature log was run in the deep piezometer on June 5, 1991, three and one half months after the well was pumped for development. The water temperature at the top of the water column (about 140-foot depth) was 74.4 °F and a depth of 1,920 feet (bottom of the piezometer is 1,930 feet) the temperature was 122.5 °F. The rate of temperature increase is about 2.7 °F per 100 feet.

MW-32

The relative water levels in the MW-32 piezometers, and lower water levels in the two medium piezometers, are probably related to Intermediate Area pumping. Only the water levels in the medium-shallow and medium-deep piezometers responded to a nearby 24-hour pumping test in the newly completed District Well #30. The medium-shallow well showed the greatest decline.

The shallow piezometer water level did not respond to the pumping test. Clay horizons between the shallow piezometer and the pumped well screened interval may have isolated the shallow aquifer for the short duration of the test. The water level in the deep well actually rose about one-half foot during the test. This temporary phenomena is called the Noordbergan effect and is cause by dewatering related load redistribution over a semi-confined aquifer.

Total dissolved solids of the water pumped from the aquifers, based on the water samples collected at the end of air-lift development, ranged from 169 mg/L in the medium-shallow aquifer to 526 mg/L in the deep aquifer. Total dissolved solids in the medium-deep aquifer is 176 mg/L and 252 mg/L in the shallow aquifer. These waters are all sodium bicarbonate.

Estimated transmissivity for the two medium aquifers are 0.31 ft^2/min and 0.23 ft^2/min respectively. The deep aquifer transmissivity, 0.11 ft^2/min, is fairly high for an aquifer nearly 2,000 feet deep, although it is about the same as the deep aquifer transmissivity found in wells BR-5, BR-6, and NR-2.

The unexpectedly low transmissivity in the shallow aquifer is believed to be an artifact of poor development which was probably caused by insufficient airline submergence. See Appendix IV for a full explanation of the hypothesis. With full development the estimated transmissivity would probably be 0.20 to 0.30 based on transmissivity estimates for the two medium MW-32 aquifers.

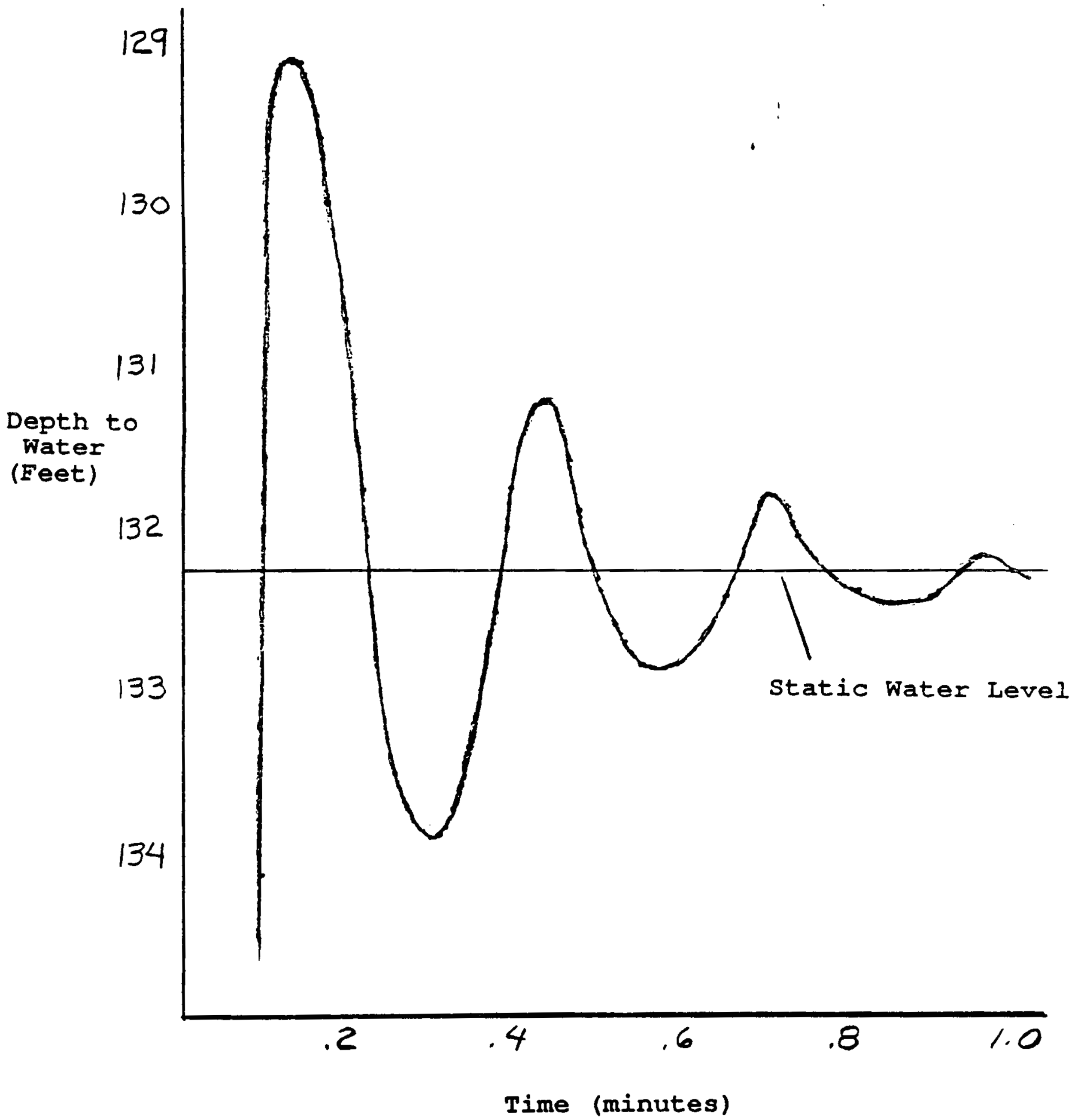

Figure 6. Water level response, in NR-2 shallow, to the pneumatic slug test. Note that the water level recovered to the static water level in about 6 seconds (0.1 minutes). The first recorded depth to water after air release is 147.8 feet at about 0.01 minutes.

WATER TABLE GRADIENTS

The groundwater table gradient is much higher in the higher elevation part of the Southwest Area (wells BR-1, BR-2, and 19D on figure 4) than in the lower elevation part. The gradient between lower Southwest Area wells, such as the Inyo Well and well 8M (one of several Water District test wells in the Inyo well area), and well MW-32 is about 2.5 feet per mile. In comparison, the gradient in the upper Southwest Area from well BR-1 through the Water District's monitoring well 3 [19D] to the Inyo Well area is about 130 to 140 feet per mile. Thus the water table gradient from the Inyo well area to the north and northeast is between one and two orders of magnitude less than the gradient to the southwest. In fact, the gradient in the vicinity of the Inyo Well and the Water District's nearby monitoring wells is virtually flat.

The change in gradient appears to occur just to the west of the Inyo Well (section 7 west of well 8M). By inspection of the water table elevations on figure 4, the break between the steep and relatively flat gradient appears to trend north-northwestward from just west of the Inyo Well to around the mouth of Indian Wells Canyon. This trend is especially suggested by the nearly equal water table elevation between wells 19D and BR-2. Therefore, groundwater elevation contours must trend close to the azimuth between 19D and BR-2.

It has been suggested that the dramatic gradient change in the Southwest Area is related to a fault. Kunkel and Chase (1969) inferred a northwest trending fault about three miles south of Inyokern based on a great increase in groundwater gradient or disparity of water levels between a well about one mile east of BR-2 and the wells around Inyokern. This inferred fault is labeled as a groundwater barrier on their figure 2. If this inferred fault is a hydraulic barrier, the water table gradient near the fault would be relatively flat. Further drilling to explore static water levels and extended aquifer testing in this area will be required to clarify these observations

Estimates of recharge based on the upper Southwest Area gradient, and assuming uniform horizontal flow through an aquifer of uniform hydraulic conductivity, will be much higher than a recharge estimate based on the lower Southwest Area gradient. However, the groundwater elevation differences in the BR-1 piezometers and the much steeper water table gradient in the upper Southwest Area suggest that there is a significant vertical flow component and that flow is not uniformly horizontal.

The apparent gradient between the shallow water level at BR-3 and the wells to the north is essentially the same as the gradient between the Inyo Well area and well MW-32. This could suggest, all other factors being equal, that the recharge from the El Paso Mountains to the south is about the same as the recharge from the Sierra Nevada Mountain basins above the Southwest Area. However, a relatively poor hydraulic connection between the BR-3 area and the pumping center to the north (Intermediate Area) as compared to the connection between the Inyo Well area and the Intermediate Area could cause the water level in the Inyo Well area to drop much more than the BR-3 area in response to the pumping. Furthermore, the recharge from the El Paso Mountains must be much less than that from the Sierra Nevada Mountains because the annual precipitation is not enough to induce a pinyon-juniper woodland on the El Paso Mountains. See the Appendices for a discussion of the relationship between pinyon-juniper woodland, precipitation, and recharge.

The east-west water table gradient through wells BR-5 and the Neal Ranch wells (NR-1 and NR-2) is very low. The gradient is about one-half to one foot per mile depending on the piezometers being compared. This suggests that recharge to the aquifer from the Sierra Nevada Mountain watersheds in the area of BR-5 is relatively low. Relatively high TDS in the aquifers screened by the BR-5 piezometers also suggests relatively low recharge (long residence time); however, the TDS of a May 4, 1993, water sample collected from the lower Sand Canyon surface flow was about 500 mg/L. This may mean that the higher TDS concentration in the water in wells BR-5 and BR-10 is partially or mostly caused by relatively high TDS recharge and only partially by dissolution of the aquifer matrix from long residence time.

In the northwest the horizontal groundwater gradient from BR-10 to BR-6 is about 2.5 feet per mile based on the water level in the BR-10 deep middle piezometer and the BR-6 middle piezometer. The shallow water levels at BR-10 are not used to estimate a horizontal water table gradient because of the large apparent vertical flow component at BR-10. Thus the lower Southwest Area water table gradient and the water table gradient in the northwest is about the same. This suggests that the mountain front recharge from each Area is about the same if the aquifer transmissivities and cross-sectional areas are about the same.

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AQUIFER MODELING

AQUIFER MODELING

INTRODUCTION

The Project participants agreed that there was a need for aquifer modeling, although this task was not in the original Project plan. The desire for a model (actually, adjustments to the USGS model) was based on new data from the Project wells and the timely USGS publication of the report documenting the modeling results from the most recent USGS groundwater model. In addition, the effects of future development scenarios could be examined through time. (Water-Resources Investigations Report 89-4191 by Berenbrock and Martin, 1991)

The USGS San Diego office provided the Project with a copy of all of the data files used in their model and the model code. The generic model code (MODFLOW) was developed by McDonald and Harbaugh in the early 1980's and it has become the standard in groundwater modeling practice.

To develop familiarity with the model, the Yuma office of the Bureau of Reclamation ran the three future development scenarios documented in the USGS report and all of the output matched that of the USGS. Since personnel at the Yuma office have experience with MODFLOW, the Project made arrangements with that office to re-run the USGS model using the data from the Project test wells.

Recharge quantity and distribution and the distribution of aquifer transmissivity are some of the key aquifer related inputs for any groundwater model. Because these distributions are interrelated, the procedure used to develop one distribution will effect the distribution of the other during calibration. During research into the derivation of these model distributions, serious doubt arose about the recharge quantity (seems too high) based on recent developments in estimating and measuring recharge in arid basins. Recharge quantity and distribution is the focus of several recommended post-Project investigations (see the recommendations chapter of this Volume).

Further model development as part of this Project was abandoned because of the questions regarding recharge quantity and distribution. However, recalibration of the Berenbrock and Martin model is recommended subsequent to a period of data collection from the recharge related recommended Project follow-on activities. It is believed that the recharge related activities will yield a much lower estimate of recharge to the Valley and will probably show that almost all of the recharge is from the Sierra Nevada watersheds.

Each of the model distributions is discussed below. The discussion includes the procedure used to develop the distribution, the concern with respect to that distribution, and recommendations, if any, for future investigation. Recharge quantity is probably the only input parameter bearing on the input distributions which is subject to relatively direct measurement. A recently developed technique from Australia appears promising.

PREVIOUS GROUNDWATER MODELS

A two-dimensional mathematical groundwater flow model was developed in 1971 by the USGS (Bloyd and Robson, 1971) to make a quantitative assessment of the geohydrology of the Valley. The alternating-direction implicit method was used to compute the mathematical solution and it was assumed that there were two aquifers in the Valley, one being deep and the other shallow. The verified model was used to generate 1983 water-level conditions in the deep aquifer (Bloyd and Robson, 1971).

In 1980 the USGS, in cooperation with the China Lake Naval Weapons Center (now Naval Air Weapons Station) and the Indian Wells Valley Water District, developed a 10-year plan to study the aquifer system of the Valley (Lipinski and Knochenmus, 1981). One of the objectives of the plan was to collect data that could be used to gain an understanding of the three-dimensional aspects of the deep and shallow aquifers in the Valley. Initial information indicated that the Bloyd and Robson groundwater flow (model) did not adequately represent the three-dimensional flow system (Berenbrock and Martin, 1991).

In 1991, the USGS updated and evaluated the hydrologic data base compiled for the two-dimensional flow model and developed a three-dimensional, two aquifer, groundwater flow model for the Valley (Berenbrock and Martin, 1991). The modeled shallow aquifer, as defined by Kunkel and Chase (1969), extends from China Lake westward to the center of the Valley and from the area south of Airport Lake southward to the community of China Lake. The base of the shallow aquifer was assumed, based in part on geologic and electric logs, to slope from an altitude of 1,950 feet above sea level on the west to an altitude of 1,850 feet on the east beneath China Lake (Berenbrock and Martin, 1991). The deep aquifer includes the total saturated thickness of the alluvium and lake deposits where the shallow aquifer is not present and the alluvium and lake deposits that underlie the shallow aquifer (Berenbrock and Martin, 1991).

RECHARGE QUANTITY

The recharge quantity used in both models is from Kunkel and Chase (1969). Kunkel and Chase estimated the quantity of diffuse groundwater discharge[2] from the China Lake Playa area (discharge equals recharge in a closed basin) by using an empirical method developed by Blaney (1951) and Blaney and Criddle (1949). The Kunkel and Chase assumptions with regard to saltgrass evapotranspiration (ET) and bare soil evaporation (E), as compared to measured diffuse discharge from recent investigations of other playas, are the basis of the concern over the modeled recharge quantity.

Recent investigators note that little detailed information existed before 1985 on diffuse discharge from wet salt desert surfaces. In contrast, many investigators have studied diffuse water losses from agricultural land, dense phreatophyte stands along apportioned rivers, and free-water surfaces in the southwest United States. Ullman (1985) lists various techniques that have been used to estimate the rate of evaporation from vegetation and from bare soil and sediment surfaces. These include empirical techniques relating evaporation to average climatic factors (Thornthwaite, 1948; Blaney and Criddle, 1950), energy budget calculations (Penman, 1948; Van Bavel, 1966), and extrapolation from free-surface evaporating pans (Gray, 1970).[3] Ullman notes that in arid and semi-arid environments these techniques may greatly overestimate the true rate of evaporative loss.

Since groundwater discharge is equal to groundwater recharge in a closed basin, recharge quantity can be determined by measuring or estimating groundwater discharge. Prior to the advent of European settlement in the Valley, groundwater discharge from the main water body occurred principally by ET and in very small part by underflow to Salt Wells Valley (Kunkel and Chase, 1969). Evapotranspiration, the combined processes of evaporation from moist soil and transpiration of plants, identified as phreatophytes, whose roots draw from groundwater or the capillary fringe, occurs in the eastern part of the Valley in the vicinity of China Lake.

Kunkel and Chase (1969) estimated that the total diffuse groundwater discharge from the China Lake playa area was 11,000 acre-feet/year in 1912 and 8,000 acre-feet/year in 1953. These rates were derived by applying an

[2] This is evaporation from free water and nonvegetated surfaces and evapotranspiration (transpiration from vegetation and evaporation from surrounding nonvegetated surfaces) from vegetated areas.

[3] The authors given by Ullman (1985) are not listed in the references at the end of this chapter.

evaporation and evapotranspiration rate to various classifications of moist land in and around China Lake. The classifications were based on bare soil surface texture, surface moisture, alkali presence and expression, and vegetation density.

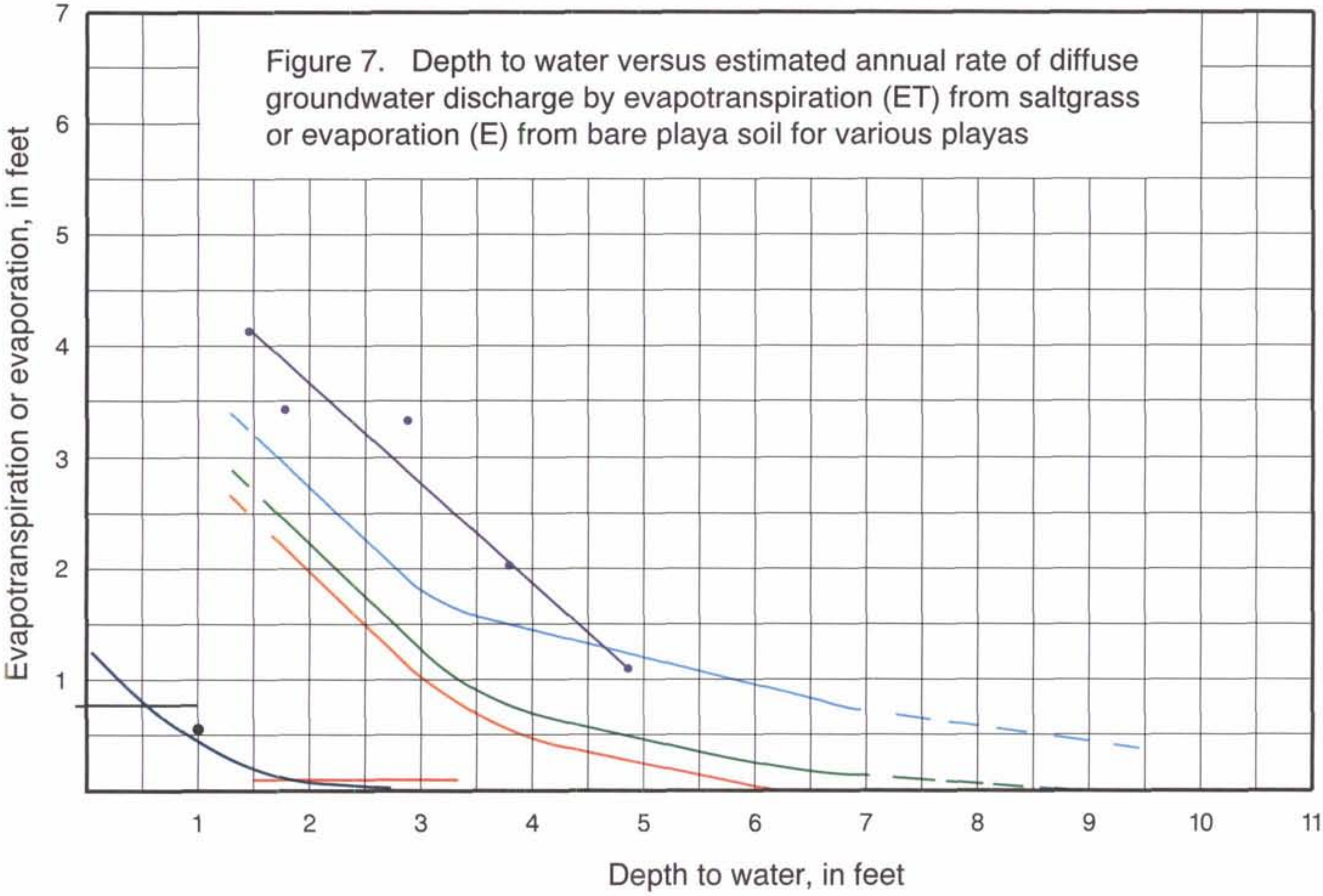
A curve of estimated evapotranspiration (consumptive use) versus depth to groundwater was made for 100 percent saltgrass cover by using the empirical equation developed by Blaney and Criddle in 1949 and Blaney in 1951[4]. The consumptive use coefficients for dense (100 percent) saltgrass growth were suggested by Blaney. A curve for 25 percent saltgrass (or pickleweed) cover and for fine-grained bare soil was estimated based on the curve for 100 percent saltgrass cover. Figure 7 shows each of these curves. Also shown is a line through the data points from Young and Blaney (1942) [as reported by Robinson (1958)] showing annual evapotranspiration of water by saltgrass grown in tanks in Owens Valley.

Recently published measured evaporation rates from bare soil on other playas [Malek and others (1990), Allison and Barnes (1985), and Ullman (1985)] are much lower for the depth to groundwater than the bare soil evaporation estimates of Kunkel and Chase. These measured rates are based on relatively direct measurement techniques developed over the last decade. Appendix II, gives a detailed account of recently developed, relatively direct methods of measuring diffuse discharge. A trial of the Ullman (1985) method on China Lake Playa is included as one of the recommended Project follow-on investigations.

RECHARGE DISTRIBUTION

Distribution of recharge is one of the most important inputs in a groundwater model. In some groundwater models of desert basins, recharge distribution is based on flow data from stream gauges which can be used to calculate transmission loss from streams draining the surrounding mountains. Transmission loss from streams, usually ephemeral, is the predominant source of natural recharge to southwest desert valleys lacking a through-flowing stream. In some models recharge distribution may be based on precipitation

[4] This is the same technique mentioned above by Ullman (1985) although the publication dates are different. Blaney and Criddle published a number of papers on applying essentially the same empirical technique to different types of vegetation. Ullman referenced their 1950 paper "Determining water requirements in irrigated areas from climatological and irrigation data." Kunkel and Chase (1969) used their 1949 paper "Consumptive use of water in the irrigated areas of Upper Colorado River Basin" and the 1951 paper by Blaney "Consumptive use of water."



100 Percent Saltgrass Cover

Indian Wells Valley rate from Kunkel and Chase (1969).

Annual evapotranspiration of water by saltgrass grown in tanks in Owens Valley (Young and Blaney [1942] as reported by Robinson [1958]).

25 Percent Saltgrass Cover

Indian Wells Valley rate from Kunkel and Chase (1969).

Bare Soil with Salt Crust

Indian Wells Valley rate from Kunkel and Chase (1969).

Estimated annual evaporation of subsurface water is 0.75 feet (229 mm) from salt crust on Pilot Valley playa (western Utah) using the Bowen ratio method to reduce data from a microclimate station. (Malek and others, 1990).

• Estimated mean whole-lake evaporation rate from Lake Frome (northeastern South Australia) is 0.56 feet/year (170 mm/yr) with a water table at about 1 foot (about 300 mm). Estimate based on depth profiles of deuterium delta-values to about 3 feet. (Allison and Barnes, 1985).

Maximum annual evaporation rate (0.19 feet) from salt crust on Owens Lake. Derived by multiplying the maximum reported daily rate (.0063 inches/day), based on salt flux, by 365. Maximum daily rate (.003 inches/day) from the evaporimeter [non-weighing lysimeter] was about 1/2 the salt flux rate. Lake-bed clays at this site are overlain by 12 to 24 inches of hard and largely insoluble salts. (Cochran and others, 1988).

Diffuse discharge measured from salt pans with shallow water tables. Data from: Allison and Barnes (1985), Jacobson and Jankowski (1989), Malek and others (1990), and Woods (1990). [Thorburn and others, in press].

distribution which is determined from precipitation gauges in the mountain front watersheds surrounding the modeled valley. In Indian Wells Valley, however, none of the mountain front streams are gauged nor are there any precipitation gauges outside the Valley floor. Without any gauge data, some other basis must be devised to distribute recharge in a groundwater model of the Valley.

Bloyd and Robson (1971), the first Indian Wells Valley groundwater modelers, started with an assumption that natural recharge is directly proportional to watershed area above 4,500 feet in the Sierra Nevada and 5,000 feet in the Coso and Argus Ranges. This yielded 102 square miles of recharge contributing watershed area in the Coso and Argus Ranges and 88 square miles in the Sierra Nevada. This recharge apportionment resulted in too much recharge emanating from the Coso and Argus Ranges and too little recharge from the Sierra Nevada. A simple trial-and-error process was then used to make changes in recharge values until the head configuration determined by the model was in agreement with the 1920-21 water-level contour map drawn from available water-level measurements (Bloyd and Robson, 1971).

Unfortunately, Bloyd and Robson (1971) are not clear about the transmissivity distribution used in the recharge distribution trial-and-error runs. They state,

> "Initial estimates of transmissivity and storage coefficient[s] for the aquifers were made by L.C. Dutcher and W.R. Moyle, Jr. (written commun., 1970). Refinements of the estimates were made during verification of the model."

Bloyd and Robson probably made the recharge trial-and-error runs after the transmissivity refinements, because if they made the recharge trial-and-error runs before refinement (with the Dutcher and Moyle transmissivity estimates) then transmissivity refinements would not be needed--the recharge (trial-and-error) would be adjusted until steady-state model water levels matched measured water levels. If this is what they did, then on what recharge distribution were the transmissivity refinements based? This is a critical question because transmissivity distribution and recharge distribution are interrelated; changes in one distribution necessitate changes in the other to match measured water levels (calibration). Furthermore, the Berenbrock and Martin (1991) transmissivity distribution is dependent on whatever process Bloyd and Robson used because they fixed the Bloyd and Robson gross recharge distribution (for the Sierra Nevada and for the Coso and Argus Ranges) in their model and then adjusted the transmissivity distribution for calibration to water levels.

The recharge from the Coso and Argus Ranges appears to be overestimated in both of the models. St. Amand (1986) notes the following below his figure 11,

> "Figure 11 shows the water-level contours that are calculated by the mathematical model of Bloyd and Robson (1971) and are compared to the depth of water as shown in several wells. Wells 1K1, 6A1, and 22N1 show water at a considerably greater depth than the model indicates the water should be. The hydraulic gradient is only about 9 feet in over 8 miles. Considering the low transmissivity of the sediments, little or no water appears to be flowing from the Coso Basin into China Lake Basin."

Berenrock and Martin (1991) note the same in *their model.*

> "Because few data are available in the northern part of the Valley, the recharge and transmissivity distribution determined by Bloyd and Robson (1971) for this area was used in the model with only slight modifications. However, model-simulated hydraulic heads in this part of the model are higher than available measured water levels (table 7); thus, these input data may be in error. Several steady-state and transient-state simulations were run to determine the effect on the model-simulated heads of decreasing the quantity of recharge originating along the Coso and Argus Ranges. The simulations with lower recharge rates more closely match the observed water levels (table 7). Lower recharge rates along the Coso and Argus Ranges, however, have little impact on the model-simulated hydraulic heads in other parts of the model (table 7)."

The lower Coso and Argus Range recharge (between 1,585 and 792 acre-feet per year) confirms the Kunkel and Chase (1969) qualitative description of recharge distribution. They stated,

> "The largest increment of recharge for Indian Wells Valley is derived from the east slopes of the Sierra Nevada, west and southwest of Inyokern, where the heaviest precipitation in the area occurs. Second in importance are the steep fans and escarpment of the Sierra Nevada northwest of Inyokern, where the catchment area is smaller and the quantity of precipitation is less. A third increment, probably small, is derived from Rose Valley through a narrow channel at Little Lake. A very small quantity of recharge reaches the main water body from the Argus Range, but the quantity is small because of the small amount of precipitation in that area. Other very minor quantities are derived from Coso Basin and the El Paso Mountains.

Based on all of the above it seems clear that recharge distribution in future groundwater models of the Valley aquifer should be based on some procedure which is independent of models.

POTENTIAL RECHARGE DISTRIBUTION METHODS

The author investigated several potential methods for distributing recharge or mapping "recharge potential" based on the premise that most, if not all, of the natural recharge is from winter precipitation runoff. A number of authors (Simpson et al., 1970; Gallaher, 1979; and Mifflin, 1968) have suggested that mountain-front recharge in the southwest is a function of winter precipitation only.

The methods investigated included average annual "snow-pack" distribution, winter precipitation distribution based on long period National Oceanic and Atmospheric Administration (NOAA) atmospheric model runs for the proposed Yucca Mountain high level nuclear waste repository, isotope distribution in the aquifer (isotope sampling is recommended as a Project follow-on activity), and pinyon-juniper area in the recharge watersheds. Lack of snow-pack data and the extremely coarse grid in the NOAA model eliminated the first two potential methods. Isotope distribution may have some potential and is described in a University of Arizona M.S. thesis by Gallaher (1979) titled "Recharge properties of the Tucson Basin aquifer as reflected by the distribution of a stable isotope." The hypothesis that the percentage of pinyon-juniper in a given watershed, as compared to the total pinyon-juniper area in all watersheds, may be related to the recharge percentage from that watershed may have some merit (see the chapter on recommended post-Project activities). The method is summarized below and is fully developed in Appendix I.

WATERSHED VEGETATION DISTRIBUTION

Recharge distribution using vegetation distribution is based on the premise that some plant specie in the recharge watershed is in equilibrium with an average long-term[5] moisture availability and that the moisture availability is proportional to recharge. Pinon and juniper was selected as the indicator plant specie based on the authors perception that the distribution of pinon and juniper woodlands is similar to the distribution of areas which receive some snow almost every year.

[5] Changes in specie distribution and density may lag many decades behind long-term atmospheric changes. However, it is assumed that any change in long-term moisture availability will affect the specie distribution and density in all watershed areas equally.

The percentage of the total recharge from a given watershed is assumed to be the same as the percentage of the total watershed pinon-juniper acreage in that watershed. Using this method and assuming the total recharge is 9,850 (used in both models), the annual recharge from the Coso and Argus Ranges is 975 acre-feet, or 10 percent of the total recharge. Berenbrock and Martin (1991) note in their table 7 that a Coso and Argus Range recharge between 1,585 and 792 acre-feet per year makes the best fit with measured water levels. This also agrees with the Kunkel and Chase (1969) qualitative description of recharge distribution noted at the end of the "Recharge Distribution" section above. The general agreement with these recharge distributions and the potential relationship between watershed soil moisture distribution (predominant factor in pinyon-juniper distribution) and recharge distribution would seem to lend some credence to this method.

CALIBRATION/VERIFICATION

Berenbrock and Martin used all of the available water level record (1920-1985) for their transient-state calibration. By using all of the record for calibration, none is left to test the predictive accuracy of the model. The predictive ability of a model can be tested by dividing the available water level record into two parts--the first part is used for transient-state calibration and the later part is for comparison to predictive model runs over the later time period. Predictive tests were not run in the Bloyd and Robson model. Transient state calibration eliminates the need to reduce Valley margin transmissivities far below known values as is require for steady state calibration to historic water elevations. This is necessary because mountain front recharge flow is probably accommodated by much less than the full aquifer thickness.

RECOMMENDATIONS FOR FUTURE MODELING

Transient state "recalibration" of the Berenbrock and Martin model is recommended subsequent to a period of data collection from the recharge related recommended Project follow-on activities (see the recommendations section). These recharge related activities are intended to refine recharge distribution and total recharge. There is some evidence that the empirical method used by Kunkel and Chase may have overestimated playa area evapotranspiration (this discharge is assumed to equal recharge). In addition, the response of the MW-32 piezometers to the pumping of District Wells 30 and 31 may suggest some reconfiguration of the model.

The Berenbrock and Martin model can be used without recalibration to predict drawdowns in areas where the model transmissivity compares well with measured transmissivity, if data from the recommended recharge related activities indicate that total recharge and distribution is similar to that used in the model. Apportioning the measured transmissivities from the screened intervals of the Project wells over the full saturated thickness indicates a much higher transmissivity than that modeled along the western margin of the Valley.

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RECOMMENDATIONS FOR FUTURE ACTIVITIES AND STUDIES

RECOMMENDATIONS FOR FUTURE ACTIVITIES AND STUDIES

INTRODUCTION

The following recommendations are offered for consideration as follow-on activities to the Indian Wells Groundwater Project after Reclamation ends its formal involvement. Regardless of the actual follow-on activities with respect to those recommended, it is believed that periodic meetings of the subcommittee would be mutually beneficial to the respective participating entities because "formal" contact might induce greater interaction than might otherwise occur.

WATER QUALITY ANALYSES

Additional water samples should be taken from most, if not all, of the Project piezometers for another Title 22 analysis. Some constituent concentrations in some of the air-lifted samples collected at the end of development suggest less than full development. The constituent concentrations exceeding regulatory limits may fall below those limits with further pumping. The new samples should be collected from a relatively steady discharge, positive displacement pump after electrical conductivity, pH, and temperature have stabilized. This will assure that the sample is reasonably representative of the aquifer water and reduce the uncertainty about any anomalous constituent concentrations. Consistency in constituent concentrations over several sampling episodes would instill even more confidence that the samples are representative.

WATER LEVEL MEASUREMENTS

Water levels in the Project piezometers have been measured every 1-2 months during the course of the Project. It is recommended that this measuring frequency continue for the next one to two years. Long-term water elevation plots (hydrographs) for Project wells near the Sierra Nevada may yield insight into what appears to be relatively narrow recharge flow paths.

Water level declines in the four BR-1 piezometers have been especially intriguing and may represent the ebb of a recharge pulse from the southwest watersheds. From April 9, 1991, to May 18, 1992, the water level has dropped almost four feet in the shallow piezometer and over 16 feet in the shallow medium piezometer. The decline has been nearly 15 feet in the medium deep piezometer and a little over 13 feet in the deep piezometer. Over the same time period the water levels in BR-2 have dropped only 0.1 feet in the shallow piezometer and 0.5 feet in the deep piezometer. Several of the water district's southwest monitoring wells have been added to the water level measuring itinerary in order to better define the areal pattern of water level changes.

Frequency of measurement is problematic and could be adjusted based on recorded water level changes. More frequent measurements may be desirable some time after (unknown lag time) a period of significant winter rainfall, such as 1986, or after a heavy snow winter and wet spring. Any change in BR-1 measuring frequency should be accompanied by the same frequency at the southwest monitoring wells. The BR-10 piezometers may also warrant extra attention if water level changes appear significant. Some consideration could be given to maintaining the same personal and equipment for the follow-on water level measurements.

WATER LEVEL MONITORING

Frequent water-level measurements in the four MW-32 piezometers during the first year of pumping from District Wells 30 and 31 could yield insight into short term aquifer dynamics. Response of the shallow and deep piezometer would be especially interesting. During a recent 24-hour pump test of Well 30, the water level in the shallow piezometer did not seem to respond (the transducer may have been set too deep) and the water level in the deep piezometer rose during the test (Noordbergen Effect). Long-term response of the deep aquifer is of interest because the total dissolved solids in the water is more than twice that of the intervals screened by the upper three piezometers. The initial and long-term water level responses in these piezometers would probably make an excellent model calibration set.

The water level in all of the Neal Ranch piezometers should be monitored if one of the Neal Ranch wells is pumped for a 30-day test as has been suggested. A data logger is probably the most efficient method for recording water levels. The Denver Office (Reclamation) data logger could be used; however, scheduling might be a problem for a 30-day test.

WATER SAMPLING FOR ISOTOPE ANALYSIS (Age Dating)

Groundwater can be age dated from a complete isotopic analysis of the water. Isotope analyses may indicate that recharge is confined to relatively narrow flow paths as the relative water level changes in BR-1 and BR-2 seem to suggest. If this is the case, then recharge estimates based on uniform flow through an aquifer cross-section, such as in the southwestern part of the Valley, will overestimate recharge. Because of the recharge delineation potential, the wells of most interest for isotope analysis sampling would probably be those closest to the mountain front recharge watersheds. This would include wells BR-1,2,3,5,6, and 10.

The Naval Air Weapons Station Geothermal Office plans to collect water samples from some of the Project wells for isotope analysis sometime in 1993. If the Navy's sampling plan does not include wells of interest to the other Project participants, consideration should be given to a financial contribution from the other participants to allow more sampling. The marginal cost of increasing the sampling scope should be relatively small.

Carbon 14 and tritium are the common isotopes used for dating groundwater. The carbon 14 content of plants, animals, water and anything else that reacts directly or indirectly with atmospheric carbon 14 will be essentially constant so long as the material is active and in equilibrium with the atmospheric CO_2. When the material is cut off from the atmospheric CO_2 pool, as by percolation to aquifers for water, the material is no longer in equilibrium with atmospheric CO_2. After that, its carbon 14 content will gradually decrease because of radioactive decay of carbon 14 and lack of replenishment with atmospheric carbon 14. The amount of carbon 14 remaining in the material in relation to the original concentration of carbon 14 when it was cut off from the atmosphere is an indicator of the time elapsed since the cutoff. Carbon 14 can be used to date groundwater to about 30,000 years (Bouwer, 1978).

Tritium is sometimes used to date young groundwater because it has a half-life of 12.4 years. It occurs as a natural isotope in the atmosphere. However, the amount of atmospheric tritium was greatly increased by atmospheric testing of nuclear weapons, starting about 1954. If groundwater is free of tritium, its last exposure to the atmosphere was before 1954. Significant tritium indicates fairly young groundwater (Fetter, 1980).

RECHARGE INVESTIGATIONS

Several recent developments in estimating and measuring desert basin recharge suggest that the estimated recharge to the Valley (around 10,000 acre-feet per year) may be too high by a factor of two or more. The initial suspicion regarding recharge was prompted by periodic observation of spring runoff during 1992 in several Sierra Nevada watersheds. A suite of reasonable fabricated runoff hydrographs fitting the few visual flow estimates for each watershed all suggest an annual base flow, assuming all base flow recharges the aquifer, far less than the recharge estimated for the watershed (based on its percentage of the total watershed area recharging the Valley and assuming a total annual recharge of 9,850 acre-feet). The following recommended recharge investigation techniques begin with an empirical estimating method and progress toward increasingly direct measurement. Preliminary indications related to each of the recharge investigation techniques suggest that the recharge estimate of about 10,000 acre-feet per year is too high.

Maxey-Eakin Method for Estimating Recharge

Application of the Maxey-Eakin method to the Valley is recommended as the first step in re-evaluating the Kunkel and Chase (1969) based recharge estimate. The Maxey-Eakin method for estimating recharge to a groundwater basin was developed by G. B. Maxey and T. E. Eakin between 1947 and 1951 and has been applied to over 200 basins in Nevada and other western states (Avon and Durbin, 1992). The Maxey-Eakin method is based on a direct relationship between precipitation and recharge. Avon and Durbin (1992) describe the application of the Maxey-Eakin method as follows: (1) estimating the mean annual volumes of precipitation within several precipitation zones for the drainage basin, (2) scaling these volumes by a factor [Maxey-Eakin coefficients] representing losses from evapotranspiration and surface-water runoff that does not become groundwater recharge, and (3) summing the resulting recharge volumes to obtain an estimate of total recharge to the groundwater basin.

The Maxey-Eakin method fell from favor in the mid-1970's as a recharge estimating method in the Great Basin based on the work of Watson and others (1976). However, the most recent investigation by Avon and Durbin (1992) concluded that the Maxey-Eakin method is a fairly reliable predictor.

Watson and others (1976) performed multiple-linear regressions to determine the individual Maxey-Eakin coefficients based on water-budget discharges for 63 basins as the dependent variable (Avon and Durbin, 1992). The method was then judged to be suspect based on the 95 percent confidence interval associated with each individual Maxey-Eakin coefficient computed by regression.

Avon and Durbin (1992) suggest that the overall predictive reliability of the Maxey-Eakin method is a more important indicator of the methods usefulness than the individual confidence intervals for each coefficient. To evaluate the method, Avon and Durbin (1992) compared Maxey-Eakin recharge estimates with water budget recharge estimates from 40 basins and with model based recharge estimates from 27 basins. For the group of 40 water-budget estimates the coefficient of variation of the Maxey-Eakin estimate is no greater than 44 percent. For the group of 27 model estimates the coefficient of variation is no greater than 25 percent (Avon and Durbin, 1992).

Bredenkamp (1990) also concluded that an empirical relationship between precipitation and recharge provides reasonably good estimates of recharge. Bredenkamp compared recharge estimates for 14 basins in South Africa, primarily from water balances, groundwater models, and chemical mass balances, to estimates based on an empirical relationship.

The Maxey-Eakin method will probably estimate 2-3,000 acre-feet per year as the recharge to the Valley.

Watershed Investigations for Estimating Recharge

Base flow gauging in the lower mountain valley section of several watersheds is recommended to help refine the estimate of recharge to the Valley and its distribution. Previous recharge estimates can be compared to actual average annual base flow, most of which probably becomes recharge, from the gauged watersheds. In addition, the average annual base flow may correlate with some watershed attribute and allow a better estimate of recharge from the non-gauged watersheds. As previously noted, the base flow from several Sierra Nevada watersheds during the spring of 1992 appeared to be much lower than that needed to match the recharge estimate for the watershed used in the groundwater models of the Valley.

Canyon constrictions formed by bedrock just upstream of the alluvial fan apex are ideal locations for base flow gauging. The bedrock constriction forces most of the water draining from the watershed to the surface for measurement and most of the base flow probably recharges the aquifer when it reaches the alluvial fan apex. Perennial flow in Sand Canyon at the lower wilderness study area boundary indicates a bedrock constriction which probably allows little underflow. This location appears to be ideal for gauging.

Gauging on Canebrake Creek (Kern River watershed, west side of the southern Sierra Nevada drainage divide) could be considered if there is a lack of relatively good gauging locations in the Sierra Nevada watersheds recharging the Valley. Canebrake Creek would offer the same potential for correlating average annual base flow with some watershed attribute, but it obviously would not help in refining recharge to the Valley. The southern gauged streams captured by the Los Angeles Aqueduct may offer further opportunities for correlation of base flow to some watershed attribute. The Haiwee Spring area may offer a gauging opportunity for Coso Mountain runoff if it is a barrier type spring.

The USGS is probably a good source for ideas on the type of gauge best suited to the requirements. In addition, they could estimate annual monitoring costs based on their experience. They may also have ideas for monitoring if the Valley interests want to monitor the stations. Weekly staff gauge readings might be sufficient for base flow hydrographs.

Playa Investigations for Estimating Recharge

Relatively direct measurement of current and historic bare ground China Lake playa evaporation, using the Allison and Barnes (1985) method, is recommend for comparison to the Kunkel and Chase (1969) empirical estimates. The estimate of average annual recharge to the Valley (about 10,000 acre-feet) used for the last two decades is based on the Kunkel and Chase empirical estimate of average annual China Lake playa area evapotranspiration. An estimate of playa area evapotranspiration is an estimate of recharge in a closed basin because discharge (playa area) equals recharge under equilibrium conditions. One of the Kunkel and Chase evapotranspiration estimates is based on depth to water under the playa before groundwater development in the Valley, when recharge and discharge were assumed to be in equilibrium.

Recent measured evaporation rates from bare soil on other playas seem low for the depth to groundwater when compared to the China Lake Playa estimates of Kunkel and Chase (1969). Ullman (1985) notes that the empirical technique used by many investigators may greatly overestimate the true value of evaporative loss from the water table in arid and semi-arid environments.

The playa soil core method, developed in Australia, seems to offer a relatively quick and easy method of determining historic playa evaporation. Allison and Barnes (1985) estimated diffuse groundwater discharge (evapotranspiration) from Lake Frome (playa) in northeastern South Australia based on depth profiles of deuterium delta-values to about 3 feet depth. The average depth to water was about one foot and the soil at several of the measurement sites was covered with a 0.20 inch (5 mm) salt crust. The estimates of diffuse groundwater discharge from the five sites ranged from 0.29 to 0.75 ft/yr. They noted that the estimated rate consistently decreased with increasing depth to water.

Weighing lysimeters, the only direct method of determining bare ground evaporation, may offer an alternative to the soil core method. However, for comparison to the Kunkel and Chase estimate, the lysimeters could only be installed in areas of the playa with the same depth to water as the 1953 water level used by Kunkel and Chase. The Desert Research Institute has recently developed a relatively simple weighing lysimeter (Tyler[6], pers. commun.).

Further investigation of diffuse discharge may be deemed desirable based on the results of the initial testing and playa groundwater depths. Microclimate

[6] Scott Tyler is an Assistant Research Soil Scientist with the Water Resources Center of the Desert Research Institute in Reno, Nevada.

stations would probably be best suited to long-term monitoring of bare soil evaporation and evapotranspiration from playa fringe phreatophytes.

RECOMMENDATIONS FOR FUTURE MODELING

Transient state recalibration of the Berenbrock and Martin model is recommended subsequent to a period of data collection from the recharge related recommended Project follow-on activities noted above. It is believed that the recharge related activities will yield a much lower estimate of recharge to the Valley and will probably show that almost all of the recharge is from the Sierra Nevada watersheds. In addition, the response of the MW-32 piezometers to the pumping of District Wells 30 and 31 may suggest some reconfiguration of the model.

The Berenbrock and Martin model can be used without recalibration to predict drawdowns in areas where the model transmissivity compares well with measured transmissivity. Apportioning the measured transmissivities from the screened intervals of the Project wells over the full saturated thickness indicates a much higher transmissivity than that modeled along the western margin of the Valley.

REVIEW OF SUBSIDENCE POTENTIAL

The extensive layer of clay in the northwest part of the Valley raises the potential for surface subsidence resulting from groundwater withdrawal in excess of recharge. Additional consideration should be given to this potential and its possible magnitude.

The thick clay section discovered by the Project in the northwest is cause for concern because groundwater pumping in other areas has induced compaction of clayey deposits. Subsidence is due to the compaction of the water-yielding deposits as the intergranular effective stresses increase (Lofgren and Klausing, 1969). The magnitude and rate of subsidence are directly related to the change in effective stress within the various compacting beds that results from water-level changes and the thickness and compressibility of the compacting deposits.

Based on the effective stress diagrams in Lofgren and Klausing (1969) and the general lack of compressible clayey units in the water table aquifer above the thick clay section, and assuming perfect confinement of the lower aquifer below the thick clay section, it appears that little or no subsidence would be induced if the water table above the thick clay in the northwest is significantly lowered.

However, if the piezometric head in the confined aquifer declines with the drop in the water table aquifer, due to less than perfect confinement, the effective stress throughout the section will increase. The magnitude of subsequent subsidence would depend on the decline in water table, drop in piezometric head, and the thickness and compressibility of the compacting deposits. The subsidence could be several feet or more.

These interpretations should be reviewed as a part of the analysis of the impact of pumping water from the northwest.

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SECTION B - FUTURE WATER REQUIREMENT PROJECTIONS

PREFACE

Material in this Section was originally prepared in September 1990. Data on estimated future water demands provided by local entities were based on information available through the late 1980's. At the time the Indian Wells Valley Groundwater Project was completed in December 1993, the high population growth rates of the 1980's had moderated and groundwater pumping for agricultural use had not expanded as anticipated several years earlier.

Those conditions led to consideration of revising the future water demand projections presented in this section. The decision was made to leave the projections as originally estimated. There were two dominant reasons for this decision:

- The current turndown in population growth is only a recent condition with minimal information on either the potential size or duration of the downturn and, therefore, whether or not the lower growth rate will constitute a future trend.

- Since it is uncertain at this time whether or not the current growth rate reduction is only a temporary phenomenon or the start of a long term situation, maintaining the original future water demand estimates constitutes either a reasonable or conservative projection.

As the future agricultural pumping and population growth develops, water use projections should be adjusted and their impacts on future water development should be re-evaluated.

It should also be noted that since completion of this Section in September 1990 names for two of the local entities have changed. Kerr-McGee Chemical Corporation sold its Trona operation to North American Chemical Company and as part of a major reorganization, the Naval Weapons Center became the Naval Air Weapons Station.

WATER REQUIREMENTS

Water Requirements

The following is based on available information. Local water users have furnished historical and future water use data. In several cases this information is limited or incomplete. The purpose of this section is to assemble the information so that it is easily understandable and can be used in the formulation of Project alternatives and designs.

Historical Water Use

Available data were analyzed in an attempt to gain insight about area water needs. The primary water users were Naval Weapons Center; Kerr-McGee Chemical Corporation; Indian Wells Valley Water District; Antelope Valley Water Company (Inyokern); Wilbur Stark Water Company; Louisiana Pacific Lumber Company; Ridgecrest Heights Water Company; several irrigated farms including Brown Road Farming Company (formerly Circle M), Spike Leroys Ranch and Neal Ranch and several hundred operators of individual wells. In many cases, little or no data are available about historical water use. Attempts have been made to estimate past annual use in the Indian Wells Valley by St.-Amand, 1986, and others. These overall estimates of water pumped range from 21,000 acre-feet to over 30,000 acre-feet annually. No attempt will be made in this section to estimate the overall historical pumping in the Valley because of the missing data and conflicting information. The available historical water use data, however, can provide valuable insights to expected water use.

The following presents and discusses the available historical data:

Naval Weapons Center

The following historical data were furnished by Michael Stoner, Naval Weapons Center, China Lake, California. It can be seen that water use has decreased and is now relatively constant at about 4,400 acre-feet per year. The decrease was probably due to the resident population shift to the city of Ridgecrest.

YEAR	ACRE-FEET
1978	5200
1979	5173
1980	4809
1981	4751
1982	4427
1983	4454
1984	4313
1985	4268
1986	4430
1987	4591
1988	4311
1989	4135

Kerr-McGee Chemical Corporation

Kerr-McGee pumps water from the Indian Wells Valley to supply not only their industrial process in the nearby Searles Valley, but the town of Trona as well. This water use has been listed under the name Searles Valley Water Users in other reports: e.g., St.-Amand, 1986. The following historical information was supplied by Michael Stoner, Naval Weapons Center, China Lake, California, and from the Kerr-McGee Chemical Corporation:

Year	Acre-Feet
1975	2781
1976	2911
1977	3315
1978	3081
1979	3081
1980	2887
1981	3065
1982	2887
1983	2476
1984	2307
1985	2397
1986	2557
1987	2560
1988	2560
1989	2320

Indian Wells Valley Water District

The Indian Wells Valley Water District was originally formed as the Ridgecrest County Water District in 1955. It was to provide water to the city of Ridgecrest and the surrounding area (Krieger and Stewart, 1990). Ridgecrest Heights Water District (previously known as the Wilbur Stark Water Company) is now a part of the Indian Wells Valley Water District. Historic water production and consumption is shown in tables 1 and 2 (Krieger and Stewart, 1990). Note that Ridgecrest Heights Water District water use is excluded from some of the quantities in these tables. The Wilbur Stark Water Company (later the Ridgecrest Heights Water Company) used 993 and 1,700 acre-feet in 1980 and 1984, respectively (St.-Amand 1986). Ridgecrest Heights Water Company was acquired by the Indian Wells Valley Water District in 1987 or 1988.

TABLE 1
INDIAN WELLS VALLEY WATER DISTRICT
DOMESTIC WATER SYSTEM
HISTORIC WATER PRODUCTION AND CONSUMPTION

YEAR	AVERAGE SERVICE CONNECTIONS (EA)	POPULATION SERVED[1] (PERSONS)	PRODUCTION (AF)	CONSUMPTION (AF)	PRODUCTION CONSUMPTION RATIO	PRODUCTION UNIT AF/CONN	PRODUCTION PER CAPITA AF	PRODUCTION PER CAPITA GPD
1965	1,730[2]	6,200	1,300	1,100	1.182	0.75	0.21	190
1970	2,220[2]	8,000	1,900	1,600	1.188	0.86	0.24	210
1975	3,480[2]	12,500	2,800	2,500	1.120	0.80	0.22	200
1980	4,860[2]	17,500	3,820	3,820	1.000	0.79	0.22	190
1981	5,080[2]	18,300	4,220	3,900	1.082	0.83	0.23	210
1982	5,210[2]	18,800	3,960	3,860	1.026	0.76	0.21	190
1983	5,430[2]	19,500	4,320	4,090	1.056	0.80	0.22	200
1984	5,730[2]	20,600	4,940	4,310	1.146	0.86	0.24	210
1985	6,010	21,600	4,980	4,440	1.122	0.83	0.23	210
1986	6,840	24,600	5,900	5,750	1.026	0.86	0.24	210
1987	8,540	30,700	7,390	6,440	1.148	0.87	0.24	210
1988	9,210	33,200	7,900	6,290	1.256	0.86	0.24	210

[1] 1985 GENERAL PLAN AMENDMENT

[2] ESTIMATED BASED ON 3.6 PERSONS PER AVERAGE SERVICE CONNECTION

TABLE 2
INDIAN WELLS VALLEY WATER DISTRICT
DOMESTIC WATER SYSTEM
HISTORIC MONTHLY PRODUCTION
1985 THROUGH 1988

	1985		1986[1]		1987[1]		1988		1985 - 1988		% OF AVERAGE MONTHLY PRODUCTION
MONTH	AF	%	AF	%	AF	%	AF	%	AF	%	
JANUARY	213	4.28	256	4.34	235	3.65	288	3.61	992	3.92	47.05
FEBRUARY	222	4.46	233	3.95	279	4.33	394	4.94	1128	4.46	53.50
MARCH	256	5.14	369	6.26	391	6.07	468	5.86	1484	5.87	70.39
APRIL	447	8.98	485	8.23	546	8.47	563	7.05	2041	8.07	96.81
MAY	553	11.11	668	11.33	567	8.80	735	9.21	2523	9.97	119.67
JUNE	581	11.67	756	12.83	815	12.65	951	11.91	3103	12.27	147.18
JULY	656	13.18	752	12.76	872	13.53	1042	13.05	3322	13.13	157.57
AUGUST	613	12.31	696	11.81	895	13.89	1080	13.53	3284	12.98	155.77
SEPTEMBER	484	9.72	636	10.79	678	10.52	800	10.02	2598	10.27	123.23
OCTOBER	424	8.52	434	7.36	539	8.37	723	9.06	2120	8.38	100.56
NOVEMBER	271	5.44	349	5.92	344	5.34	502	6.29	1466	5.79	69.54
DECEMBER	259	5.20	260	4.41	282	4.38	437	5.47	1238	4.89	58.72
TOTAL	4979	100	5894	100	6443	100	7983	100	25299	100	

[1] Excludes Ridgecrest Heights

Inyokern (Inyokern Services District)

This small community is presently pumping 259 acre-feet per year according to Pam Ernst, general manager. The community supplier was previously called the Antelope Valley Water Company. Reference may be to this entity in earlier reports.

Louisiana-Pacific Corporation

This sawmill is no longer in operation. The last water use was in 1986. The estimated past annual water use was about 3,000 acre-feet (St.-Amand, 1986).

Irrigation

In the past, three ranches have used most, if not all, of the water pumped for irrigated agriculture. They are: Brown Road Farming Company, (formerly Circle M Ranch), Neal Ranch, and Spike Leroys Ranch. The Neal Ranch was purchased by the Indian Wells Valley Water District in 1988. Complete historical data are not available. Irrigation water use has decreased in recent years, however. Alfalfa is the primary crop grown. It was reported that the Brown Road Farming Company has seven center-pivot irrigation systems in operation pumping about 12,000 acre-feet annually. [Assuming six acre-feet per acre consumptive use (California Department of Water Resources, 1975, 1986, and Erie et al., 1982), 75 percent application efficiency and 130 acres per system, the estimated pumping would only be 7,300 acre feet per year.] The Spike Leroys Ranch is estimated to have pumped about 1,600 acre-feet per year (estimate by Michael Stoner). This ranch is not presently irrigating but is expected to resume soon.

Some small orchards (almonds, pistachios and apricots) exist, but it is assumed the irrigation water is from individual domestic wells (See next section).

Private Wells

It has been reported that over 3,000 wells exist in the Indian Wells Valley. The majority of these have been abandoned. It is estimated that about 550 wells are currently in production that supply private water users. Little or no information exists about historical use of these wells.

The following derives a rough estimate of present annual use. Assuming two-thirds of the wells are serving individual users on 2.5 acre plots (one connection per well using 1.5 acre-feet per connection), these would pump about 550 acre-feet per year. Most (75 percent) of the remaining one-third of the wells serve about four households per well. These are estimated to pump 824 acre-feet per year. The remaining wells service larger plots up to 10 acres, having as many as 15 households per well. Assuming 1.1 acre-feet per connection per year, the remaining wells are estimated to pump 756 acre-feet per year. Total private ground water withdrawals would be about 2100 acre-feet per year (550 + 824 + 756), which may be conservatively high.

FUTURE WATER USE

Future Water Use

Certain water user entities have analyzed their future water needs in great detail while others have not. The following summarizes available data: When data are lacking, estimates are made instead.

Naval Weapons Center

The historical and projected use was furnished by Michael Stoner, Naval Weapons Center, China Lake, California. This is shown in figure 1. The use is expected to be relatively constant at 4,400 acre-feet per year.

Kerr-McGee Chemical Corporation

The following projections of water use were furnished by Bob Garrod of Kerr-McGee Chemical Corporation:

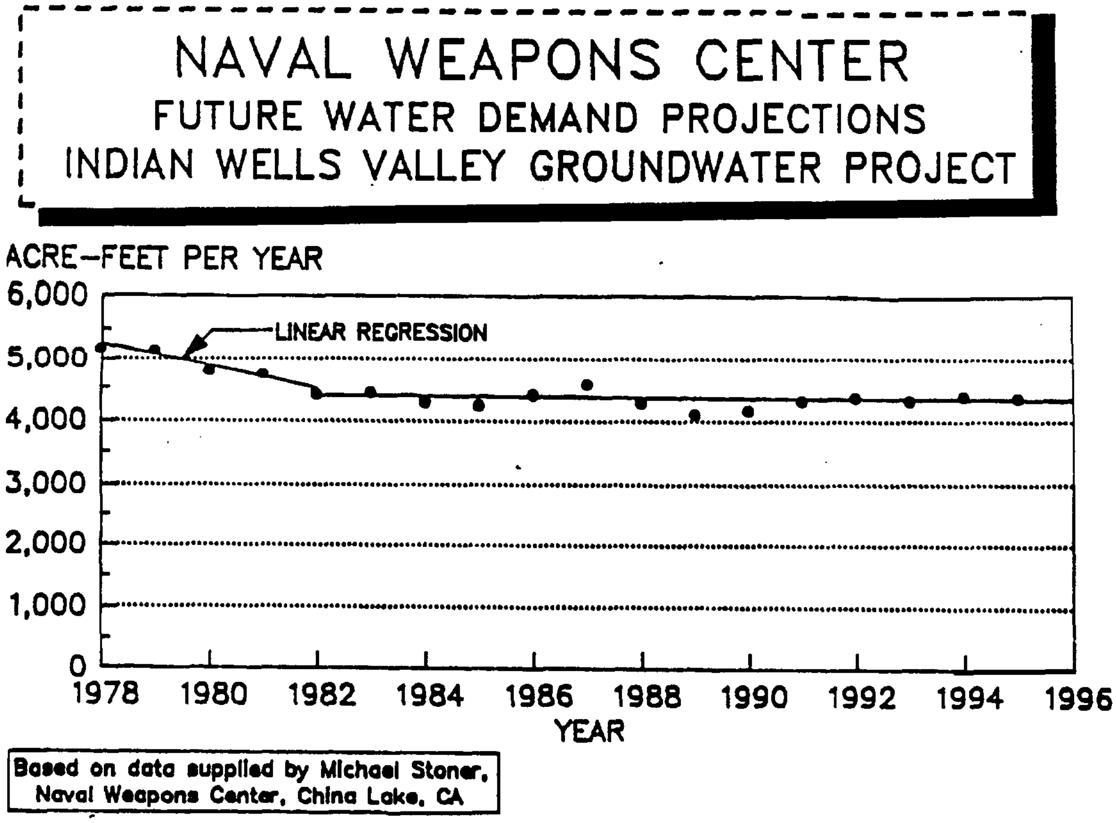
Year	Acre-Feet
1989	2320
1990	2500
1991	2800
1992 and future	2800-3000

Indian Wells Valley Water District

The following information is from the Indian Wells Valley Water District's "1990 Water General Plan" (Krieger and Stewart, 1990). The projected water requirements are based on 0.86 acre-feet per year per connection:

Year	Projected Population	Projected Service Connections	Projected Water Requirements (Acre-feet)
1980	15,800	4,350	3,820
1990	36,000	10,000	8,600
1995	51,300	14,200	12,250
2000	69,050	19,200	16,500
2005	85,800	23,800	20,500
2010	104,650	29,100	25,000

Figure 1


NAVAL WEAPONS CENTER
FUTURE WATER DEMAND PROJECTIONS
INDIAN WELLS VALLEY GROUNDWATER PROJECT
ACRE-FEET PER YEAR
6,000
5,000
4,000
3,000
2,000
1,000
0
LINEAR REGRESSION
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
YEAR
Based on data supplied by Michael Stoner,
Naval Weapons Center, China Lake, CA

Inyokern (Inyokern Community Services District)

The following information was provided by Pam Ernst, general manager. The annual water use is expected to reach 340-360 acre-feet by 1992. After 1992 they expect about 5 percent growth per year. This would put water use at about 400 and 735 acre-feet per year for 1995 and 2010 population levels, respectively.

Louisiana - Pacific Corporation

The sawmill is no longer in production and is not expected to operate in the future.

Irrigation

It is assumed that the Spike Leroys Ranch will resume irrigation (1,600 acre-feet per year). Therefore, irrigation water use would reach 13,600 acre-feet per year (12,000 + 1,600). Future water use is assumed to be constant at 13,600 acre-feet per year.

Private Wells

It is assumed that there will be a 2 percent growth rate over a 20-year period. This would result in 2,400 and 3,100 acre-feet annually for 1995 and 2010 levels, respectively.

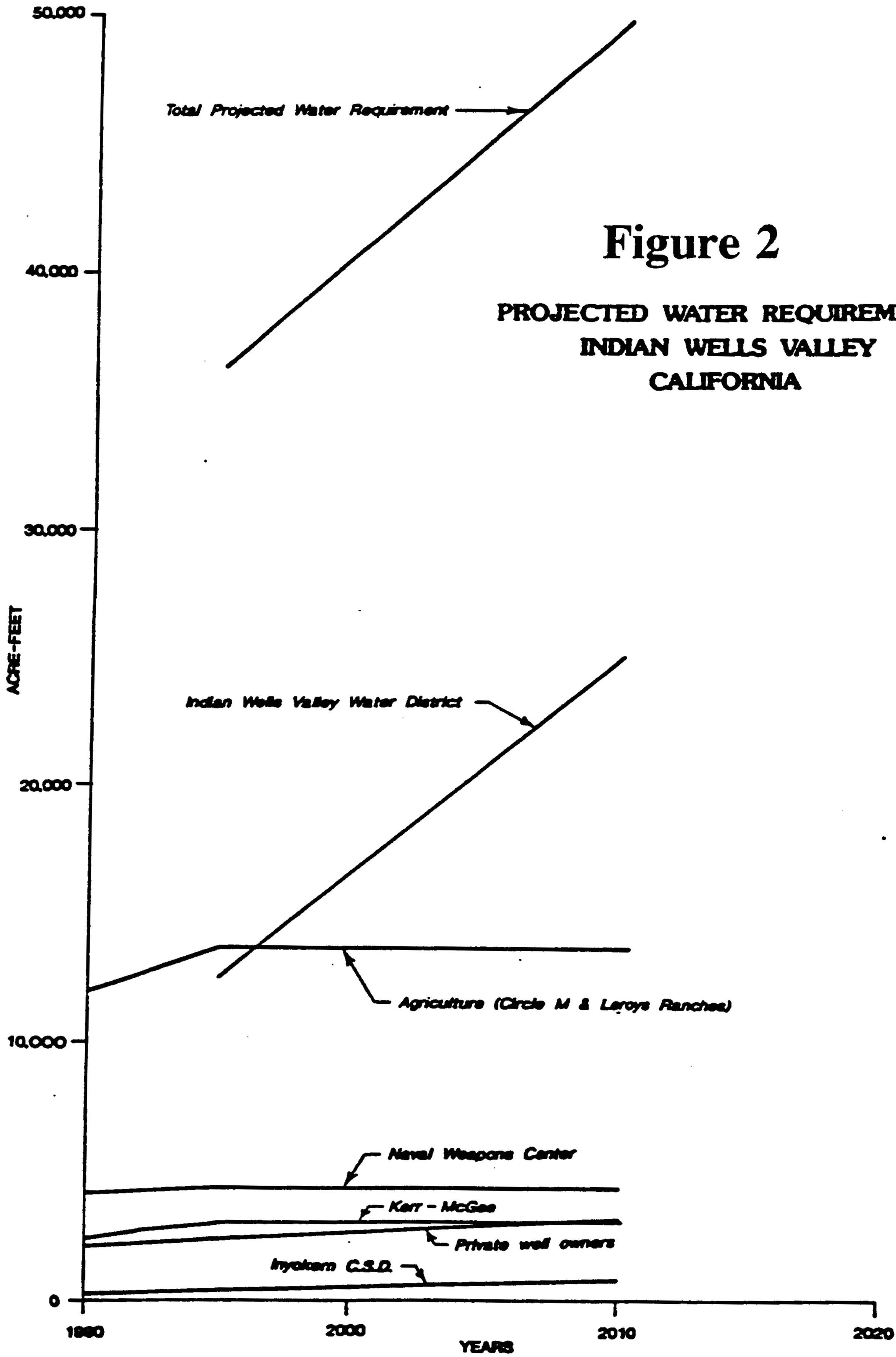
Total Projected Future Water Use

The following tabulation summarizes the projected water use for the Indian Wells Valley. The values are also portrayed in figure 2.

Water Use	Future Demand (Acre-Feet)	
	1995	2010
Naval Weapons Center	4,400	4,400
Kerr-McGee Chemical	3,000	3,000
I.W.V. District	12,500	25,000
Inyokern CSD	400	735
Irrigation	13,600	13,600
Private Wells	2,400	3,100
Total Valley	36,300	49,835
		49,800 (rounded)

Figure 2

PROJECTED WATER REQUIREMENTS
INDIAN WELLS VALLEY
CALIFORNIA



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Erie, L.J.; French, O.F.; Bucks, D.A; and Harris, K., 1982. *Consumptive Use of Water by Major Crops in the Southwestern United States.* Conservation Research Report Number 29, Agricultural Research Service, U.S. Department of Agriculture.

Krieger and Stewart, 1990. *Indian Wells Valley Water District Domestic Water System 1990 Water General Plan.* Krieger and Stewart, Incorporated, Riverside, California (DRAFT).

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SECTION C - ESTIMATE OF WATER RESOURCE LIFE

INTRODUCTION

This Section describes the methods used to estimate the life of six future groundwater development possibilities identified during the Project. The six possible future water development alternatives were:

1. Continue pumping from the Intermediate Area only

2. Continue pumping from the Intermediate Area and expand into the Southwest Area

3. Continue pumping from the Intermediate Area and blend water from the Northwest Area

4. Continue pumping from the Intermediate Area, expand into the Southwest Area, and blend water from the Northwest Area

5. Continue pumping from the Intermediate Area and blend **treated** water from the Northwest Area

6. Continue pumping from the Intermediate Area, expand into the Southwest Area, and blend **treated** water from the Northwest Area

In estimating the life of the water resource in Indian Wells Valley, major assumptions have to be made in three areas--future groundwater withdrawals, extractable groundwater volume, and recharge volume and distribution. Determination and usage of values in each of these areas in estimating resource life is the subject of this Section.

Models used here for developing the parameters that determine resource life are neither sophisticated nor complex. An elementary approach was used because uncertainty in available data would not have allowed additional accuracy even with a more rigorous mathematical approach. In order to compensate for uncertainties in assumptions and simplicity in the modelling effort, reasonable extremes were developed in an effort to bracket the parameters. Three scenarios were evaluated. A "worst case" condition was developed by using conservative values for all evaluation parameters. More optimistic values were used to develop a scenario at the other extreme of the range. Intermediate values based on interpretation of available data and professional judgement were then used to define a scenario that is considered to be a realistic representation of future conditions.

FUTURE WITHDRAWALS

Section B of this volume provides documentation of Valley water extraction projections made in 1990. Those projections were essentially a straight-line extrapolation resulting in annual withdrawal increases starting at about eight percent a year and decreasing to about four percent a year by the year 2010. For the purposes of this analysis, after the year 2010 the demand was assumed to remain constant at the 2010 level. That projection is now considered to be on the high side of the range of future withdrawal estimates and will represent the "worst case" condition.

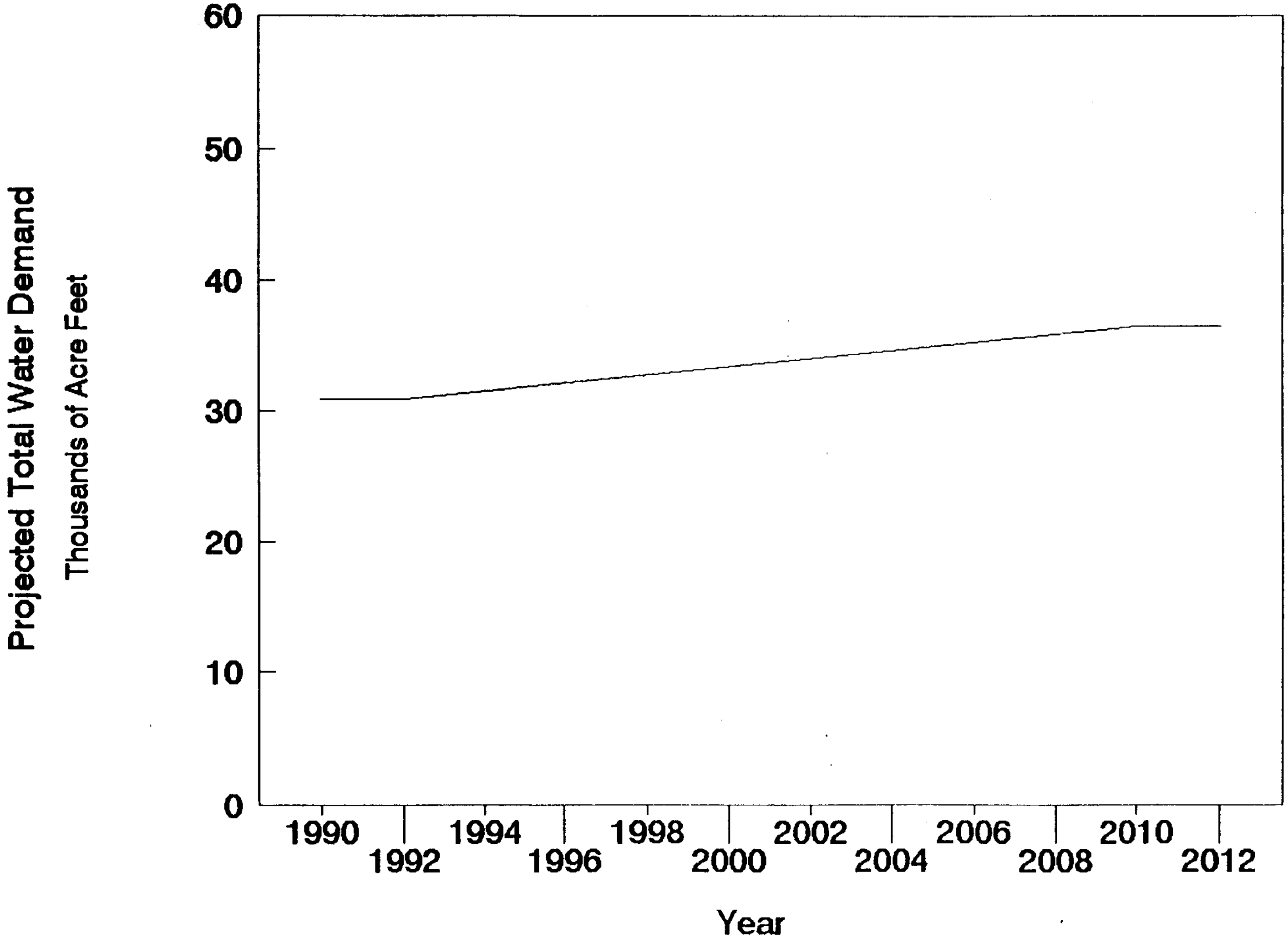
As pointed out in the Preface to Section B, Valley growth moderated in the early 1990's. Current population growth in the Valley is flat, as is the increase in water withdrawals. This condition will be used to represent the low side of the range of future withdrawal estimates. Current annual groundwater withdrawals as presented in Section B are:

Naval Air Weapons Station	4,400 acre-feet
North American Chemical Company	3,000
Indian Wells Valley Water District	9,000
Inyokern Community Services District	300
Agriculture	12,000
Private residential wells	2,000
Total	30,700 acre-feet

While it is conceivable that groundwater pumpage will remain at or near current levels, it is highly unlikely that the Valley will experience growth represented by the projections given in Section B. Perhaps a more likely groundwater withdrawal estimate would be derived by assuming that pumping for the Naval Air Weapons Station, North American Chemical Company, and agriculture will remain at current levels in the future and that the other entities will increase pumpage in a straight line so that by the year 2010 it will increase 50 percent. After 2010, pumpage is assumed constant. With these assumptions, the current and midrange or intermediate values for future annual water withdrawals in acre-feet are as shown below and in Figure 1:

	1992	2010
Naval Air Weapons Station	4,400	4,400
North American Chemical Company	3,000	3,000
Indian Wells Valley Water District	9,000	13,500
Inyokern Community Services District	300	450
Agriculture	12,000	12,000
Private residential wells	2,000	3,000
Total	30,700	36,350

Figure 1: Revised Projected Total Future Water Demands



EXTRACTABLE GROUNDWATER VOLUMES

The Project identified three areas that could be used to provide future groundwater resources for the Valley. These are the Intermediate Area, the Northwest Area, and the Southwest Area (see Figure 2 for location). The Intermediate Area is the traditional groundwater extraction area for the Indian Wells Valley and the area for volume calculation is assumed to be 4 miles by 6 miles. The Northwest Area is 9 miles by 4.5 miles and the Southwest Area is 4 miles by 7 miles.

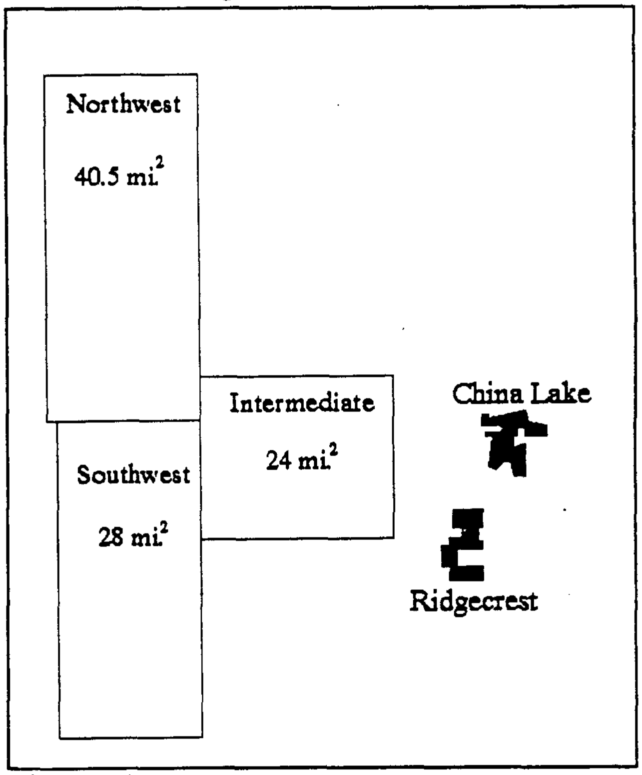


Figure 2

To determine the extractable groundwater volume, assumptions were made on specific yield and the saturated thickness that would reasonably be expected to be dewatered. Specific yield was assumed to be 20 percent or 0.20, since most references suggest a range of 0.10 to 0.30 for sand aquifers. St.-Amand (1986) used a range from 0.10 to 0.20, depending upon Valley location.

While data obtained during the Project indicate good quality water in the Intermediate Area and Southwest Area to a depth of at least 2,000 feet, dewatering the aquifer to that depth is not considered reasonable for both physical and economic reasons. However, given the high economic value of municipal and industrial water as compared to agricultural water, dewatering to depths of 500 to 600 feet is not unreasonable. Therefore, based on current depth to groundwater, as much as 300 feet of aquifer could be dewatered in the Intermediate and Southwest Area.

In order to bracket reasonable dewatering depths, dewatered thicknesses of 100, 200, and 300 feet are used. A dewatering depth of 100 feet is considered the low side of the range and 300 feet is assumed to be the high end of the range. With a 300-foot dewatered thickness the total static pumping head may be reaching the current edge of the economic pumping range. For this analysis, 200 feet of dewatering will be considered the realistic value of dewatering depth. In the Northwest Area the depth to groundwater and depth to the top of the extensive clay layer limits dewatering to about 200 feet.

As pointed out in a later discussion on water quality, depression of the groundwater surface caused by pumping will result in a head difference between water in the pumped areas and water in surrounding areas. This will cause surrounding water to migrate into the pumped areas. This additional volume will be accounted for during the water quality calculations.

The extractable groundwater volumes in millions of acre feet based on the assumptions above are about:

Area	100-Foot Dewatering Depth	200-Foot Dewatering Depth	300-Foot Dewatering Depth
Intermediate	0.31	0.61	0.92
Southwest	0.36	0.72	1.06
Northwest	0.52	1.04	1.04

RECHARGE VOLUME AND DISTRIBUTION

Recharge quantity and distribution has been the subject of speculation and discussion among local water experts. Resolution of the various viewpoints continues to be elusive, even with the additional data obtained under this Project. However, calculation of a resource life demands making recharge assumptions, so an attempt was made here to use all existing information, including data from other researchers, to develop reasonable resource life estimates.

Recent research suggests that the previous quantitative estimate of Valley recharge may be too high (see the AQUIFER MODELING chapter of Section A). Based on that possibility, the low estimate for recharge quantity used here was 3,000 acre-feet a year from the east slope of the Sierra Nevada. Distribution of this quantity was 1,000 acre-feet into the Southwest Area and 2,000 acre-feet into the Northwest Area. This distribution was based on the assumption that recharge distribution is proportional to watershed vegetation distribution as reported in Appendix I (see table 1 of that appendix).

For the intermediate recharge case, values and distribution presented in Berenbrock and Martin (1991) were used. Recharge developed by those researchers was about 6,000 acre-feet a year from the eastern Sierra Nevada, with about half coming into the Northwest Area and half into the Southwest Area.

The high end of the range for recharge from the eastern Sierra Nevada used in this analysis was 9,000 acre-feet a year. This was derived by assuming 3,000 acre-feet enters the Northwest Area from the Little Lake area in addition to the Berenbrock and Martin estimate. This assumption, then, gives 3,000 acre-feet a year recharge into the Southwest Area and 6,000 acre-feet a year recharge into the Northwest Area.

For all cases, it was assumed that there is no natural recharge into the Intermediate Area. This assumption is probably quite conservative for Alternative 1 where all the pumping occurs in the Intermediate Area, but may be more realistic under other alternative water development possibilities. As discussed on the next page, however, there is a five percent estimated annual contribution to pumping quantities from groundwater storage outside the pumped areas.

A summary of all the evaluation parameters discussed in the sections above are shown in the following table.

Evaluation Parameter	Conservative Condition	Intermediate Condition	Optimistic Condition
Future Withdrawals	1990 projections	50% increase in 18 years for some pumpers	No change from current pumping quantities
Extractable Water Volume	100-foot dewatering depth	200-foot dewatering depth	300-foot dewatering depth
Total Recharge	3,000 a-f/yr	6,000 a-f/yr	9,000 a-f/yr

DESCRIPTION OF RESOURCE LIFE MODEL

There are two prime considerations in determining a strategy for future water development and estimating the life of water resources in the Valley--volume of water available and water quality. Selection of a future groundwater development strategy will also depend upon the approach to water quality. As water quality declines from the good quality source areas there is less opportunity for use of poorer quality water by blending. Early blending of poorer quality water with good quality water will result in a rapid (but scarcely perceptible) decline in delivered water quality, but the total water volume available to the Valley will be expanded.

The model used to estimate resource life has three components--withdrawals from the groundwater, inflow into the groundwater from both natural recharge and migration of surrounding water, and changes in water quality. Withdrawals are described under FUTURE WITHDRAWALS and natural recharge is described under RECHARGE VOLUME AND DISTRIBUTION. The method for determining surrounding water inflow and water quality is described below.

Historical data were used to estimate the amount of surrounding water that would migrate into the pumped areas. Between 1965 and 1985 groundwater elevations in the Intermediate Area dropped about 40 feet (Berenbrock, 1991, p. 45), a rate of decline of about 2 feet a year. If the pumped area is assumed to be round with a diameter of six miles and a specific yield of 20 percent, a 2-foot annual decline over the entire area would amount to an annual withdrawal of about 7,250 acre-feet. During the 1965 - 1985 time period, actual annual pumping from the Intermediate Area was about 7,500 acre-feet a year (Krieger and Stewart, 1988). It appears from this calculation that if the pumping cone of depression is inducing any inflow from the surrounding area, that amount of inflow is quite small in comparison with the pumped quantity. However, for the purposes of the resource life model developed here, it was assumed that inflow from the surrounding area is a constant five percent of the pumped quantity.

Inflow from the surrounding area will have an impact on the quality of water in the Intermediate Area because the surrounding water is of poorer quality. For purposes of this model, water surrounding the Intermediate Area was assumed to have a quality of 1,000 mg/l. Then, as surrounding water migrates into the Intermediate Area, water in the Intermediate Area will gradually become more saline. This change in dissolved solids concentration was calculated by combining the migrating 1,000 mg/l surrounding water with the 250 mg/l Intermediate Area water. The following equation was used:

$$Q^n_i = \{(V^o_i \times Q^o_i) + (Q_s \times I_s) - (Q_p \times V_p)\}/V^n_i$$

Where, Q^o_i = Original Intermediate Area water quality
V^o_i = Original Intermediate Area water volume
Q^n_i = New Intermediate Area water quality
V^n_i = New Intermediate Area water volume
Q_s = Surrounding water quality
I_s = Annual surrounding water inflow
Q_p = Pumped water quality
V_p = Annual pumped water volume

Since water surrounding the Southwest Area appears to have a dissolved solids concentration approximately equal to water in the Southwest Area, no water quality change would result from pumping that area. Similarly, water quality in the Northwest Area would not change from migration of surrounding water.

Natural recharge quality is assumed to be 250 mg/l in the Southwest Area. However, in the Northwest Area there is evidence that recharge is of poorer quality. In order to provide conservative results and to allow simple calculations, natural recharge to the Northwest Area was assumed to have a dissolved solids concentration of 1,000 mg/l.

A sample calculation is shown below. This example shows computations for first year pumping from the Intermediate Area (Alternative 1). The most conservative withdrawal parameter was used for this example--18,700 acre-feet of water pumped the first year. Recharge is assumed to be zero and so is not a consideration in this equation; however, recharge must enter into the calculation for other alternatives. Dewatered depth is also not a consideration in the calculation because volume is used here only in the determination of water quality, not in determining resource life.

V^o_i = 2,150,000 acre-feet. This assumes an area of 24 square miles and a water depth affected by incoming surrounding water of 700 feet. The 700-foot number was derived by assuming a well screen depth of 1,000 feet and a current groundwater surface elevation of 300 feet below ground level.

Q^o_i = 250 mg/l

$V^n_i = V^o_i - V_p + I_s$ = 2,132,235 acre-feet

Q_s = 1,000 mg/l

I_s = 5% of 18,700 = 935 acre-feet

Q_p = 250 mg/l for the first year. Q_p is actually always the same as Q^n_i for the previous year.

V_p = 18,700 acre-feet

Then, $Q^n_i = \{(2,150,000 \times 250) + (1,000 \times 935) - (250 \times 18,700)\}/2,132,235$
$= 250.33$ mg/l

For the second year calculation, Q^n_i becomes Q^o_i and V^n_i becomes V^o_i. The calculation is repeated until either the available water is depleted or Q^n_i reaches 500 mg/l.

CALCULATED RESOURCE LIFE VALUES

Using the technique and assumptions described above, resource life values were calculated for each of the potential resource development alternatives. Since there are three evaluation parameters (recharge, dewatering depth, and future pumping), each with three possible values, there are 27 possible combinations of resource life for each potential development alternative. Instead of calculating a resource life for each combination, calculations were made only for the worst or conservative conditions, for optimistic conditions, and for what is considered here as more realistic conditions. Results of each of these calculations are shown in the table below.

Resource Development Alternative	Resource Life, years		
	Conservative Condition	Inter-mediate Condition	Optimistic Condition
No. 1--Pump Intermediate Area only	14	29	52
No. 2--Pump Intermediate Area, expand into the Southwest Area	26	68	134
No. 3--Pump Intermediate Area, blend Northwest Area water	19	42	77
No. 4--Pump Intermediate Area, expand into the Southwest Area, blend Northwest Area water	33	92	169
No. 5--Pump Intermediate Area, blend <u>treated</u> water from the Northwest Area	19	42	77
No. 6--Pump Intermediate Area, expand into the Southwest Area, blend <u>treated</u> water from the Northwest Area	33	92	169

For alternatives that included pumping from both Intermediate and Southwest Areas, the pumping distribution was adjusted to maximize the life of the resource. Pumping percentage from the Southwest Area varied between 55 and 61, with the rest being pumped from the Intermediate Area.

It should also be noted that water quality never became a limiting factor. That is, the water volume in the Intermediate or Southwest Area became depleted before the water quality reached the Environmental Protection Agency recommended total dissolved solids concentration of 500 mg/l. This is why the resource life for Alternatives 5 and 6 are the same as for Alternatives 3 and 4, respectively. This also means that treatment of the Northwest Area water for blending purposes is unnecessary if total dissolved solids is the only consideration. There are, however, individual constituents that may limit the blending associated with Alternatives 3 and 4. In that case, treatment is required in order to achieve the resource life values shown in the table on the previous page.

In several blending cases, water in the Northwest Area became depleted while there was still water available in the Intermediate Area or Southwest Area. In that event, agricultural pumping from the Northwest Area would be limited to the recharge volume and the quantity of water migrating in from the surrounding area, and pumping in the Intermediate or Southwest Areas would be increased to meet all municipal and industrial demands.

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APPENDIXES

APPENDIX I

Estimating Recharge Distribution to Indian Wells Valley Based on Vegetation Distribution in the Recharge Watersheds

APPENDIX I.

ESTIMATING RECHARGE DISTRIBUTION TO INDIAN WELLS BASED ON VEGETATION DISTRIBUTION IN THE RECHARGE WATERSHEDS

Dennis E. Watt

INTRODUCTION

Bloyd and Robson (1971) estimated, by trial-and-error using their groundwater model, that about 64 percent (6,250 acre-feet/year) of the mountain front recharge to Indian Wells Valley (Valley) originates from the Sierra Nevada on the west side of the Valley, about 32 percent (3,170 acre-feet/year) originates in the Coso and Argus Ranges on the north and northeast sides of the Valley, and about 4 percent (400 acre-feet/year) originates in the El Paso Mountains on the south side of the Valley (Berenbrock and Martin, 1991). Berenbrock and Martin (1991) also used this recharge distribution in their groundwater model of the Valley.

St. Amand (1986) and Berenbrock and Martin (1991) note that 3,170 acre-feet/year from the Coso and Argus Ranges is too much based on the simulated groundwater gradient in the northeast part of the Valley in the two groundwater models (Bloyd and Robson, 1971; Berenbrock and Martin, 1991). Kunkel and Chase (1969) seem to suggest a recharge distribution different from that in the models. They state,

> "The largest increment of recharge for Indian Wells Valley is derived from the east slopes of the Sierra Nevada, west and southwest of Inyokern, where the heaviest precipitation with the area occurs. Second in importance are the steep fans and escarpment of the Sierra Nevada northwest of Inyokern, where the catchment area is smaller and the quantity of precipitation is less. A third increment, probably small, is derived from Rose Valley through a narrow channel at Little Lake. A very small quantity of recharge reaches the main water body from the Argus Range, but the quantity is small because of the small amount of precipitation in that area. Other very minor quantities are derived from Coso Basin and the El Paso Mountains."

The statements above suggest the need for another method of distributing recharge. Distributing recharge based on watershed vegetation distribution, as described below, may have merit.

PREVIOUS RECHARGE DISTRIBUTION METHOD

Bloyd and Robson (1971), the first Indian Wells Valley groundwater modelers, started with an assumption that natural recharge is directly proportional to watershed area above 4,500 feet in the Sierra Nevada and 5,000 feet in the Coso and Argus Ranges. This yielded 102 square miles of recharge contributing watershed area in the Coso and Argus Ranges and 88 square miles in the Sierra Nevada. Apportioning this watershed area based recharge in the model resulted in too much recharge emanating from the Coso and Argus Ranges and too little recharge from the Sierra Nevada. A simple trial-and error process was then used to make changes in recharge values until the head configuration determined by the model was in agreement with the 1920-21 water-level contour map drawn from available water-level measurements (Bloyd and Robson, 1971). Berenbrock and Martin (1991) used the Bloyd and Robson gross recharge distribution (for the Sierra Nevada and for the Coso and Argus Ranges) in their model.

OTHER POTENTIAL RECHARGE DISTRIBUTION METHODS

The author investigated several potential methods for distributing recharge or mapping "recharge potential" based on the premise that most if not all recharge is from winter precipitation runoff. A number of authors (Simpson et al., 1970; Gallagher, 1979; and Mifflin, 1968) have suggested that mountain-front recharge in the southwest is a function of winter precipitation only. The methods investigated included a distribution based on: (1) average annual "snow-pack" distribution, (2) winter precipitation distribution based on long period National Oceanic and Atmospheric Administration (NOAA) atmospheric model runs for the proposed Yucca Mountain high level nuclear waste repository, and (3) vegetation distribution in the recharge watersheds.

The apparent lack of data eliminates any method based on measured or estimated "snowpack." Watershed snowpack measurements and estimates are only available for California watersheds draining to the large reservoirs, mostly west of the Sierra Nevada drainage divide. The only winter precipitation data available for the east slope is believed to be that collected in the Carson-Truckee watershed and the watersheds draining into Los Angeles Department of Water and Power (LADWP) eastern Sierra reservoirs and aqueducts.

The NOAA model is of little use because the 60 kilometer grid size is too coarse. The coarse grid is a function of the wide spacing of sites in the western U.S. for which relatively long term weather data is available. The node size can be reduced to 10 kilometers (still much too coarse) locally with a local data collection effort.[1]

RECHARGE DISTRIBUTION BASED ON WATERSHED VEGETATION DISTRIBUTION

Estimating recharge distribution from vegetation distribution is based on the premise that the areal distribution of some vegetation community in the recharge watershed may be in equilibrium with"some average long-term[2]" areal moisture availability in the watershed and that moisture availability may be proportional to recharge. Therefore, distribution of vegetation with high sensitivity to moisture availability and low sensitivity to other climatic and substrate conditions may be a potential indicator of watershed recharge potential.

Vegetation distribution may only indicate general moisture conditions in a watershed. Because of evapotranspiration, the amount of precipitation draining below the root zone (to become recharge) of watershed vegetation may be less than that draining below that same depth under less vegetated slopes. Ng and Miller (1980) found that drainage averaged 1 cm/yr [0.4 in/yr] on the north-facing slope but was almost 3 cm/yr [1.2 in/yr] on the less vegetated south-facing slope. Precipitation at the research site, in the mountains east of San Diego, for the water years 1972, 1973, and 1974 was 25.9 [10.2], 66.8 [26.3], and 35.1 [13.8] cm [in], respectively.

PINYON-JUNIPER

Pinyon-juniper woodland area was selected as the watershed moisture distribution indicating vegetation based on the author's perception that the distribution of pinyon and juniper woodlands is similar to the distribution of areas which receive snow most every year and because a number of authors (Simpson et al., 1970; Gallagher, 1979; and Mifflin, 1968) have suggested that mountain-front recharge in the southwest is a function of winter precipitation only. Moreover, pinyon-juniper distribution seems to be sensitive to moisture availability and insensitive to substrate based on findings summarized below.

[1] Personal communication with J.C. Lease, U.S. Bureau of Reclamation, Denver, 1992.

[2] Changes is specie distribution and density may lag many decades behind long-term atmospheric changes, however it is assumed that any change in long-term moisture availability will affect the specie distribution and density in all watershed areas equally.

Pinyon and juniper woodlands are found in many parts of California, although they are most extensive east of the Sierra Nevada and Cascade Ranges. Pinyon-juniper trees generally grow where annual precipitation averages between 8 and 12 inches and the frost-free season is about 120 days (Arno and Hammerly, 1984; Garrison and others, 1977). Although soil and geology differ, the basic tree growth patterns appear to be similar (Young, 1984).

Daubenmire (1943) suggests that soil moisture availability is the most important factor in determining the lower limit of dominant tree and shrub species in Rocky Mountain vegetation zones. In the Great Basin, pinyon-juniper woodlands form a distinct zone on the mountain ranges, with upper and lower limits thought to be due primarily to water availability and extreme temperatures (Tueller and others, 1979).

Whittaker and Niering (1968) made traverses sampling species distribution and conducted a "special sample series" on various rock types on the north slope of the Santa Catalina Mountains [north of Tucson], Arizona. In comparing the vegetation supported by diorite [granitic rock] and limestone they noted that several species occurred on both alkaline and acid soils. These included Juniperus deppeana [juniper]. Bradbury (1969) found that the distribution of five tree forms in the southern Swisshelm Mountains of southeast Arizona [including Juniperus deppeana and J. monosperma] present the possibility of factors other than substrata influencing their distribution [in a limestone and igneous rock terrain]. Bradbury presumed that moisture factors are active in regard to the preferences of these species.

Wentworth (1981), on the other hand, found that within the Mule Mountains [southeast Arizona], limestone and granite sites existing under similar climatic regimes support markedly different plant communities. He attributed this to the finer texture of the calcareous soils which would tend to allow only shallow penetration of small amounts of precipitation which in turn would be more readily lost by evaporation than that penetrating to greater depth in a coarser textured granitic soil. However, based on the findings of Whittaker and Neiring (1968), Bradbury (1969), and the others noted above, the author believes the vegetation pattern found by Wentworth (1981) may be a function of slope or soil maturity or some other factor which causes shallow soil conductivity to supersede precipitation distribution as the primary factor in vegetation distribution. The potential for pinyon-juniper distribution shifts due to limestone versus igneous substrate does not exist in the watersheds recharging the Valley as there are no significant limestone outcrops.

PINYON-JUNIPER MAPS

The green shading on the 1943-1956 vintage U.S.Geological Survey 15-minute topographic maps appears to be the only mapping available which shows pinyon-juniper woodland distribution in sufficient detail. Inquiries to various state and federal agency botanists for potential sources of vegetation mapping did not yield any likely sources. The vegetation map in "Terrestrial Vegetation of California" (Vasek, 1988) is not sufficiently detailed and does not show the pinyon-juniper woodland in the Coso Range.

The relatively small pinyon-juniper woodland area in the Coso Range relative to the pinyon-juniper woodland area in the Sierra Nevada, at the same elevation, may be a function the "moisture shadow" effect of the Sierra Nevada. Additionally, many of the watersheds trend north-south which limits winter shading of snow. Snow exposed to the sun may be more likely to sublimate instead of draining into the substrate as compared to snow shaded from direct solar radiation.

APPLICATION OF METHOD

Table 1 lists the recharge for each watershed based on the percentage of pinyon-juniper woodland area in each recharge watershed as a percentage of the total pinyon-juniper area in all the potential recharge watersheds. Based on this recharge distribution procedure, the annual recharge from the Coso and Argus Ranges is 975 acre-feet per year, assuming the total recharge to the Valley is 9,850 acre-feet per year (as used in the groundwater models). This agrees with the model based findings of Berenbrock and Martin (1991). They note that a recharge from the Coso and Argus Ranges of between 1,585 and 792 acre-feet per year allows the groundwater model to make a good fit with measured water levels. This recharge distribution also seems to agree with the distribution described by Kunkel and Chase (1969) quoted in the introduction of this Appendix.

Note also that distributing recharge in proportion to watershed vegetation distribution indicates zero recharge from the El Paso Mountains, an area receiving 5 to 6 inches of average annual precipitation (Rantz, 1969). This agrees with the Maxey-Eakin (1949 and 1951) recharge coefficients for areas with less than 8 inches of precipitation. The Maxey-Eakin method for estimating recharge to a groundwater basin was developed by G. B. Maxey and T. E. Eakin between 1947 and 1951 and has been applied to over 200 basins in Nevada and other western states (Avon and Durbin, 1992). The Maxey-Eakin method is an empirical relation between annual precipitation rate and recharge efficiency in the Great Basin, see table 2.

TABLE 1.
DISTRIBUTION OF INDIAN WELLS VALLEY GROUNDWATER RECHARGE

Watershed	Percentage of veg. indicating recharge potential	Recharge (af/yr)			
			B & M		B & R
Coso	9.9	975	3,170		3,168
Sierra Nevada					
Fivemile Cyn.	7.4	729	532	668	475
Deadfoot Cyn.	2.2	217	136		
Ninemile Cyn.	11.3	1,113	487	723	775
Noname Cyn.	1.2	118	236		
Sand Cyn.	18.1	1,783	659		495
Grapevine Cyn.	10.2	1,005	330		1,620
Short Cyn.	2.7	30	76		0
Indian Wells Cyn.	7.6	749	569		400
Freeman Cyn. and Cyns. south (Little Dixie)	31.8	3,132	983 2,065		430 2040
El Paso Mtns.		0	400		400

Table 1. Distribution of Indian Wells Valley groundwater recharge based on the percentage of the green shaded area (on 15-minute U.S.G.S. topographic maps) in each potential recharge watershed as a percentage of the total green shaded area mapped in all the potential recharge watersheds. Also shown is the recharge distributions from the models by Berenbrock and Martin (B & M) (1991) and Bloyd and Robson (B & R) (1971).

TABLE 2 MAXEY-EAKIN RECHARGE COEFFICIENTS	
Precipitation Zone	Maxey-Eakin Coefficient (%)
greater than 20 in.	25
15-20 in.	15
12-15 in.	7
8-12 in.	3
less than 8 in.	0 [to monitor][1]

[1]Some investigators indicate that less than 8 inches of annual precipitation can yield minor recharge (Dettinger, 1989). This agrees with observations by the author in the Corn Springs watershed, about 40 miles west of Blythe, California, where 6 inches of annual precipitation (Rantz, 1969) yields spring flow of one percent or less of the watershed precipitation above this barrier type spring.

The vegetation based recharge percentage for each watershed shown in table 1 can be used to estimate recharge from each individual watershed if total recharge to the Valley is re-estimated in the future. Application of the Maxey-Eakin recharge estimating method to all of the recharge watersheds would probably yield less that one-half of the currently accepted annual recharge to the Valley of about 10,000 acre-feet (St. Amand, 1986).

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APPENDIX II

Re-evaluation of Recharge to the Indian Wells Valley
Aquifer Based on Evaporation and Transpiration from China Lake Playa

APPENDIX II.

RE-EVALUATION OF RECHARGE TO THE INDIAN WELLS VALLEY AQUIFER BASED ON EVAPORATION AND TRANSPIRATION FROM CHINA LAKE PLAYA

Dennis E. Watt

INTRODUCTION

Recent studies of other playas suggest that the rate of diffuse groundwater discharge[1] from the China Lake playa area as estimated by Kunkel and Chase (1969) for 1912 [before significant groundwater development] and 1953 may be too high. Recently measured diffuse discharge rates from bare soil on other playas, using several relatively direct measurement techniques developed over the last decade, are lower for a given depth to groundwater than those estimated for China Lake Playa. Diffuse groundwater discharge from the China Lake playa area is important because it is assumed to be the only significant natural, pre-development discharge from the Valley and is therefore equal to natural recharge.

Relatively direct measurement of historic diffuse discharge from the China Lake playa area, if feasible, could have significant aquifer management implications and would probably suggest modification of the most recent U.S. Geological Survey Indian Wells Valley aquifer model (Berenbrock and Martin, 1991).

PREVIOUS STUDIES

Little detailed information existed before 1985 on diffuse discharge from wet salt desert surfaces. In contrast, many investigators have studied diffuse water ›sses from agricultural land, dense phreatophyte stands along apportioned ›rs, and free-water surfaces in the southwest United States. Ullman (1985) . various techniques that have been used to estimate the rate of evaporation › vegetation and from bare soil and sediment surfaces. These include ›pirical techniques relating evaporation to average climatic factors ›rnthwaite, 1948; Blaney and Criddle, 1950), energy budget calculations ›an, 1948; Van Bavel, 1966), and extrapolation from free-surface ›ting pans (Gray, 1970).[2] Ullman notes that in arid and semi-arid ›ents these techniques may greatly over estimate the true rate of › loss.

lc riv lists from em

›lwater discharge is defined as evaporation from free water and › and evapotranspiration (transpiration from vegetation and evaporation ›nvegetated surfaces) from vegetated areas.

› given by Ullman (1985) are not listed in the references at the end of this

Most of the recent papers on relatively direct measurement of diffuse groundwater discharge from shallow groundwater bare soil areas are from Australia. Allison and Barnes (1985) used depth profiles of deuterium composition to estimate evaporation from the floor of the normally "dry" Lake Frome, a salt lake in northeastern South Australia. Ullman (1985) estimated evaporation using one-dimensional transport models for the distribution of Cl^- and Br^- from a salt-covered surface of Lake Eyre, also in South Australia.

In the United States, Cochran and others (1988) estimated maximum daily water table evaporation based on salt flux and non-weighing lysimeters from a thick salt crust site on Owens Lake in California. Malek and others (1990) estimated annual evaporation from Pilot Valley playa in western Utah using the Bowen ratio method to reduce microclimate data collected every 20 minutes.

CHINA LAKE PLAYA

Kunkel and Chase (1969) estimated that the total diffuse groundwater discharge from the China Lake playa area was 11,000 acre-feet/year in 1912 and 8,000 acre-feet/year in 1953. These rates were derived by applying an evaporation and evapotranspiration rate to various classifications of the types of moist land in and around China Lake. The classifications were based on bare soil surface texture, surface moisture, alkali presence and expression, and vegetation density.

A curve of estimated evapotranspiration (consumptive use) versus depth to groundwater was made for 100 percent saltgrass cover by using the empirical equation developed by Blaney and Criddle in 1949 and Blaney in 1951[3]. The consumptive use coefficients for dense (100 percent) saltgrass growth were suggested by Blaney. A curve for 25 percent saltgrass (or pickleweed) cover and for fine-grained bare soil was estimated based on the curve for 100 percent saltgrass cover. Figure 1 shows each of these curves. Also showr a line through the data points from Young and Blaney (1942) [as reported Robinson (1958)] showing annual evapotranspiration of water by saltgrass grown in tanks in Owens Valley.

[3] This is the same technique mentioned above by Ullman (1985) although the publication dates are different. Blaney and Criddle published a number of papers on applying essentially the same empirical technique to different types of vegetation. Ullman referenced their 1950 paper "Determining water requirements in irrigated areas from climatological and irrigation data." Kunkel and Chase (1969) used their 1949 paper "Consumptive use of water in the irrigated areas of Upper Colorado River Basin" and the 1951 paper by Blaney "Consumptive use of water."

OTHER PLAYAS

Several recent papers present measured rates of groundwater evaporation from playas by use of relatively direct measurement techniques. Malek and others (1990) estimated 0.75 feet/year (229mm/yr) of subsurface water depletion from the Pilot Valley playa (western Utah) for a one year period beginning on October 1, 1986, see figure 1. They used the Bowen ratio method to reduce data collected every 20 minutes from a microclimate station. The water table at the site varied from 1 to 2 inches of surface water to about one foot below the surface as the season progressed. As soon as the surface water was lost, a salt crust began to form and by mid-summer it was about one inch thick. They note that the very high osmotic pressure of the soil and salt crust caused most of the absorbed radiation to be partitioned to sensible heat. Variation of the evaporation rate with changes in depth to water was not discussed, however their figure 9 shows that the rate was constant as long as the water was below the salt crust.

Allison and Barnes (1985) estimated 0.56 ft/yr (170 mm/yr) for the mean whole-lake diffuse groundwater discharge from Lake Frome (playa) in northeastern South Australia based on depth profiles of deuterium delta-values to about 3 feet. The average depth to water was about one foot and the soil at several of the measurement sites was covered with a 0.20 inch (5 mm) salt crust. The estimates of diffuse groundwater discharge from the five sites ranged from 0.29 to 0.75 ft/yr. They note that the estimated rate consistently decreased with increasing depth to water.

Cochran and others (1988) report 0.0063 in/day as the maximum daily evaporation rate of subsurface water at an Owens Lake site. Multiplying this rate by 365 days yields 0.19 feet/year. Depth to water ranged from about 20 to 40 inches. At the test site lake clays are overlain by 12 to 24 inches of hard, but porous and largely insoluble, salts. This in turn is overlain by 2 to 3 inches of unconsolidated and highly soluble salts which are capped by a ½ to 1 inch rind of salt crust. This site is probably not representative of the salt crust thickness on China Lake playa.

DISCUSSION

Diffuse groundwater discharge rates from other playas may not be directly applicable in judging the 1912 and 1953 estimates of total evapotranspiration from the China Lake playa area. However, Ullman (1985) notes that the empirical technique used may greatly over estimate the true value of evaporative loss from the water table in arid and semi-arid environments.

Thorburn and others (in press) confirm Ullman (1985). They draw a fitted curve through points representing diffuse discharge fluxes measured on salt pans versus depth to water using data from Allison and Barnes (1985), Jacobson and Jankowski (1989), Malek and others (1989), and Woods (1990). The fitted curve from Thorburn and others (in press) is shown on figure 1. Based on diffuse discharge from other playas, the estimate of bare soil diffuse discharge from the China Lake Playa area appears too high. However, the actual discharge may not be as low as that indicated by the "Thorburn curve" because the China Lake playa may differ from the playas used to develop the curve.

The presence of vegetation complicates the determination of diffuse discharge. Plants can take up water from close to the water table, overcoming the resistance to upward movement in the soil. However, Thornburn and others (in press) note that as plants usually have access to sources of water other than the water table, diffuse discharge of groundwater may be over estimated. They are currently using stable isotopes from plant tissues to partition transpired water sources.

PROPOSED DIRECT MEASUREMENT OF DIFFUSE DISCHARGE FROM THE CHINA LAKE PLAYA

It is believed that some of the relatively direct methods discussed above (and below) for measuring diffuse discharge should be attempted on the China Lake playa in a reconnaissance level investigation. As previously mentioned, diffuse groundwater discharge from the playa is significant because it is assumed to be the only notable natural, pre-development discharge from the Valley and is therefore equal to natural recharge.

The Ullman (1985) method is based on the premise that evaporation of water from saturated saline soils or sediments induces gradients of the solutes in the remaining interstitial solution. These gradients lead to a systematic and predictable solute distribution in the soil solution which may be used to estimate the rate of evaporation. Long-term average annual evaporation estimates can be made based on the Cl^- profile over long cores (two or more feet) whereas the evaporation over the most recent summer season can be estimated based on the concentration gradient over the top 2 to 3 inches. The Allison and Barnes (1985) method of estimating diffuse discharge is based on the same premise but uses depth profiles of deuterium composition expressed as delta-values.

Weighing lysimeters, the only direct method of determining diffuse discharge, would probably of little value for comparison to the estimates of Kunkel and Chase (1969) if the water table depth has declined from that mapped by Kunkel and Chase.

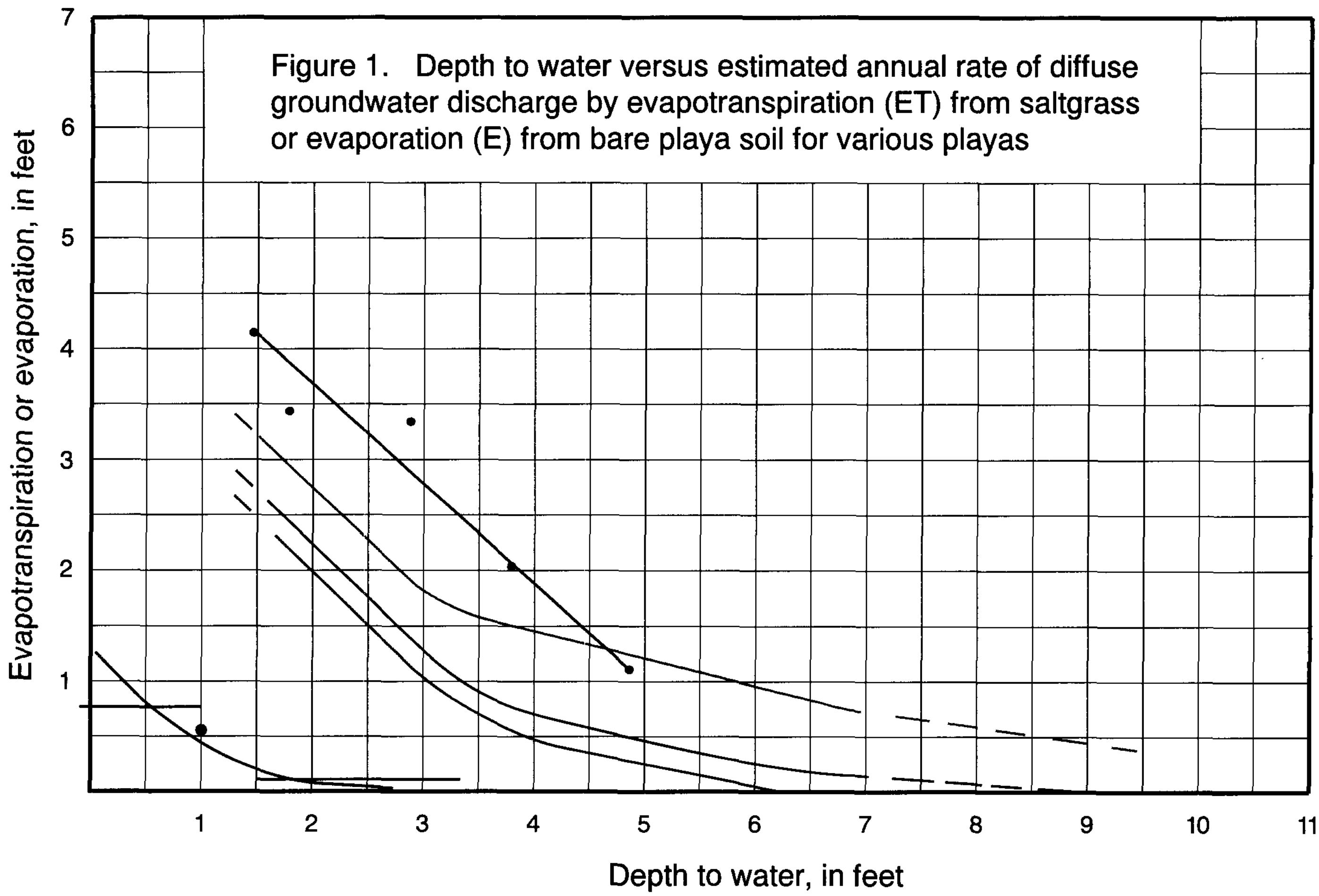

Figure 1. Depth to water versus estimated annual rate of diffuse groundwater discharge by evapotranspiration (ET) from saltgrass or evaporation (E) from bare playa soil for various playas

100 Percent Saltgrass Cover

Indian Wells Valley rate from Kunkel and Chase (1969).

Annual evapotranspiration of water by saltgrass grown in tanks in Owens Valley (Young and Blaney [1942] as reported by Robinson [1958]).

25 Percent Saltgrass Cover

Indian Wells Valley rate from Kunkel and Chase (1969).

Bare Soil with Salt Crust

Indian Wells Valley rate from Kunkel and Chase (1969).

Estimated annual evaporation of subsurface water is 0.75 feet (229 mm) from salt crust on Pilot Valley playa (western Utah) using the Bowen ratio method to reduce data from a microclimate station. (Malek and others, 1990).

• Estimated mean whole-lake evaporation rate from Lake Frome (northeastern South Australia) is 0.56 feet/year (170 mm/yr) with a water table at about 1 foot (about 300 mm). Estimate based on depth profiles of deuterium delta-values to about 3 feet. (Allison and Barnes, 1985).

Maximum annual evaporation rate (0.19 feet) from salt crust on Owens Lake. Derived by multiplying the maximum reported daily rate (.0063 inches/day), based on salt flux, by 365. Maximum daily rate (.003 inches/day) from the evaporimeter [non-weighing lysimeter] was about 1/2 the salt flux rate. Lake-bed clays at this site are overlain by 12 to 24 inches of hard and largely insoluble salts. (Cochran and others, 1988).

Diffuse discharge measured from salt pans with shallow water tables. Data from: Allison and Barnes (1985), Jacobson and Jankowski (1989), Malek and others (1990), and Woods (1990). [Thorburn and others, in press].

Estimating vegetation transpiration will probably be more difficult than measuring evaporation from bare soil. The total leaf area measurement technique used by Groeneveld (1986) in Owens Valley, for determining areal transpiration from porometer[4] measurements, appears to be rather time consuming. A full-scale diffuse discharge measurement program might only include the bare soil methods, the results of which may be sufficient to either generally confirm the Kunkel and Chase estimates or suggest otherwise.

A reconnaissance investigation to measure diffuse discharge with relatively direct methods could be planned by the technical subcommittee with the participation of individuals experienced in the proposed methods. They would certainly have suggestions to enhance the soundness of the investigation and the validity of the resulting estimates. This type of investigation would probably be an excellent topic for a master's thesis.

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[4] A chamber temporarily clamped over a branchlet which measures transpiration and other parameters bearing on leaf transpiration.

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APPENDIX III

Pneumatic Slug Test Procedure and Data Analysis

APPENDIX III.

PNEUMATIC SLUG TEST PROCEDURE AND DATA ANALYSIS

Dennis E. Watt

INTRODUCTION

A pneumatic slug test was conducted in each piezometer of the Project wells to collect the data needed to estimate the transmissivity of the screened aquifer. Some form of slug test is the only practical method by which to gather data needed to estimate transmissivity in small diameter, deep static water level wells (hundreds of feet) like the Project piezometers.

The pneumatic technique is a recent advancement in slug testing because it increases the aquifer hydraulic conductivity and depth to water range where slug tests can be applied. The test proceeds as follows: (1) a well head assembly is attached to the top of a piezometer and a pressure transducer, attached to an electronic data logger, is lowered down the piezometer and set below the static water level, (2) the water level is forced down by filling the piezometer with air [author used SCUBA tanks], (3) after equilibrium is re-established, the data logger is started and the air pressure is immediately released, (4) the data logger is stopped after water level recovery and the recovery data is inspected to determine if the test was "good." Calculation of estimated hydraulic conductivity is made in the office.

OTHER SLUG TEST METHODS

Hydraulic conductivity has long been successfully determined in single wells by introducing or removing water or solid slugs (Hvorslev; Ferris and Knowles, 1954; Cooper and others, 1967; Papadopulos and others, 1973; Bouwer and Rice, 1976). These methods, coupled with water level measurement devices such as electrical water level indicators or percussion sounding instruments [popper tape], can accurately determine hydraulic conductivities in the range of 8×10^{4} cm/sec to 1×10^{3} cm/sec (McLane and others, 1991).

McLane and others (1991) continue,

> "The advent of data logging devices used in conjunction with pressure transducers allows successful slug testing in aquifers with hydraulic conductivities in the range of 1×10^{2} cm/sec. However, these methods typically cannot be applied in aquifers with hydraulic conductivities greater than 1×10^{2}. In these instances, water levels rapidly reach equilibrium before the entire slug is added or removed. This initial change in water level is neither instantaneous nor of great enough magnitude to adequately monitor the recovery period. The use of solid

slugs also makes it difficult to measure water levels, since the slug can jar and offset the pressure transducer suspended inside the well. This problem particularly occurs in small diameter wells. At sites where wells are to be sampled for environmental parameters, traditional slug test methods have the additional limitation because the addition of potentially contaminated solid slugs or clean water can bias subsequent sampling results.

The pneumatic method for conducting slug tests overcomes all of these limitations. This method involves either injecting air into a sealed well to lower the water level (Leap, 1984) or applying a partial vacuum to a sealed well to raise the water level (Orient and others, 1987)."

PNEUMATIC SLUG TEST DEVELOPMENT

Krauss (1977) suggests, as an aside, that compressed air can be used in slug testing to lower the water level below the initial stage and that a pressure transducer can be used to record water levels after the pressure is suddenly released. However, based on the literature, Leap (1984) appears to have been the first to use an "automatic" water level recording device in conjunction with pneumatic slug tests. His pneumatic water level "depressor" consists of three major pieces of equipment: 1) a pneumatic system including a hand carried air tank for providing compressed air to the well; 2) a well head manifold which screws onto the casing top; and 3) an electrical system for recording water level recovery rate, see figure 1. Air pressure is released, initiating water level recovery, by knocking loose the knock-off plate with a hammer blow. A stop watch is started at the same instant to time the recovery of the water level. After the rising water level contacts each electrode hung at known depths in the well, and its time of arrival is noted by the stopwatch, the channel selector is switched to the next electrode above the rising water level. The process is repeated until the water level fully recovers and contacts the uppermost electrode at the full recovery position.

Orient and others (1987) appear to be the first to have used a down hole pressure transducer connected to an automatic data logger with a pneumatic slug testing device. Their device is shown in figure 2. McLane and others (1991) used a quick release pressure valve in place of a knock-off plate, see figure 3, and ran both rising and falling head slug tests. They used this method at sites with distinctly different geology and well construction which ranged from 2-inch wells where the depth to water was only 10 feet to 4-inch wells where depth to water was 125 feet.

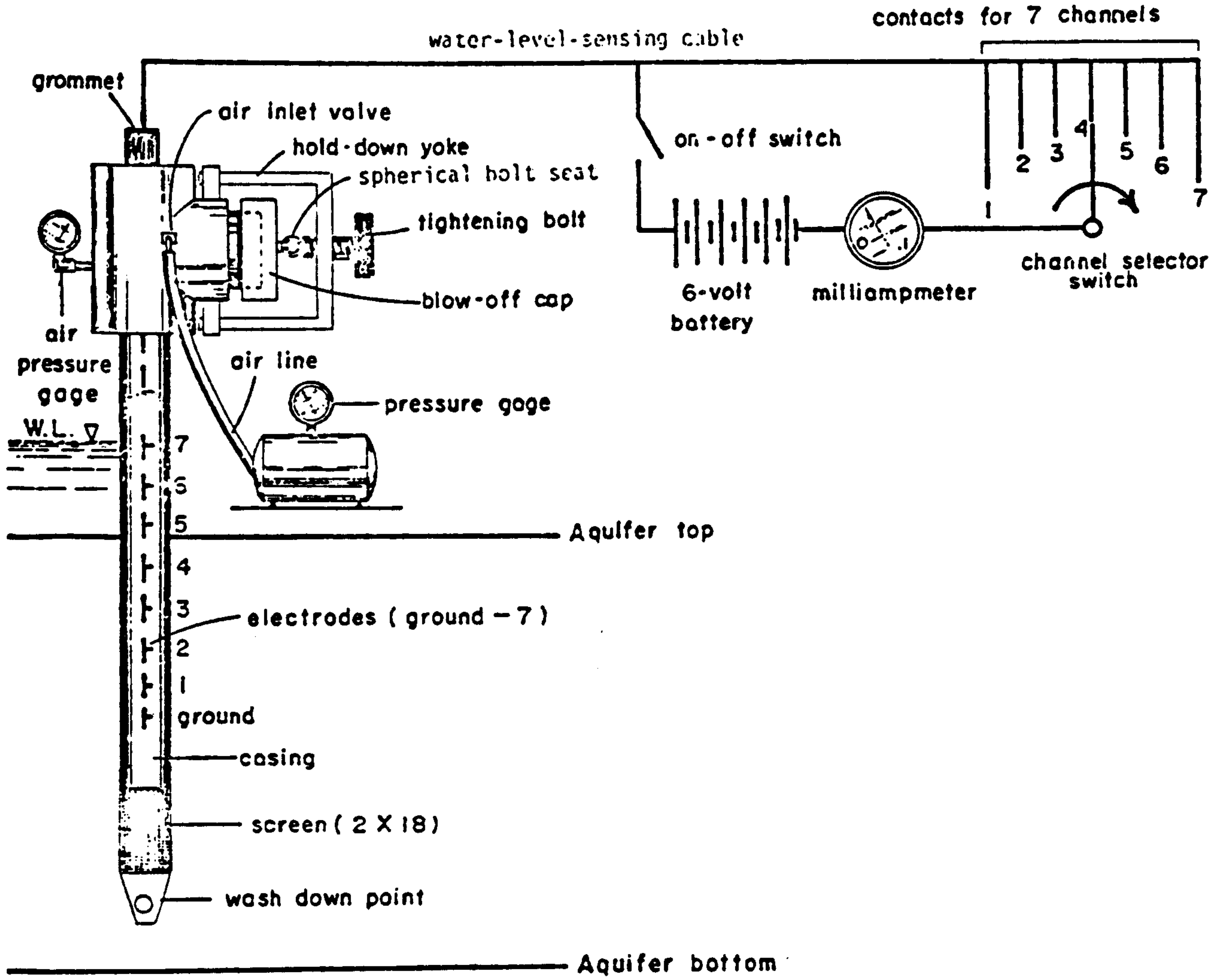


Figure 1. Slug testing apparatus developed by Leap (1984).

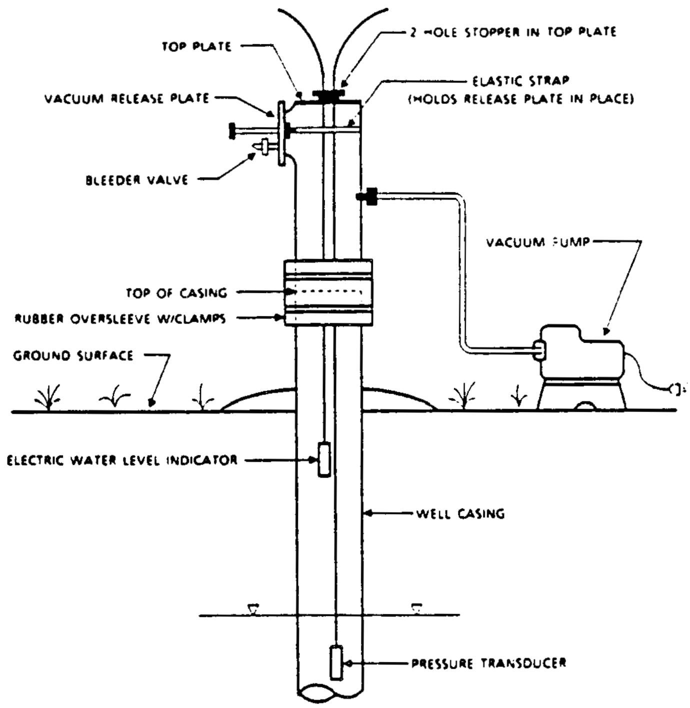
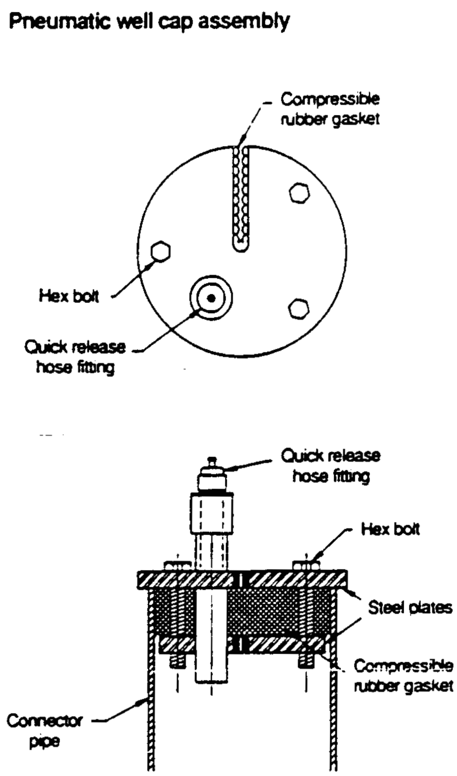


Figure 2. Pnuematic slug testing system designed by Orient and others (1987).



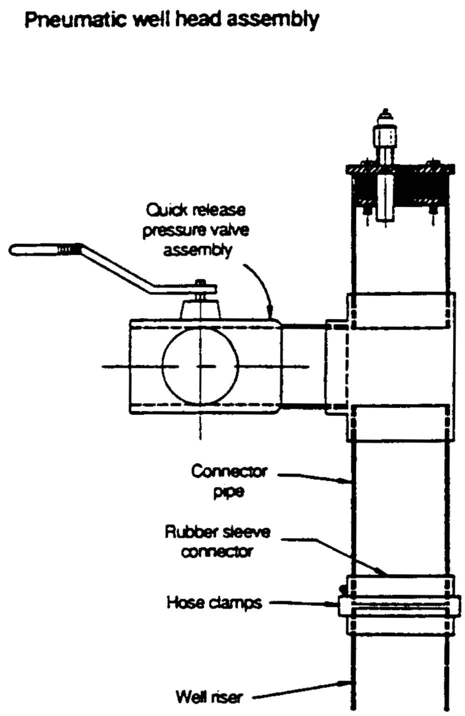


Figure 3. Pnuematic well head assembly and cap constructed by McLane and others (1991).

EQUIPMENT

The equipment used to conduct pneumatic slug tests in the Project piezometers includes a well head assembly, a pressure transducer coupled with a high speed electronic data logger, and a source of air. The principal component of this system is the well head assembly. The assembly consists of a rubber sleeve connector, a quick release pressure valve, and the fitting cap (see figure 4).

The well head assembly was designed by the author for relatively high positive pressure (tested to 15 psi) and easy field replacement of the parts subject to wear. Only the connector pipe, the threaded coupling for the ball-valve, and the fitting cap reducer are permanently glued to the central T-connector. The fitting cap is attached to the fitting cap reducer by a 4-inch rubber sleeve with four hose clamps. This type of mounting allows field removal of the fitting cap and easy replacement of the fittings in the cap. The threaded ball-valve coupling allows easy replacement of the quick release ball-valve should it begin to leak air.

A pressure gauge, truck tire air valve, and a cable tension relief fitting are mounted in the fitting cap. The most important fitting is the cable tension relief fitting[5], see figure 5, which allows passage of a ¾ inch pressure transducer and provides an air tight seal around the ¼ inch transducer cable after the transducer is set in the well.

McLane (1991) notes that

> "the internal diameters of the well head assembly should not be less that the well riser diameter to ensure that pressure equalization is not inhibited after the valve is opened. This relative sizing is required if air pressure inside the piezometer is to return to atmospheric pressure instantly. Smaller internal diameters prohibit the [near] instantaneous return to atmospheric pressure. This retards the water level recovery rate during the time period the internal air pressure is above atmospheric."

Graphs in McLane (1991) show the initial recovery rate lag caused by an apparatus that restricts air flow into or out of the well. However, a small diameter well with a static water level several hundred feet below the surface, such as in the Project piezometers, will probably not return instantly to atmospheric pressure on opening the quick release valve, even with the same diameter or larger diameter well head assembly. Total pressure release in the deep water level piezometers seemed to take about one second.

[5] This fitting is commonly called a "CGB" fitting by personnel at electrical or lighting supply houses. The description on the invoice is "3/4 CGB .125-.250 CORD."

PNEUMATIC SLUG TEST PROCEDURE

The well head assembly bottom is sealed to the well by pushing the 2 inch rubber sleeve over the top of the piezometer and tightening the hose clamps. The transducer is passed through the cable tension relief fitting (fitting) and lowered until it is about 30 feet (dependent on transducer pressure range) below the static water level. An adjustable length boom mounted on a pickup truck overhead rack and a large diameter opening block (snatch-block) hung on the end of the boom allows the transducer to be easily lowered down the piezometer. See figure 6 for a typical field set-up. The transducer cable is tied to the boom to hold the transducer at the proper depth. To fill the annular space between the transducer cable and fitting body, the vertical slit [cut with a single edge razor blade] in the rubber stopper is opened and the ¼ inch transducer cable is pushed through the slit into the ¼ inch stopper hole. The stopper is then slid down into the tension relief fitting, the two halves of the plastic washer [cut with tin snips] are set on top of the stopper, and the threaded fitting cap is lightly cinched with pliers on the tension relief fitting body. After the well is sealed, the data logger reading is set to the previously measured depth to static water level.

The water level is lowered in the well by adding air through the tire fitting. Air sources for wells needing only small air volumes to lower the water level (small diameter well with a shallow static water level) include small 12 volt air compressors and small compressed air storage tanks, both usually available at auto supply stores. Air sources for wells requiring a large volume of air include oil-less air compressors and, the author's choice, SCUBA tanks.

The water level in the Project piezometers was lowered 20 to 30 feet depending on the pressure range of the transducer. After the well is pressured, the apparent height of the water column above the transducer can be monitored with the data logger. The apparent height will rapidly return to static in wells screened opposite highly transmissive aquifers. The return to static will be slow in wells screened in poorly transmissive aquifers.

When the apparent water level has stabilized at the depressed static level for a few minutes, recording by the pre-programmed data logger is started and the quick release valve is immediately opened to release the pressure in the piezometer. The rate of water level recovery is automatically recorded by the data logger. Data recording is stopped after the water level has returned to static. The test data is printed for easy inspection and possession of a permanent record. The test is repeated in cases where the water level was lowered beyond the range of the transducer. Transducer "lock-up" is evidenced by numerous equal water level readings during the early portion of the recovery. Calculation of the estimated transmissivity is made in the office.

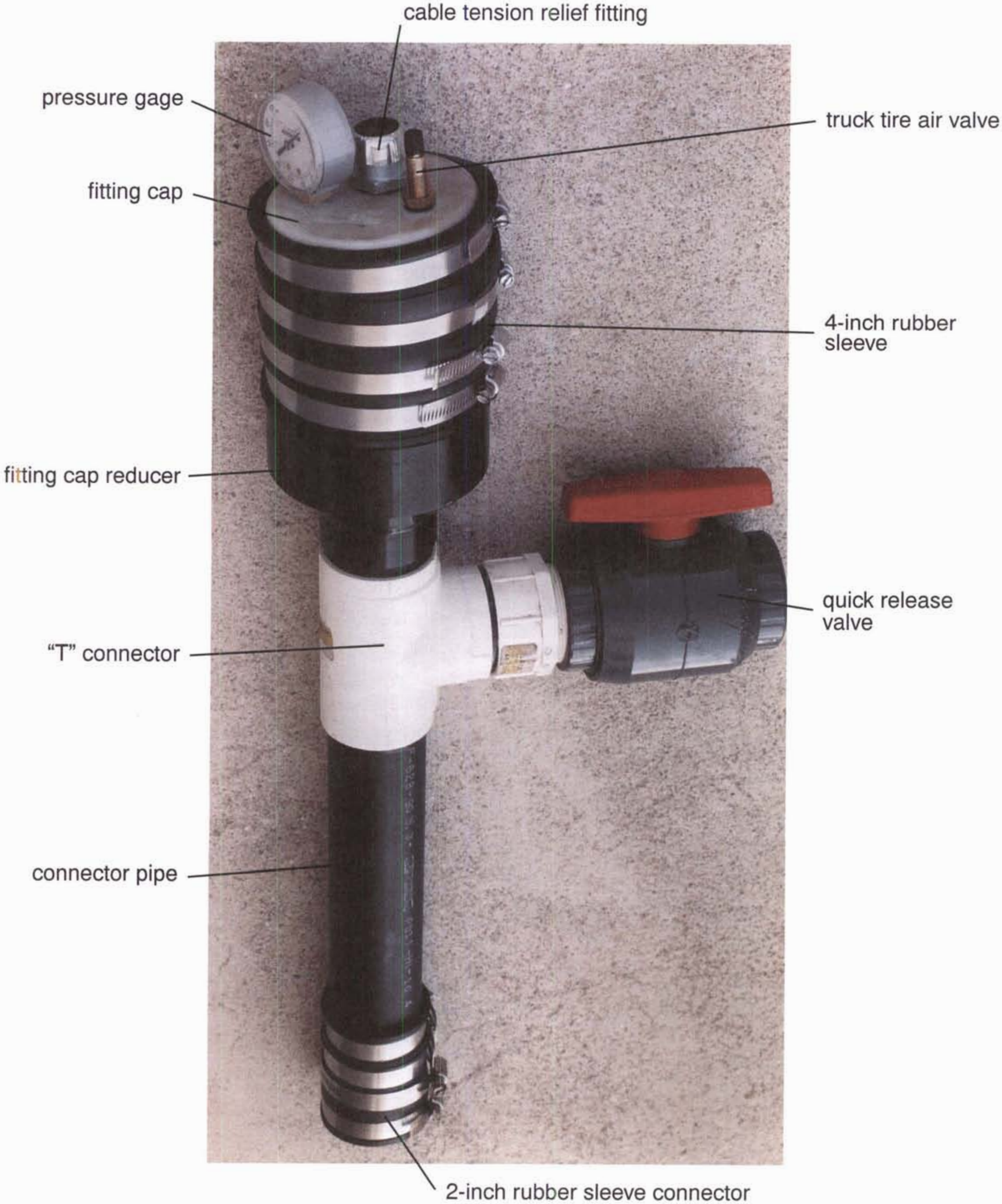


Figure 4. Pneumatic slug test well head assembly developed by the author.

Cable Tension Relief Fitting (CGB)

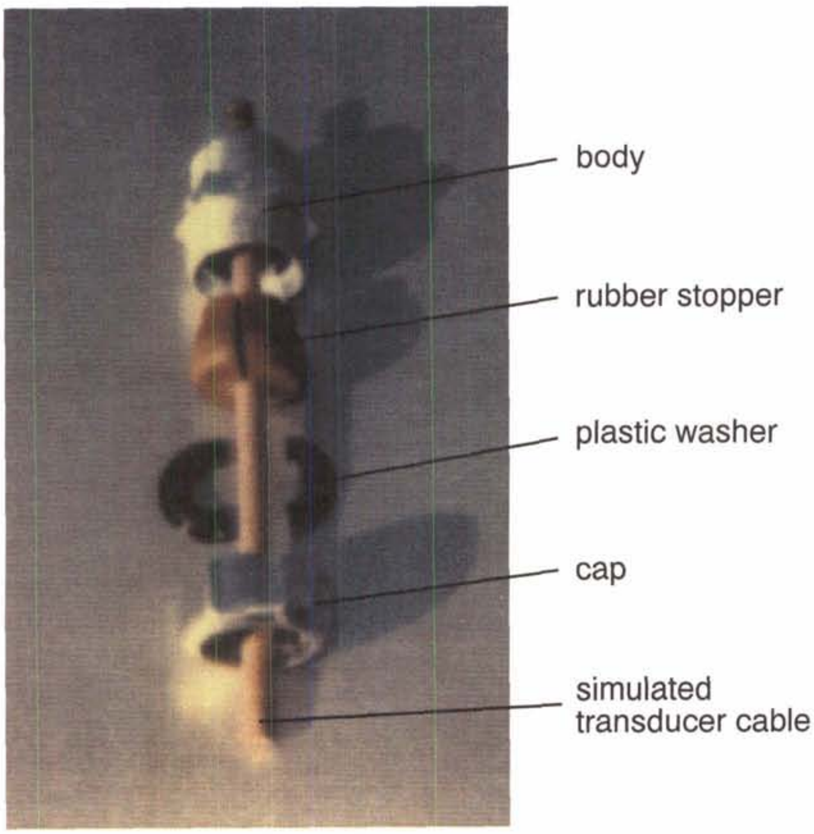


Figure 5. Exploded view of the 3/4-inch cable tension relief fitting (CGB fitting) parts. The 1/4 inch diameter transducer cable is simulated by the 1/4 inch diameter eraser. This long eraser (used in electric erasers) was also used in cable tension relief fitting pressure tests and pressure tests of the complete well head assembly.

Figure 6. Pneumatic slug testing on well BR-6 (2-11-92). Pressuring the well (upper). Logging water level recovery (lower). The blue box is the data logger and the field printer is in the black, foam padded suitcase.

SLUG TEST RECOVERY DATA ANALYSIS

The Cooper slug test solution was used to estimate transmissivity of the aquifer screened in each Project piezometer (see table 1). Cooper and others (1967) developed a solution to calculate transmissivity of confined aquifers from the rate of rise of the water level in a fully penetrating well after a sudden removal of a slug of water. Cooper and others (1967) note, however, that few wells completely penetrate an aquifer, but that it is nevertheless possible under some circumstances to derive useful information from a test on a partially penetrating well. They further conclude that

> "Since the vertical permeabilities of most stratified aquifers are only small fractions of the horizontal permeabilities, the induced flow within the small radius of the cone that develops during the short period of observation is likely to be essentially 2-dimensional. Therefore, the determined value of transmissivity would represent approximately the transmissibility of that part of the aquifer in which the well is screened or open, provided that the aquifer is reasonably homogenous and isotropic in planes parallel to the bedding and provided that the effective radius can be estimated closely."

Cooper and others (1967) also suggest that the judgement of an experienced hydrologist is needed to decide the significance, if any, of a determination of transmissivity from a slug test. Furthermore, Ferris and others (1962) caution, "the duration of a "slug" test is very short, hence the estimated transmissibility determined from the test will be representative only of the water-bearing material close to the well [screen]."

The aquifers screened by the Project piezometer are assumed to sufficiently meet the conditions on which the Cooper (1967) method is based, that the resulting transmissivities are at least useful for relative comparison. Kunkel and Chase (1969) assumed that these conditions were met by the wells in which they ran pumping tests for determining transmissibility of the Valley alluvium. In support of their contention that "the transmissibility obtained probably apply almost wholly to the saturated deposits tapped by the wells," they cite

> "...the very large differences between vertical and horizontal permeability of the deposits, as evidenced by the high barometric efficiency of the wells, by the lenticular character of the deposits, by the differences in head or water level between shallow and deep wells such as 26/40-22P1 and 22N1, and by the differences in the pumping-test results themselves."

Table 1. Estimated transmissivity from the slug recovery data as determined by the Cooper (1967) method for the 20 feet of aquifer opposite each piezometer screen.

Well	Piezometer		Transmissivity (ft^2/min)	Comments
BR-1	tall	(shal)	.21	
	next tall	(sh/med)	.24	
	next short	(dp/med)	.01	
	short	(deep)	.004	
BR-2	tall (blue)	(shal)	.01	Confirmed by second slug.
	(yellow)	(med)	.19	
	(red)	(deep)	.016	
BR-3	tall	(shal)	.00005	Too low.
	medium	(med)	.06	
	short	(deep)	.006	
BR-4			.28	
BR-5	tall	(shal)	.23	
	medium	(med)	.15	
	short	(deep)	.18	
BR-6	tall	(shal)	.02	Suspiciously low.
	medium	(med)	.25	
	short	(deep)	.20	
BR-10	tall	(shal)	.19	
	next tall	(sh/med)	.02	Too low
	next short	(dp/med)	.14	
	short	(deep)	.09	
NR-1	(red)	(shal)	.004	Confirmed by re-slug. Too low.
	(yellow)	(med)	?	Can't remove reducers (no room)
	(white)	(deep)	.05	
NR-2	tall	(shal)	.48	
	medium	(med)	.14	
	short	(deep)	.12	
MW-32	tall	(shal)	.009	Too low.
	next tall	(sh/med)	.31	
	next short	(dp/med)	.23	
	short	(deep)	.11	

Note the number of shallow piezometers with low transmissivity (slow to very slow recovery rates). This is discussed in Attachment IV.

The estimated transmissivities presented herein (table 1) are meant to at least convey the relative difference in transmissivity between the aquifer screened by the Project piezometers. The actual degree to which the Project piezometers meet the governing assumptions for the Cooper method is not known exactly nor is the degree of development known. It is suspected that well development may be less than complete because of the relatively long screen and relatively small water quantity pumped (reported as 5-15 gal/min) during airlift development. The estimated aquifer transmissivities are less than the actual transmissivity if the screens are not fully developed.

SOLUTION SOFTWARE

The Cooper slug test solution "package" in AQTESOLV (software from Geraghty and Miller, a Groundwater Consulting Company) was used to determine the transmissivities shown in table 1. The initial recovery to static water level portion of the slug induced water level response curve was used for the Cooper solution in the case of an undampened recovery (discussed below). The AQTESOLV Cooper slug solution was checked by the original curve-fitting procedure, described in the paper by Cooper and others (1967), for BR-4. The curve-fitting transmissivity was .275 ft^2/min and the software solution was .28 ft^2/min.

UNDAMPENED SLUG RECOVERIES

Several of the slug test water level recoveries showed the effect of water column inertia; the water level recovery was "undampened." However, Cooper and others (1967), in the derivation of their slug test solution for transmissivity, did not account for water column inertia.

Bredehoeft and others (1966) discovered that the response of a well [water level] to a seismic disturbance [Cooper and others, 1965] was like the mechanical spring-mass system with viscous damping; i.e., as a simple harmonic oscillator. They demonstrated, by a series of field tests in wells in Florida and Georgia during July 1964, that the column of water in some wells can oscillate very much like the classic spring-mass system. It was apparent from these investigations that many wells will behave as underdamped oscillators--the water level will oscillate following a rapid disturbance. Van der Kamp (1976) found this especially true for deep wells and/or wells screening highly permeable aquifers. This fact places certain restrictions on the use of a number of accepted methods of aquifer analysis; perhaps the most obvious example of the importance of inertial effects concerns the slug test (Bredehoeft and others, 1966).

Van der Kamp (1976) classified slug test water level recoveries as follows:

> (1) Overdamped system [well-aquifer]--the water level returns to the equilibrium level in an approximately exponential manner.
> (2) Underdamped system - the water level oscillates about the equilibrium level (NR-2 shallow).
> (3) Critical damping - The transition between overdamped and underdamped (BR-4).

Several papers offer solutions for the underdamped case (van der Kamp, 1976; Krauss, 1977). Krauss (1977) notes that the parameters of the free oscillation, damping coefficient, and natural frequency are determined by the parameters of the aquifer, particularly the transmissibility, and well geometry. To determine transmissivity, Krauss (1977) offers a relation between the natural frequency and the height of the water column and he presents a graph relating the damping coefficient to a solution coefficient for a range of aquifer storage coefficients.

The Krauss (1977) solution is fairly simple and was applied to BR-4 and NR-2 shallow. The estimated transmissivity for BR-4 ranged from 0.15 ft^2/min for a .001 storage coefficient to 0.50 ft^2/min for a storage coefficient of $1x10^{-8}$. The mean transmissivity over the range of storage coefficients is a little higher than the transmissivity of 0.28 ft^2/min determined by the Cooper method over the initial recovery limb of the water level recovery oscillation. The Krauss transmissivity for NR-2 shallow ranged from 1.05 ft^2/min for a .001 storage coefficient to 2.62 ft^2/min for a storage coefficient of $1x10^{-8}$. The mean of this range is considerably higher than the transmissivity of 0.48 ft^2/min determined by the Cooper method using the initial recovery limb of the slug induced water level oscillation.

A rigorous analysis of the undamped slug test water level responses is beyond the needs of this Project. All of the data logger slug test print-outs are provided in Appendix XI for those readers interested in further investigation of underdamped or critical damped responses.

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APPENDIX IV

Anomalously Low Shallow Aquifer Transmissivities

APPENDIX IV.

ANOMALOUSLY LOW SHALLOW AQUIFER TRANSMISSIVITIES

(Probably a Function of Poor Development)

Dennis E. Watt

INTRODUCTION

The water level recovery rate during the slug test was relatively slow in a number of the shallow Project piezometers as compared to the recovery rate in many of the deeper piezometers. The estimated transmissivity, therefore, was also relatively low in comparison. The relatively low shallow piezometer transmissivities (BR-2, MW-32, NR-1, BR-6, and the medium-shallow piezometer of BR-10) are not believed to be representative of the aquifer, but are probably a function of insufficient development. Insufficient air-line submergence during air-lift development and/or partial aquifer air lock may be the cause. It is assumed that the air-line was down to as near the top of the screen as possible, so as to maximize submergence yet minimize aquifer air locking potential, when the shallow wells were developed. Drill hole cuttings, drilling rate, and geophysical logs generally indicate a decreasing hydraulic conductivity trend with increasing depth, as is normal for alluvial basin fill aquifers.

PIEZOMETER DESIGN

Allowance for a minimum of 50 percent submergence of the air-line during air-lift development was the "rule-of-thumb" for the placement of the shallow piezometer screen relative to the apparent water level on the electric logs. All the completed shallow piezometers, except MW-32, will allow 50 percent or greater airline submergence based on the measured water level and the completed depth to the top of the piezometer screen.

Two curves are shown on figure 1. The upper curve is the approximate submergence percentage for optimum air-lift efficiency from Ingersoll-Rand (1971). The lower curve is the lower submergence percentage of the range called the "customary allowable submergence" from table 45T (originally from Compressed Air Magazine) in the appendix of Campbell and Lehr (1973). This table was the source of the 50 percent submergence design "rule-of-thumb" for air-lifting. However, based on the plot of the maximum possible submergence (figure 1) in the completed shallow piezometers and the apparently successful development of the shallow piezometers at BR-1, BR-5, and BR-10, it appears that optimum air-lift submergence may be the minimum needed for development of these mud drilled holes.

Maximum Possible Submergence (Air-Lifting)
in the Shallow Piezometer

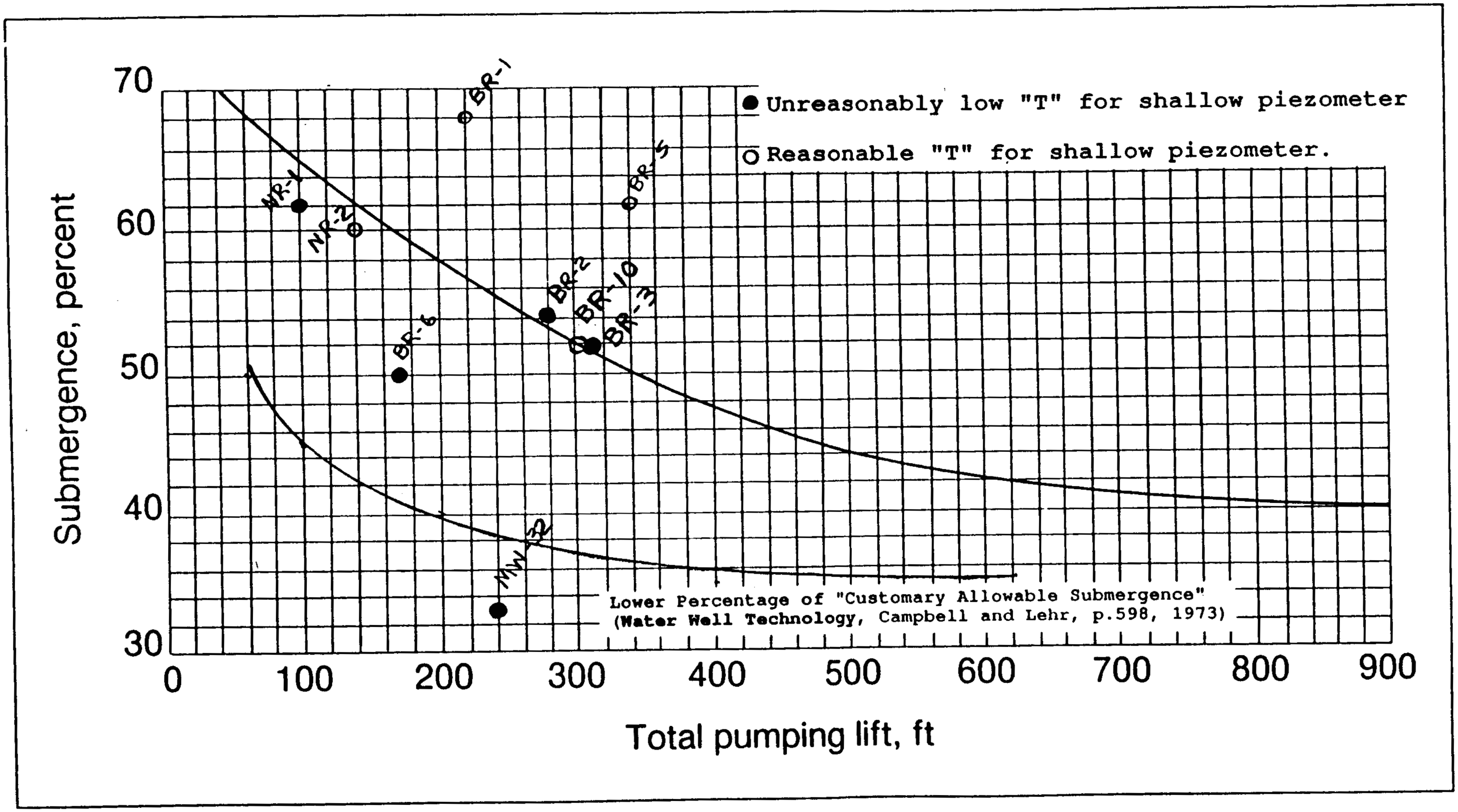

Figure 1. **Approximate percent pumping submergence for optimum air-lift efficiency. In general, development proceeds most efficiently when the discharge is maximized. Therefore, the submergence should always be as great as possible within practical limits.** *(Ingersoll-Rand, 1971)*

This conclusion assumes that the air line was down to near the top of the screen when the shallow piezometers were air-lift developed. If that was the case, then the "extra" submergence is probably needed in an undeveloped well when the initial air-lift pumping water level is potentially lower than the air-lift pumping water level for the same well after it is developed.

Inspection of the electric logs did not reveal any apparent water table responses above the measured water table. This could cause insufficient submergence if a shallow piezometer screen depth was selected based on an apparent water table which was above the actual water table. Most of the logs, however, showed the water table close to the actual, although the character on the BR-2 electrics is relatively indistinct.

AIR LOCKED AQUIFER

The aquifer may become air locked if the airline is just above or in the screen. Driscoll (1986) notes that the aquifer may become air locked when a large burst of air is injected into the screened area of a well. He notes that certain kinds of formations are more prone to air locking, especially those formations that consist of stratified, coarse sand or gravel lenses separated by thin, impermeable clay layers. Aquifers with good vertical hydraulic conductivity are generally not affected. If some air becomes trapped in the aquifer, it may impede the flow of water toward the screen (Driscoll, 1968).

The degree to which air locking is a factor in the anomalously low shallow aquifer transmissivities is not known. However, if all other factors are equal, the apparent successful development of BR-10 shallow as compared to the apparent poor development of the shallow piezometers at BR-2 and BR-3, all on or very near the optimum submergence curve (see figure 1), may be an indication of some aquifer air locking in BR-2 and BR-3 shallow.

CONCLUSION

It is suspected that poor development caused by inadequate submergence during air-lift development is the predominant cause of the anomalously low shallow piezometer transmissivities. Aquifer air locking may also have occurred during development and may play a part.

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APPENDIX V

Pre-Project Well Data Maps

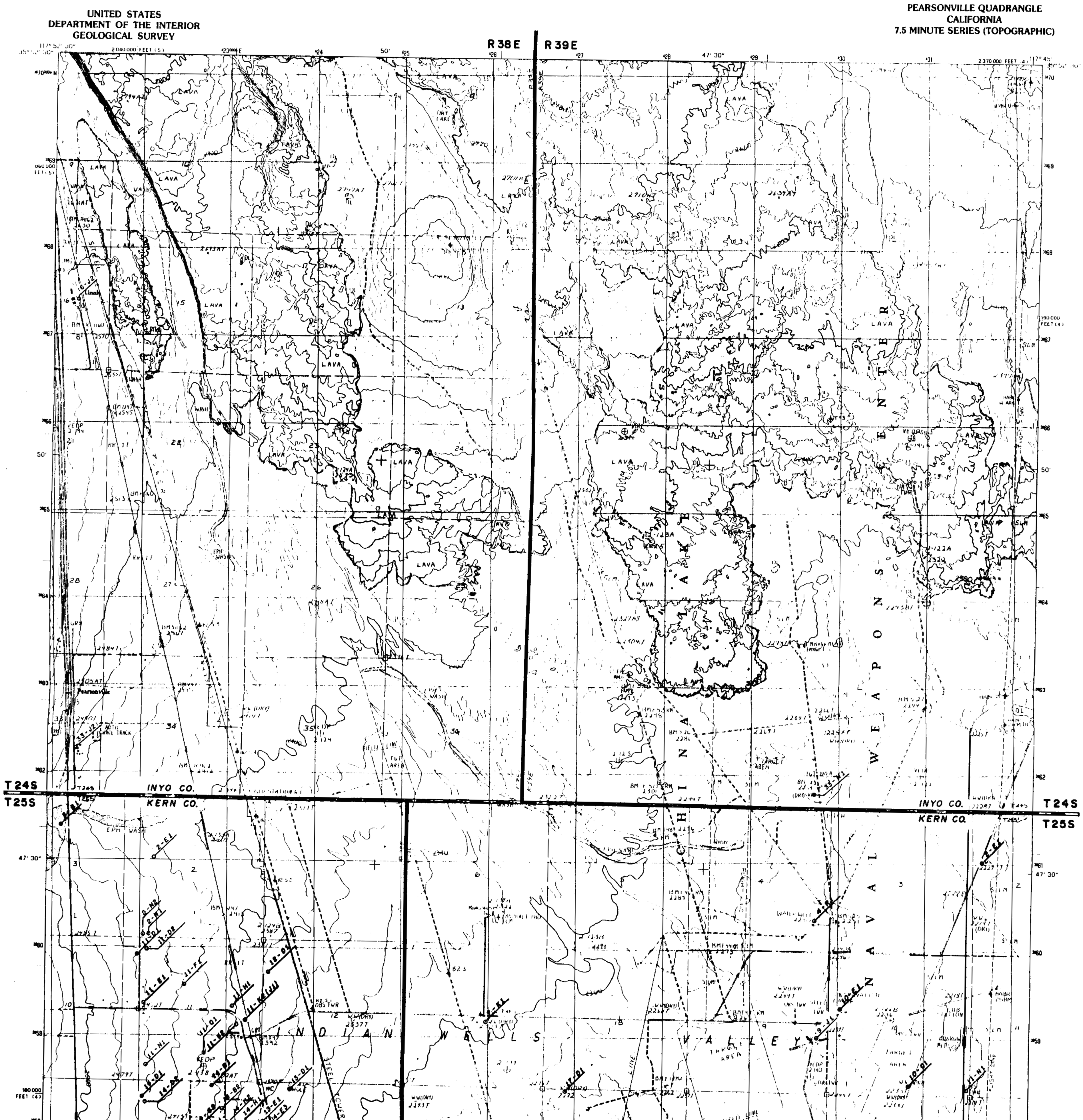
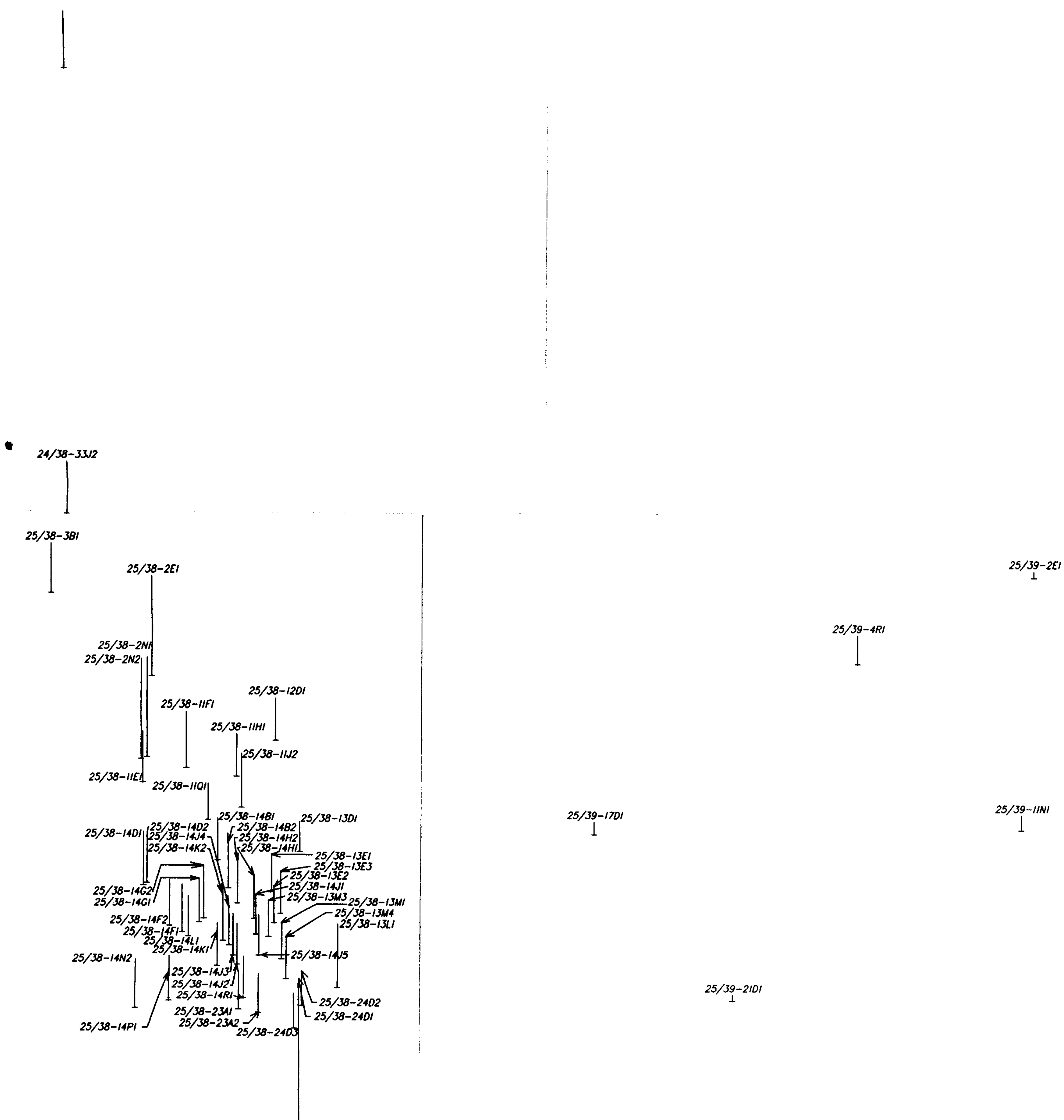


Figure 1

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

INDIAN WELLS VALLEY GROUNDWATER PROJECT

Pearsonville, CA

2000 0 2000 4000 Feet
Horizontal Scale

400 0 400 800 Feet
Vertical Scale

Figure 1a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

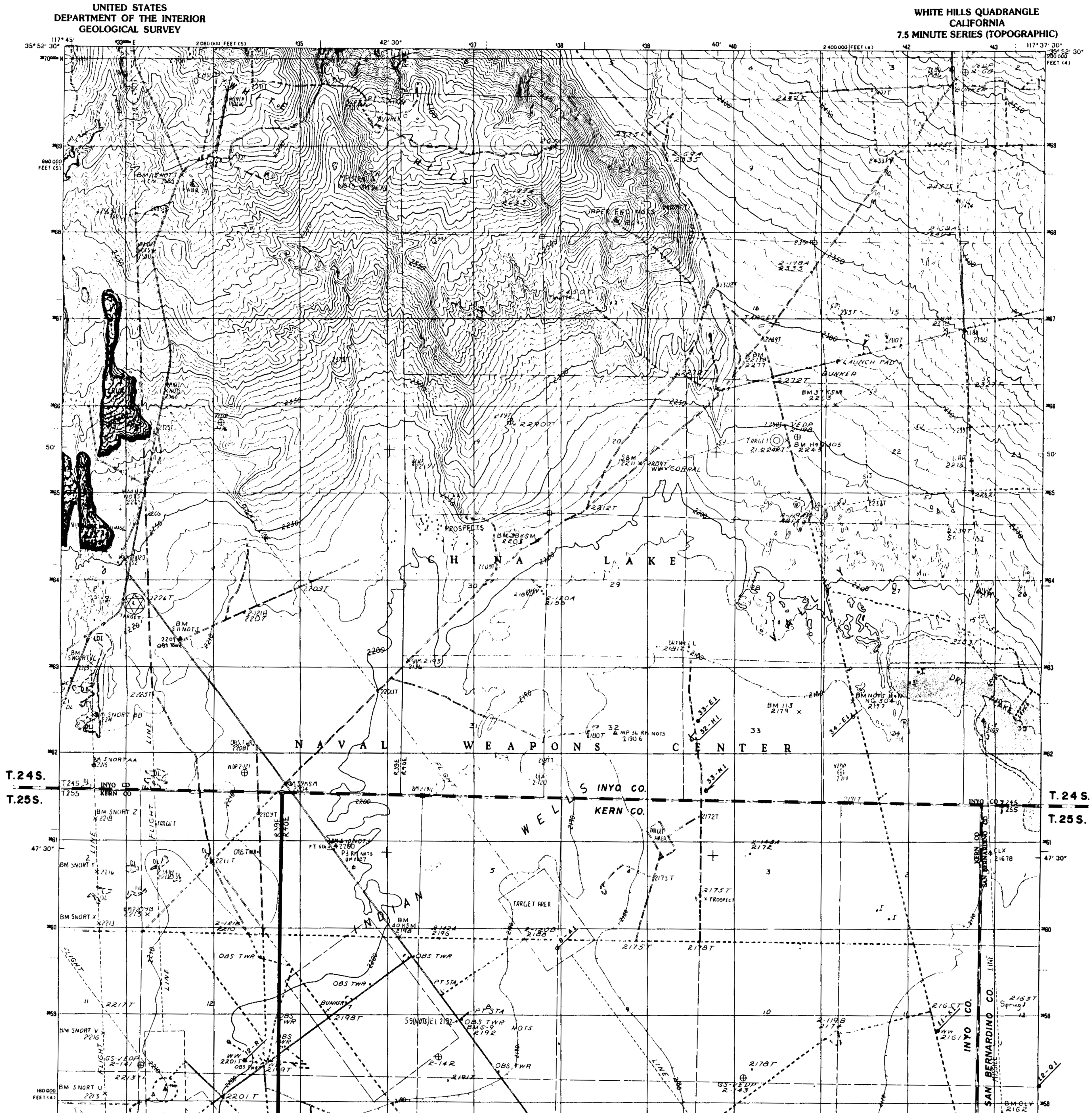
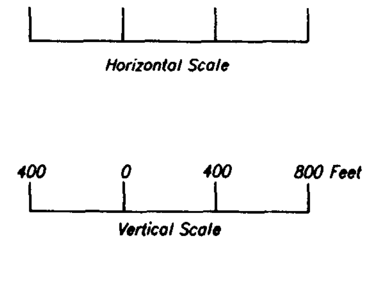


Figure 2

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.

Indian Wells Valley Groundwater Project

White Hills, Calif.



All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth

Each well is represented by a "stick".

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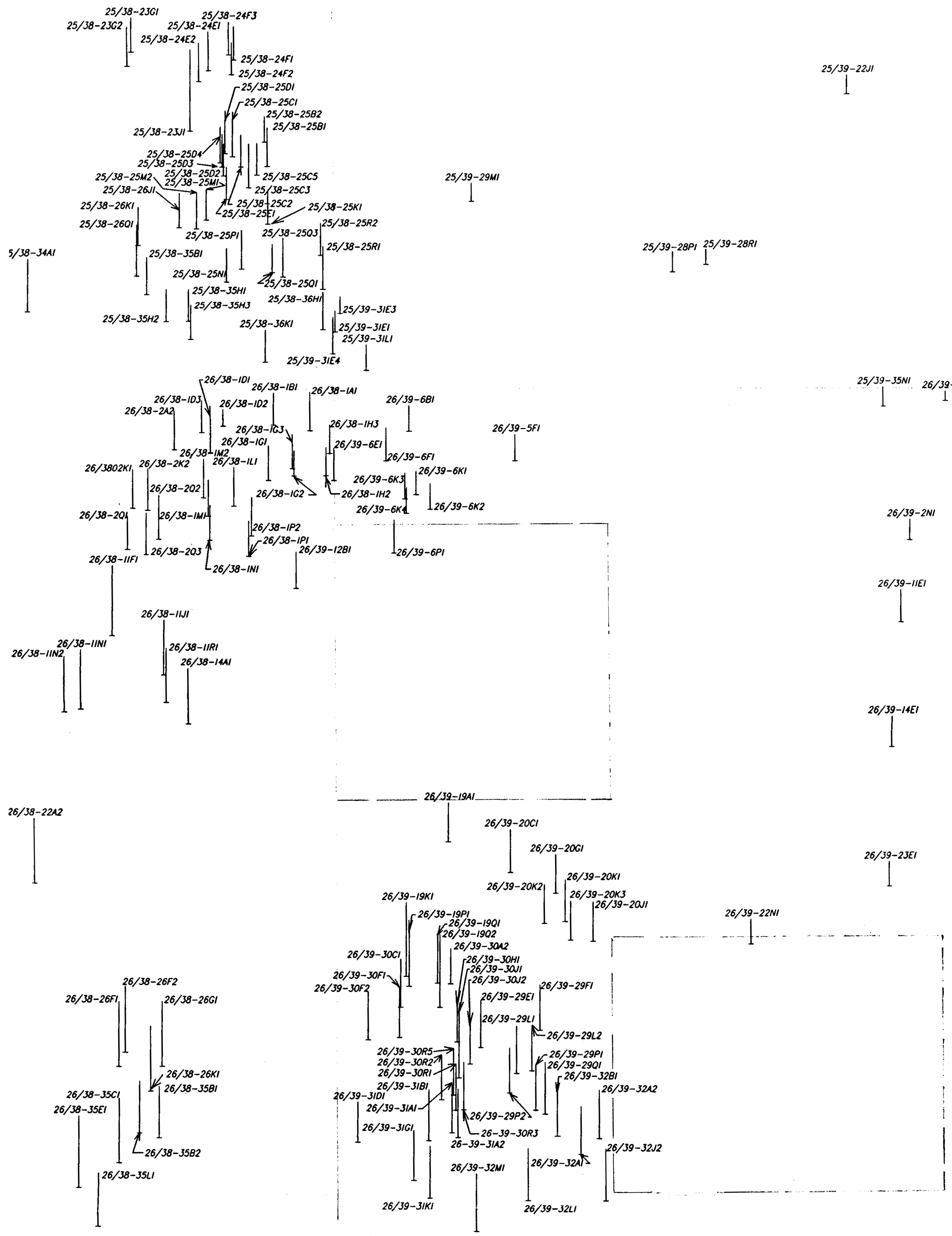
Figure 2a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.



INDIAN WELLS VALLEY GROUNDWATER PROJECT

All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth

Inyokern, CA

Each well is represented by a "stick".

2000 0 2000 4000 Feet

Horizontal Scale

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

400 0 400 800 Feet

Vertical Scale

Figure 3a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

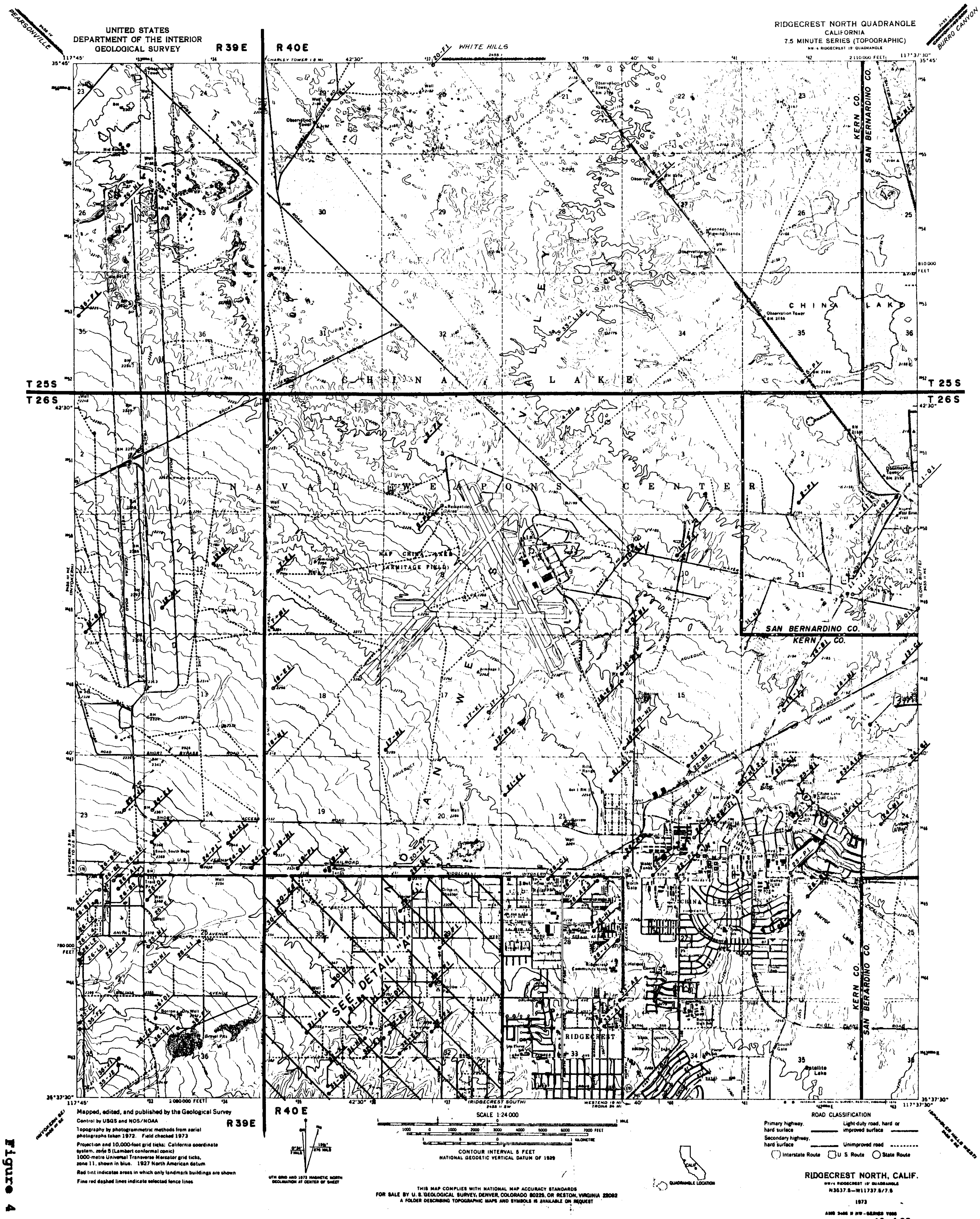
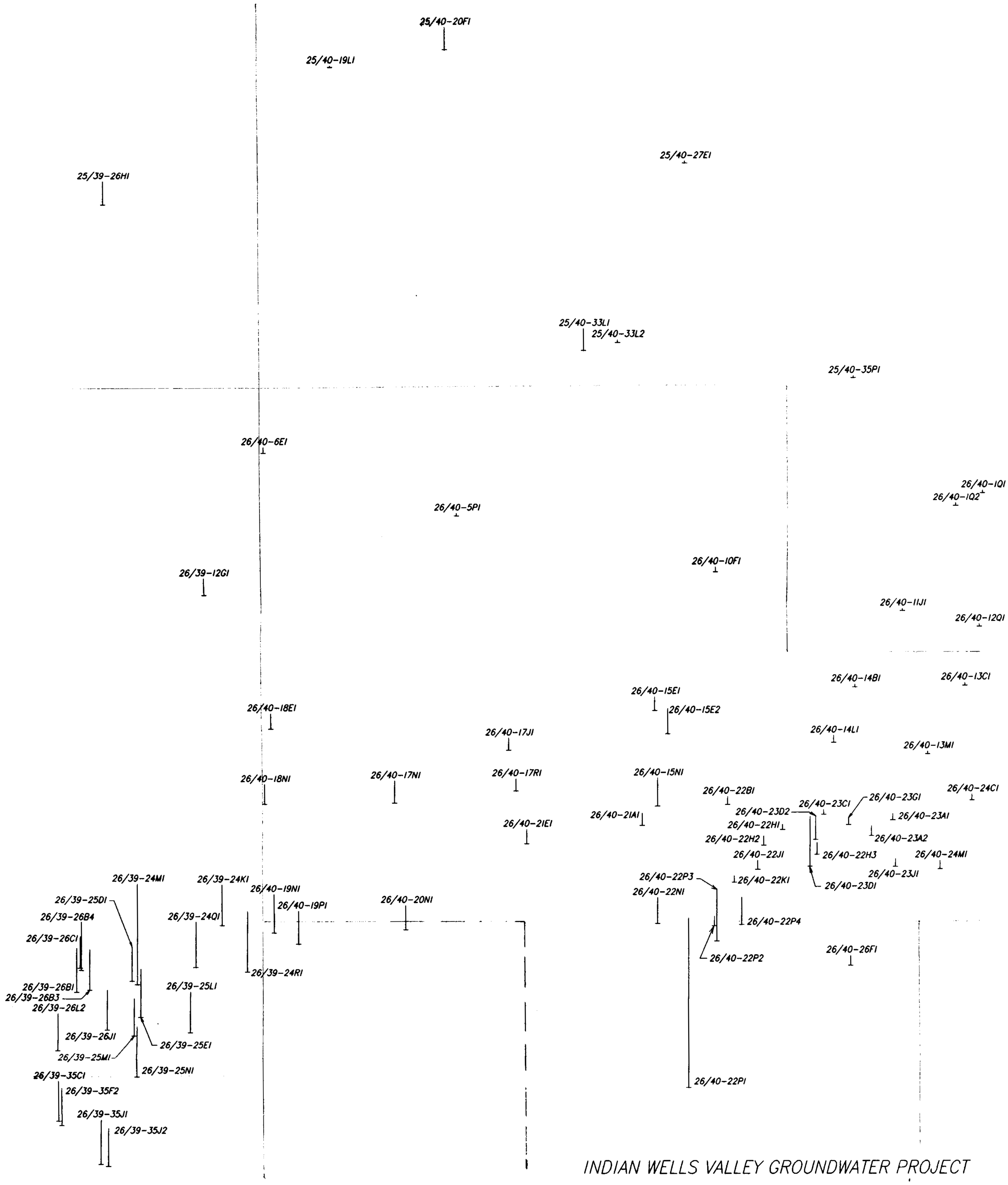


Figure 4

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



INDIAN WELLS VALLEY GROUNDWATER PROJECT

Ridgecrest North

2000 0 2000 4000 Feet
Horizontal Scale

400 0 400 800 Feet
Vertical Scale

All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

Figure 4a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

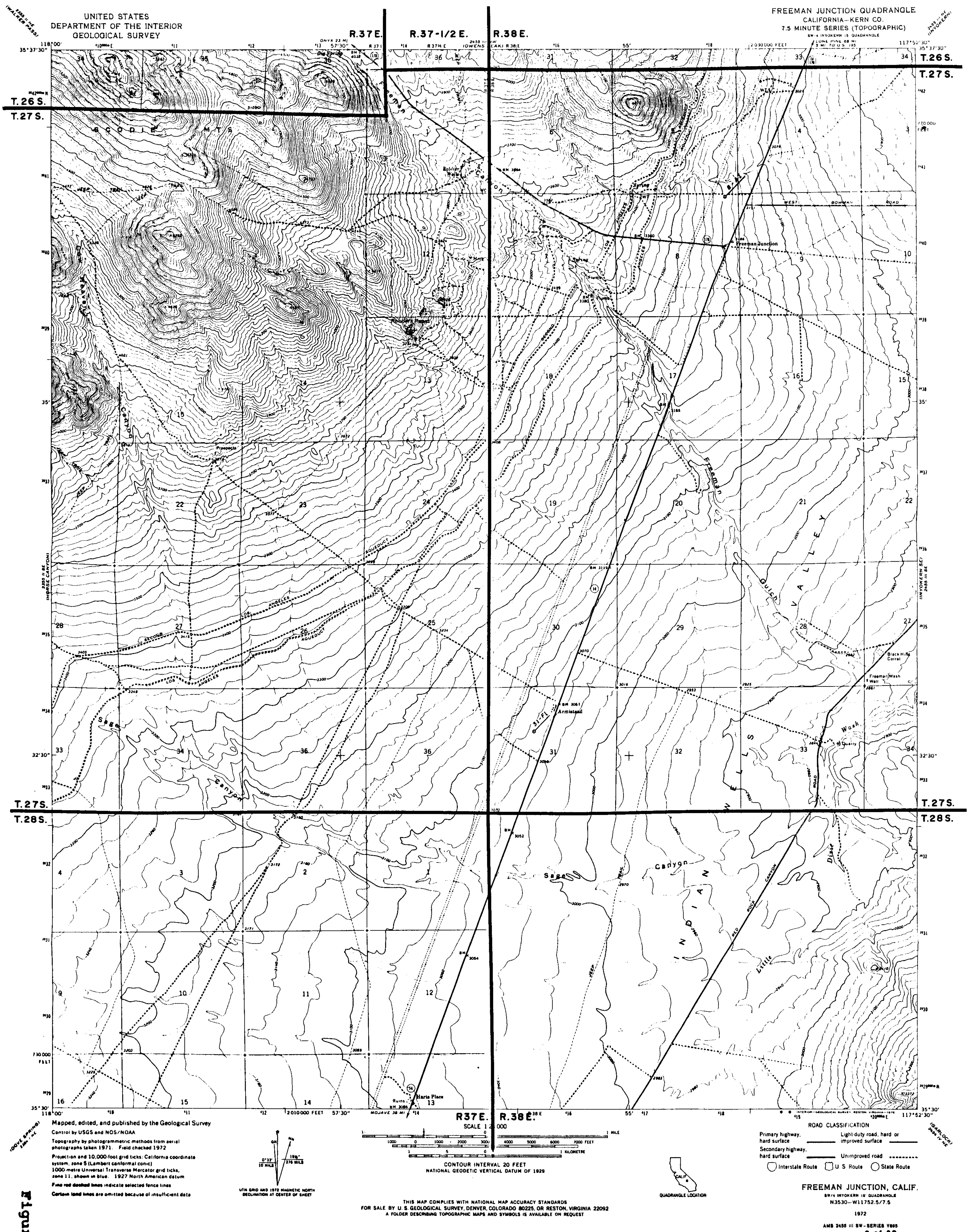
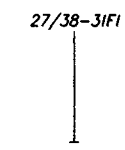


Figure 5

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



Indian Wells Valley Groundwater Project

All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

Freeman Junction, Ca.

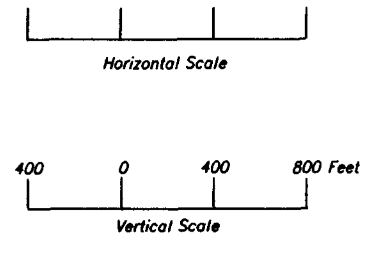


Figure 5a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

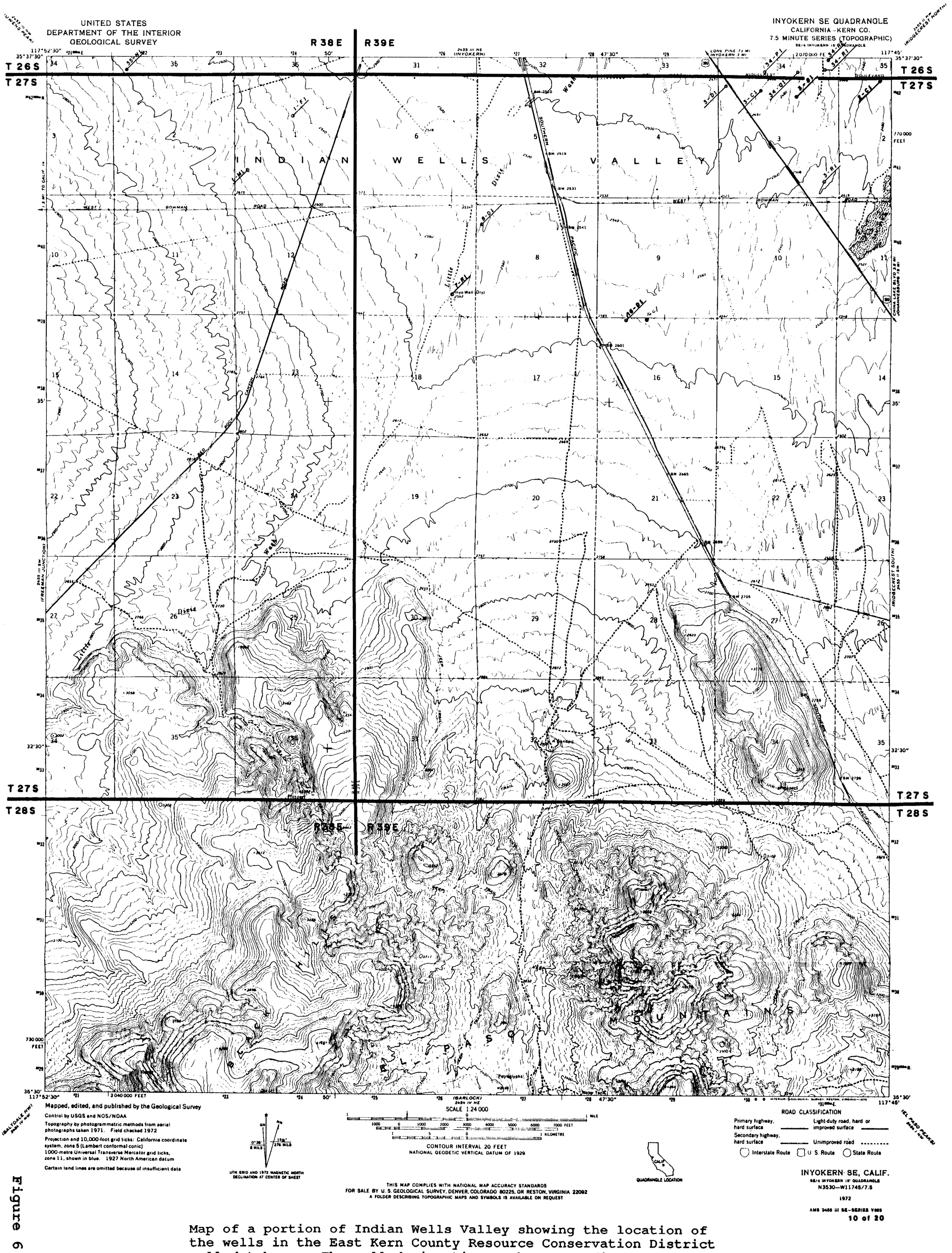
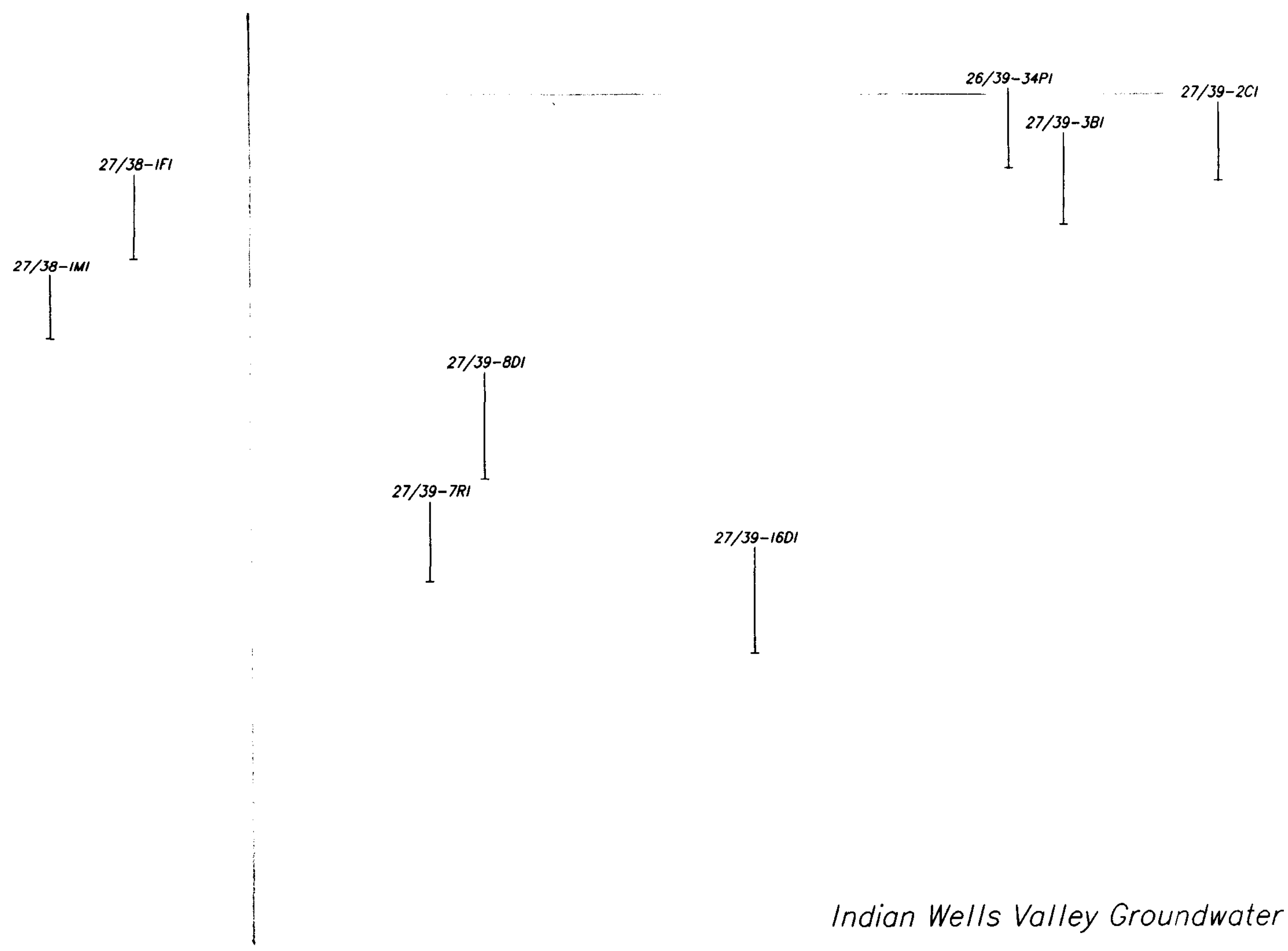


Figure 6

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



Indian Wells Valley Groundwater Project

All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

Inyokern, SE

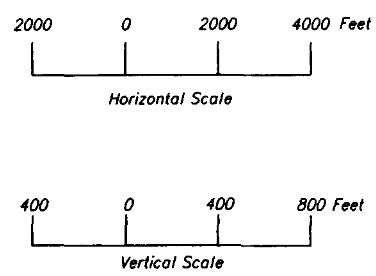


Figure 6a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

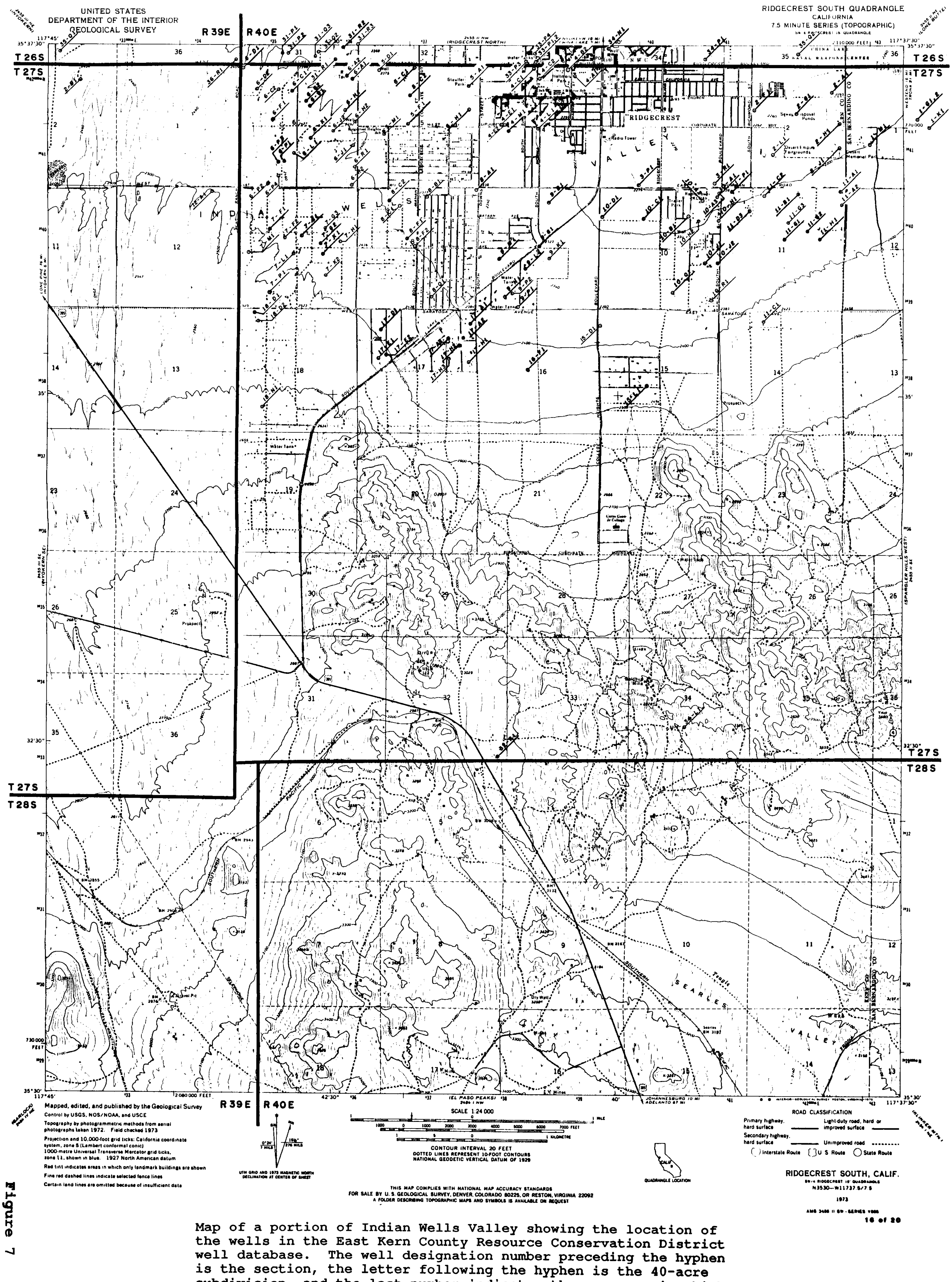
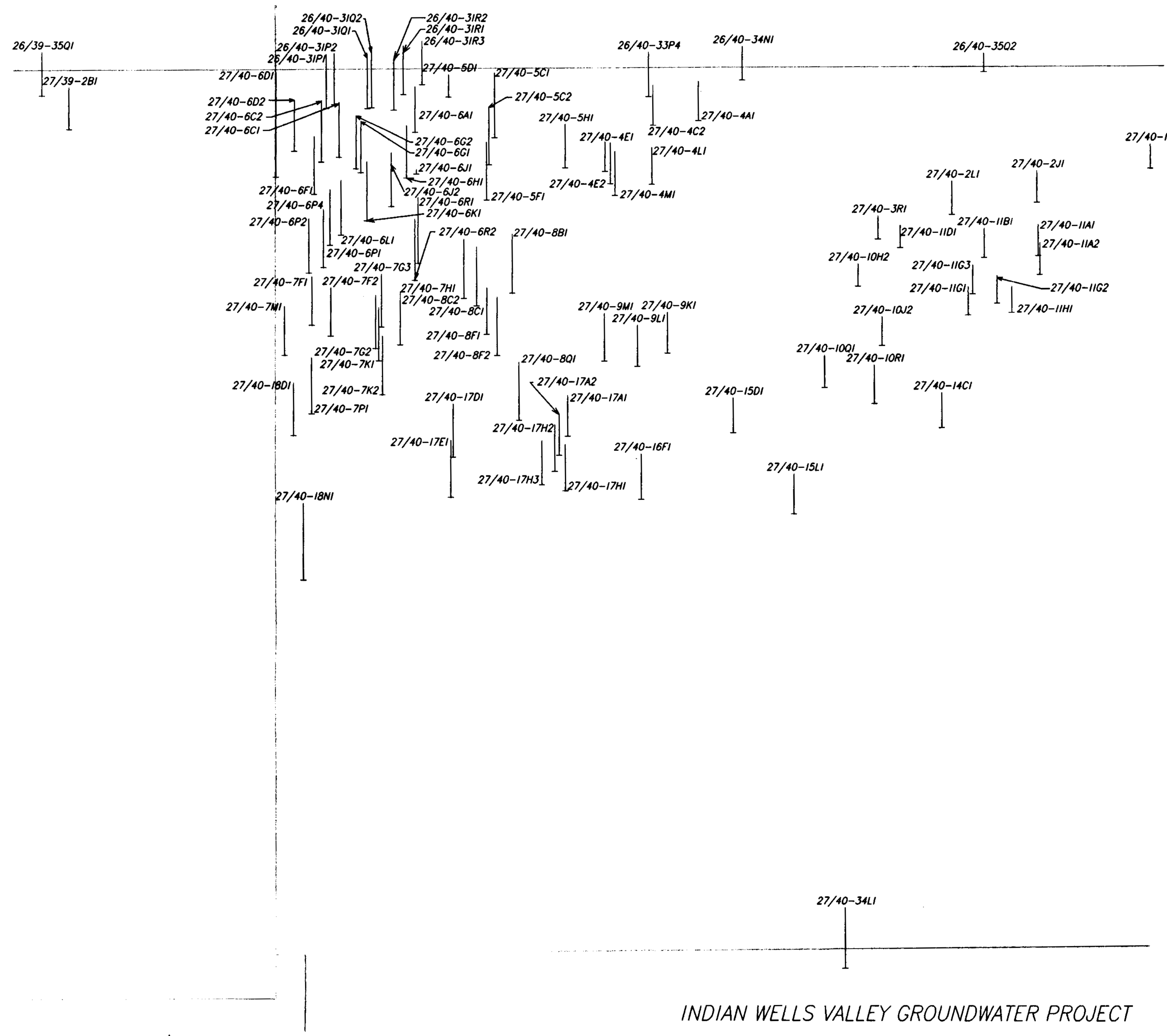


Figure 7

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



INDIAN WELLS VALLEY GROUNDWATER PROJECT

Ridgecrest South

All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

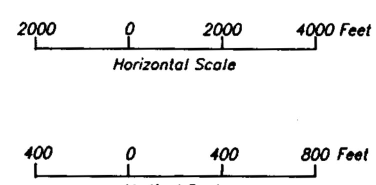


Figure 7a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

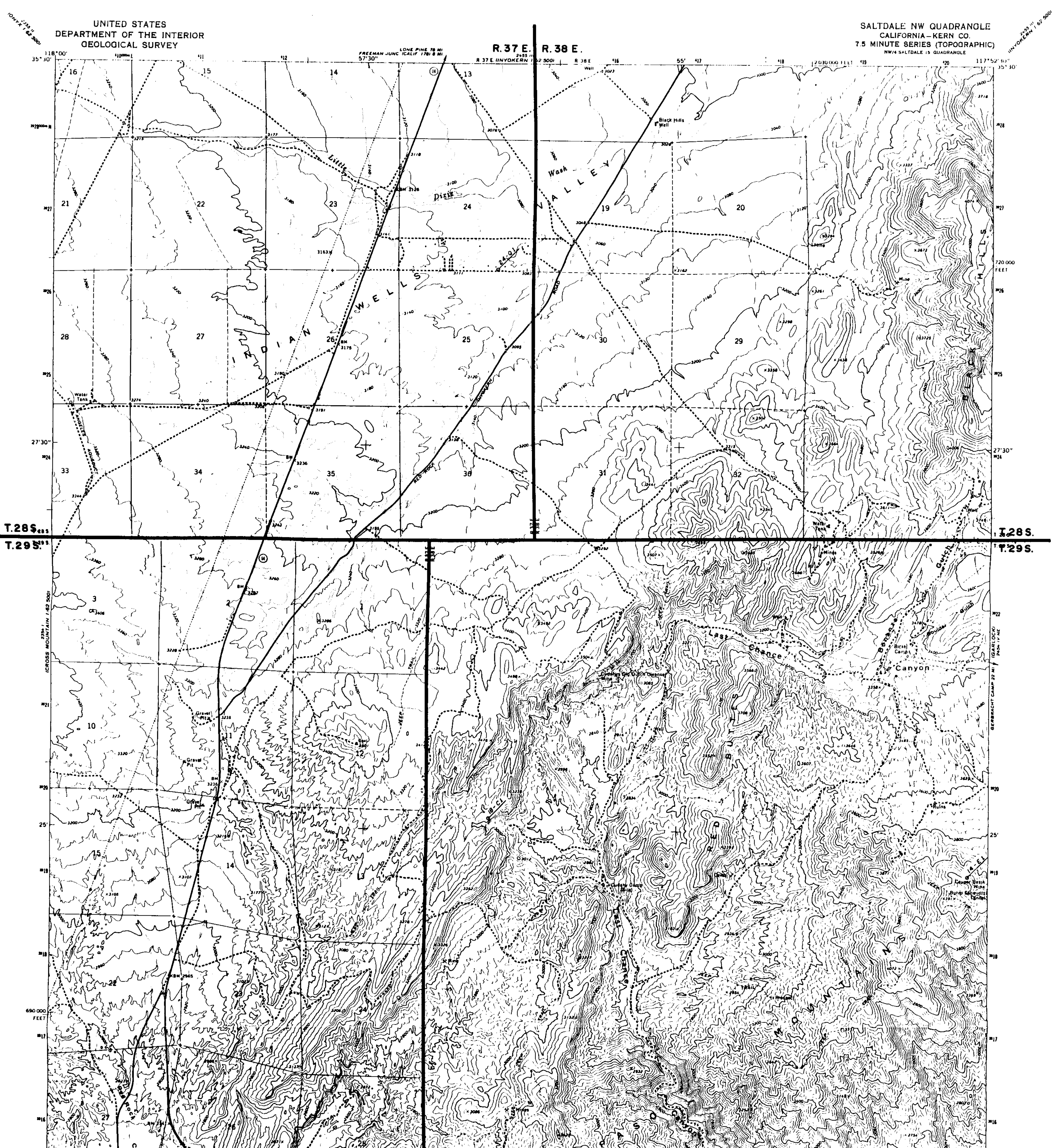
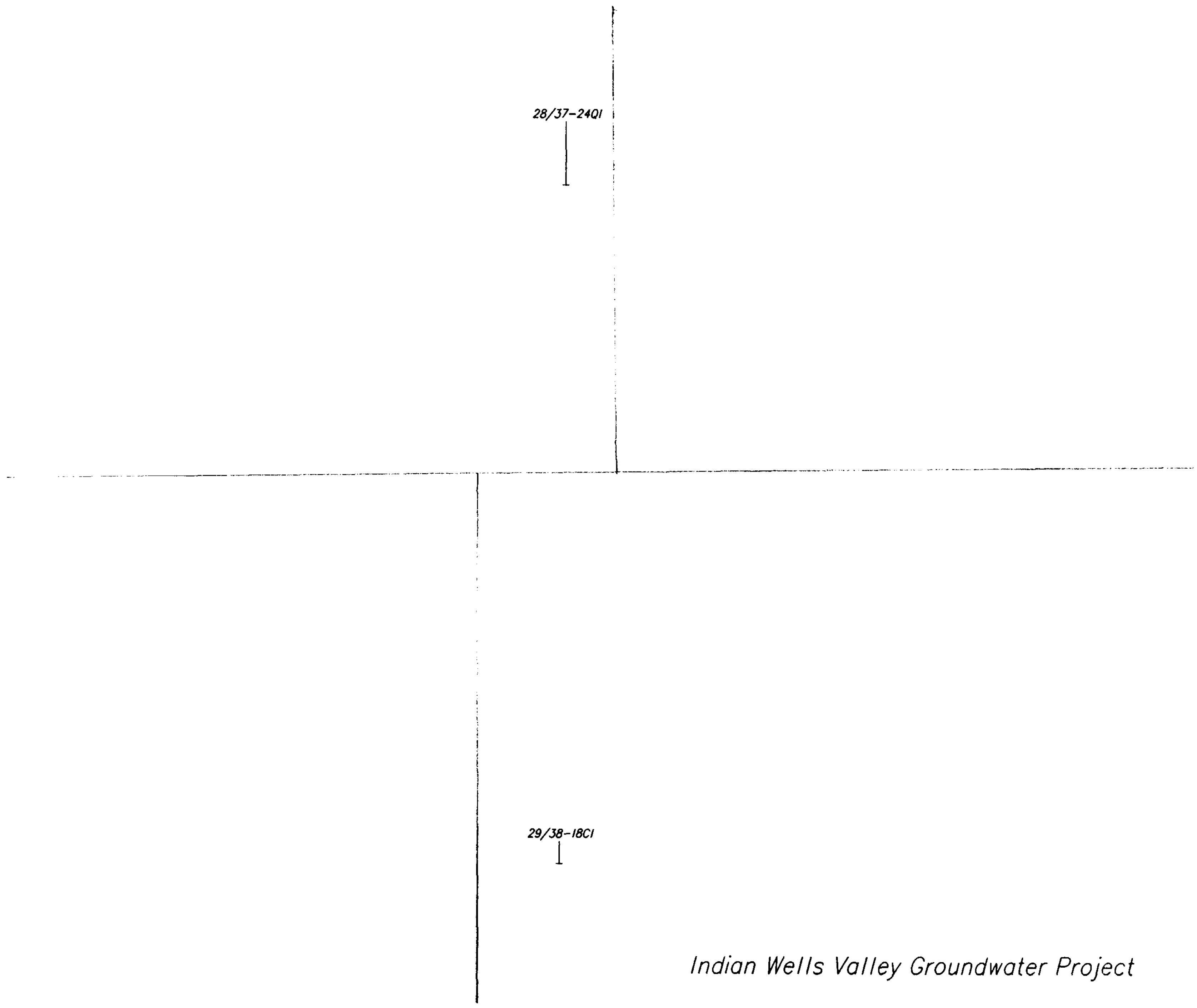


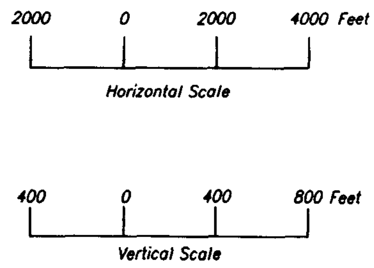
Figure 8

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



Indian Wells Valley Groundwater Project

Saltdale NW



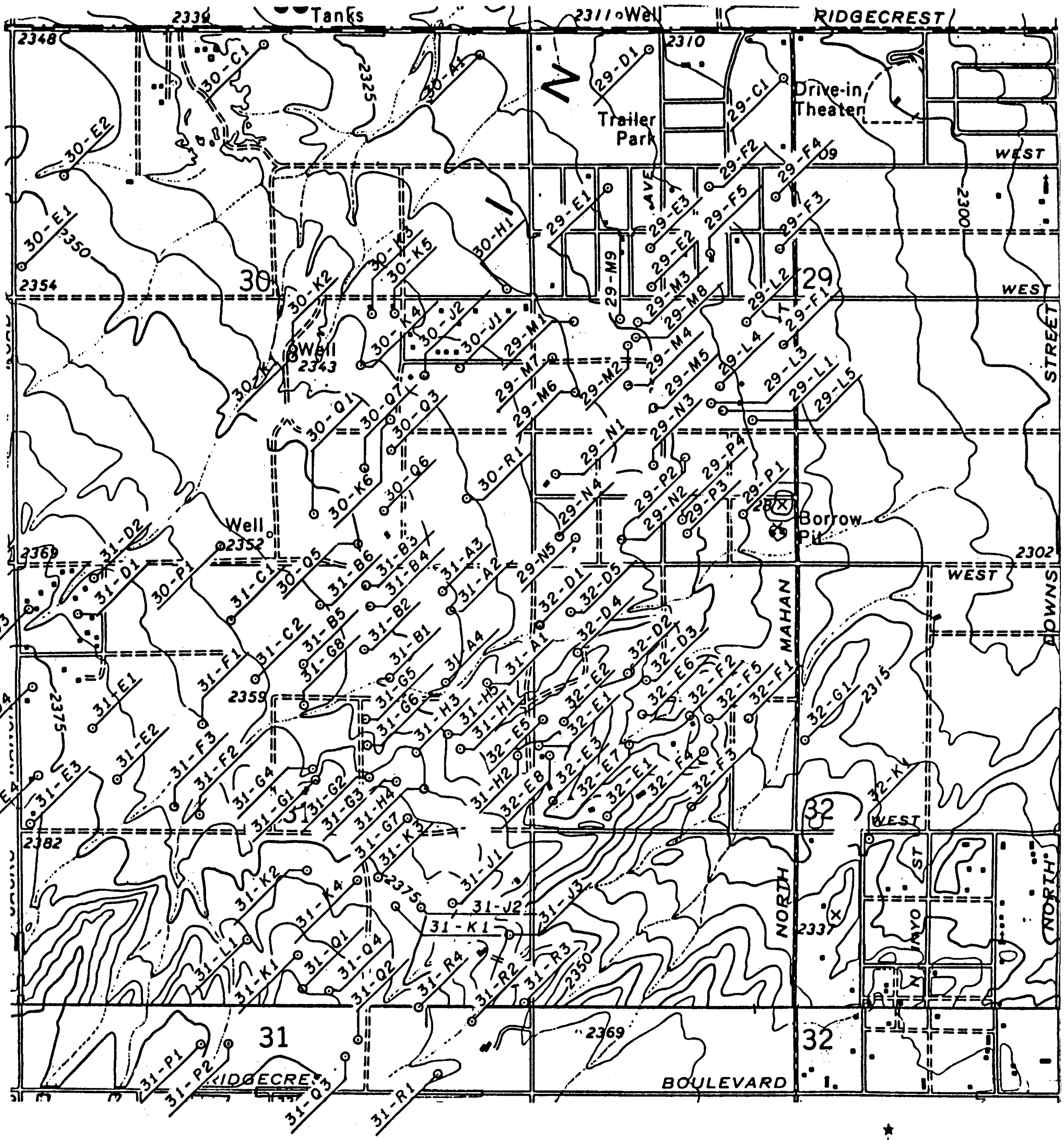
All wells in the East Kern County Resource Conservation District (EKCRCD) Database with a Total Depth

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

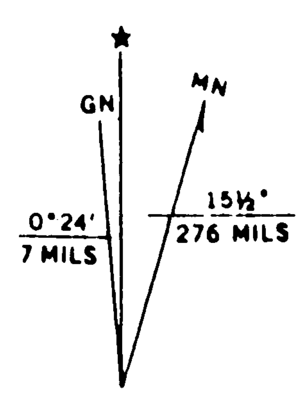
Figure 8a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.



DETAIL "A"

T. 26 S., R. 40 E.



UTM GRID AND 1973 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Figure 9

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.

All wells in the East Kern County Resource Conservation District (EKCRCD) database with a total depth.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

INDIAN WELLS VALLEY GROUNDWATER PROJECT

Detail A

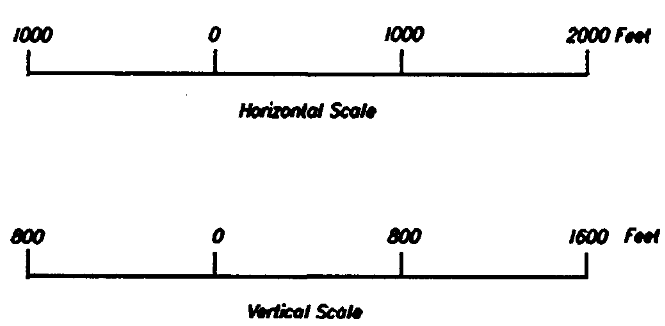


Figure 9a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

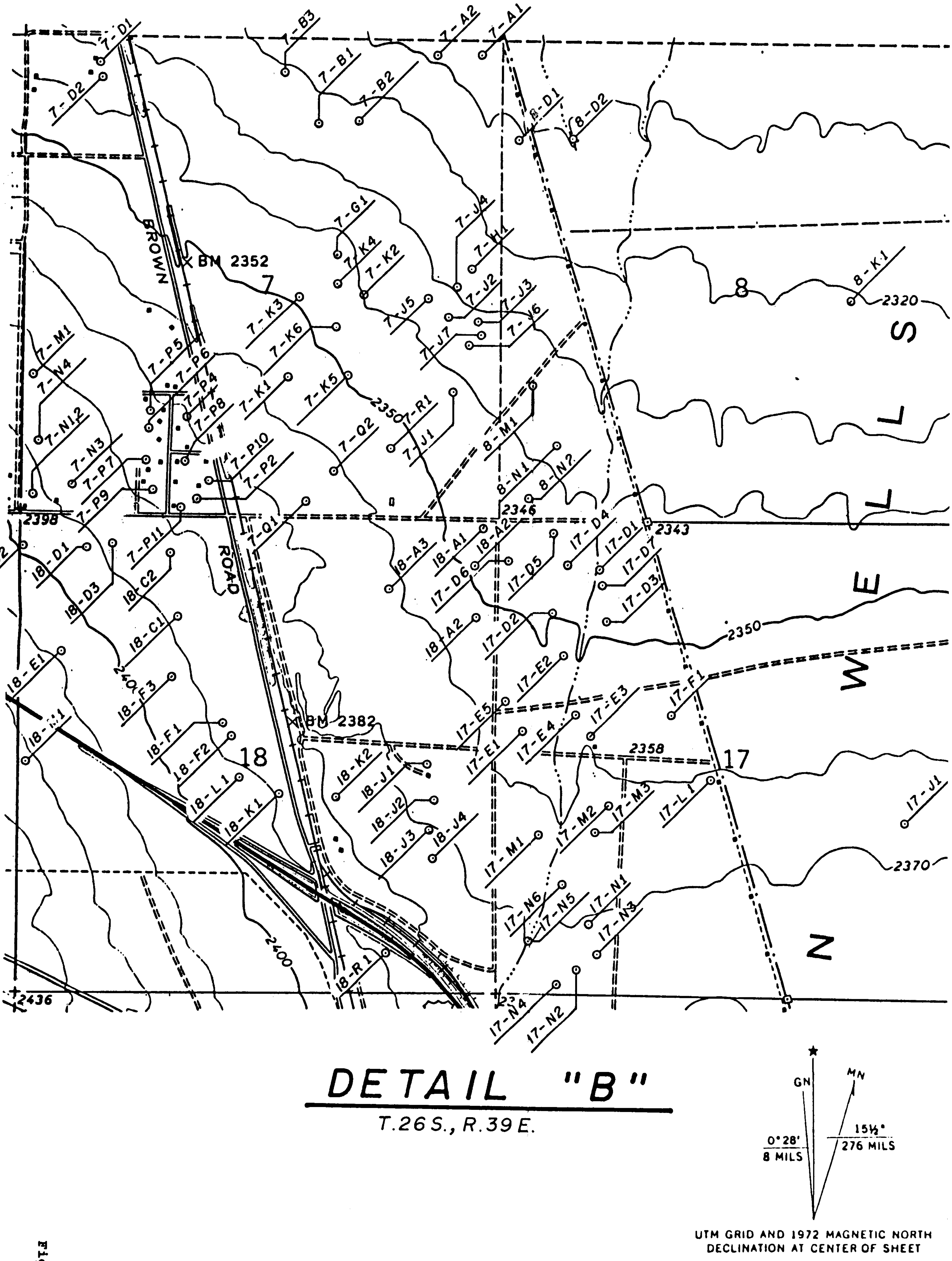
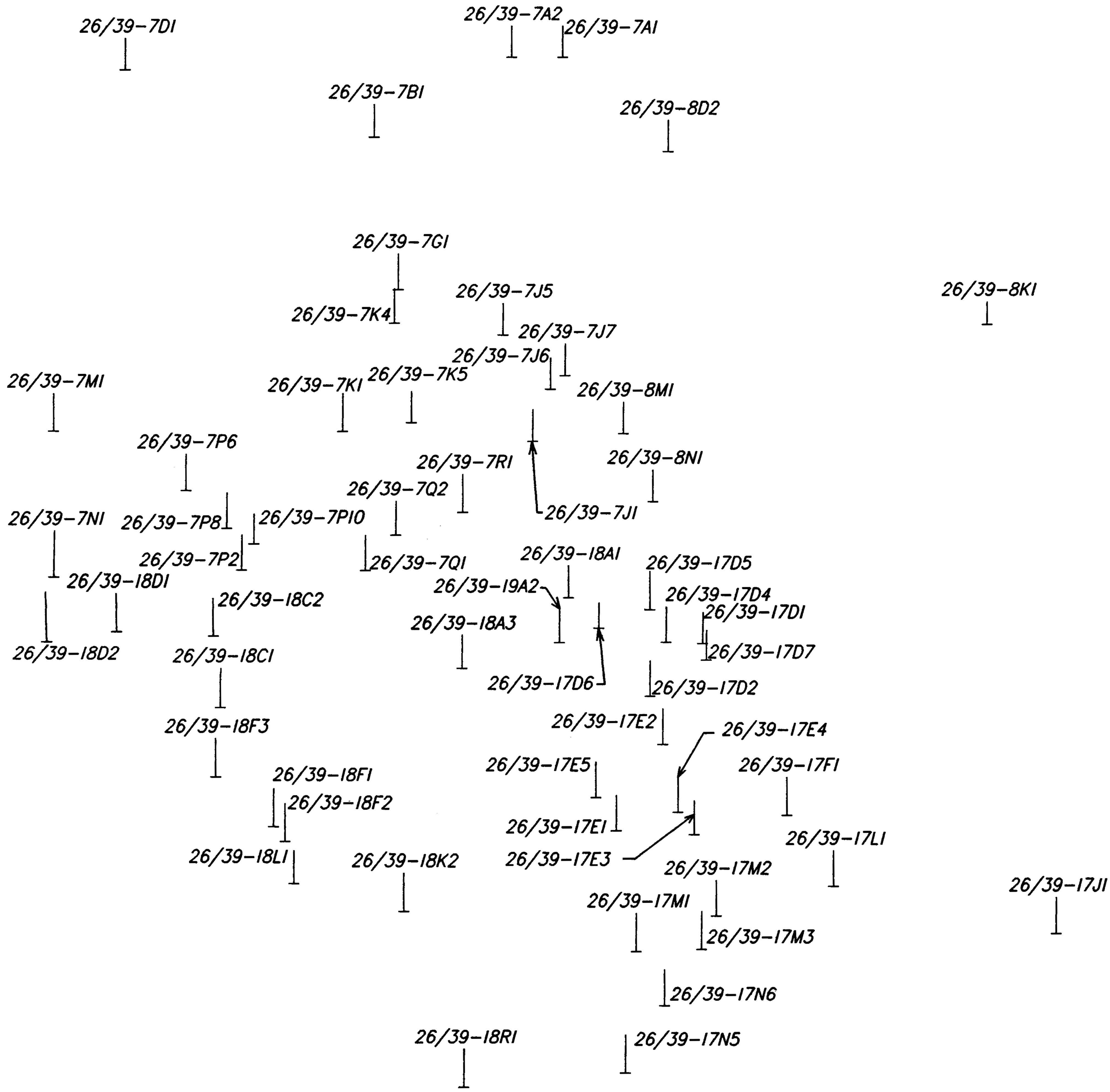


Figure 10

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



INDIAN WELLS VALLEY GROUNDWATER PROJECT

Detail B

All wells in the East Kern County Resource Conservation District (EKCRCD) database with a total depth.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the EKCRCD database.

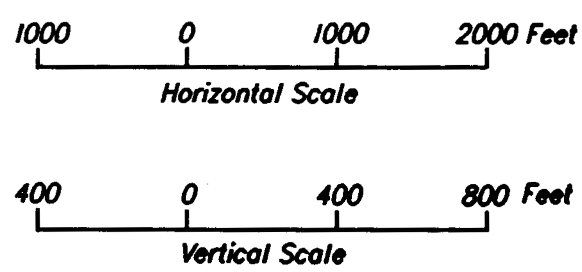


Figure 10a

Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

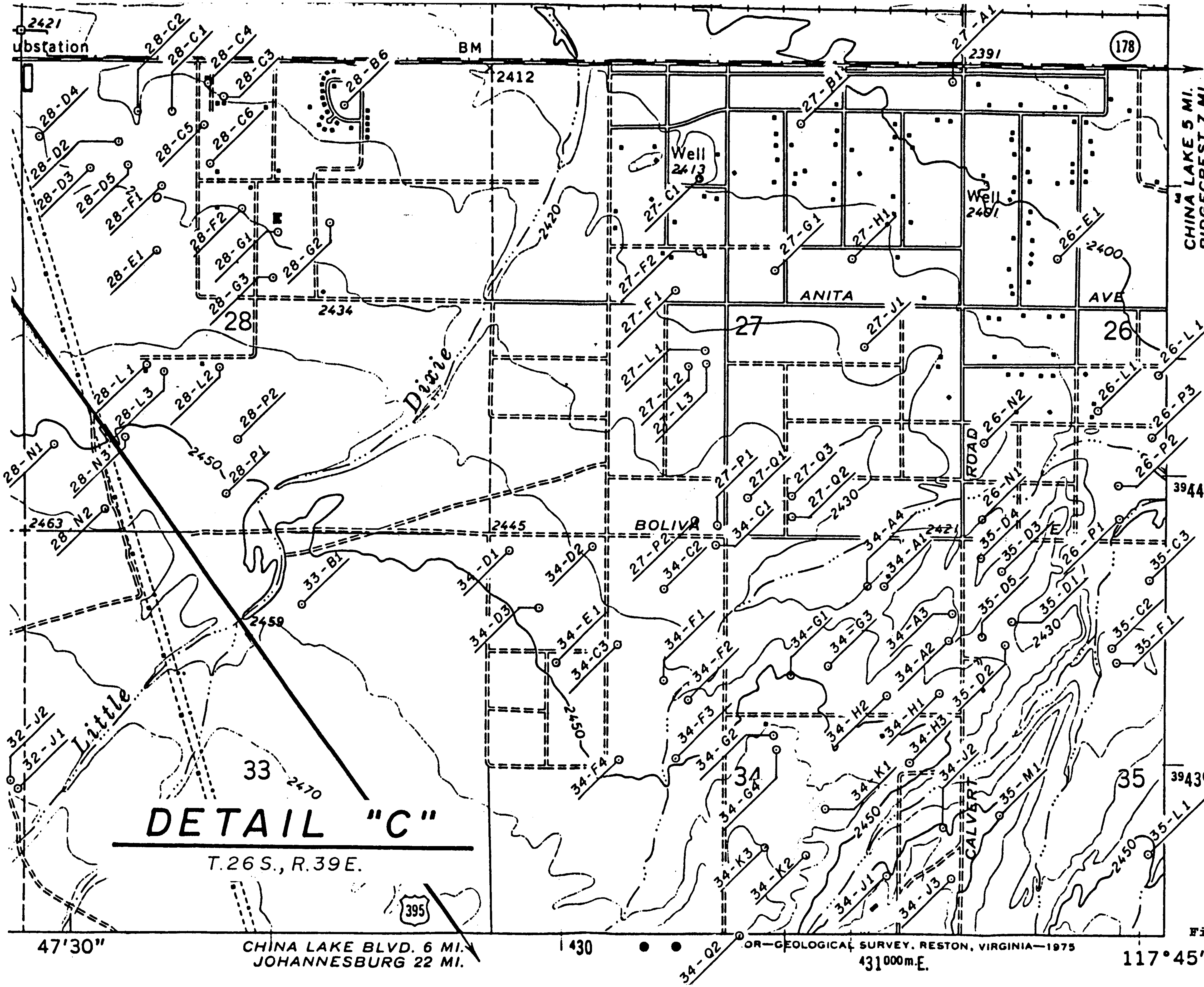
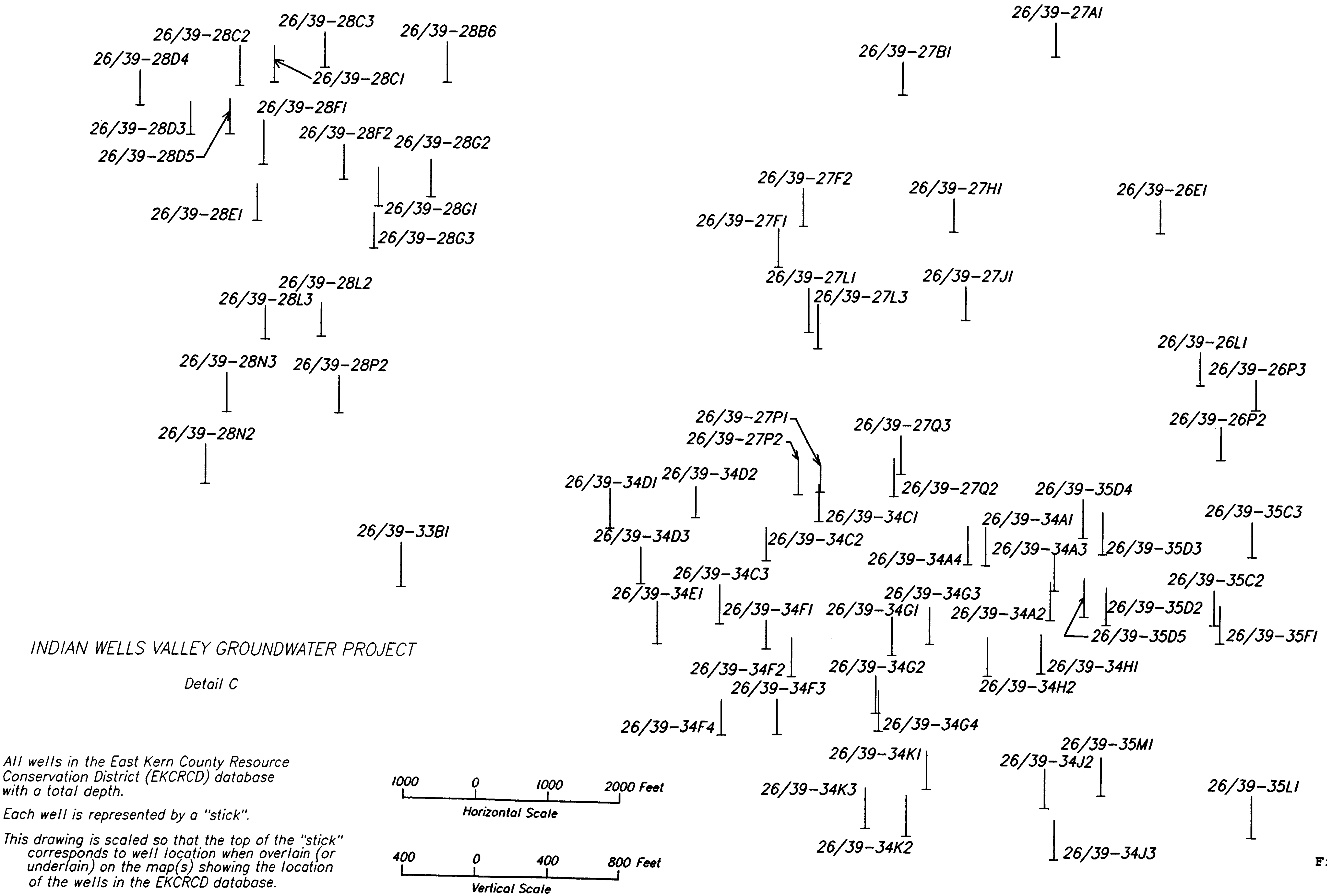


Figure 11

Map of a portion of Indian Wells Valley showing the location of the wells in the East Kern County Resource Conservation District well database. The well designation number preceding the hyphen is the section, the letter following the hyphen is the 40-acre subdivision, and the last number indicates the sequence in which the wells were inventoried.



Depiction of well depths from the EKCRCD database in the portion of the Indian Wells Valley shown on the preceding figure.

Figure 11a

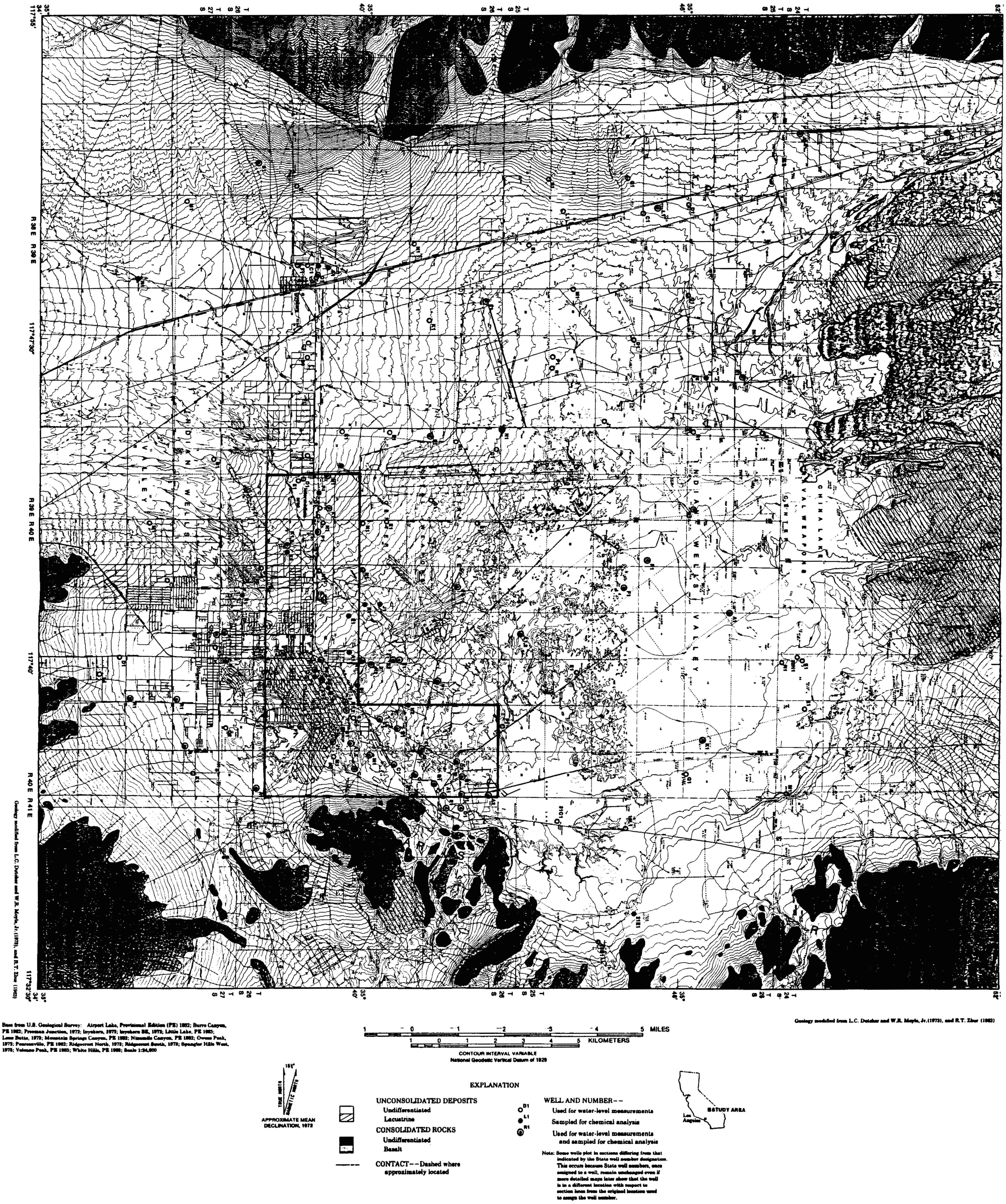
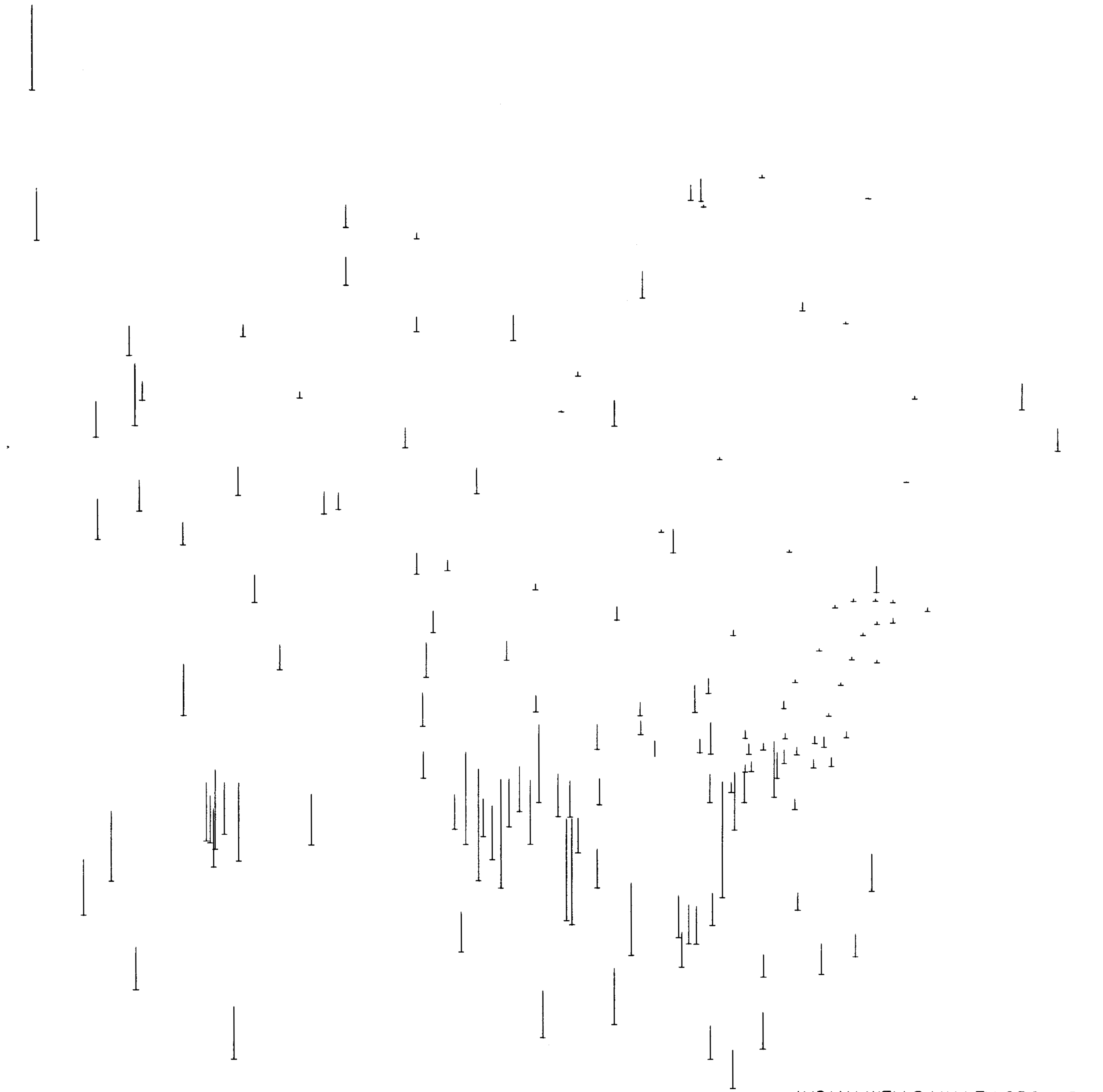


Figure 12

MAP OF INDIAN WELLS VALLEY, KERN, INYO, AND SAN BERNARDINO COUNTIES, CALIFORNIA, SHOWING GENERALIZED GEOLOGY AND LOCATION OF OBSERVATION WELLS, 1977-84

(From: U.S. Geological Survey Open-File Report 86-315 by C. Berenbrock)



All wells in the USGS Open-file Report 86-315
with a total depth.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

INDIAN WELLS VALLEY GROUNDWATER PROJECT

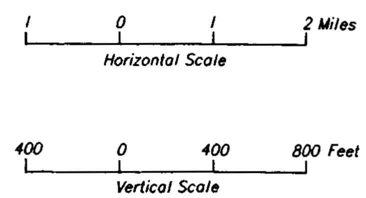
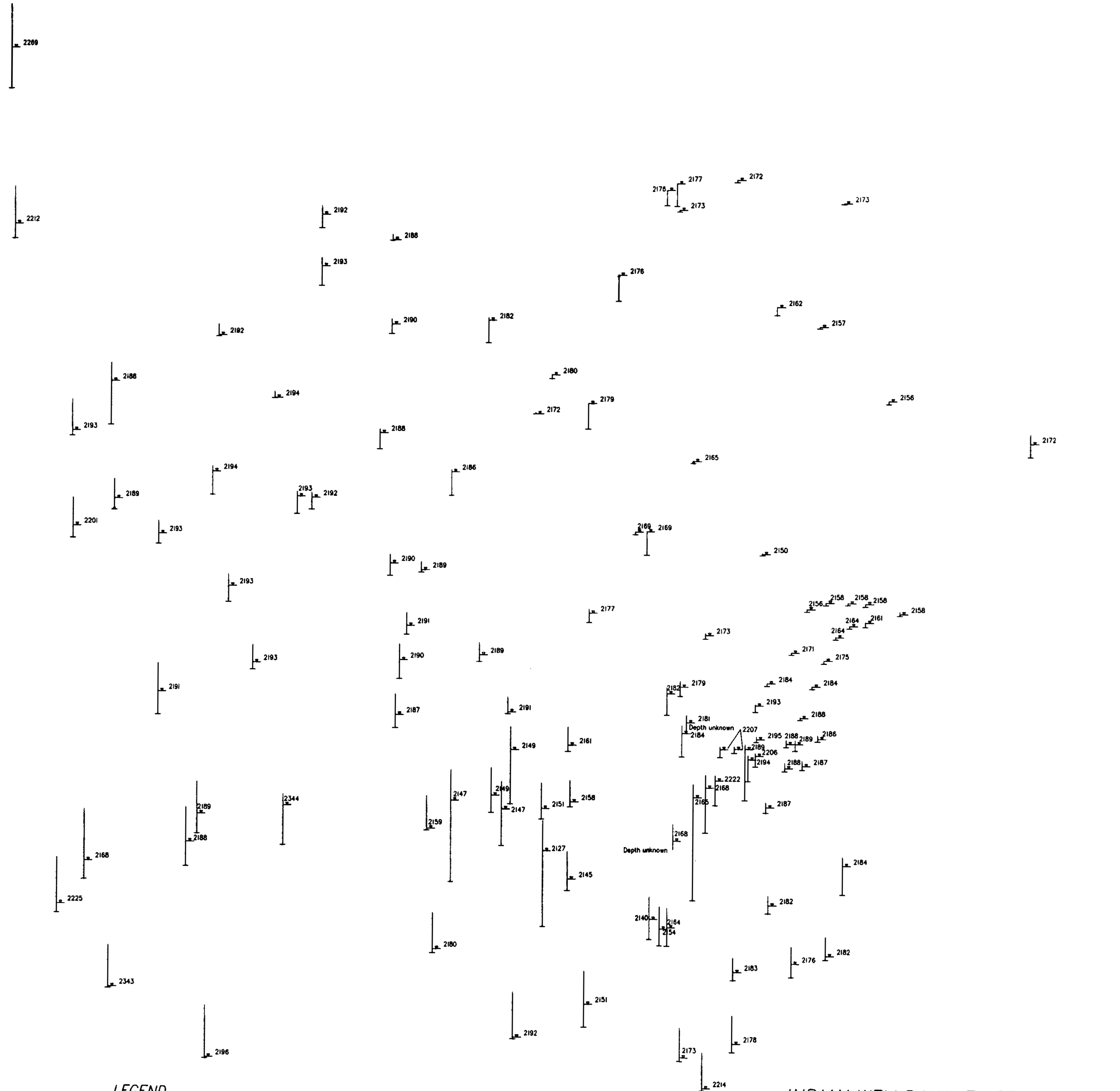


Figure 12a



LEGEND

2180 Groundwater elevation

All wells in the USGS Open-file Report 86-315 with a total depth and water level.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

INDIAN WELLS VALLEY GROUNDWATER PROJECT

1 0 1 2 Miles
Horizontal Scale

400 0 400 800 Feet
Vertical Scale

Figure 12b

LEGEND

2151 Groundwater elevation
— Screen Interval

All wells in the USGS Open-file Report 86-315 with a total depth, water level and screen interval(s).

Each well is represented by a "stick".

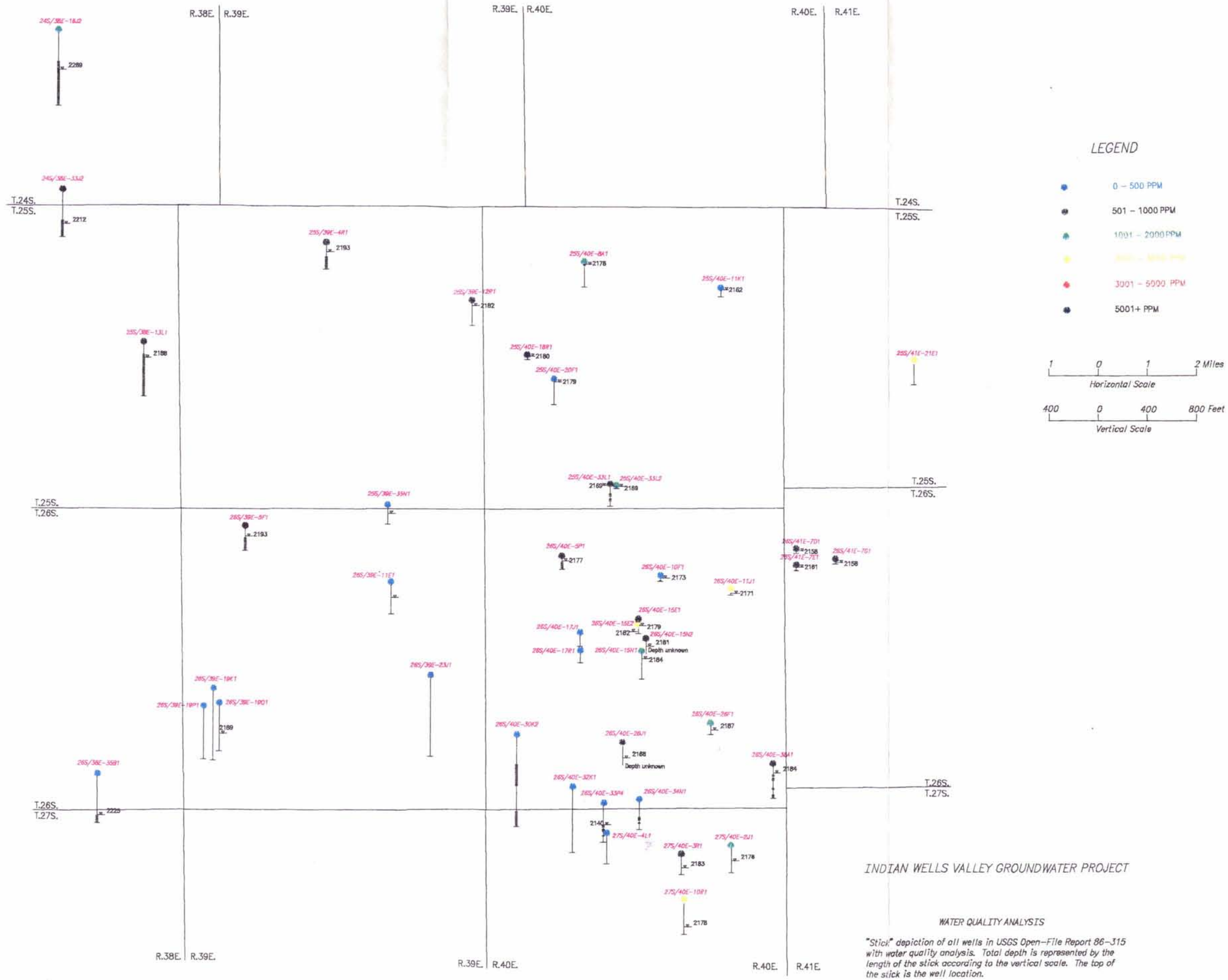
This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

INDIAN WELLS VALLEY GROUNDWATER PROJECT

1 0 1 2 Miles
Horizontal Scale

400 0 400 800 Feet
Vertical Scale

Figure 12c

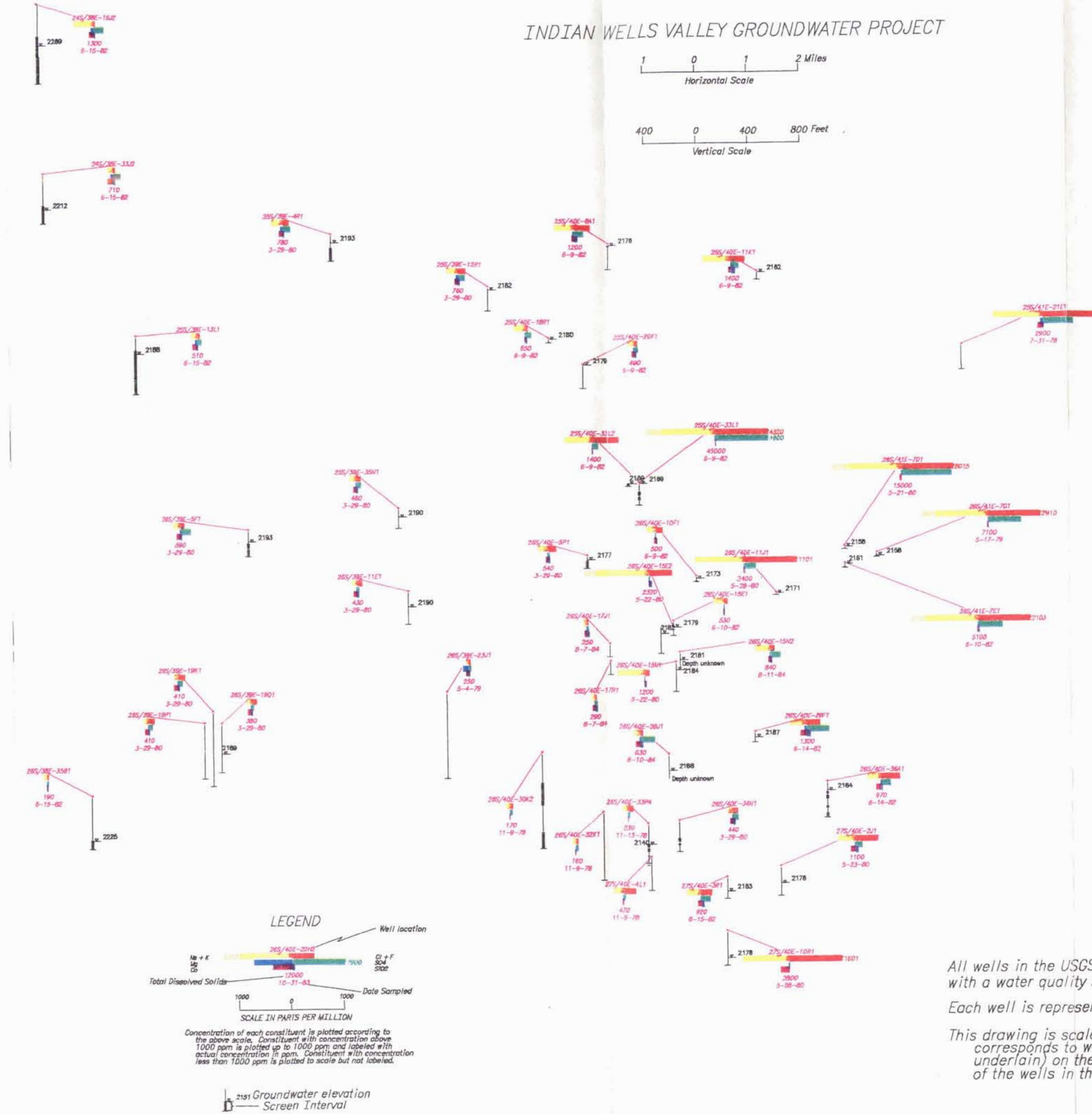


INDIAN WELLS VALLEY GROUNDWATER PROJECT

WATER QUALITY ANALYSIS

"Stick" depiction of all wells in USGS Open-File Report 86-315 with water quality analysis. Total depth is represented by the length of the stick according to the vertical scale. The top of the stick is the well location.

Figure 12f



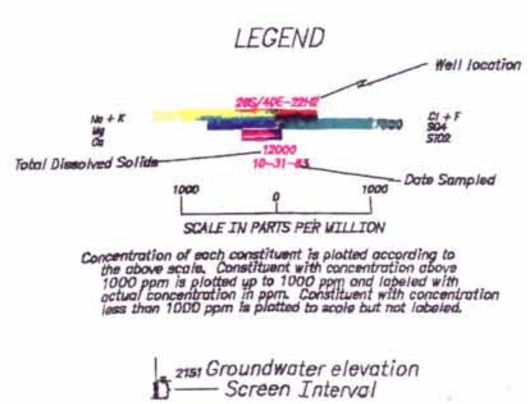
All wells in the USGS Open-file Report 86-315 with a water quality stiff diagram.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

Figure 12e

INDIAN WELLS VALLEY GROUNDWATER PROJECT



All wells in the USGS Open-file Report 86-315 with a total depth, water level, screen interval(s) and water quality stiff diagram.

Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

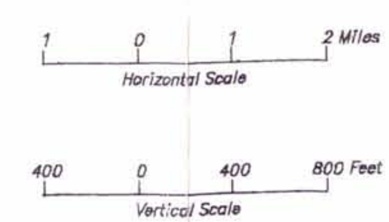


Figure 12d

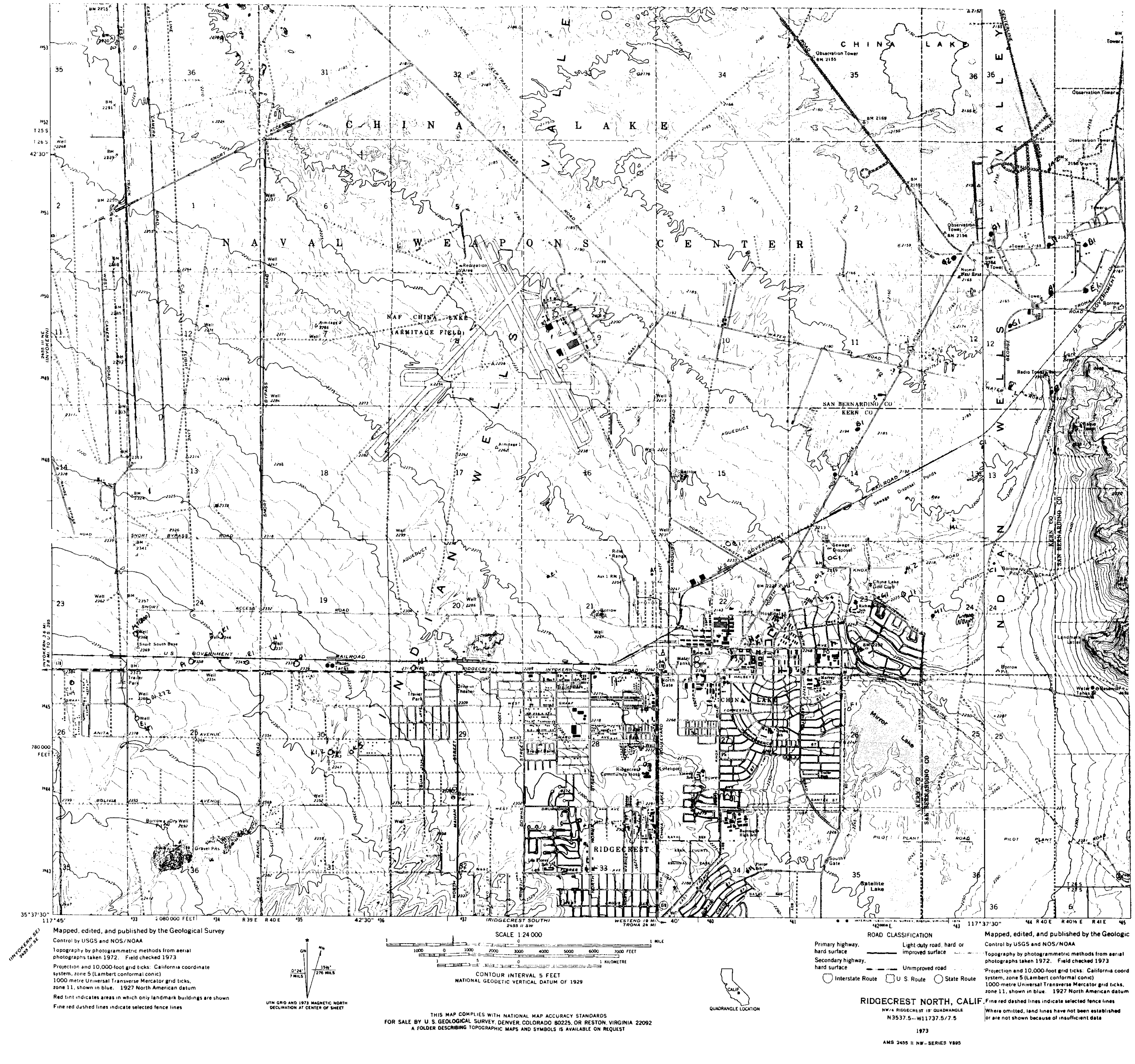

CHINA LAKE
NAVAL WEAPONS CENTER
INDIAN WELLS VALLEY
NAF CHINA LAKE (ARMITAGE FIELD)
RIDGECREST
Mirror Lake
SAN BERNARDINO CO
KERN CO
Mapped, edited, and published by the Geological Survey
Control by USGS and NOS/NOAA
SCALE 1:24 000
CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
ROAD CLASSIFICATION
RIDGECREST NORTH, CALIF.
N3537.5—W11737.5/7.5
1973
QUADRANGLE LOCATION

Figure 13

INDIAN WELLS VALLEY GROUNDWATER PROJECT

All wells in the USGS Open-file Report 86-315 with a total depth.

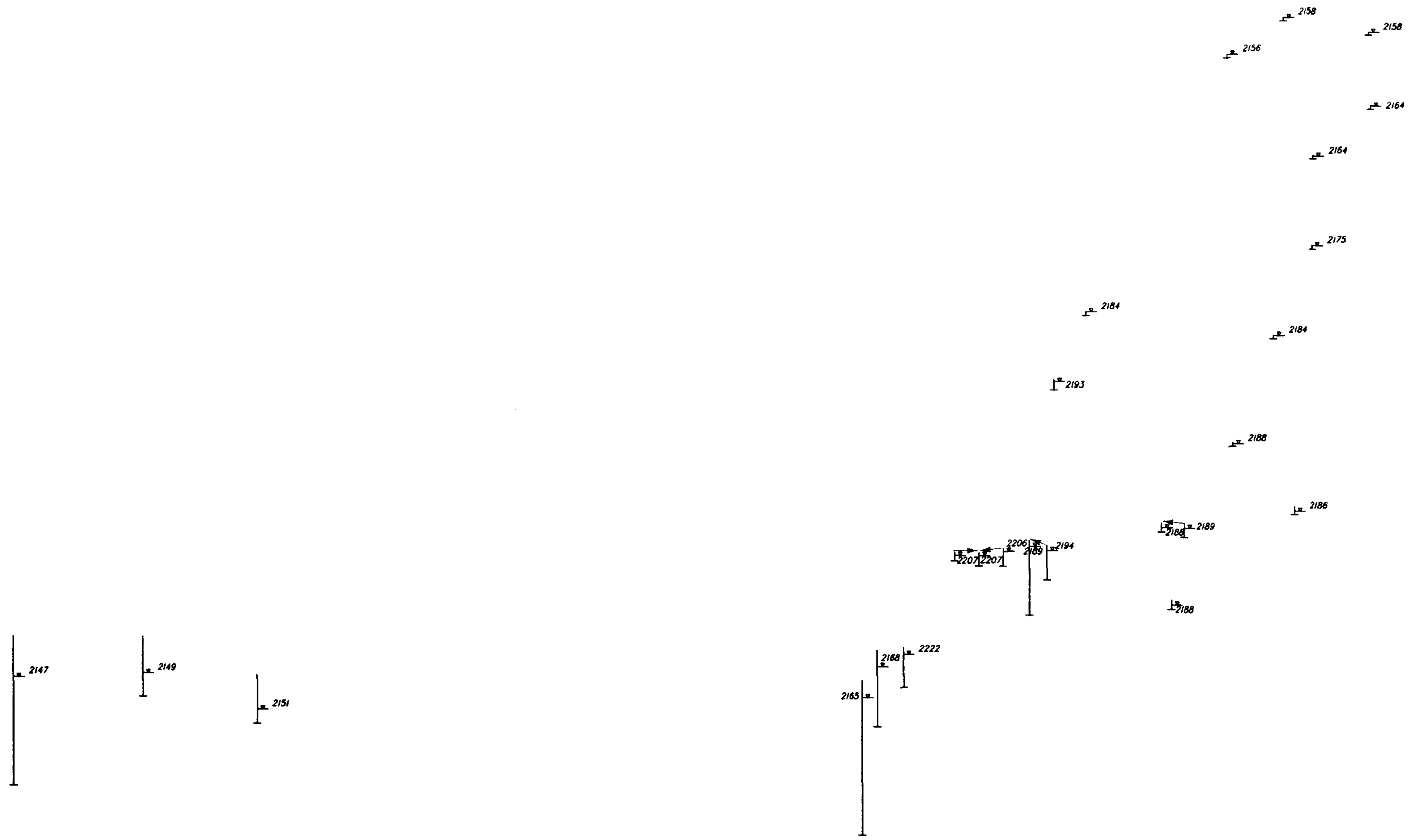
Each well is represented by a "stick".

This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

2000 0 2000 4000 Feet
Horizontal Scale

400 0 400 800 Feet
Vertical Scale

Figure 13a



LEGEND

2151 Groundwater elevation

All wells in the USGS Open-file Report 86-315 with a total depth and water level.

Each well is represented by a "stick".

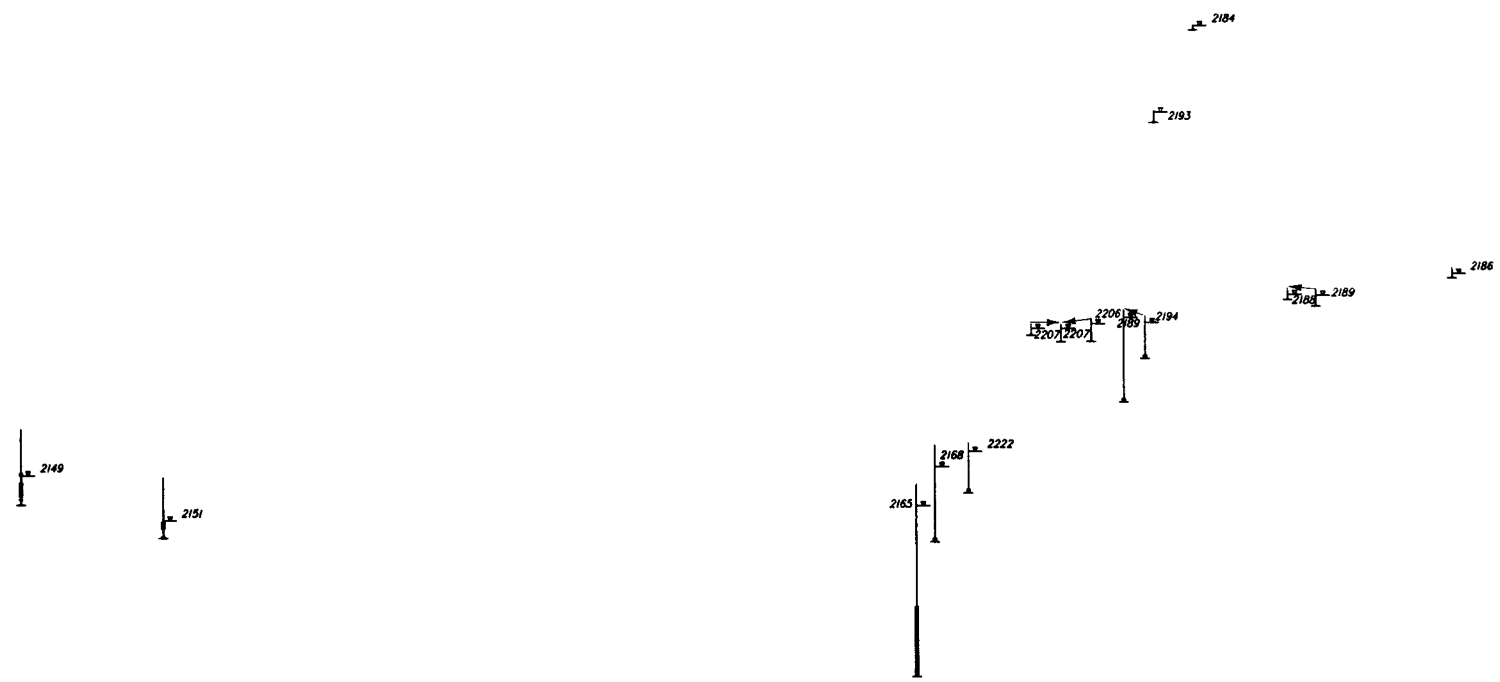
This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

INDIAN WELLS VALLEY GROUNDWATER PROJECT

2000 0 2000 4000 Feet
Horizontal Scale

400 0 400 800 Feet
Vertical Scale

Figure 13b



LEGEND

2151 Groundwater elevation
Screen interval

All wells in the USGS Open-file Report 86-315 with a total depth, water level and screen interval(s).

Each well is represented by a "stick".

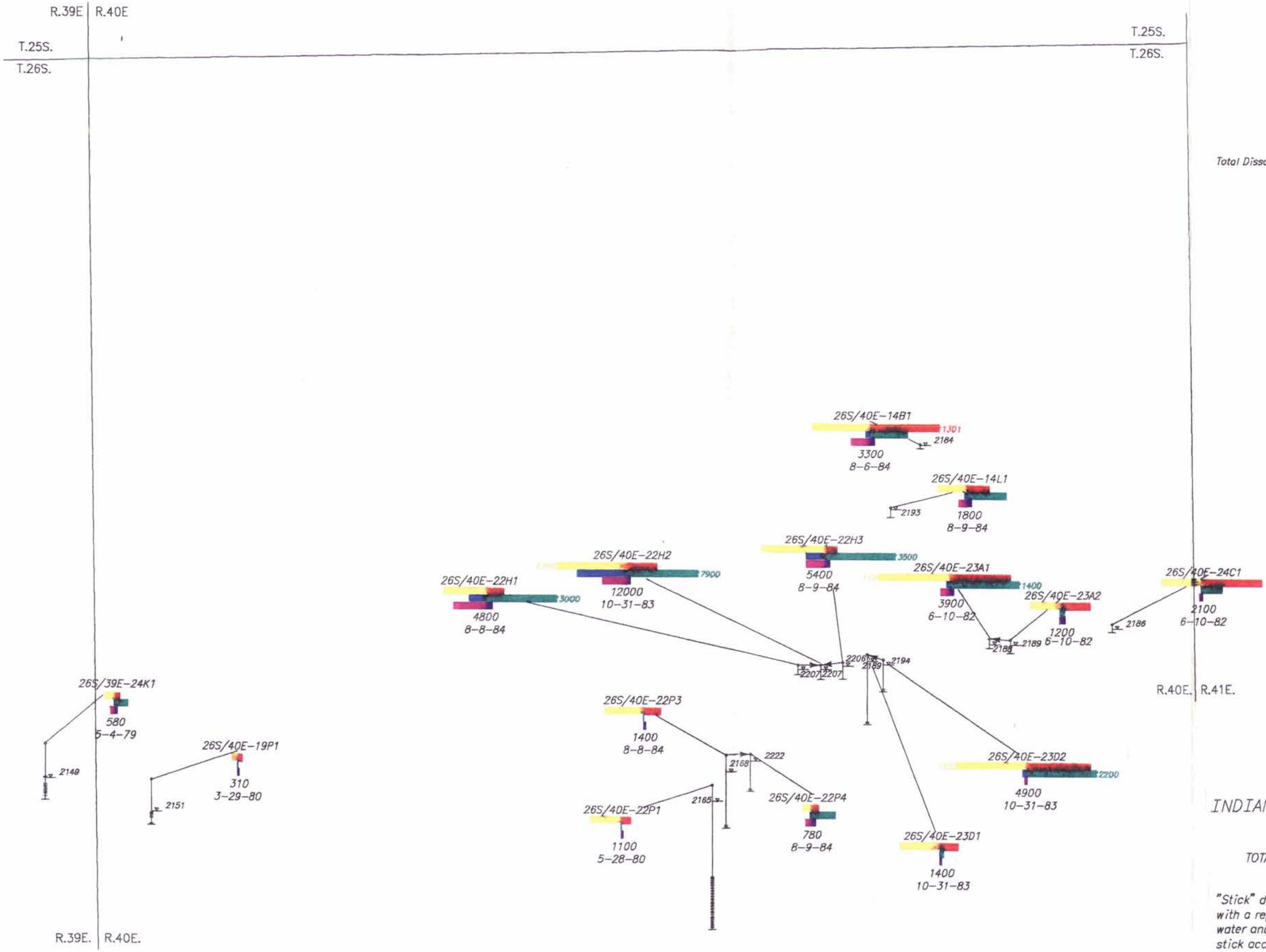
This drawing is scaled so that the top of the "stick" corresponds to well location when overlain (or underlain) on the map(s) showing the location of the wells in the USGS Open-file Report 86-315.

INDIAN WELLS VALLEY GROUNDWATER PROJECT

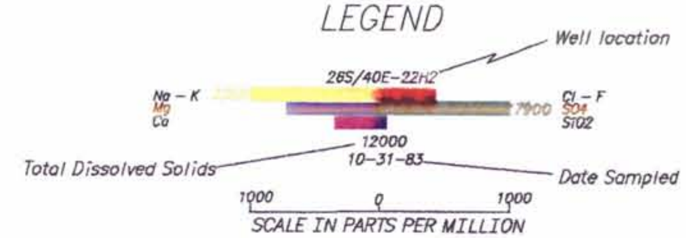
2000 0 2000 4000 Feet
Horizontal Scale

400 0 400 800 Feet
Vertical Scale

Figure 13c



LEGEND



Concentration of each constituent is plotted according to the above scale. Constituent with concentration above 1000 ppm is plotted up to 1000 ppm and labeled with actual concentration in ppm. Constituent with concentration less than 1000 ppm is plotted to scale but not labeled.

2151 Groundwater elevation
Screen interval

2000 0 2000 4000 Feet
Horizontal Scale

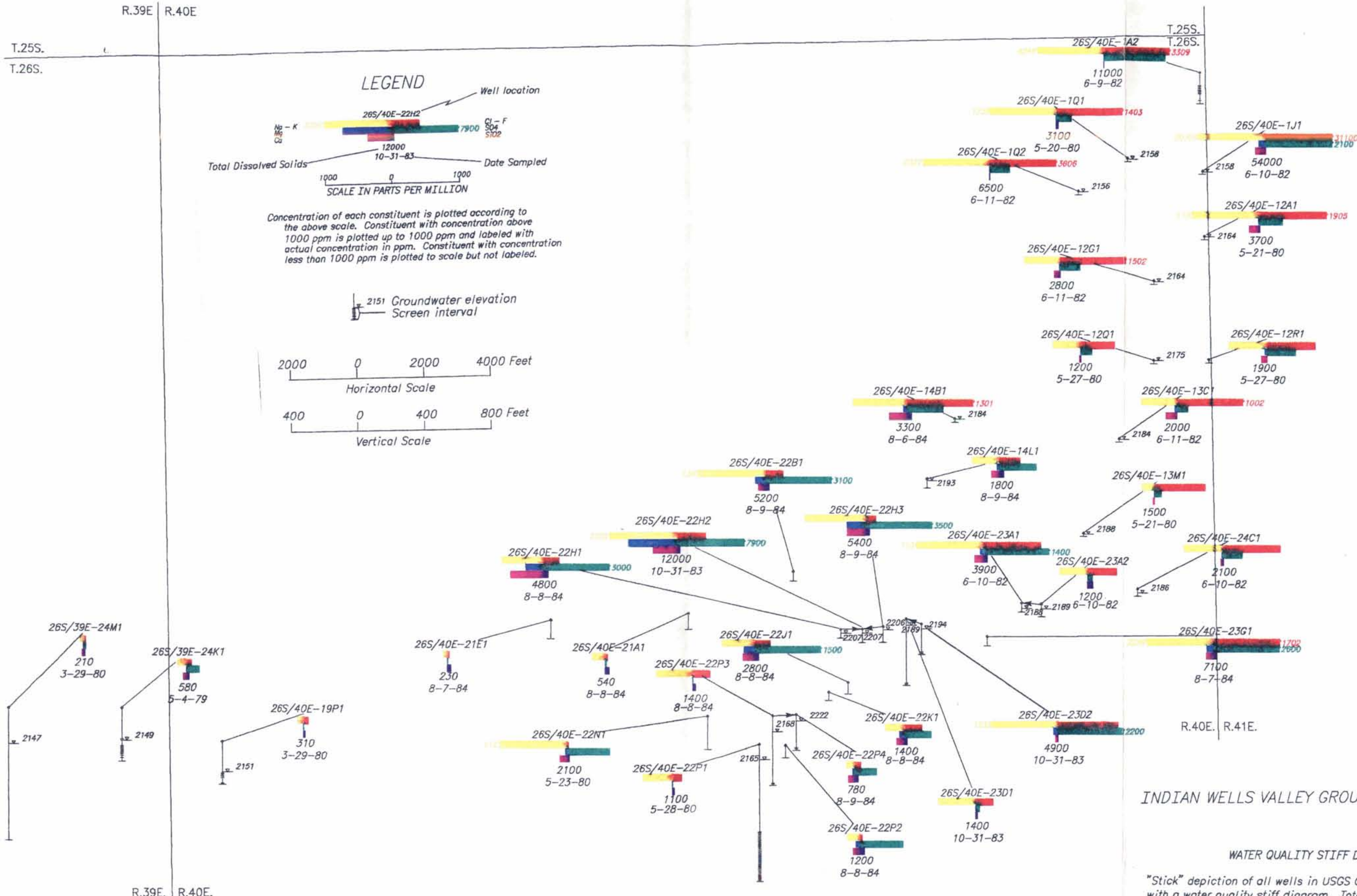
400 0 400 800 Feet
Vertical Scale

INDIAN WELLS VALLEY GROUNDWATER PROJECT

TOTAL DEPTH, WATER ELEVATION, SCREEN INTERVAL, AND WATER ANALYSIS

"Stick" depiction of all wells in USGS Open-File Report 86-315 with a reported total depth, water elevation, screen interval, and water analysis. Total depth is represented by the length of the stick according to the vertical scale. The top of the stick is the well location.

Figure 13d

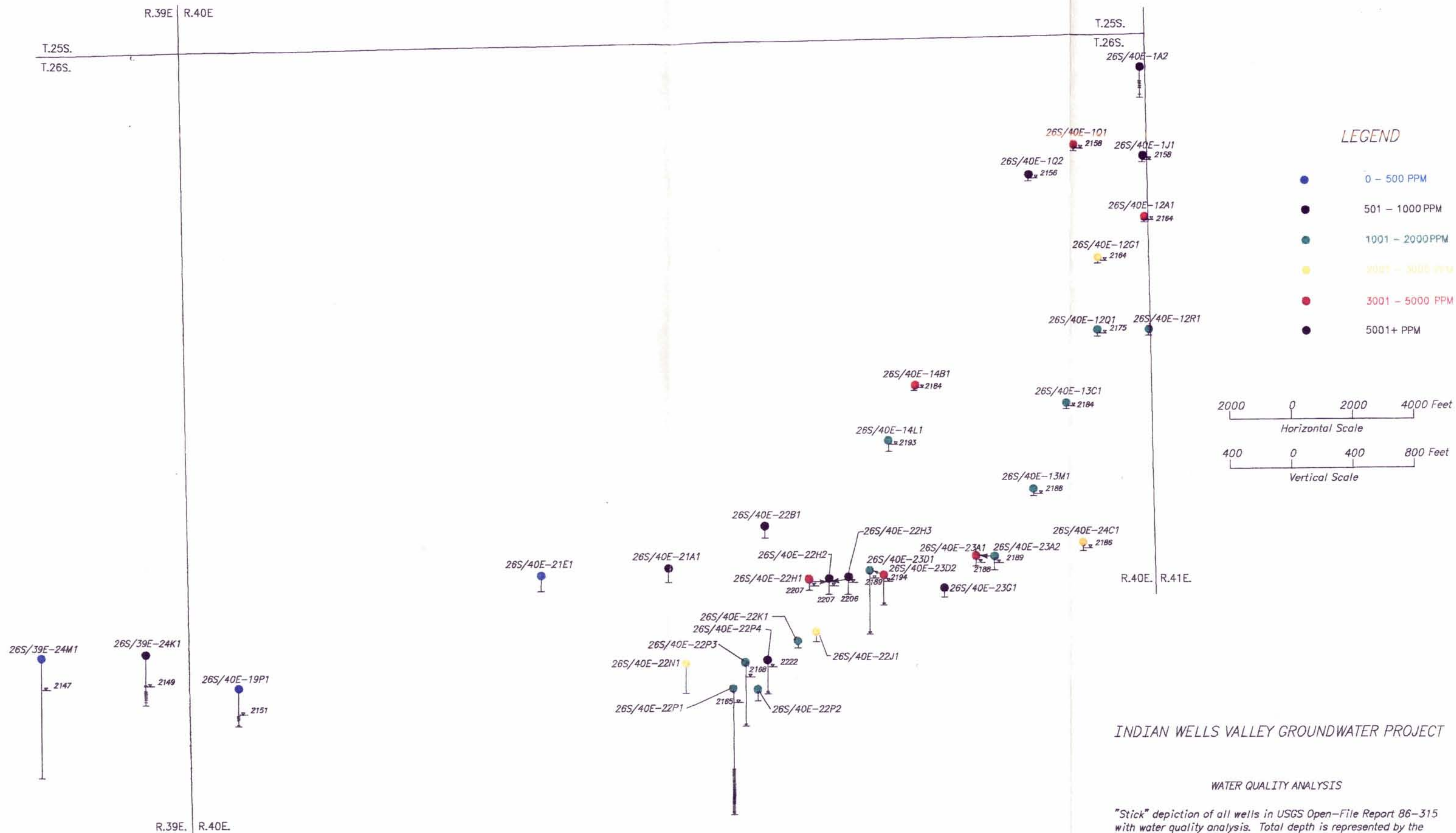


INDIAN WELLS VALLEY GROUNDWATER PROJECT

WATER QUALITY STIFF DIAGRAMS

"Stick" depiction of all wells in USGS Open-File Report 86-315 with a water quality stiff diagram. Total depth is represented by the length of the stick according to the vertical scale. The top of the stick is the well location.

Figure 13e



INDIAN WELLS VALLEY GROUNDWATER PROJECT

WATER QUALITY ANALYSIS

"Stick" depiction of all wells in USGS Open-File Report 86-315 with water quality analysis. Total depth is represented by the length of the stick according to the vertical scale. The top of the stick is the well location.

Figure 13f

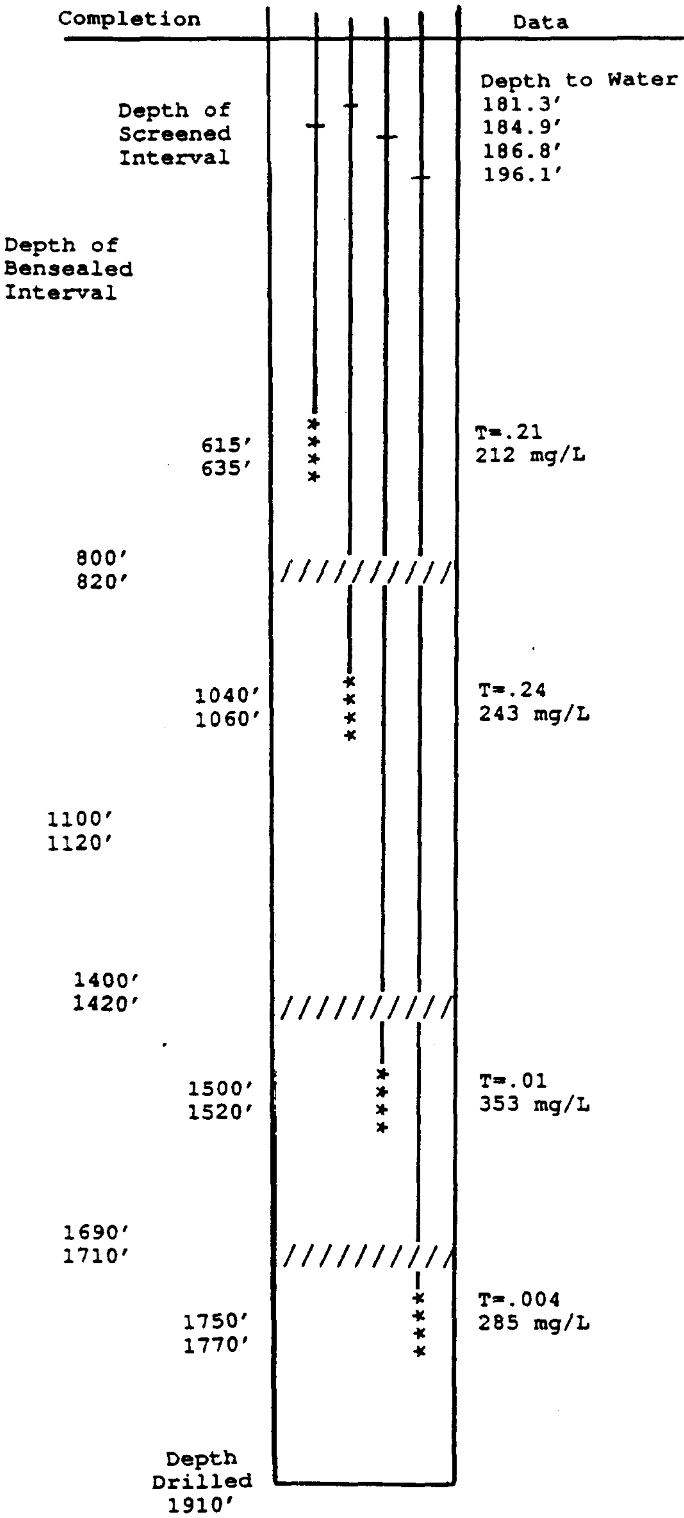
APPENDIX VI

Diagrammatic Piezometer Completion and Data Summary

Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well BR-1 ****
4 - 2" Piezometers

Ground Elevation - 2848.3



Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is located about 200 feet west of the Red Rock-Inyokern Road about 5.2 miles south of Hwy. 178.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed four 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 5-10 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on October 22, 1991 from the top of the protective casing.

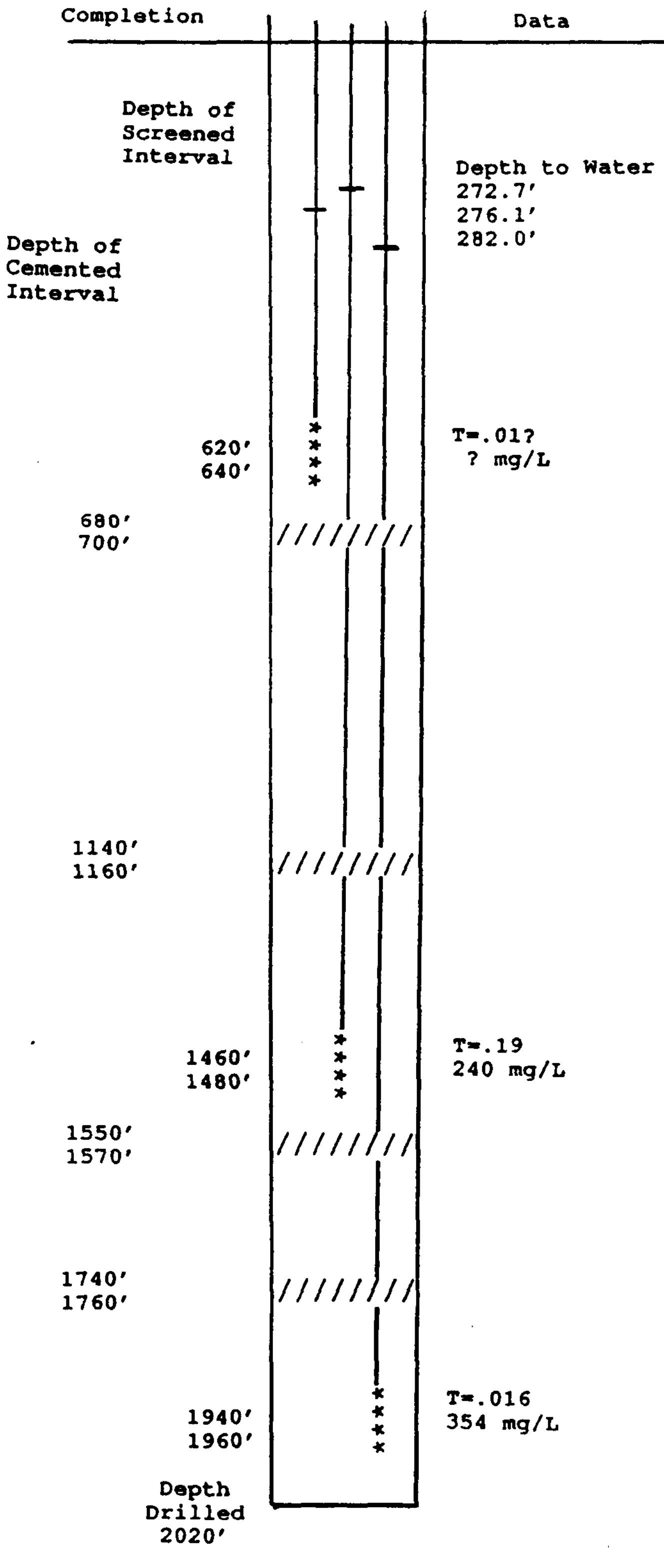
SLUG TEST RESULTS:
Estimated transmissivity (T) (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well BR-2 ****
3 - 2" Piezometers

Ground Elevation - 2655.9



Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is located about 1 1/4 miles south of Hwy. 178 at the end of Sierra Vista Road.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 10 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on October 22, 1991 from the top of the outer casing.

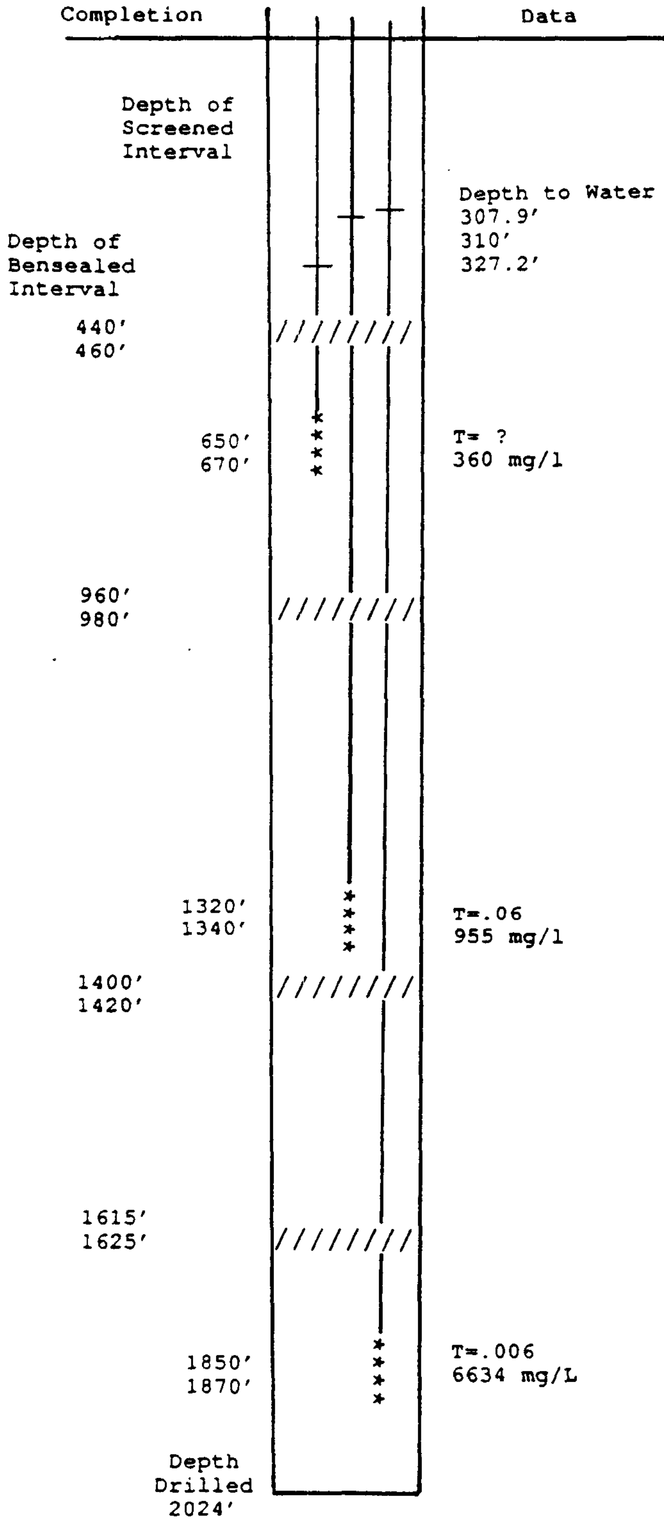
SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well BR-3 ****
3 - 2" Piezometers

Ground Elevation - 2508.6



Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is located on the south side of Bowman Road about 1500 east of Hwy. 395.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each.

DEVELOPMENT:
Each piezometer was air-lifted for about 12-20 hours and discharged an estimated 5-10 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on December 12, 1991 from the top of the outer casing. Shallow was measured with temperature logger.

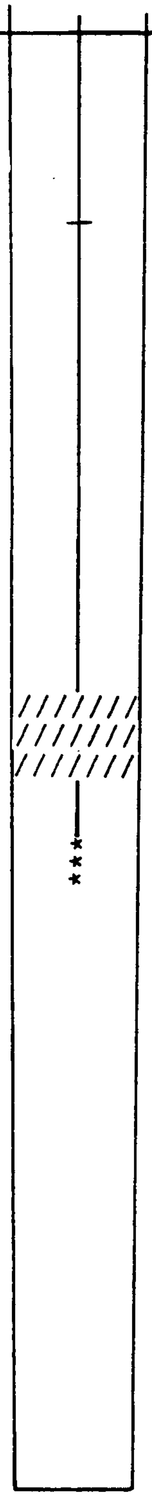
SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well BR-4 ****
1 - 2" Piezometer

Completion | Data | Ground Elevation - 2375.2



Depth of Screened Interval

Depth of Bensealed Interval

Depth to Water
252'

960'
1130'

1190'
1200'

T=.28
183 mg/L

Depth Drilled 2020'

Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is located about 600 feet south of Hwy. 170, 1.05 miles west of Jack Ranch Road.

DRILLING METHOD:
Direct rotary with bentonite mud. 7 7/8 inch roller cone bit to total depth. Reamed to total depth with a 10 1/4 inch roller cone bit.

HOLE COMPLETION:
Installed one 2" diameter steel pipe with a 10' two inch diameter screen on the bottom.

DEVELOPMENT:
The piezometer was air-lifted and discharged an estimated 5-10 gallons per minute. The water sample for lab analysis was collected at the end of development.

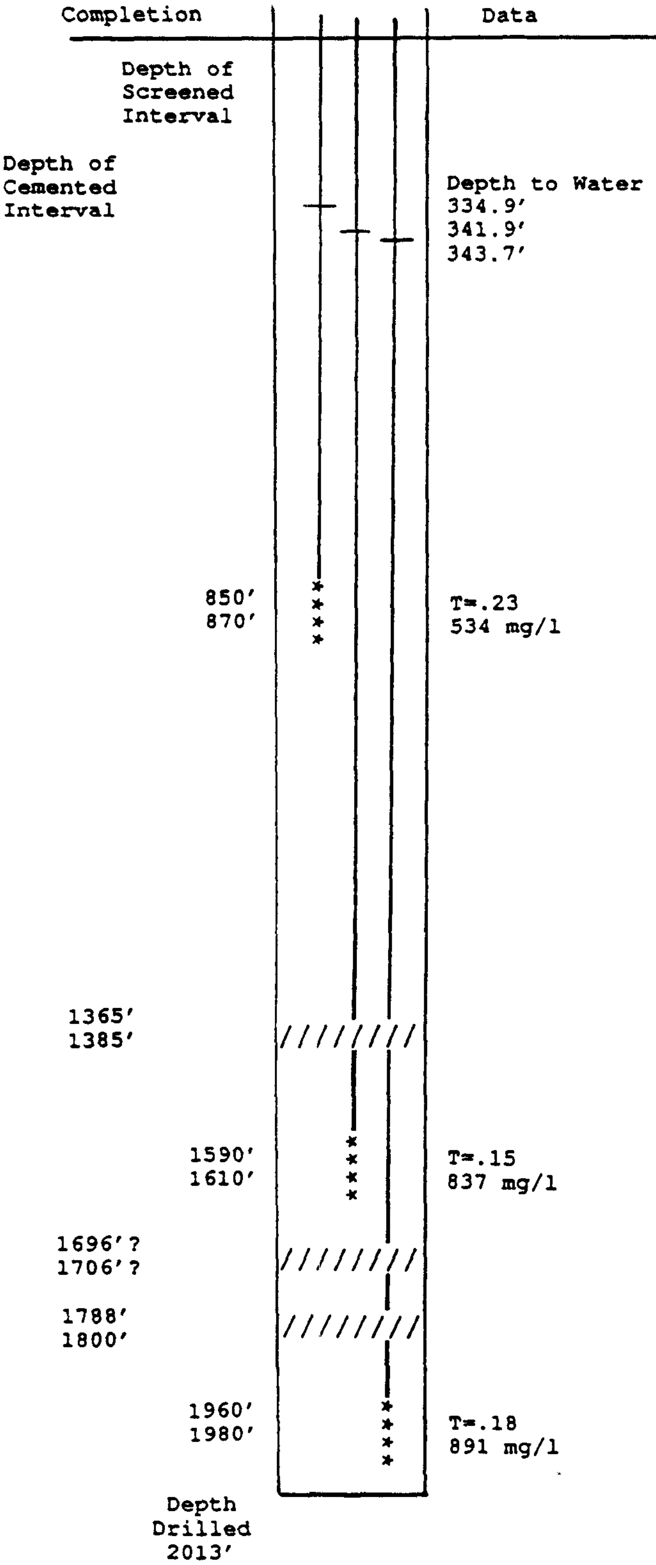
DEPTH TO WATER:
Depth was measured on December 12, 1991 from the top of the outer casing.

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 10 feet of aquifer at the screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well BR-5 ****
3 - 2" Piezometers



Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is about 200 feet west of Hwy. 395 at a point about 1/2 mile north of the intersection of Leliter Road and Hwy. 395.

DRILLING METHOD:
Direct rotary with bentonite mud. 14 3/4 inch roller cone bit from 56 to 1014 feet. 12 1/4 roller cone bit from 1014 to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each.

DEVELOPMENT:
Each piezometer was air-lifted 3-4 hours <u>and discharged an estimated 5-10 gallons per minute</u>. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on January 28, 1992 from the top of the protective casing.

SLUG TEST RESULTS:
Estimated transmissivity (T) (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

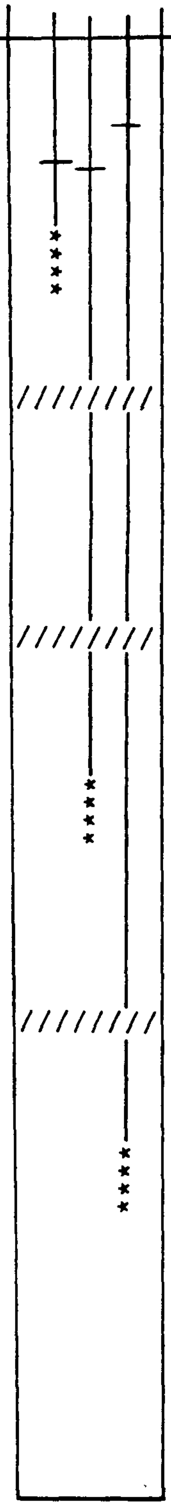
Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well BR-6 ****
3 - 2" Piezometers

Completion | Data | Ground Elevation - 2352.2

Depth of Screened Interval

Depth of Cemented Interval



Depth to Water
149.9'
163.9'
164.6'

330' – 350' : T=.02? 596 mg/l

520' – 550'

900' – 925'?

1190' – 1210' : T=.25 481 mg/l

1400' – 1420'

1640' – 1660' : T=.20 540 mg/l

Depth Drilled 2012'

Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is just inside (east) the Naval Air Warfare Station boundary (which is parallel Brown Road) along dirt eastward extension of the east-west section of Brown Road.

DRILLING METHOD:
Direct rotary with bentonite mud. 14 3/4 inch roller cone bit from 56 to 1010 feet. 12 1/4 roller cone bit from 1010 to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each.

DEVELOPMENT:
Each piezometer was air-lifted about 2 hours and discharged an estimated 5-10 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on January 28, 1992 from the top of the protective casing.

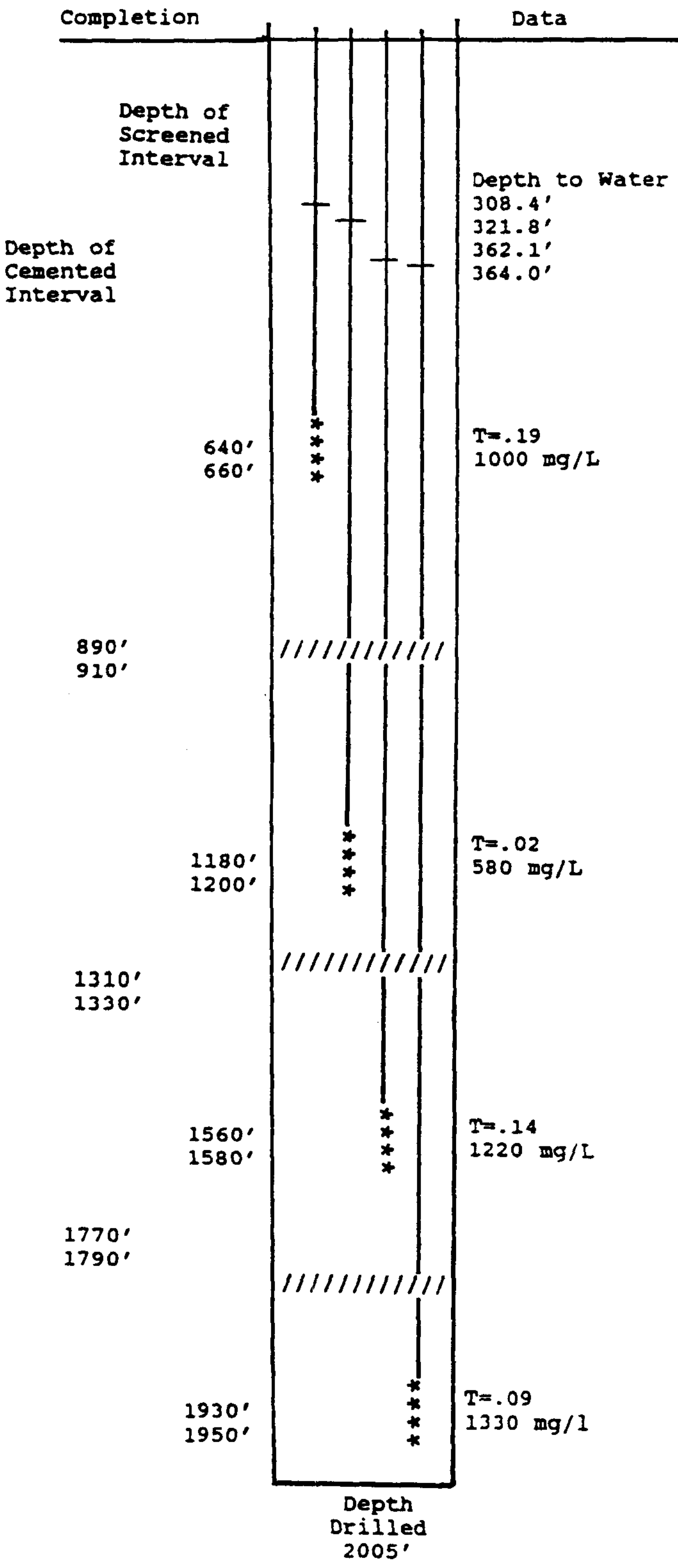
SLUG TEST RESULTS:
Estimated transmissivity (T) (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well BR-10 ****
4 - 2" Piezometers

Ground Elevation - 2560.3



Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is about 0.1 mile southeast of the intersection of Hwy 395 and Ninemile Canyon Road

DRILLING METHOD:
Direct rotary with bentonite mud. 14 3/4 inch roller cone bit from 56 to 1010 feet. 12 1/4 roller cone bit from 1010 to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each.

DEVELOPMENT:
Each piezometer was air-lifted at least 4 hours. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on September 30, 1992 from the top of the outer casing.

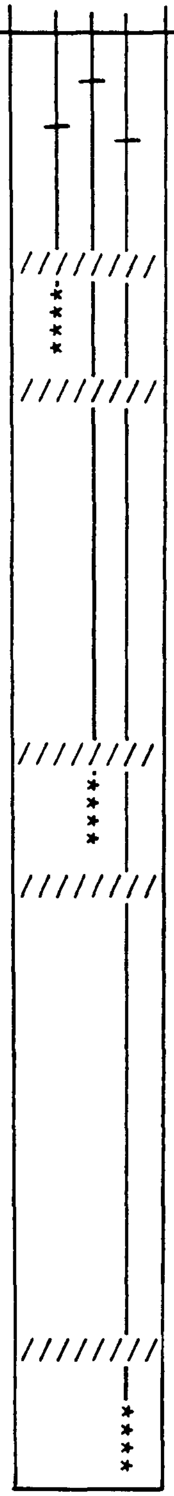
SLUG TEST RESULTS:
Estimated transmissivity (T) (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well NR-1 ****
[Water District Well]
3 - 2" Piezometers

Completion | Data | Ground Elevation - 2275.7



Depth of Screened Interval

Depth of Bensealed Interval

Bensealed interval	Screened interval	Data
		Depth to Water: 76.8′, 95.1′, 101.3′
220′–240′		
	250′–270′	T=.004* Damaged 2406 mg/L
290′–300′		
	1130′–1150′	T= ? 3660 mg/L
1170′–1190′		
1920′–1940′		
	1960′–1980′	T=.05 3251 mg/L

Depth Drilled 2012′

Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is located in the extreme northeast corner of the Indian Wells Valley Water District's Neal Ranch property.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20′ two inch diameter screen on the bottom of each.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 10 gallons per minute. Water samples for lab analysis were collected at the end of development.

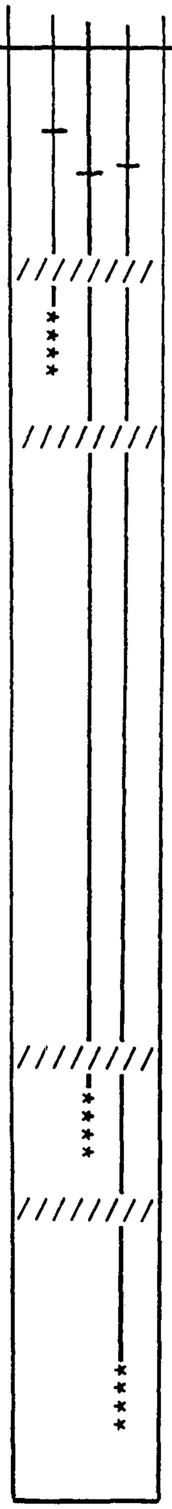
DEPTH TO WATER:
All depths reported below were measured on October 22, 1991 from the top of the outer casing.

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well NR-2 ****
[Water District Well]
3 - 2" Piezometers



Completion		Data
Depth of Screened Interval		Depth to Water 133.1' 140.0' 140.3'
Depth of Bensealed Interval		
250' 270'		
	330' 350'	T=.48 808 mg/L
450' 470'		
1480' 1500'		
	1540' 1560'	T=.14 1367 mg/L
1620' 1640'		
	1910' 1930'	T=.12 3305 mg/L
Depth Drilled 1994'		

Ground Elevation - 2314.7

Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is located in the southwest corner of the southwestern block of the Indian Wells Valley Water District's Neal Ranch property.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 10 gallons per minute. Water samples for lab analysis were collected at the end of development.

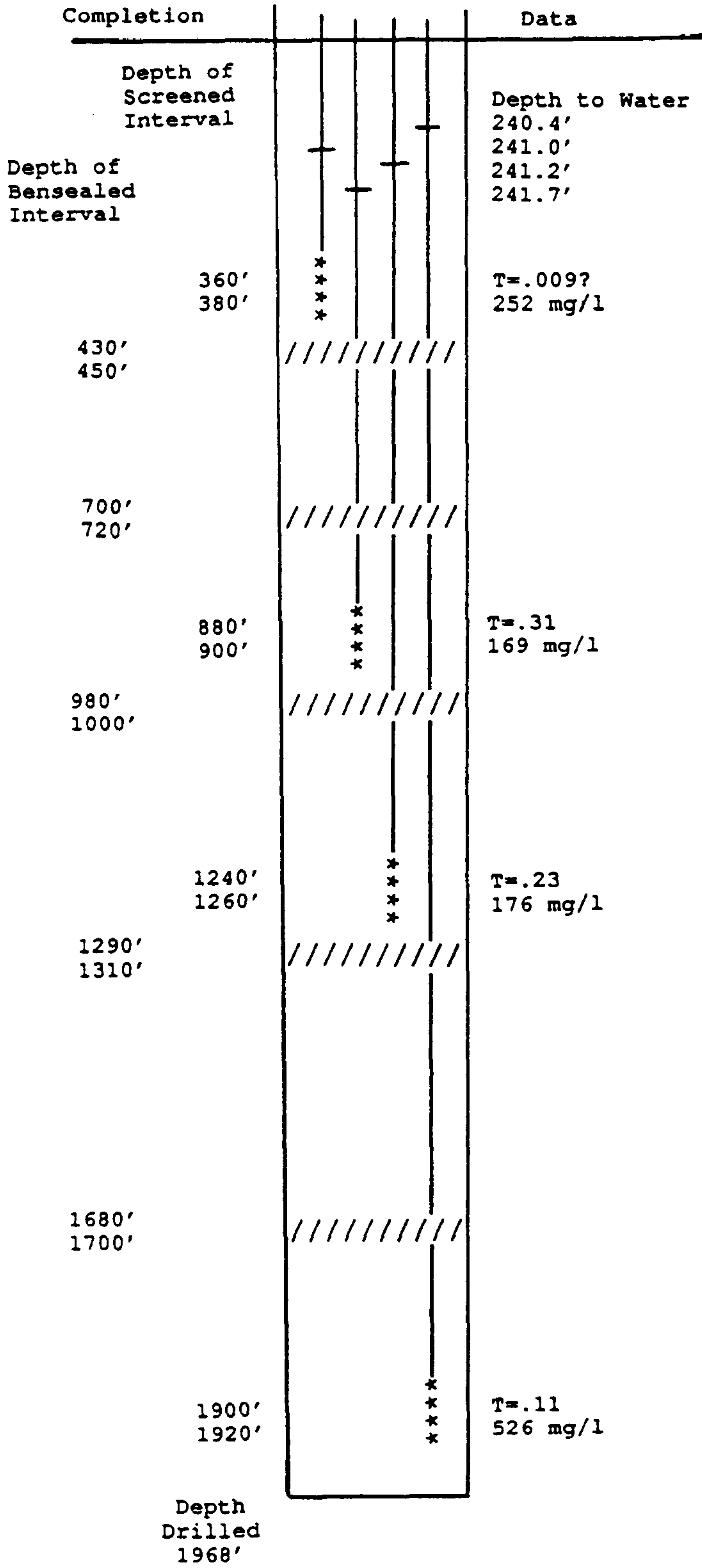
DEPTH TO WATER:
All depths reported below were measured on October 22, 1991 from the top of the outer casing.

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

Indian Wells Valley Groundwater Project (IWVGWP)*
Diagrammatic Completion and Data Summary Sheet

**** Well MW-32 ****
[Water District Well]
4 - 2" Piezometers



Notes

T = Transmissivity. See note below on slug tests.

mg/L = Total filterable residue at 180 C in milligrams per liter.

DRILL SITE:
The well is located just north of the east west dirt road just to the east of the center of the Indian Wells Valley Water District's Victor Street property.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed four 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 5-15 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on December 12, 1991 from the top of the outer casing.

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

* The IWVGWP (1990-1992) was a cooperative endeavor by Indian Wells Valley Water District, China Lake Naval Weapons Center, North American Chemical Company, and the U.S. Bureau of Reclamation to install nested piezometers, such as the one shown, in holes drilled to 2000 +/- feet.

APPENDIX VII

Drill Hole Completion and Geologic Logs

USBR Drill Hole Completion and Data Log
Monitoring Well BR-1

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 1910 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1790 Ft.
LOCATION: T.27 S., R.38 E., Sec. 23b — STATE: CA — BEGUN: 2-15-91
TYPE OF WELL: Observation — FINISHED: 3-5-91
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2848.3
COORDINATES: — TOP OF CASING ELEV. 2852.2
HOLE LOGGED BY: Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES	BARBOUR CORP WELL SURVEYING 805-482-4988 ELECTRIC LOG	DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

DRILL SITE:
The well is located about 200 feet west of the Red Rock-Inyokern Road about 5.2 miles south of Hwy. 178.

DRILLED BY:
Southern California Drilling Company of Lancaster CA.

DRILLING RIG:
Custom built, small oil-field rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed four 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 615'-635', 1040'-1060', 1500'-1520', 1750'-1770'. Twenty feet of 2" pipe below each screen. Benseal (bentonite) plugs set at the following depth intervals: 800'-820', 1400'-1420', 1690'-1710'.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 5-10 gallons per minute.

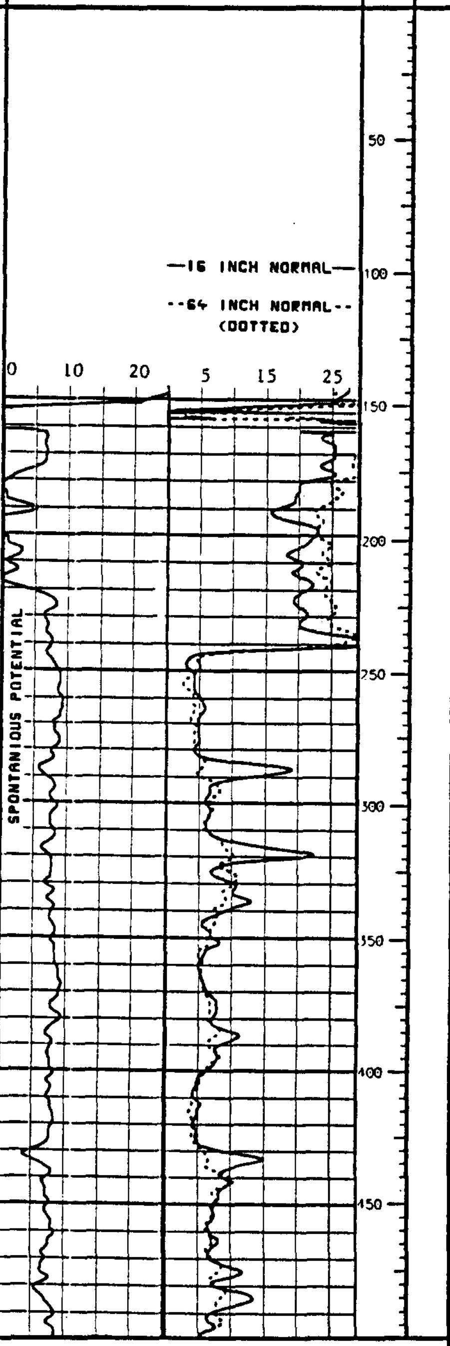
DEPTH TO WATER:
All depths reported below were measured on October 22, 1991 from the top of the protective casing.

Screen Interval	Depth (Ft)
615'-635'	184.9
1040'-1060'	181.3
1500'-1520'	186.8
1750'-1770'	196.1

All depth to water measurements are available in the Geohydrologic Appendix for this project.

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.21
Shallow Medium	.24
Deep Medium	.01
Deep	.004



The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.

GENERAL

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-250 SAND
Mostly medium to coarse sand with scattered fine gravel layers.

250-280 CLAY
Light brown to light gray clay.

280-350 SAND
Fine to coarse sand with clay lenses.

350-380 CLAY
Brown-white to brown clay.

380-400 SAND
Medium to coarse sand.

400-430 CLAY
Light brown to yellow brown clay with sand lenses.

430-450 SAND
Medium to coarse sand.

450-470 CLAY
Brown clay with sand lenses.

470-510 SAND
Mostly medium to coarse sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-1

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 1910 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1790 Ft.
LOCATION: T.27 S., R.38 E., Sec. 23b — STATE: CA — BEGUN: 2-15-91
TYPE OF WELL: Observation — FINISHED: 3-5-91
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2848.3
COORDINATES: — TOP OF CASING ELEV.: 2852.2
HOLE LOGGED BY: Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES

WATER QUALITY:
Water analysis by:

Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

Depth: 615-635'

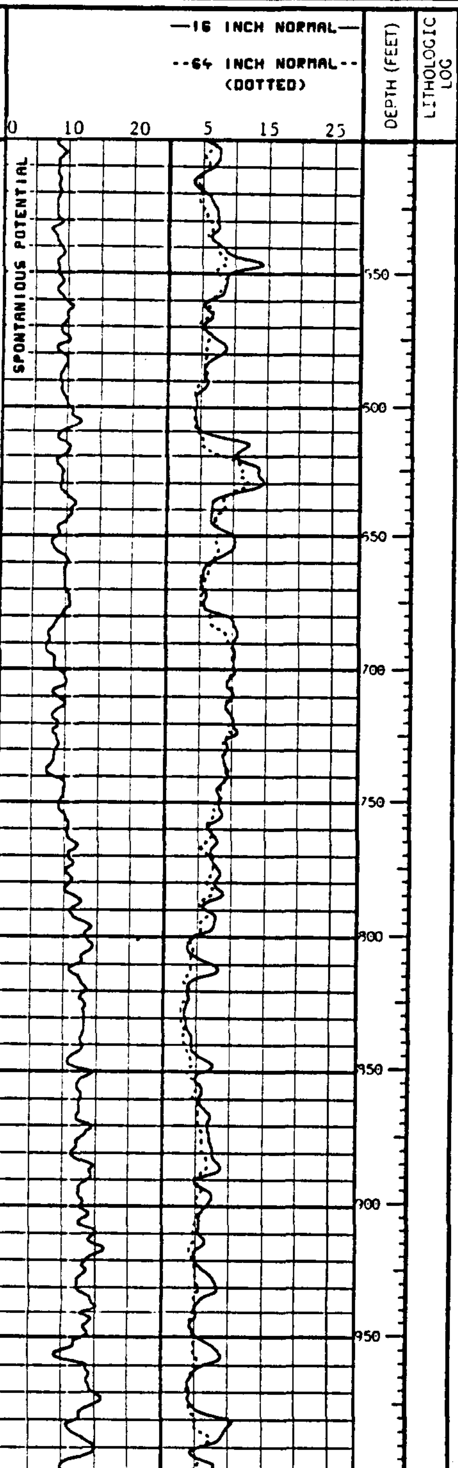
REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	22.4
mg/L	Calcium (Ca)	6.4
mg/L	Magnesium (Mg)	1.6
mg/L	Sodium (NA)	79.2
mg/L	Potassium (K)	3.5
Total Cations	Meq/L Value: 4.0	
mg/L	Total Alkalinity (AS CaCO3)	124.8
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	152.3
mg/L*	Sulfate (SO4)	27.9
mg/L*	Chloride (Cl)	17.1
mg/L	Nitrate (as NO3)	9.8
mg/L	Fluoride (F) Temp. Depend.	1.4
Total Anions	Meq/L Value: 3.8	
Std. Units	PH (Laboratory)	8.7
umho/cm**	Specific Conductance (E.C.)	380.0
mg/L***	Total Filterable Residue at 180C	212.8
Units	Apparent Color (Unfiltered)	> 70
TON	Odor Threshold at 60 C	2.0
NTU	Lab Turbidity	170.0
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	< 10
ug/L	Barium (Ba)	< 100
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	< 100
ug/L	Lead (Pb)	< 5
ug/L	Manganese (Mn)	< 30
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	< 5
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	< 50
ug/L	Aluminum	< 100

Depth: 1040-1060'

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	12.8
mg/L	Calcium (Ca)	3.2
mg/L	Magnesium (Mg)	1.2
mg/L	Sodium (NA)	95.0
mg/L	Potassium (K)	1.5
Total Cations	Meq/L Value: 4.4	
mg/L	Total Alkalinity (AS CaCO3)	183.2
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	223.5
mg/L*	Sulfate (SO4)	16.0
mg/L*	Chloride (Cl)	9.4
mg/L	Nitrate (as NO3)	6.7
mg/L	Fluoride (F) Temp. Depend.	0.7
Total Anions	Meq/L Value: 4.4	
Std. Units	PH (Laboratory)	9.1
umho/cm**	Specific Conductance (E.C.)	420.0
mg/L***	Total Filterable Residue at 180C	243.6
Units	Apparent Color (Unfiltered)	20.0
TON	Odor Threshold at 60 C	2.0
NTU	Lab Turbidity	61.0
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	< 10
ug/L	Barium (Ba)	< 100
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	< 100
ug/L	Lead (Pb)	< 5
ug/L	Manganese (Mn)	< 30
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	< 5
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	< 50
ug/L	Aluminum	< 100



CONDENSED CUTTINGS DESCRIPTION

470-510 SAND
Mostly medium to coarse sand.

510-520 CLAY
Brown silty clay.

520-580 SAND
Fine to coarse sand.

560-580 Thin clays.

580-610 CLAY
Brown clay.

600-610 Sand lenses.

610-760 SAND
Medium to coarse sand.

660-730 Scattered clay lenses.

760-800 SAND AND CLAY
Fine to coarse sand with interbedded with clay.

800-880 CLAY
Mostly brown clay. Interbedded sand lenses.

880-1370 SAND WITH CLAY LENSES
Fine to coarse sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-1

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 1910 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1790 Ft.
LOCATION: T.27 S., R.38 E., Sec. 23b — STATE: CA — BEGUN: 2-15-91
TYPE OF WELL: Observation — FINISHED: 3-5-91
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2848.3
COORDINATES: — TOP OF CASING ELEV.: 2852.2
HOLE LOGGED BY: Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES

Depth: 1500-1520'

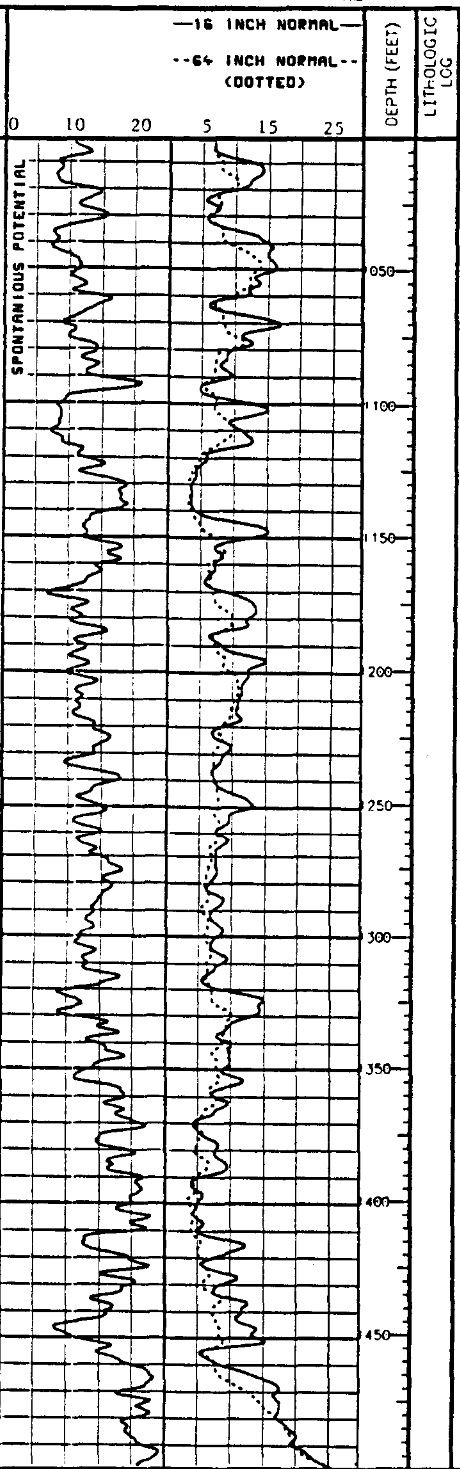
REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	72.0
mg/L	Calcium (Ca)	20.0
mg/L	Magnesium (Mg)	5.3
mg/L	Sodium (NA)	110.2
mg/L	Potassium (K)	7.9
Total Cations	Meq/L Value: 6.4	
mg/L	Total Alkalinity (AS CaCO3)	248.8
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	303.5
mg/L*	Sulfate (SO4)	25.3
mg/L*	Chloride (Cl)	14.3
mg/L	Nitrate (as NO3)	9.1
mg/L	Fluoride (F) Temp. Depend.	2.3
Total Anions	Meq/L Value: 6.2	
Std. Units	PH (Laboratory)	8.8
umho/cm**	Specific Conductance (E.C.)	610.0
mg/L***	Total Filterable Residue at 180C	353.8
Units	Apparent Color (Unfiltered)	> 70.0
TON	Odor Threshold at 60 C	2.0
NTU	Lab Turbidity	> 200.0
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	< 10
ug/L	Barium (Ba)	< 100
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	< 100
ug/L	Lead (Pb)	< 5
ug/L	Manganese (Mn)	< 30
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	< 5
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	150
ug/L	Aluminum	< 100

Depth: 1750-1770'

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	32.0
mg/L	Calcium (Ca)	9.6
mg/L	Magnesium (Mg)	1.9
mg/L	Sodium (NA)	107.9
mg/L	Potassium (K)	4.8
Total Cations	Meq/L Value: 5.4	
mg/L	Total Alkalinity (AS CaCO3)	218.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	266.0
mg/L*	Sulfate (SO4)	16.6
mg/L*	Chloride (Cl)	10.2
mg/L	Nitrate (as NO3)	7.1
mg/L	Fluoride (F) Temp. Depend.	3.3
Total Anions	Meq/L Value: 5.3	
Std. Units	PH (Laboratory)	8.7
umho/cm**	Specific Conductance (E.C.)	500.0
mg/L***	Total Filterable Residue at 180C	285.0
Units	Apparent Color (Unfiltered)	> 70.0
TON	Odor Threshold at 60 C	1.0
NTU	Lab Turbidity	> 200.0
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	< 10
ug/L	Barium (Ba)	< 100
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	< 100
ug/L	Lead (Pb)	< 5
ug/L	Manganese (Mn)	< 30
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	< 5
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	50
ug/L	Aluminum	< 100



CONDENSED CUTTINGS DESCRIPTION

880-1370 SAND WITH CLAY LENSES
Fine to coarse sand.

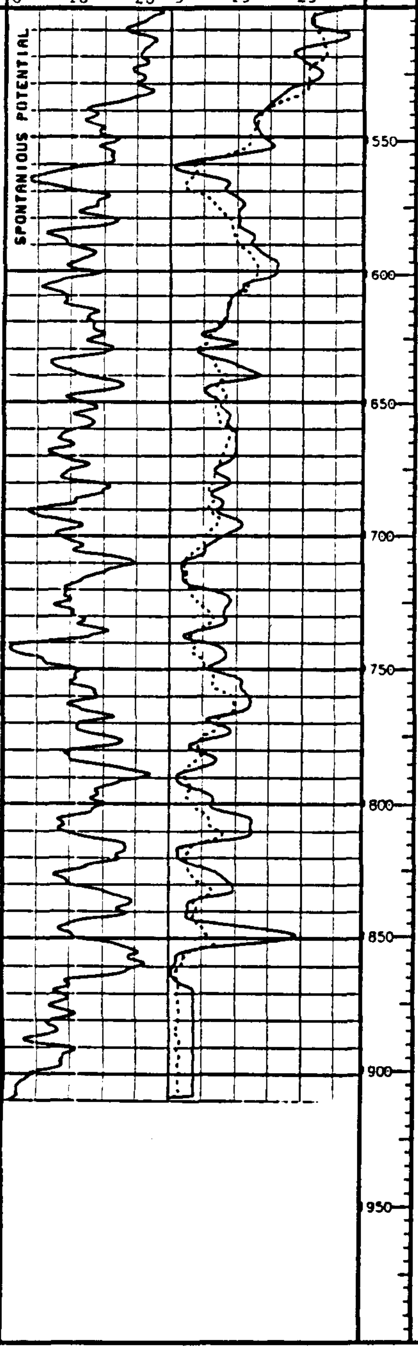
1370-1420 CLAY
Mostly brown to gray clay with thin sand lenses.

1420-1890 SAND
Mostly fine to coarse sand with interbedded clays.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-1

FEATURE Drill Hole Completed with Nested Piezometers . DRILLED DEPTH 1910 Ft.
PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1790 Ft.
LOCATION T.27 S., R.38 E., Sec. 23b STATE CA BEGUN 2-15-91
TYPE OF WELL Observation FINISHED 3-5-91
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2848.3
COORDINATES TOP OF CASING ELEV. 2852.2
HOLE LOGGED BY Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, LAB ANALYSIS Yes, See Notes
Temperature TDS See Notes
OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR

NOTES	—16 INCH NORMAL— / --64 INCH NORMAL-- (DOTTED)	DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION



1420-1890 SAND
Mostly fine to coarse sand with interbedded clays.

1610-1760 Driller reports volcanic conglomerate.

1760-1830 Volcanic sands reported by driller.

1830 Drilling time doubling with each added drill rod.

1890-1910 CLAY
Cemented dark brown clay with bluish tint.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-2

FEATURE	Drill Hole Completed with Nested Piezometers	DRILLED DEPTH	2020 Ft.
PROJECT	Indian Wells Valley Groundwater Project	COMPLETED DEPTH	1984 Ft.
LOCATION	T.27 S., R 38 E., Sec. 2c STATE CA	BEGUN	10-01-90
TYPE OF WELL	Observation	FINISHED	10-24-90
PURPOSE	Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity	GROUND ELEVATION	2655.9
COORDINATES		TOP OF CASING ELEV.	2658.8
HOLE LOGGED BY	Cuttings Description by Ken Turner, Kern Co. Water Agency	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature	LAB ANALYSIS	Yes, See Notes
		TDS	See Notes
OTHER LOGS	Drilling Time	REVIEWED BY	Dennis Watt, USBR

NOTES

DRILL SITE:
The well is located about 1 1/4 miles south of Hwy. 178 at the end of Sierra Vista Road.

DRILLED BY:
Southern California Drilling Company of Lancaster CA.

DRILLING RIG:
Custom built small oil-field rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 570'-590', 1460'-1480', 1940'-1960'. Twenty feet of 2" pipe below each screen. Neat cement plugs set at the following depth intervals: 680'-700', 1140'-1160', 1550'-1570', 1740'-1760'.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 10 gallons per minute.

DEPTH TO WATER:
All depths reported below were measured on October 22, 1991 from the top of the outer casing.

Screen Interval	Depth (Ft)
620'-640'	276.1
1460'-1480'	282.0
1940'-1960'	272.7

All depth to water measurements are available in an attachment to the Geohydrologic Appendix for this project.

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.017
Medium	.19
Deep	.016

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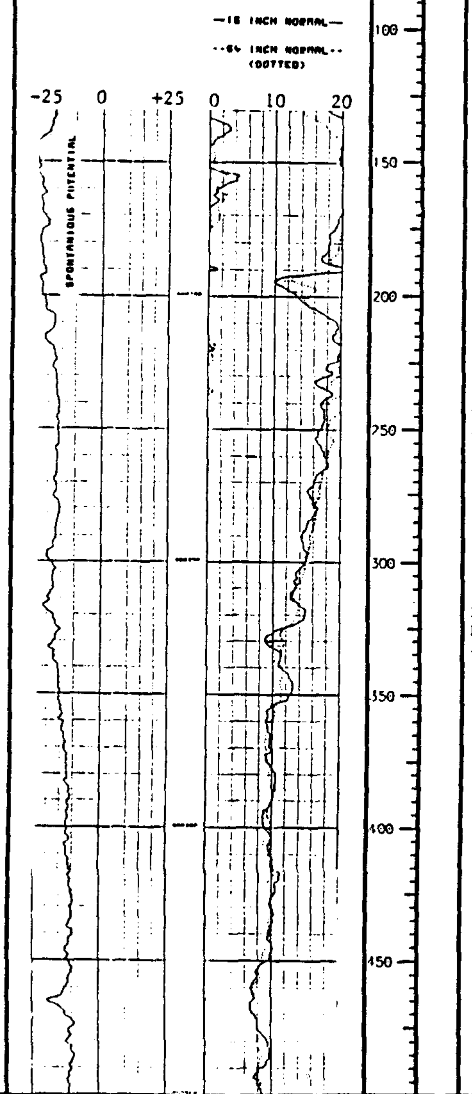
ELECTRIC LOG

DEPTH (FEET) | LITHOLOGIC LOG



CONDENSED CUTTINGS DESCRIPTION

The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.

GENERAL

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-80 SAND
Fine to coarse, subangular to subrounded, brown to light brown sand.

- 0-10 Silty.
- 30-40 Coarse to very coarse.
- 70-80 Some small pebbles.

80-250 SAND
Medium to very coarse, mostly subangular with some subrounded, light brownish gray to light gray sand.

- 150-160 Some pebbles.
- 170-180 Some pebbles.
- 190-220 Some pebbles.

250-380 SAND
Fine to coarse, subangular to subround, light gray sand.

- 270-290 Medium to coarse.
- 310-330 Medium to very coarse.
- 330-340 Very fine to medium.
- 350-370 Medium to very coarse.

380-490 SILTY SAND
Fine to coarse, subangular to subrounded, light gray, silty sand.

- 400-490 Well rounded.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-2

FEATURE Drill Hole Completed with Nested Piezometers — DRILLED DEPTH 2020 Ft.
PROJECT Indian Wells Valley Groundwater Project — COMPLETED DEPTH 1984 Ft.
LOCATION T.27 S., R 38 E., Sec. 2c — STATE CA — BEGUN 10-01-90
TYPE OF WELL Observation — FINISHED 10-24-90
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION 2655.9
COORDINATES — TOP OF CASING ELEV. 2658.8
HOLE LOGGED BY Cuttings Description by Ken Turner, Kern Co. Water Agency — DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS Yes, See Notes
TDS See Notes
OTHER LOGS Drilling Time — REVIEWED BY Dennis Watt, USBR

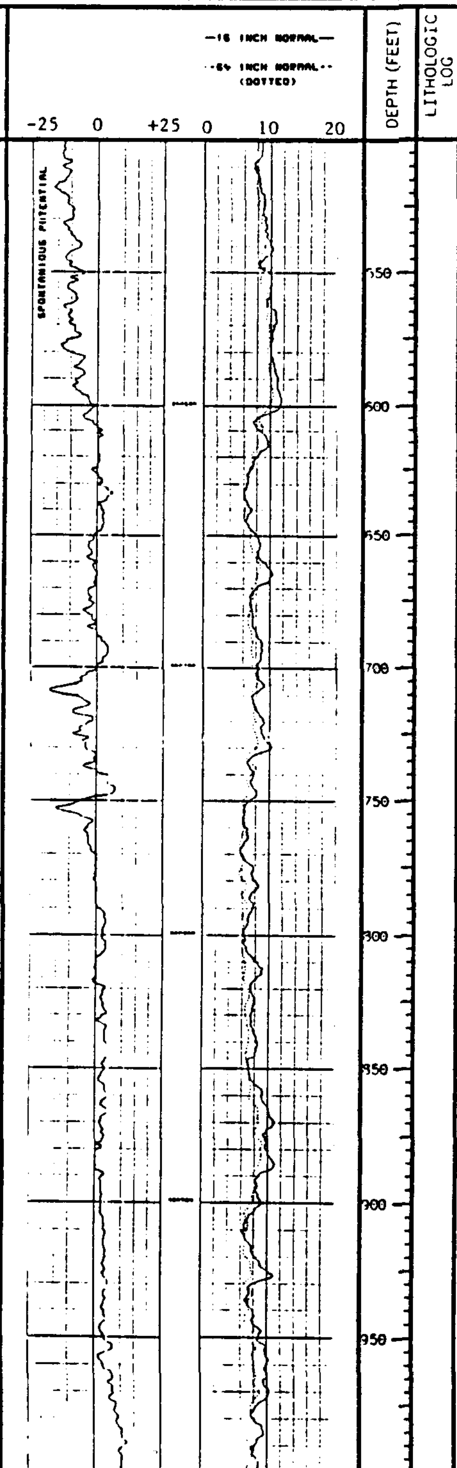
NOTES

WATER QUALITY:
Water analysis by:

Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

Depth: 620'-640'

Water quality sample not available. See following pages for water quality analyses from medium and deep piezometers.



CONDENSED CUTTINGS DESCRIPTION

490-550 SAND (CLAY RICH)
Fine to coarse, subangular to well rounded, light gray sand.

500-510 Very coarse sand.

550-580 SILTY SAND
Medium to coarse, subround to well rounded, light gray silty sand.

580-630 SAND
Medium to very coarse, subround, pale brown sand.

630-760 SANDY CLAY
Fine to medium, pale brown, sandy clay.

690-710 Silty.

760-1020 SILTY SAND
Clay rich, pale brown, silty sand.

800-810 Sandy clay.

850-870 Fine to coarse silty sand.

900-910 Sandy clay.

940-950 Sandy clay.

950-990 Fine to coarse, silty sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-2

FEATURE: Drill Hole Completed with Nested Piezometers
PROJECT: Indian Wells Valley Groundwater Project
LOCATION: T.27 S., R 38 E., Sec. 2c
STATE: CA
TYPE OF WELL: Observation
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity
COORDINATES:
HOLE LOGGED BY: Cuttings Description by Ken Turner, Kern Co. Water Agency
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature
OTHER LOGS: Drilling Time

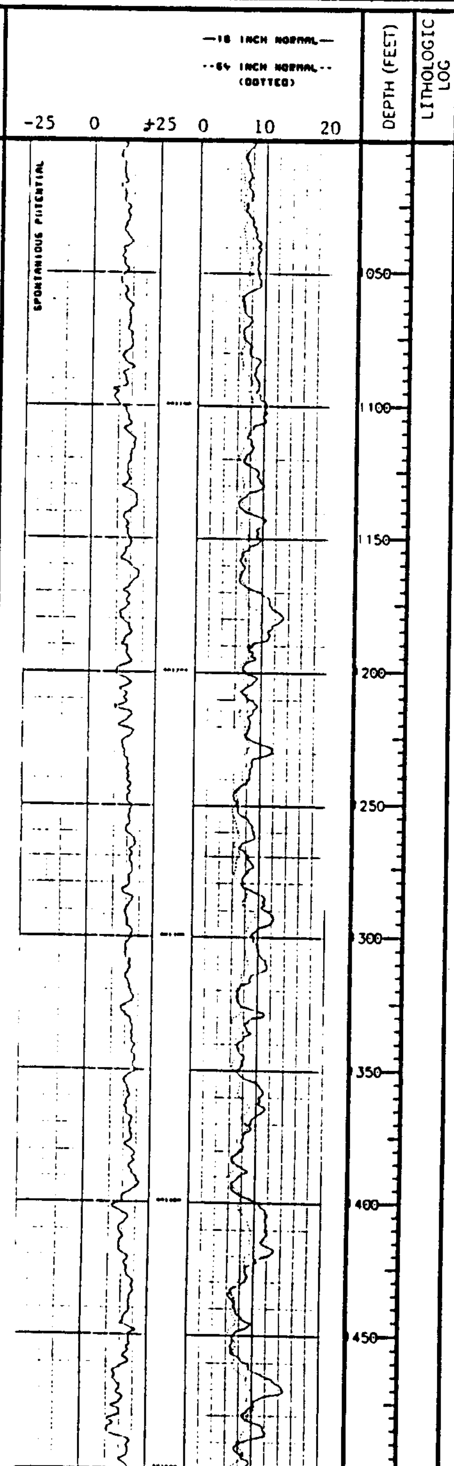
DRILLED DEPTH: 2020 Ft.
COMPLETED DEPTH: 1984 Ft.
BEGUN: 10-01-90
FINISHED: 10-24-90
GROUND ELEVATION: 2655.9
TOP OF CASING ELEV.: 2658.8
DEPTH TO WATER (DATE): See Notes
LAB ANALYSIS: Yes, See Notes
TDS: See Notes
REVIEWED BY: Dennis Watt, USBR

NOTES

WATER QUALITY:
Water analysis by:

Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

Depth: 1460-1480'



CONDENSED CUTTINGS DESCRIPTION

1020-1140 SILTY SAND
Fine to coarse, pale brown, silty sand.

- 1030-1040 Medium to very coarse, subrounded to well rounded sand.
- 1080-1100 Clay rich.
- 1100-1110 Sandy clay.

1140-1220 SILTY SAND
Fine to very coarse, pale brown, silty sand.

- 1140-1170 Sandy clay.
- 1190-1200 Sandy clay.

1220-1240 SANDY CLAY
Fine to medium, pale brown, sandy clay.

1240-1950 SILTY SAND
Fine to very coarse, pale brown, silty sand.

- 1260-1270 Clay rich.
- 1280-1320 Fine to very coarse, subangular to subrounded sand.
- 1370-1400 Clay rich.
- 1410-1430 Clay rich.
- 1440-1540 Clay rich.

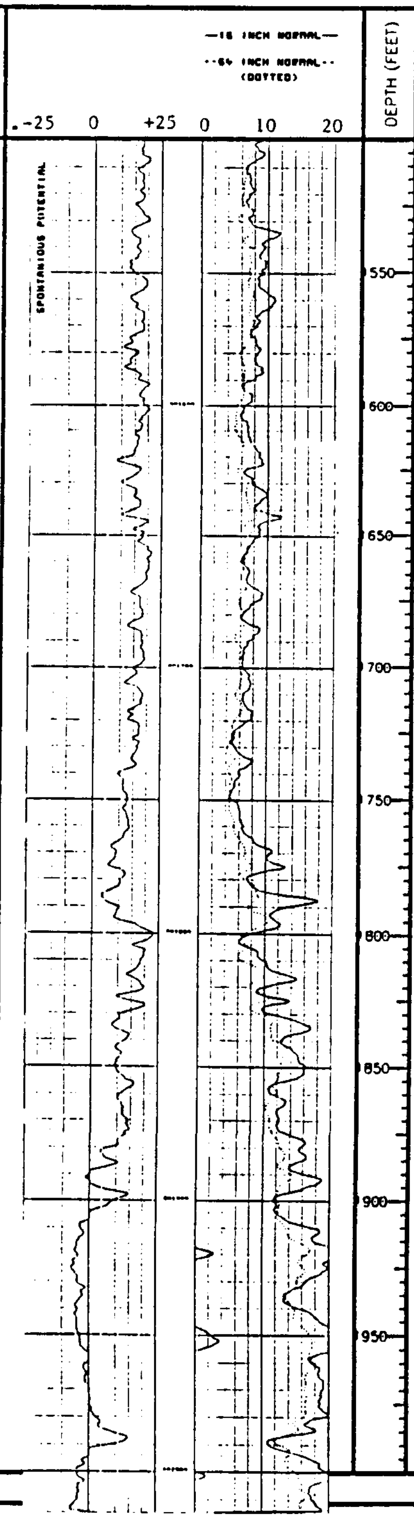
USBR Drill Hole Completion and Data Log
Monitoring Well BR-2

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 2020 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1984 Ft.
LOCATION: T.27 S., R 38 E., Sec. 2c — STATE: CA — BEGUN: 10-01-90
TYPE OF WELL: Observation — FINISHED: 10-24-90
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2655.9
COORDINATES: — TOP OF CASING ELEV.: 2658.8
HOLE LOGGED BY: Cuttings Description by Ken Turner, Kern Co. Water Agency — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES	GEOPHYSICAL LOGS	DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

NOTES

Depth: 1940-1960'



CONDENSED CUTTINGS DESCRIPTION

1240-1950 SILTY SAND
Fine to very coarse, pale brown, silty sand.

- 1440-1540 Clay rich.
- 1570-1640 Fine to coarse.
- 1670-1710 Fine to coarse.
- 1730-1750 Clay rich.
- 1780-1810 Fine to coarse.
- 1850-1880 Medium to coarse.
- 1880-1910 Fine to coarse.
- 1910-1950 Sandy clay.

1970-2020 SAND
Fine to coarse, pale brown sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-3

FEATURE	Drill Hole Completed with Nested Piezometers	DRILLED DEPTH	2024 Ft.
PROJECT	Indian Wells Valley Groundwater Project	COMPLETED DEPTH	1990 Ft.
LOCATION	T.27 S., R.39 E., Sec. 11d STATE CA	BEGUN	3-06-91
TYPE OF WELL	Observation	FINISHED	3-19-91
PURPOSE	Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity	GROUND ELEVATION	2508.6
COORDINATES		TOP OF CASING ELEV.	2511.9
HOLE LOGGED BY	Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature	LAB ANALYSIS	Yes, See Notes
		TDS	See Notes
OTHER LOGS	Drilling Time	REVIEWED BY	Dennis Watt, USBR

NOTES

DRILL SITE:
The well is located on the south side of Bowman Road about 1500 east of Hwy. 395.

DRILLED BY:
Southern California Drilling Company of Lancaster CA.

DRILLING RIG:
Custom built, small oil-field rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 650'-670', 1320'-1340', 1850'-1870'. Twenty feet of 2" pipe below each screen. Benseal (bentonite) plugs set at the following depth intervals: 440'-460', 960'-980', 1400'-1420', 1615'-1625'.

DEVELOPMENT:
Each piezometer was air-lifted for about 12-20 hours and discharged an estimated 5-10 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on December 12, 1991 from the top of the outer casing. Medium was measured with temperature logger.

Screen Interval	Depth (Ft)
650'-670'	327.6'
1320'-1340'	310'
1850'-1870'	308.6'

All depth to water measurements are available in the Geohydrologic Appendix for this project.

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.06
Medium	.00005*
Deep	.006

*Note - This is believed to be too low. Poor development?

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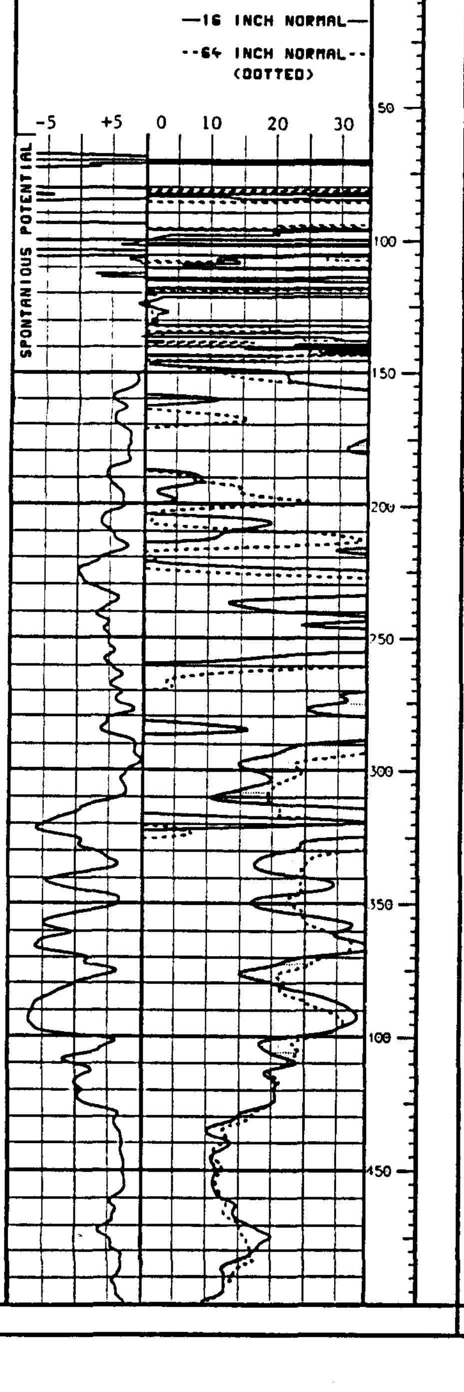
ELECTRIC LOG



CONDENSED CUTTINGS DESCRIPTION

The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.

GENERAL

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-1380 SAND
Fine to coarse sand with scattered gravel lenses down to 600 feet.

180-200 Clay lenses.

240-480 Thin clay lenses.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-3

FEATURE Drill Hole Completed with Nested Piezometers — DRILLED DEPTH 2024 Ft.
PROJECT Indian Wells Valley Groundwater Project — COMPLETED DEPTH 1990 Ft.
LOCATION T.27 S., R.39 E., Sec. 11d — STATE CA — BEGUN 3-06-91
TYPE OF WELL Observation — FINISHED 3-19-91
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION 2508.6
COORDINATES — TOP OF CASING ELEV. 2511.9
HOLE LOGGED BY Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS Yes, See Notes
TDS See Notes
OTHER LOGS Drilling Time — REVIEWED BY Dennis Watt, USBR

NOTES

WATER QUALITY:
Water analysis by:

Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

Depth: 650-670'

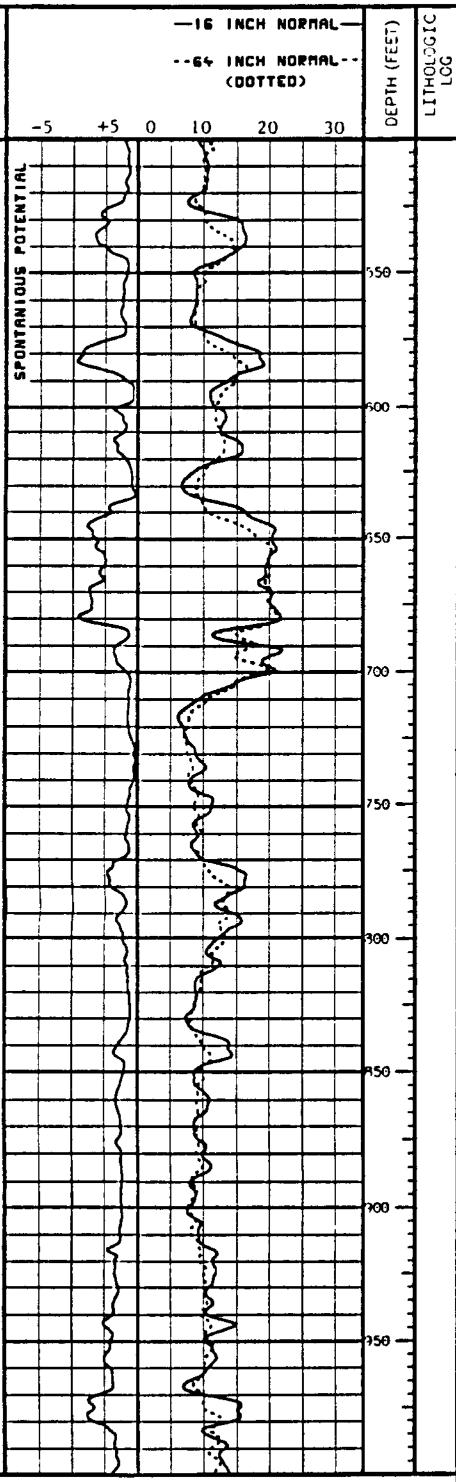
REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED mG/L	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	96.0
mg/L	Calcium (Ca)	17.6
mg/L	Magnesium (Mg)	12.9
mg/L	Sodium (NA)	91.4
mg/L	Potassium (K)	5.9
Total Cations	Meq/L Value: 6.0	
mg/L	Total Alkalinity (AS CaCO3)	132.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	162.0
mg/L*	Sulfate (SO4)	78.5
mg/L*	Chloride (Cl)	47.3
mg/L	Nitrate (as NO3)	11.1
mg/L	Fluoride (F) Temp. Depend.	0.5
Total Anions	Meq/L Value: 5.8	
Std. Units	PH (Laboratory)	8.4
umho/cm**	Specific Conductance (E.C.)	600.0
mg/L***	Total Filterable Residue at 180C	360.0
Units	Apparent Color (Unfiltered)	70.0
TON	Odor Threshold at 60 C	1.0
NTU	Lab Turbidity	71.0
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	< 10
ug/L	Barium (Ba)	< 100
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	4550
ug/L	Lead (Pb)	120
ug/L	Manganese (Mn)	< 30
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	< 5
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	< 50
ug/L	Aluminum	670

Depth: 1320-1340'

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED mG/L	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	126.5
mg/L	Calcium (Ca)	38.4
mg/L	Magnesium (Mg)	7.8
mg/L	Sodium (NA)	255.9
mg/L	Potassium (K)	7.9
Total Cations	Meq/L Value: 13.9	
mg/L	Total Alkalinity (AS CaCO3)	113.2
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	138.1
mg/L*	Sulfate (SO4)	65.6
mg/L*	Chloride (Cl)	372.0
mg/L	Nitrate (as NO3)	< 1.0
mg/L	Fluoride (F) Temp. Depend.	1.1
Total Anions	Meq/L Value: 14.2	
Std. Units	PH (Laboratory)	7.4
umho/cm**	Specific Conductance (E.C.)	1540.0
mg/L***	Total Filterable Residue at 180C	954.8
Units	Apparent Color (Unfiltered)	70.0
TON	Odor Threshold at 60 C	2.0
NTU	Lab Turbidity	5.9
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	< 10
ug/L	Barium (Ba)	120
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	3200
ug/L	Lead (Pb)	< 5
ug/L	Manganese (Mn)	100
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	< 5
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	< 50
ug/L	Aluminum	1800



CONDENSED CUTTINGS DESCRIPTION

0-1380 SAND
Fine to coarse sand with scattered gravel lenses down to 600 feet.

580-600 Thin clay lenses.

750-760 Some gravel.

860-1000 Thin clay lenses.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-3

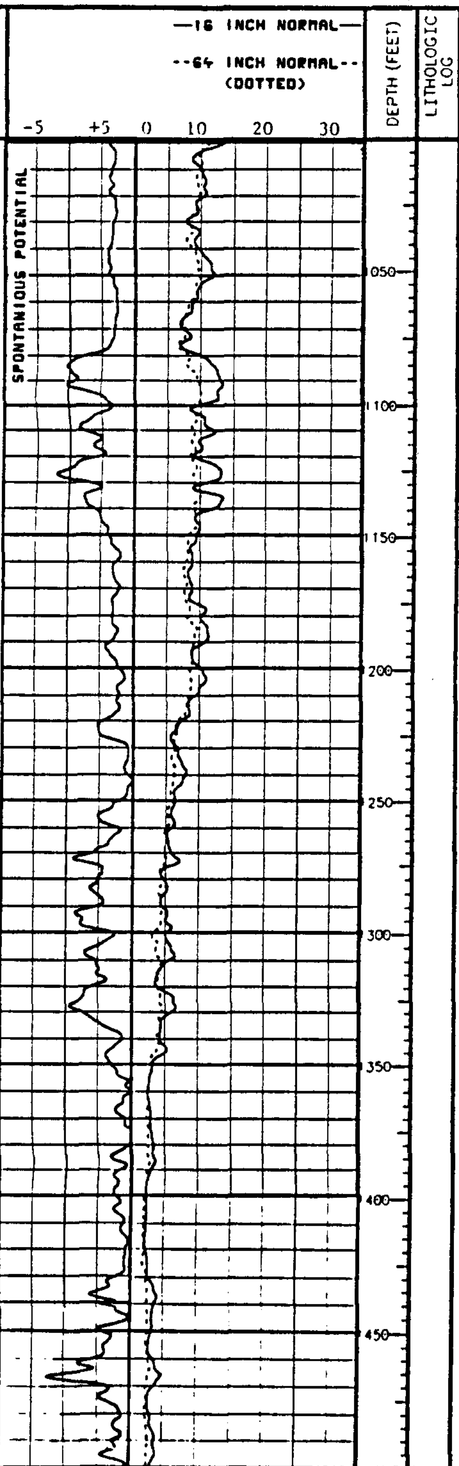
FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 2024 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1990 Ft.
LOCATION: T.27 S., R.39 E., Sec. 11d — STATE: CA — BEGUN: 3-06-91
TYPE OF WELL: Observation — FINISHED: 3-19-91
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2508.6
COORDINATES: — TOP OF CASING ELEV.: 2511.9
HOLE LOGGED BY: Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES

Depth: 1850-1870'

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	1400.0
mg/L	Calcium (Ca)	496.6
mg/L	Magnesium (Mg)	38.9
mg/L	Sodium (NA)	1936.4
mg/L	Potassium (K)	14.6
Total Cations	Meq/L Value: 95.2	
mg/L	Total Alkalinity (AS CaCO3)	32.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO2)	< 1.0
mg/L	Bicarbonate (HCO3)	39.0
mg/L*	Sulfate (SO4)	257.5
mg/L*	Chloride (Cl)	3280.0
mg/L	Nitrate (as NO3)	38.1
mg/L	Fluoride (F) Temp. Depend.	5.4
Total Anions	Meq/L Value: 97.0	
Std. units	PH (Laboratory)	7.2
umho/cm**	Specific Conductance (E.C.)	10700.
mg/L***	Total Filterable Residue at 180C	6634.8
Units	Apparent Color (Unfiltered)	40.0
TON	Odor Threshold at 60 C	3.0
NTU	Lab Turbidity	71.0
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	< 10
ug/L	Barium (Ba)	100
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	780
ug/L	Lead (Pb)	< 5
ug/L	Manganese (Mn)	350
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	< 5
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	< 50
ug/L	Aluminum	340



CONDENSED CUTTINGS DESCRIPTION

0-1380 SAND
Fine to coarse sand with scattered gravel lenses down to 600 feet.

1240-1380 Thin clay lenses.

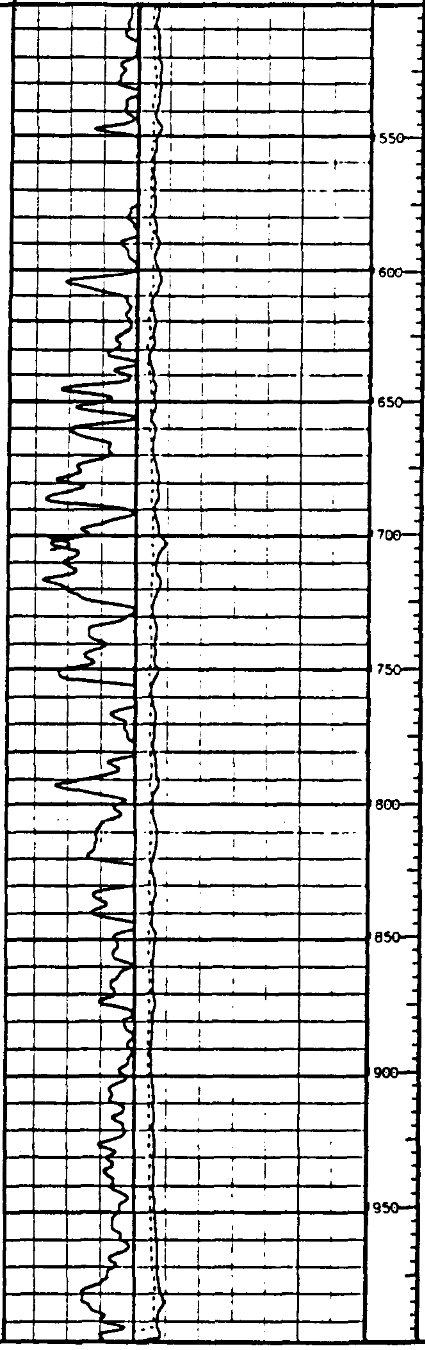
1380-1740 CLAY
Mostly brown clay with some reddish brown and yellow brown clay.

1380-1410 Thin clay lenses.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-3

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 2024 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1990 Ft.
LOCATION: T.27 S., R.39 E., Sec. 11d — STATE: CA — BEGUN: 3-06-91
TYPE OF WELL: Observation — FINISHED: 3-19-91
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2508.6
COORDINATES: — TOP OF CASING ELEV.: 2511.9
HOLE LOGGED BY: Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES		DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION



1380-1740 CLAY
Mostly brown clay with some reddish brown and yellow brown clay.

1680-1740 Sand layers.

1740-1880 SAND WITH CLAY LAYERS
Fine to coarse sand with brown clay layers.

1880-1970 SAND
Medium to coarse sand with a few thin clay lenses.

1970-2024 SAND WITH CLAY LAYERS
Mostly medium to coarse sand. Twenty to thirty percent of the cuttings were clay.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-4

FEATURE Drill Hole Completed with Single Piezometer (Intended Mulitiple Completion) DRILLED DEPTH 2020 Ft.
PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1210 Ft.
LOCATION T.26 S., R.39 E., Sec. 26a STATE CA BEGUN 8-29-90
TYPE OF WELL Observation FINISHED 9-14-90
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2375.2
COORDINATES TOP OF CASING ELEV. 2377.5
HOLE LOGGED BY Cuttings Description by Ken Turner, Kern Co. Water Agency DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Notes
TDS See Notes
OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR

NOTES	welenco ELECTRIC LOG	DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

NOTES

DRILL SITE:
The well is located about 600 feet south of Hwy. 170, 1.05 miles west of Jack Ranch Road.

DRILLED BY:
U.S. Bureau of Reclamation. One crew from Sacramento and the other from Phoenix.

DRILLING RIG:
Truck mounted Portadrill TLS-542 rotary.

DRILLING METHOD:
Direct rotary with bentonite mud. 7 7/8 inch roller cone bit to total depth. Reamed to total depth with a 10 1/4 inch roller cone bit.

HOLE COMPLETION:
Installed one 2" diameter steel pipe with a 10' two inch diameter screen on the bottom. The screen is at a depth interval of 1190'-1200'. Benseal (bentonite) plug set at the following depth interval: 960'-1130'.

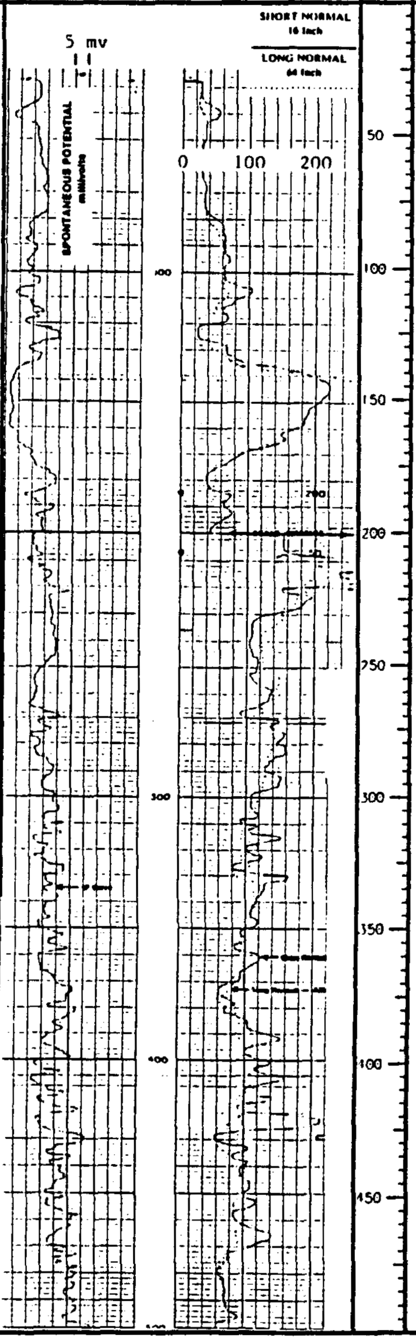
This hole was to be completed with multiple piezometers. However, much difficulty ensued when the 2" filter pack tremie pipe could not be moved from the bottom of the hole. The deep piezometer (2000 ft.) was pulled out and the tremie broke during the attempt to pull it. An overshot was washed and rotated over the top of the stuck tremie. The overshot twisted off near the bottom after retrieving most of the tremie. Numerous fishing trips removed pipe down to 1220 feet. Lead impression showed that the hole was filled around the pipes at 1220 feet. Decided to complete the remaining open hole with one piezometer to 1200 feet. Nearby production wells are screened down to about 1000 feet.

DEVELOPMENT:
The piezometer was air-lifted and discharged an estimated 5-10 gallons per minute. The water sample for lab analysis was collected at the end of development.

DEPTH TO WATER:
Depth was measured on December 12, 1991 from the top of the outer casing.

Screen Interval	Depth (Ft)
1190'-1200'	252'

All depth to water measurements are available in the Geohydrologic Appendix for this project.



CONDENSED CUTTINGS DESCRIPTION

The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.

GENERAL

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-160 SAND
Light brown, medium to coarse.

- 40-60 Coarse.
- 60-120 Coarse, occasional fine gravel.
- 120-130 Yellowish brown, very fine to fine.
- 130-140 Brownish gray.
- 140-150 Pinkish gray.
- 150-160 Gravelly, pinkish gray.

160-250 GRAVELLY SAND
Pinkish gray, fine to coarse.

- 240-250 Dark gray to black, medium to coarse.
- 250-270 Gray, medium to coarse.
- 330-390 Silty with fine gravel, brownish gray.
- 390-420 Brown.

420-510 SILTY SAND
Brown, fine to coarse.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-4

FEATURE Drill Hole Completed with Single Piezometer (Intended Mulitiple Completion) DRILLED DEPTH 2020 Ft.
PROJECT Indian Wells Valley Groundwater Project COMPLETED DEPTH 1210 Ft.
LOCATION T.26 S., R.39 E., Sec. 26a STATE CA BEGUN 8-29-90
TYPE OF WELL Observation FINISHED 9-14-90
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity GROUND ELEVATION 2375.2
COORDINATES TOP OF CASING ELEV. 2377.5
HOLE LOGGED BY Cuttings Description by Ken Turner, Kern Co. Water Agency DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature LAB ANALYSIS Yes, See Note
TDS See Notes
OTHER LOGS Drilling Time REVIEWED BY Dennis Watt, USBR

NOTES

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 10 feet of aquifer at the screen.

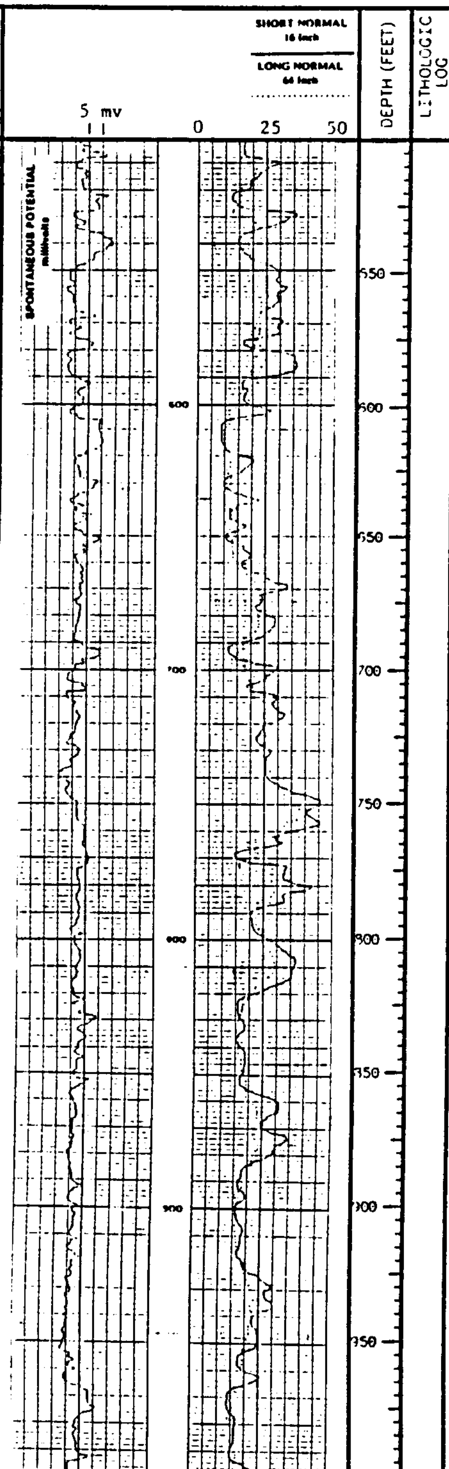
Piezometer	T
Medium	.28

WATER QUALITY:
Water analysis by:

Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

Depth 1190'-1200'

[illegible]



CONDENSED CUTTINGS DESCRIPTION

420-510 SILTY SAND
Brown, fine to coarse.

500-510 Clayey, light gray to pale yellow.

510-600 GRAVELLY SAND
Light brown, medium to coarse sand, fine gravel.

520-530 Silty, fine to coarse.

580-600 Silty, light gray to yellow brown, very fine to medium.

600-630 CLAY
Dark gray, plastic.

630-680 SILTY, CLAYEY SAND
Dark gray, very fine to medium

680-990 GRAVELLY SAND
Light brown, fine to coarse sand, fine gravel.

740-810 Silty, gray to light brown.

810-950 Pink to gray to light brown, medium to coarse sand.

950-970 Silty, pink to gray to light brown.

970-990 Sand, light brown to gray.

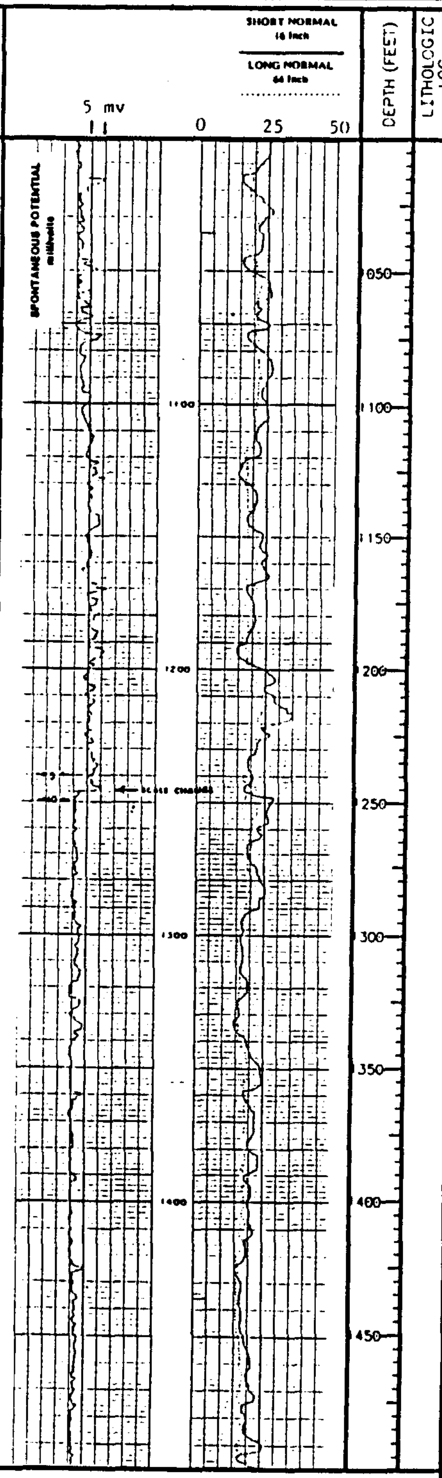
990-1200 SANDY SILT
Grayish brown, fine to medium sand.

990-1000 Very fine to coarse.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-4

FEATURE: Drill Hole Completed with Single Piezometer (Intended Mulitiple Completion) — DRILLED DEPTH: 2020 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1210 Ft.
LOCATION: T.26 S., R.39 E., Sec. 26a — STATE: CA — BEGUN: 8-29-90
TYPE OF WELL: Observation — FINISHED: 9-14-90
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2375.2
COORDINATES: — TOP OF CASING ELEV.: 2377.5
HOLE LOGGED BY: Cuttings Description by Ken Turner, Kern Co. Water Agency — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Note
OTHER LOGS: Drilling Time — TDS: See Notes
REVIEWED BY: Dennis Watt, USBR

NOTES		DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION



990-1200 SANDY SILT
Grayish brown, fine to medium sand.

1050-1080 Clayey.

1140-1160 Pinkish gray, medium to coarse sand, chunks of olive green dense clay.

1160-1200 Light brown to gray, fine to coarse sand, some gravel.

1200-1500 SAND
Pale brown, fine to coarse.

1230-1300 Silty.

1300-1340 Clayey, very fine to coarse.

1340-1450 Very fine to coarse.

1450-1460 Coarse to very coarse, chunks of olive green clay.

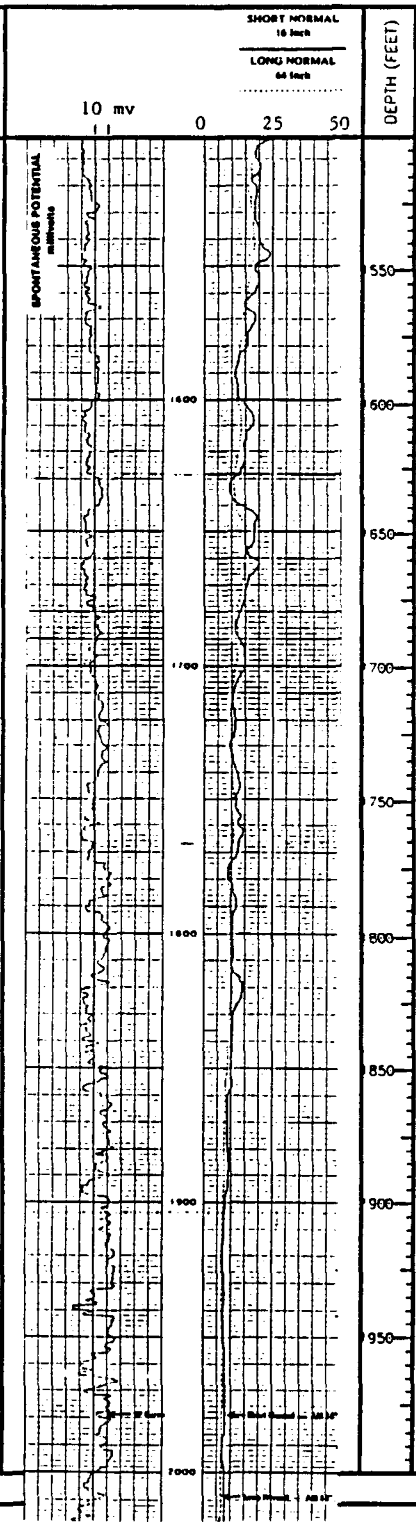
1460-1490 Silty, light brown to gray, very fine to coarse.

1490-1500 Light brown to gray, medium to coarse.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-4

FEATURE: Drill Hole Completed with Single Piezometer (Intended Mulitiple Completion) — DRILLED DEPTH: 2020 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1210 Ft.
LOCATION: T.26 S., R.39 E., Sec. 26a — STATE: CA — BEGUN: 8-29-90
TYPE OF WELL: Observation — FINISHED: 9-14-90
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2375.2
COORDINATES: — TOP OF CASING ELEV.: 2377.5
HOLE LOGGED BY: Cuttings Description by Ken Turner, Kern Co. Water Agency — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Note
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES		DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION



1500-1995 SAND
Light brown to gray, fine to coarse.

- 1560-1570 Silty.
- 1600-1610 Silty.
- 1630-1650 Silty.
- 1680-1720 Silty.
- 1740-1780 Silty.
- 1780-1840 Gray, medium to coarse.
- 1840-1880 Silty, pale brown.
- 1880-1995 Pale brown to light gray.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-5

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 2013 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1980 Ft.
LOCATION: T.25 S., R.38 E., Sec. 341 — STATE: — BEGUN: 12-19-91
TYPE OF WELL: Observation — FINISHED: 1-03-92
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2518.6
COORDINATES: — TOP OF CASING ELEV.: 2512.5
HOLE LOGGED BY: Cuttings Description by Mike Stoner, Naval Air Warfare Station — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES	BARBOUR CORP WELL SURVEYING 805-482-4988 ELECTRIC LOG	DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

NOTES

DRILL SITE:
The well is about 200 feet west of Hwy. 395 at a point about 1/2 mile north of the intersection of Leliter Road and Hwy. 395.

DRILLED BY:
Welch and Howell Drilling of El Centro CA.

DRILLING RIG:
Mac double (106' total height) direct rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 14 3/4 inch roller cone bit from 56 to 1014 feet. 12 1/4 roller cone bit from 1014 to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 850'-870', 1590'-1610', 1960'-1980'. Cement plugs set at the following depth intervals: 1365'-1385', 1696'-1706'?, 1788'-1800'.

DEVELOPMENT:
Each piezometer was air-lifted 3-4 hours and discharged an estimated 5-10 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on January 28, 1992 from the top of the protective casing. These depths were measured only about 5 minutes after the cap was removed. Actual and relative depths may be different in subsequent measurements.

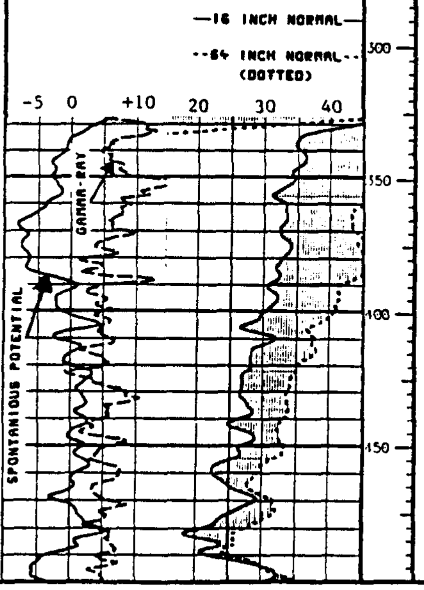
Screen Interval	Depth (Ft)
850'-870'	334.9
1590'-1610'	341.9
1960'-1980'	343.7

All depth to water measurements made during the project life are available in the Geohydrologic Appendix for this project.

SLUG TEST RESULTS:
Estimated transmissivity (T) (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.23
Medium	.15
Deep	.18

ELECTRIC LOG



CONDENSED CUTTINGS DESCRIPTION

The description below is reduced from a description of samples collected every 10 feet from the drilling mud return.

GENERAL

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-60 No samples.

60-800 **SAND**
Medium to coarse, off-white, fairly to very well sorted, subrounded sand. Feldspars and quartz dominate.

- 60-80 Well rounded.
- 100-110 Very coarse.
- 120-130 Coarse to very coarse.
- 180-190 Very coarse.
- 240-250 Very coarse.
- 250-260 Subangular.
- 300-310 Fine to medium and unsorted.
- 440-450 Very coarse.
- 490-500 Coarse to very coarse.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-5

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 2013 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1980 Ft.
LOCATION: T.25 S., R.38 E., Sec. 34J — STATE: — BEGUN: 12-19-91
TYPE OF WELL: Observation — FINISHED: 1-03-92
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2518.6
COORDINATES: — TOP OF CASING ELEV.: 2512.5
HOLE LOGGED BY: Cuttings Description by Mike Stoner, Naval Air Warfare Station — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES

SLUG TEST RESULTS:
Estimated transmissivity (T) (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.23
Medium	.15
Deep	.18

WATER QUALITY:
Water analysis by:

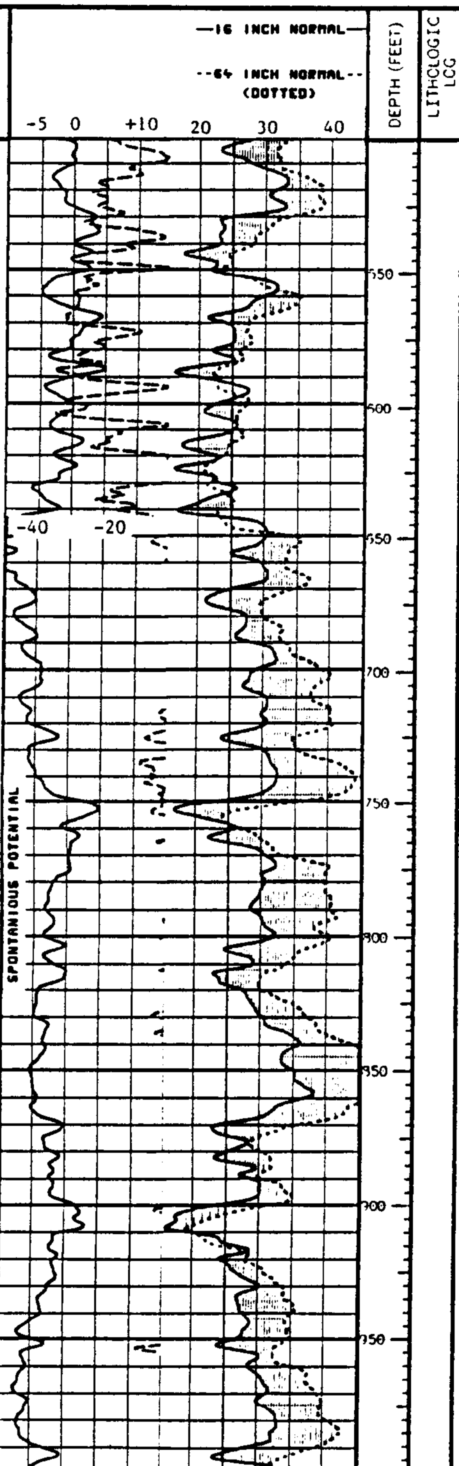
Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

850-870'

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	128.0
mg/L	Calcium (Ca)	20.8
mg/L	Magnesium (Mg)	18.5
mg/L	Sodium (Na)	154.6
mg/L	Potassium (K)	9.4
Cations	Meq/L Value: 9.5	
mg/L	Total Alkalinity (AS CaCO3)	186.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	226.9
mg/L*	Sulfate (SO4)	149.6
mg/L*	Chloride (Cl)	85.5
mg/L	Nitrate (as NO3)	< 1.0
mg/L	Fluoride (F) Temp. Depend.	1.1
Anions	Meq/L Value: 9.3	
Std. Units	PH (Laboratory)	9.5
umho/cm**	Specific Conductance (E.C.)	1000.0
mg/L***	Total Filterable Residue at 180C	533.5
Units	Apparent Color (Unfiltered)	< 70.0
TON	Odor Threshold at 60 C	2.0
NTU	Lab Turbidity	56.0
mg/L	MBAS	< 0.02

INORGANIC CHEMICALS

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	210.00
ug/L	Arsenic (As)	17.00
ug/L	Barium (Ba)	<100.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	2655.0
ug/L	Lead (Pb)	11.00
ug/L	Manganese (Mn)	175.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	< 50.00



CONDENSED CUTTINGS DESCRIPTION

60-800 SAND
Medium to coarse, off-white, fairly to very well sorted, subrounded sand. Feldspars and quartz dominate.

600-610 Very coarse.

620-640 Very coarse.

790-800 Fine to medium.

800-900 SAND
Fine, off-white, fairly to very well sorted, subrounded sand. Feldspar and quartz dominated.

820-840 With medium sand.

840-860 Medium sand.

880-900 Very fine sand with silt.

900-930 SILTY SAND
Very fine, light gray, very well sorted, subrounded, silty sand with some clay.

930-1090 SAND
Fine, off-white, very well sorted, subrounded, sand.

970-980 Very fine.

980-990 Medium.

990-1000 Fine to medium.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-5

FEATURE: Drill Hole Completed with Nested Piezometers	DRILLED DEPTH: 2013 Ft.
PROJECT: Indian Wells Valley Groundwater Project	COMPLETED DEPTH: 1980 Ft.
LOCATION: T.25 S., R.38 E., Sec. 34? STATE:	BEGUN: 12-19-91
TYPE OF WELL: Observation	FINISHED: 1-03-92
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity	GROUND ELEVATION: 2518.6
COORDINATES:	TOP OF CASING ELEV.: 2512.5
HOLE LOGGED BY: Cuttings Description by Mike Stoner, Naval Air Warfare Station	DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral Temperature	LAB ANALYSIS: Yes, See Notes
	TDS: See Notes
OTHER LOGS: Drilling Time	REVIEWED BY: Dennis Watt, USBR

NOTES

1590-1610'

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	80.0
mg/L	Calcium (Ca)	20.8
mg/L	Magnesium (Mg)	6.6
mg/L	Sodium (Na)	346.0
mg/L	Potassium (K)	9.0
Cations	Meq/L Value: 16.9	
mg/L	Total Alkalinity (AS CaCO3)	626.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	763.7
mg/L*	Sulfate (SO4)	63.5
mg/L*	Chloride (Cl)	71.7
mg/L	Nitrate (as NO3)	< 1.0
mg/L	Fluoride (F) Temp. Depend.	3.1
Anions	Meq/L Value: 16.8	
Std. Units	PH (Laboratory)	8.7
umho/cm**	Specific Conductance (E.C.)	1880.0
mg/L***	Total Filterable Residue at 180C	936.9
Units	Apparent Color (Unfiltered)	> 70.0
TON	Odor Threshold at 60 C	1.0
NTU	Lab Turbidity	> 200.0
mg/L	MBAS	< 0.02

INORGANIC CHEMICALS

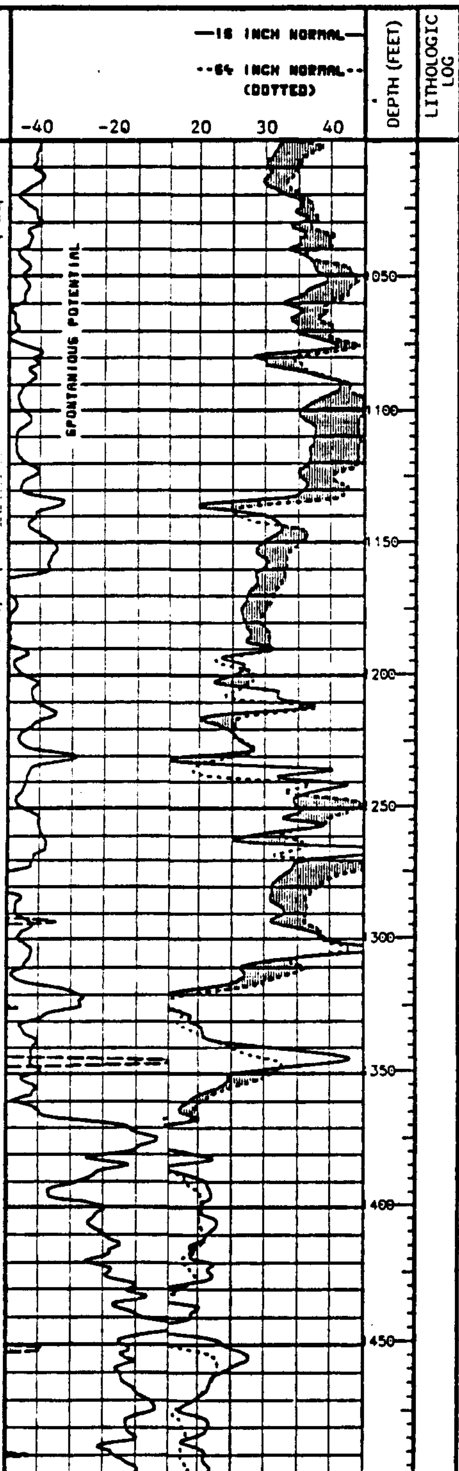
REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	460.00
ug/L	Arsenic (As)	88.00
ug/L	Barium (Ba)	170.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	1320.0
ug/L	Lead (Pb)	6.00
ug/L	Manganese (Mn)	165.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	< 50.00

1960-1980'

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	108.0
mg/L	Calcium (Ca)	14.4
mg/L	Magnesium (Mg)	17.5
mg/L	Sodium (Na)	334.9
mg/L	Potassium (K)	8.7
Cations	Meq/L Value: 16.9	
mg/L	Total Alkalinity (AS CaCO3)	708.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	863.8
mg/L*	Sulfate (SO4)	98.0
mg/L*	Chloride (Cl)	68.6
mg/L	Nitrate (as NO3)	< 1.0
mg/L	Fluoride (F) Temp. Depend.	1.5
Anions	Meq/L Value: 18.8	
Std. Units	PH (Laboratory)	8.7
umho/cm**	Specific Conductance (E.C.)	1870.0
mg/L***	Total Filterable Residue at 180C	890.6
Units	Apparent Color (Unfiltered)	>70.0
TON	Odor Threshold at 60 C	1.0
NTU	Lab Turbidity	>200.0
mg/L	MBAS	< 0.02

INORGANIC CHEMICALS

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	760.00
ug/L	Arsenic (As)	25.00
ug/L	Barium (Ba)	200.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	1160.0
ug/L	Lead (Pb)	11.00
ug/L	Manganese (Mn)	175.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	< 50.00



CONDENSED CUTTINGS DESCRIPTION

930-1090 SAND
Fine, off-white, very well sorted, subrounded, sand.

1020-1030 Some silt.

1030-1040 Very fine.

1050-1060 Very fine.

1070-1080 Some mafics.

1080-1090 Some medium sand.

1090-1340 SAND
Medium, off-white, very well sorted, subrounded sand. Feldspars and quartz dominate.

1120-1130 Some fine sand.

1150-1170 Some fine sand.

1200-1210 Coarse with medium sand.

1210-1230 Fine to medium with some coarse sand.

1250-1270 Medium with some fine sand.

1270-1330 Fine to medium sand with some silt.

1340-1450 SAND
Fine and fine to medium, off-white, fairly to very well sorted, subrounded sand. Feldspars and quartz dominate.

1400-1410 Medium sand.

1410-1420 Some silt.

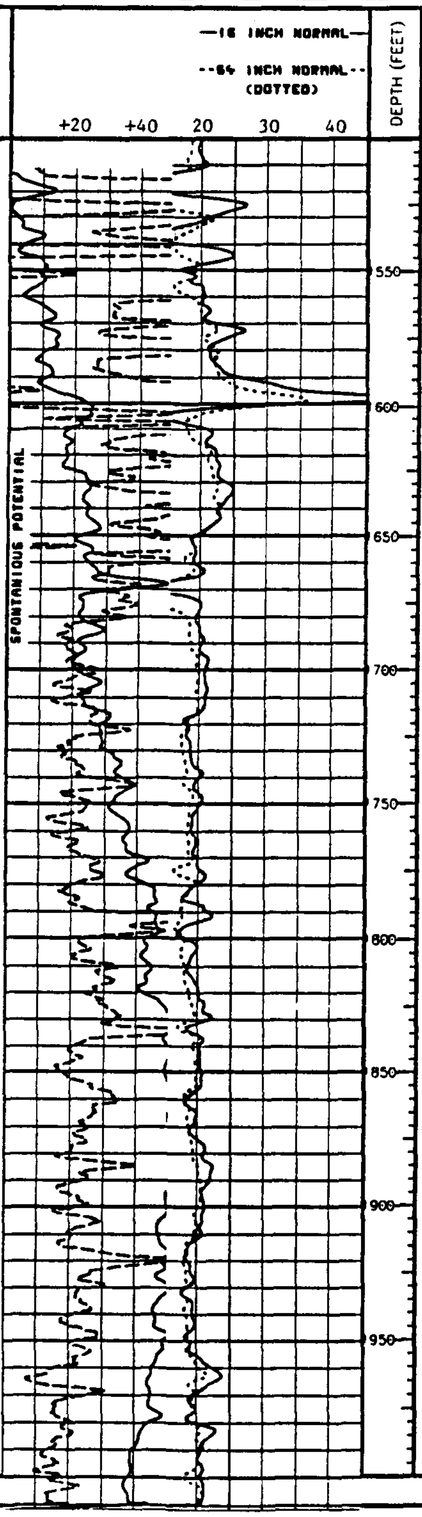
1450-1500 SAND
Medium, off-white, very well sorted, subrounded sand. Feldspars and quartz dominate.

1480-1500 Some coarse sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-5

FEATURE Drill Hole Completed with Nested Piezometers — DRILLED DEPTH 2013 Ft.
PROJECT Indian Wells Valley Groundwater Project — COMPLETED DEPTH 1980 Ft.
LOCATION T.25 S., R.38 E., Sec. 34J — STATE ____ BEGUN 12-19-91
TYPE OF WELL Observation — FINISHED 1-03-92
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION 2518.6
COORDINATES ____ — TOP OF CASING ELEV. 2512.5
HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station — DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral — LAB ANALYSIS Yes, See Notes
Temperature — TDS See Notes
OTHER LOGS Drilling Time — REVIEWED BY Dennis Watt, USBR

NOTES		DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION



1500-1720 SAND
Fine, off-white, fairly to very well sorted, subrounded sand. Feldspars and quartz dominate.

1580-1610 Fine to medium sand.

1610-1630 Medium sand.

1640-1650 Medium sand.

1660-1670 Medium with some coarse sand.

1700-1710 Some medium sand.

1720-2000 SAND
Medium, off-white, fairly to very well sorted, subrounded sand. Feldspars and quartz dominate.

1850-1860 Fine to medium sand.

1860-1870 Some coarse sand.

1880-1890 Some coarse sand.

1910-1920 Some coarse sand.

1930-1950 Some fine sand.

1960-1970 Some fine sand.

1970-1980 Some coarse sand.

1990-2000 Fine to medium sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-6

FEATURE	Drill Hole Completed with Nested Piezometers	DRILLED DEPTH	2012 Ft.
PROJECT	Indian Wells Valley Groundwater Project	COMPLETED DEPTH	1660 Ft.
LOCATION	T.25 S., R. 38 E., Sec. 12m STATE CA	BEGUN	1-10-92
TYPE OF WELL	Observation	FINISHED	1-17-92
PURPOSE	Lithology, Groundwater Quality, Piezometeric Level, Hydraulic Conductivity	GROUND ELEVATION	2352.2
COORDINATES		TOP OF CASING ELEV.	2354.1
HOLE LOGGED BY	Cuttings Description by Mike Stoner, Naval Air Warfare Station	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral Temperature	LAB ANALYSIS	Yes, See Notes
		TDS	See Notes
OTHER LOGS	Drilling Time	REVIEWED BY	Dennis Watt, USBR

NOTES	BARBOUR CORP WELL SURVEYING 805-482-4988 ELECTRIC LOG	DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

NOTES

DRILL SITE:
The well is just inside (east) the Naval Weapons Center boundary (which is parallel Brown Road) along dirt eastward extension of the east-west section of Brown Road.

DRILLED BY:
Welch and Howell Drilling of El Centro CA.

DRILLING RIG:
Mac double (106' total height) direct rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 14 3/4 inch roller cone bit from 56 to 1010 feet. 12 1/4 roller cone bit from 1010 to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 330'-350', 1190'-1210', 1640'-1660'. Cement plugs set at the following depth intervals: 520'-550', 900'-925'?, 1400'-1420'.

DEVELOPMENT:
Each piezometer was air-lifted about 2 hours and discharged an estimated 5-10 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on January 28, 1992 from the top of the protective casing. These depths were measured only about 5 minutes after the cap was removed. Actual and relative depths may be different in subsequent measurements.

Screen Interval	Depth (Ft)
330'-350'	163.9
1190'-1210'	164.6
1640'-1660'	149.9

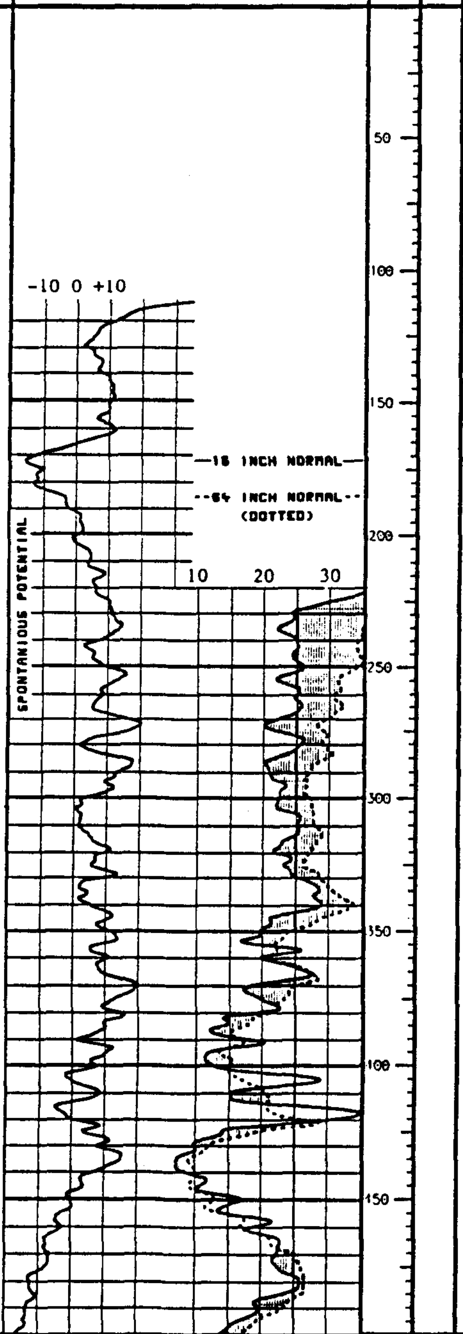
All depth to water measurements made during the project life are available in the Geohydrologic Appendix for this project.

SLUG TEST RESULTS:
Estimated transmissivity (T) (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.02*
Medium	.25
Deep	.20

*Note - This is suspiciously low.

ELECTRIC LOG



CONDENSED CUTTINGS DESCRIPTION

The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.

GENERAL

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-60 Missing samples.

60-90 SAND
Light brown medium sand.

90-210 SAND
Light brown coarse sand.

- 90-100 Medium to coarse sand.
- 120-130 Medium to coarse sand.
- 140-150 Medium to coarse sand.
- 170-180 Trace of volcanics.
- 180-190 Very coarse sand and fine gravel.
- 200-210 Medium to coarse sand.

210-230 SAND
Light brown medium sand.

230-260 SAND
Light brown, medium to coarse sand.

260-290 SAND
Light brown very coarse sand with fine gravel.

290-320 SAND
Light brown coarse to very coarse sand.

- 310-320 Coarse.

320-340 SAND
Light brown medium to coarse sand.

340-370 SAND
Light brown medium sand.

- 350-360 Silty.
- 360-370 Medium to coarse, silty.

370-400 CLAY
Light gray-green clay.

- 380-400 Some fine to medium sand.

400-510 CLAY
Sandy gray-green clay.

- 440-450 Silty medium sand.
- 460-470 Gray-green clay.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-6

FEATURE	Drill Hole Completed with Nested Piezometers	DRILLED DEPTH	2012 Ft.
PROJECT	Indian Wells Valley Groundwater Project	COMPLETED DEPTH	1660 Ft.
LOCATION	T.25 S., R. 38 E., Sec. 12m STATE CA	BEGUN	1-10-92
TYPE OF WELL	Observation	FINISHED	1-17-92
PURPOSE	Lithology, Groundwater Quality, Piezometeric Level, Hydraulic Conductivity	GROUND ELEVATION	2352.2
COORDINATES		TOP OF CASING ELEV.	2354.1
HOLE LOGGED BY	Cuttings Description by Mike Stoner, Naval Air Warfare Station	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral Temperature	LAB ANALYSIS	Yes, See Notes
		TDS	See Notes
OTHER LOGS	Drilling Time	REVIEWED BY	Dennis Watt, USBR

NOTES

WATER QUALITY:
Water analysis by:

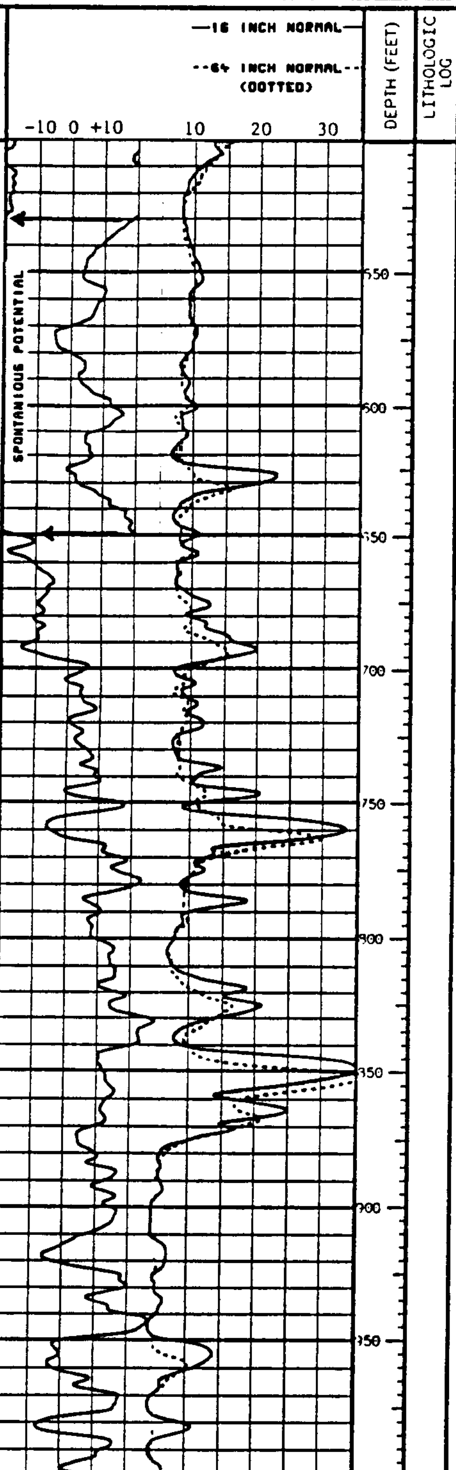
Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

Depth: 330-350'

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	100.5
mg/L	Calcium (Ca)	24.0
mg/L	Magnesium (Mg)	9.7
mg/L	Sodium (Na)	198.7
mg/L	Potassium (K)	13.9
Cations	Meq/L Value: [illegible]	
mg/L	Total Alkalinity (AS CaCO3)	192.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	234.2
mg/L*	Sulfate (SO4)	168.0
mg/L*	Chloride (Cl)	76.0
mg/L	Nitrate (as NO3)	6.1
mg/L	Fluoride (F) Temp. Depend.	1.7
Anions	Meq/L Value: 9.8	
Std. Units	PH (Laboratory)	8.9
umho/cm**	Specific Conductance (E.C.)	1030.0
mg/L***	Total Filterable Residue at 180C	596.1
Units	Apparent Color (Unfiltered)	15.0
TON	Odor Threshold at 60 C	2.0
NTU	Lab Turbidity	180.0
mg/L	MBAS	< 0.02

INORGANIC CHEMICALS

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	1405.0
ug/L	Arsenic (As)	195.00
ug/L	Barium (Ba)	<100.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	12330.
ug/L	Lead (Pb)	[illegible].00
ug/L	Manganese (Mn)	910.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	91.00



CONDENSED CUTTINGS DESCRIPTION

510-600 CLAY
Dark gray-green clay.

600-1700 CLAY
Gray-green clay.

- 610-620 Some medium to coarse sand.
- 780-800 Some fine to medium sand.
- 820-850 Some fine sand.
- 850-890 Missing samples.
- 890-1040 Some very fine sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-6

FEATURE	Drill Hole Completed with Nested Piezometers	DRILLED DEPTH	2012 Ft.
PROJECT	Indian Wells Valley Groundwater Project	COMPLETED DEPTH	1660 Ft.
LOCATION	T.25 S., R. 38 E., Sec. 12m — STATE CA	BEGUN	1-10-92
TYPE OF WELL	Observation	FINISHED	1-17-92
PURPOSE	Lithology, Groundwater Quality, Piezometeric Level, Hydraulic Conductivity	GROUND ELEVATION	2352.2
COORDINATES		TOP OF CASING ELEV.	2354.1
HOLE LOGGED BY	Cuttings Description by Mike Stoner, Naval Air Warfare Station	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral Temperature	LAB ANALYSIS	Yes, See Notes
		TDS	See Notes
OTHER LOGS	Drilling Time	REVIEWED BY	Dennis Watt, USBR

NOTES

Depth: 1190-1210'

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	80.0
mg/L	Calcium (Ca)	4.8
mg/L	Magnesium (Mg)	16.5
mg/L	Sodium (Na)	188.6
mg/L	Potassium (K)	8.6
Cations	Meq/L Value: 10.8	
mg/L	Total Alkalinity (AS CaCO3)	380.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	463.6
mg/L*	Sulfate (SO4)	36.6
mg/L*	Chloride (Cl)	33.3
mg/L	Nitrate (as NO3)	1.7
mg/L	Fluoride (F) Temp. Depend.	3.3
Anions	Meq/L Value: 9.5	
Std. Units	PH (Laboratory)	9.1
umho/cm**	Specific Conductance (E.C.)	950.0
mg/L***	Total Filterable Residue at 180C	481.6
Units	Apparent Color (Unfiltered)	5.0
TON	Odor Threshold at 60 C	2.0
NTU	Lab Turbidity	85.0
mg/L	MBAS	< 0.02

INORGANIC CHEMICALS

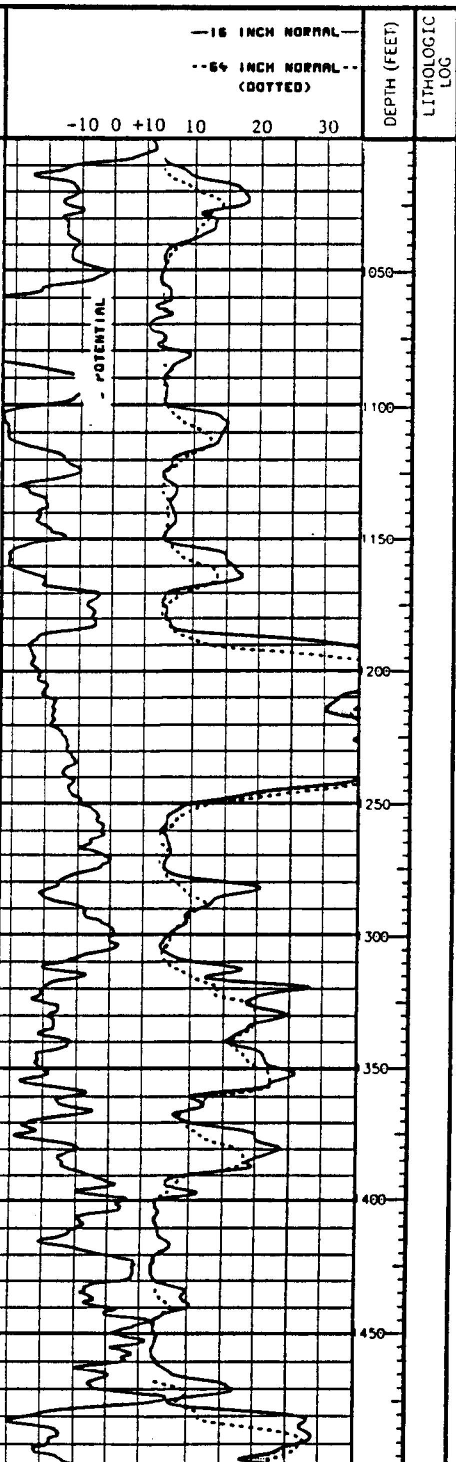
REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	865.00
ug/L	Arsenic (As)	135.00
ug/L	Barium (Ba)	<100.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	4535.0
ug/L	Lead (Pb)	6.00
ug/L	Manganese (Mn)	140.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	< 50.00

Depth: 1640-1660'

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	76.0
mg/L	Calcium (Ca)	5.8
mg/L	Magnesium (Mg)	15.0
mg/L	Sodium (Na)	233.4
mg/L	Potassium (K)	7.4
Cations	Meq/L Value: 11.4	
mg/L	Total Alkalinity (AS CaCO3)	440.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	536.8
mg/L*	Sulfate (SO4)	37.5
mg/L*	Chloride (Cl)	29.4
mg/L	Nitrate (as NO3)	< 1.0
mg/L	Fluoride (F) Temp. Depend.	1.7
Anions	Meq/L Value: 10.5	
Std. Units	PH (Laboratory)	8.9
umho/cm**	Specific Conductance (E.C.)	980.0
mg/L***	Total Filterable Residue at 180C	540.1
Units	Apparent Color (Unfiltered)	40.0
TON	Odor Threshold at 60 C	2.0
NTU	Lab Turbidity	140.0
mg/L	MBAS	< 0.02

INORGANIC CHEMICALS

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	1325.0
ug/L	Arsenic (As)	75.00
ug/L	Barium (Ba)	<100.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	3925.0
ug/L	Lead (Pb)	< 5.00
ug/L	Manganese (Mn)	160.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	< 50.00



CONDENSED CUTTINGS DESCRIPTION

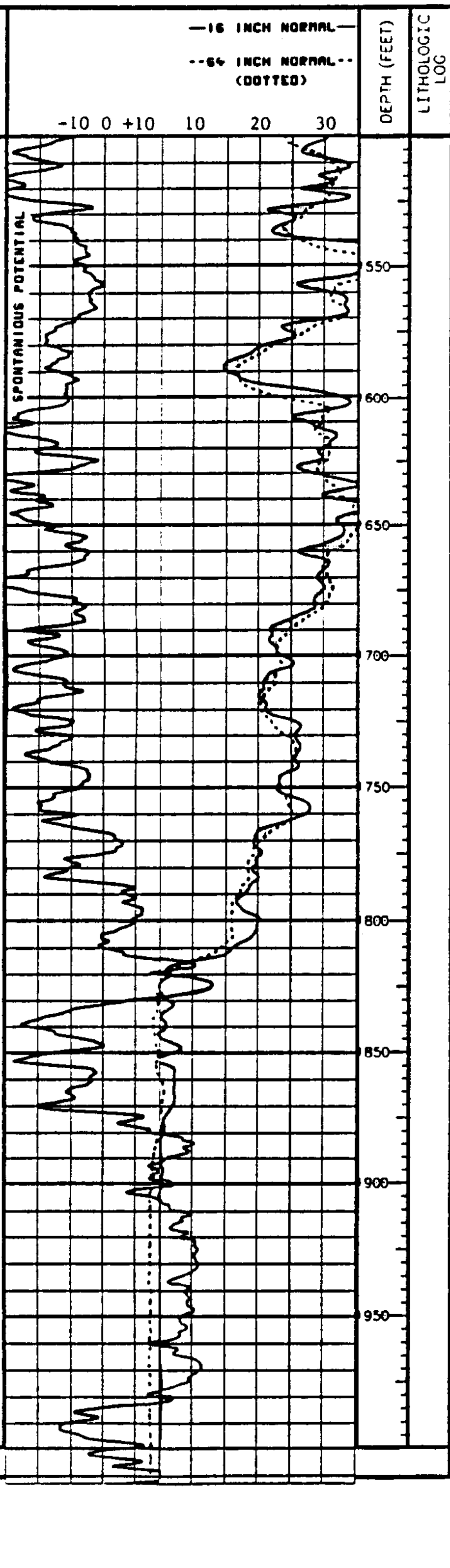
600-1700 CLAY
Gray-green clay.

- 890-1040 Some very fine sand.
- 1040-1050 Some fine to medium sand.
- 1080-1090 Some gravel.
- 1110-1190 Some medium sand.
- 1190-1270 Some fine to medium sand.
- 1280-1400 Some fine sand.
- 1400-1500 Some fine to medium sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-6

FEATURE: Drill Hole Completed with Nested Piezometers
DRILLED DEPTH: 2012 Ft.
PROJECT: Indian Wells Valley Groundwater Project
COMPLETED DEPTH: 1660 Ft.
LOCATION: T.25 S., R. 38 E., Sec. 12m
STATE: CA
BEGUN: 1-10-92
TYPE OF WELL: Observation
FINISHED: 1-17-92
PURPOSE: Lithology, Groundwater Quality, Piezometeric Level, Hydraulic Conductivity
GROUND ELEVATION: 2352.2
COORDINATES:
TOP OF CASING ELEV.: 2354.1
HOLE LOGGED BY: Cuttings Description by Mike Stoner, Naval Air Warfare Station
DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral Temperature
LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time
REVIEWED BY: Dennis Watt, USBR

NOTES



CONDENSED CUTTINGS DESCRIPTION

600-1700 CLAY
Gray-green clay.

- 1500-1520 Some fine sand.
- 1520-1610 Some fine to medium sand.
- 1620-1640 Some fine sand.
- 1640-1700 Some fine to medium sand.

1700-1850 SAND
Gray-green, clayey fine to medium sand.

1850-1920 SAND
Gray-green medium sand with some silt and clay.

- 1870-1890 Missing samples.

1920-1980 SAND
Medium to coarse sand with some dark gray-green silty clay.

1980-2000 CLAY
Dark gray-green clay with a trace of fine sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-10

FEATURE Drill Hole Completed with Nested Piezometers — DRILLED DEPTH 2005 Ft.
PROJECT Indian Wells Valley Groundwater Project — COMPLETED DEPTH 1950 Ft.
LOCATION T.24 S., R.38 E., Sec. 21J — STATE CA — BEGUN 8-24-92
TYPE OF WELL Observation — FINISHED 9-02-92
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION
COORDINATES — TOP OF CASING ELEV. 2561.4
HOLE LOGGED BY Cuttings Description by Mike Stoner, Naval Air Warfare Station — DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Dual Induction, Natural Gamma Ray Spectrometry, Caliper — LAB ANALYSIS See Notes
Long Spaced Sonic Waveforms, Long Spaced Sonic, Temperature — TDS See Notes
OTHER LOGS Drilling Time — REVIEWED BY Dennis Watt, USBR

NOTES

DRILL SITE:
The well is about 0.1 mile southeast of the intersection of Hwy 395 and Ninemile Canyon Road

DRILLED BY:
Welch and Howell Drilling of El Centro CA.

DRILLING RIG:
Mac double (106' total height) direct rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 14 3/4 inch roller cone bit from 56 to 1010 feet. 12 1/4 roller cone bit from 1010 to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 640'-660', 1180'-1200', 1560'-1580', and 1930'-1950'. Cement plugs set at the following depth intervals: 890'-910', 1310'-1330', and 1770'-1790'.

DEVELOPMENT:
Each piezometer was air-lifted at least 4 hours. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on September 30, 1992 from the top of the outer casing.

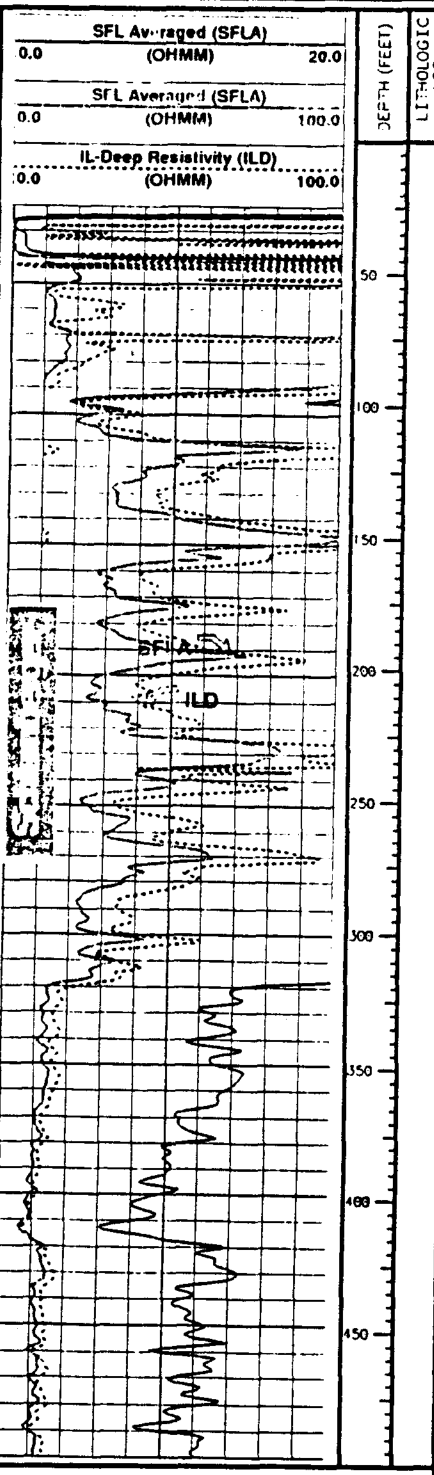
Screen Interval	Depth (Ft)
640'-660'	308.4
1180'-1200'	321.8
1560'-1580'	362.1
1930'-1950'	364.0

All depth to water measurements made during the project life are available in the Geohydrologic Appendix for this project.

SLUG TEST RESULTS:
Estimated transmissivity (T) (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.19
Shal/Med	.02*
Deep/Med	.14
Deep	.09

*Note - This is suspiciously low.



CONDENSED CUTTINGS DESCRIPTION

The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.

GENERAL

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-40 Missing samples.

40-60 GRAVEL
Dark salt and pepper color with basalt.

80-680 SAND
Tan-gray medium to coarse sand.

- 80-120 Very coarse with gravel to 1/4 inch.
- 160-180 Coarse sand with gravel.
- 180-300 Medium sand with silt.
- 300-320 Fine to medium sand with some silt.
- 320-360 Silty.
- 360-380 Medium sand with silt.
- 380-400 Silt.
- 400-420 Silty medium sand.
- 420-460 Medium sand with silt.
- 460-520 Silty.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-10

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 2005 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1950 Ft.
LOCATION: T.24 S., R.38 E., Sec. 21J — STATE: CA — BEGUN: 8-24-92
TYPE OF WELL: Observation — FINISHED: 9-02-92
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION:
COORDINATES: — TOP OF CASING ELEV.: 2561.4
HOLE LOGGED BY: Cuttings Description by Mike Stoner, Naval Air Warfare Station — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Dual Induction, Natural Gamma Ray Spectrometry, Caliper — LAB ANALYSIS: See Notes
Long Spaced Sonic Waveforms, Long Spaced Sonic, Temperature — TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES		DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

NOTES

WATER QUALITY:
Water analysis by:

BC Laboratories
4100 Atlas Ct.
Bakersfield CA 93308

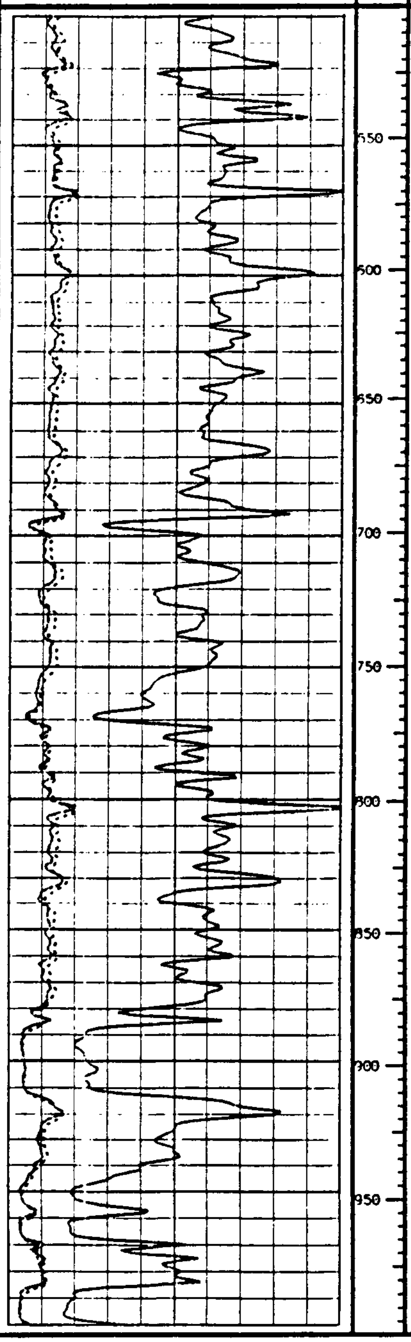
Depth: 640'-660'

(GENERAL CHEMISTRY)

Constituents		Results	Units
Calcium		21.	mg/L
Magnesium		19.0	mg/L
Sodium		295.	mg/L
Potassium		24.	mg/L
Total Cations		16.1	meq/L
Hydroxide	<	0.8	mg/L
Carbonate		40.2	mg/L
Bicarbonate		300.	mg/L
Chloride		176.	mg/L
Sulfate		225.	mg/L
Nitrate/Nitrite as NO3		2.7	mg/L
Fluoride		1.3	mg/L
Bromide		0.45	mg/L
Total Anions		16.0	meq/L
pH		8.7	pH Units
Electrical Conductivity @ 25 C		1570.	umhos/cm
Total Dissolved Solids @ 180 C		1000.	mg/L
Color		10.	Color Units
Odor		2.	Odor Units
Turbidity		31.	NT Units
MBAS		0.40	mg/L
Hardness as CaCO3		131.	mg/L
Alkalinity as CaCO3		313.	mg/L
Ammonia as NH3	<	0.02	mg/L
Nitrite Nitrogen	<	0.1	mg/L
Ortho-phosphate		0.36	mg/L

(METALS)

Constituents	Results	Units
Aluminum	2790.	µg/L
Antimony	None Detected	µg/L
Arsenic	16.	µg/L
Barium	None Detected	µg/L
Boron	4.9	mg/L
Cadmium	None Detected	µg/L
Chromium	None Detected	µg/L
Copper	None Detected	µg/L
Lead	None Detected	µg/L
Lithium	250.	µg/L
Manganese	388.	µg/L
Mercury	None Detected	µg/L
Selenium	2.7	µg/L
Si as SiO2	46.	mg/L
Silver	None Detected	µg/L
Strontium	399.	µg/L
Thallium	None Detected	µg/L
Zinc	None Detected	µg/L
Total Iron	3530.	µg/L



CONDENSED CUTTINGS DESCRIPTION

80-680 SAND
Tan-gray medium to coarse sand.

- 520-540 Silt with medium sand.
- 540-560 Silty medium sand.
- 560-580 Silty.
- 580-620 Some silt.
- 620-640 Fine to medium sand with silt.
- 640-680 Silty.

680-1000 CLAY
Light gray-green clay with some sand.

- 680-740 Tan-gray clay with medium sand.
- 740-780 Some fine to medium sand.
- 780-820 Some fine sand.
- 820-840 Tan-gray, lots of fine to medium sand.
- 840-860 Tan-gray fine sand with clay.
- 860-1000 Some fine to medium sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-10

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 2005 Ft.
PROJECT: Indian Wells Valley Groundwater Project — COMPLETED DEPTH: 1950 Ft.
LOCATION: T.24 S., R.38 E., Sec. 21J — STATE: CA — BEGUN: 8-24-92
TYPE OF WELL: Observation — FINISHED: 9-02-92
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION:
COORDINATES: — TOP OF CASING ELEV.: 2561.4
HOLE LOGGED BY: Cuttings Description by Mike Stoner, Naval Air Warfare Station — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Dual Induction, Natural Gamma Ray Spectrometry, Caliper — LAB ANALYSIS: See Notes
Long Spaced Sonic Waveforms, Long Spaced Sonic, Temperature — TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES		DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

NOTES

Depth: 1180'-1200'

(GENERAL CHEMISTRY)

Constituents		Results	Units
Calcium		8.3	mg/L
Magnesium		2.7	mg/L
Sodium		200.	mg/L
Potassium		11.5	mg/L
Total Cations		9.63	meq/L
Hydroxide	<	0.0	mg/L
Carbonate		11.1	mg/L
Bicarbonate		60.0	mg/L
Chloride		139.	mg/L
Sulfate		193.	mg/L
Nitrate/Nitrite as NO3		1.8	mg/L
Fluoride		1.9	mg/L
Bromide		0.36	mg/L
Total Anions		9.42	meq/L
pH		8.7	pH Units
Electrical Conductivity @ 25 C		1040.	umhos/cm
Total Dissolved Solids @ 180 C		580.	mg/L
Color		20.	Color Units
Odor		4.	Odor Units
Turbidity		15.	NT Units
MBAS		0.72	mg/L
Hardness as CaCO3		31.8	mg/L
Alkalinity as CaCO3		67.7	mg/L
Ammonia as NH3		0.38	mg/L
Nitrite Nitrogen	<	0.1	mg/L
Ortho-phosphate	<	0.10	mg/L

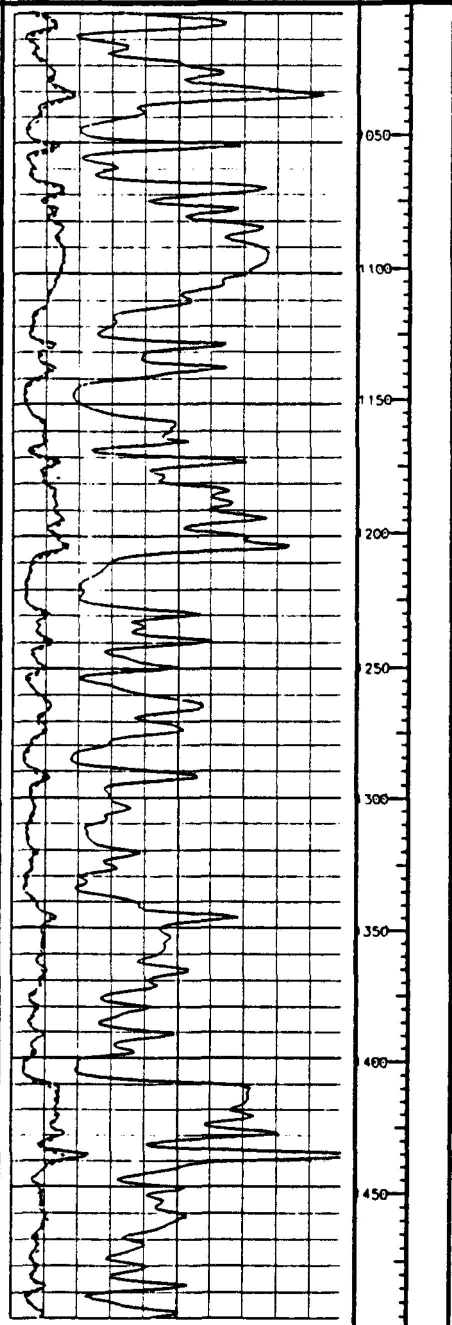
(METALS)

Constituents	Results	Units
Aluminum	762.	µg/L
Antimony	None Detected	µg/L
Arsenic	2.7	µg/L
Barium	None Detected	µg/L
Boron	1.3	mg/L
Cadmium	None Detected	µg/L
Chromium	None Detected	µg/L
Copper	None Detected	µg/L
Lead	None Detected	µg/L
Lithium	None Detected	µg/L
Manganese	69.	µg/L
Mercury	None Detected	µg/L
Selenium	2.4	µg/L
Si as SiO2	12.	mg/L
Silver	None Detected	µg/L
Strontium	84.	µg/L
Thallium	None Detected	µg/L
Zinc	None Detected	µg/L
Total Iron	1830.	µg/L

Depth: 1560'-1580'

(GENERAL CHEMISTRY)

Constituents		Results	Units
Calcium		47.	mg/L
Magnesium		105.	mg/L
Sodium		254.	mg/L
Potassium		32.	mg/L
Total Cations		22.8	meq/L
Hydroxide	<	0.0	mg/L
Carbonate	<	2.6	mg/L
Bicarbonate		1130.	mg/L
Chloride		49.5	mg/L
Sulfate		256.	mg/L
Nitrate/Nitrite as NO3		0.9	mg/L
Fluoride		0.56	mg/L
Bromide		0.12	mg/L
Total Anions		23.2	meq/L
pH		7.9	pH Units
Electrical Conductivity @ 25 C		1910.	umhos/cm
Total Dissolved Solids @ 180 C		1220.	mg/L
Color		30.	Color Units
Odor		4.	Odor Units
Turbidity		27.	NT Units
MBAS		0.66	mg/L
Hardness as CaCO3		550.	mg/L
Alkalinity as CaCO3		926.	mg/L
Ammonia as NH3		0.17	mg/L
Nitrite Nitrogen	<	0.1	mg/L
Ortho-phosphate		0.48	mg/L



CONDENSED CUTTINGS DESCRIPTION

1000-1440 CLAY
Gray-green clay with medium sand.

- 1000-1020 Some fine to medium sand.
- 1020-1040 Some medium to coarse sand.
- 1100-1200 Clay with medium to coarse sand.
- 1200-1220 Medium to coarse sandy clay.
- 1240-1260 Some fine to medium sand.
- 1260-1280 Clay with fine to medium sand.
- 1280-1300 Trace of fine sand.
- 1400-1420 Clay with medium to coarse sand.
- 1420-1440 Trace of medium to coarse sand.

1440-1600 SAND
Medium to coarse, gray-green sand with a trace of clay.

- 1480-1500 Clay with medium to coarse sand.

USBR Drill Hole Completion and Data Log
Monitoring Well BR-10

FEATURE: Drill Hole Completed with Nested Piezometers	DRILLED DEPTH: 2005 Ft.
PROJECT: Indian Wells Valley Groundwater Project	COMPLETED DEPTH: 1950 Ft.
LOCATION: T.24 S., R.38 E., Sec. 21J — STATE: CA	BEGUN: 8-24-92
TYPE OF WELL: Observation	FINISHED: 9-02-92
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity	GROUND ELEVATION:
COORDINATES:	TOP OF CASING ELEV.: 2561.4
HOLE LOGGED BY: Cuttings Description by Mike Stoner, Naval Air Warfare Station	DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Dual Induction, Natural Gamma Ray Spectrometry, Caliper, Long Spaced Sonic Waveforms, Long Spaced Sonic, Temperature	LAB ANALYSIS: See Notes
	TDS: See Notes
OTHER LOGS: Drilling Time	REVIEWED BY: Dennis Watt, USBR

NOTES		DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

NOTES

(METALS)

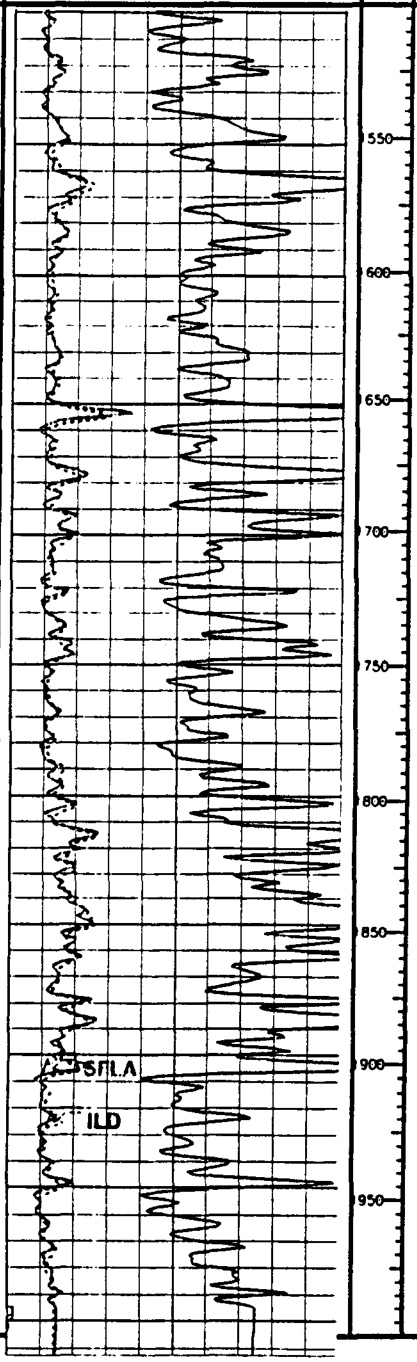
Constituents	Results	Units
Aluminum	None Detected	µg/L
Antimony	None Detected	µg/L
Arsenic	7.8	µg/L
Barium	None Detected	µg/L
Boron	1.1	mg/L
Cadmium	None Detected	µg/L
Chromium	None Detected	µg/L
Copper	None Detected	µg/L
Lead	None Detected	µg/L
Lithium	250.	µg/L
Manganese	95.	µg/L
Mercury	None Detected	µg/L
Selenium	None Detected	µg/L
Si as SiO2	81.	mg/L
Silver	None Detected	µg/L
Strontium	678.	µg/L
Thallium	None Detected	µg/L
Zinc	None Detected	µg/L
Total Iron	6910.	µg/L

Depth: 1930'-1950'

(GENERAL CHEMISTRY)

Constituents	Results	Units
Calcium	30.	mg/L
Magnesium	121.	mg/L
Sodium	320.	mg/L
Potassium	44.	mg/L
Total Cations	26.5	meq/L
Hydroxide	< 0.8	mg/L
Carbonate	< 2.6	mg/L
Bicarbonate	1280.	mg/L
Chloride	58.2	mg/L
Sulfate	171.	mg/L
Nitrate/Nitrite as NO3	0.9	mg/L
Fluoride	0.8	mg/L
Bromide	0.18	mg/L
Total Anions	26.2	meq/L
pH	8.1	pH Units
Electrical Conductivity @ 25 C	2400.	umhos/cm
Total Dissolved Solids @ 180 C	1330.	mg/L
Color	30.	Color Units
Odor	4.	Odor Units
Turbidity	27.	NT Units
MBAS	0.96	mg/L
Hardness as CaCO3	576.	mg/L
Alkalinity as CaCO3	1050.	mg/L
Ammonia as NH3	0.05	mg/L
Nitrite Nitrogen	< 0.1	mg/L
Ortho-phosphate	0.39	mg/L

Constituents	Results	Units
Aluminum	None Detected	µg/L
Antimony	None Detected	µg/L
Arsenic	9.8	µg/L
Barium	None Detected	µg/L
Boron	1.6	mg/L
Cadmium	None Detected	µg/L
Chromium	None Detected	µg/L
Copper	None Detected	µg/L
Lead	None Detected	µg/L
Lithium	180.	µg/L
Manganese	286.	µg/L
Mercury	None Detected	µg/L
Selenium	None Detected	µg/L
Si as SiO2	59.	mg/L
Silver	None Detected	µg/L
Strontium	554.	µg/L
Thallium	None Detected	µg/L
Zinc	None Detected	µg/L
Total Iron	5820.	µg/L



CONDENSED CUTTINGS DESCRIPTION

1440-1600 SAND
Medium to coarse, gray-green sand with a trace of clay.

1600-1640 CLAY
Gray-green clay with medium sand.

1600-1620 With medium to coarse sand.

1640-2000 SAND
Fine to medium, gray-green sand with a trace of clay.

1760-1780 Silty clay with medium sand.

1800-1840 Medium sand a with trace of clay.

1860-1940 Medium sand with clay.

1960-2005 Medium to coarse sand with a trace of clay.

USBR Drill Hole Completion and Data Log
Monitoring Well NR-1

FEATURE	Drill Hole Completed with Nested Piezometers	DRILLED DEPTH	2012 Ft.
PROJECT	Indian Wells Valley Groundwater Project (Water District Well)	COMPLETED DEPTH	2001 Ft.
LOCATION	T.25 S., R.38 E., Sec. 25j — STATE CA	BEGUN	1-07-91
TYPE OF WELL	Observation	FINISHED	2-06-91
PURPOSE	Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity	GROUND ELEVATION	2275.7
COORDINATES		TOP OF CASING ELEV.	2278.6
HOLE LOGGED BY	Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature	LAB ANALYSIS	Yes, See Notes
		TDS	See Notes
OTHER LOGS	Drilling Time	REVIEWED BY	Dennis Watt, USBR

NOTES	BARBOUR CORP ELECTRIC LOG	DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

NOTES

DRILL SITE:
The well is located in the extreme northeast corner of the Indian Wells Valley Water District's Neal Ranch property.

DRILLED BY:
Southern California Drilling Company of Lancaster CA.

DRILLING RIG:
Custom built, small oil-field rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 250'-270', 1130'-1150', 1960'-1980'. Twenty feet of 2" pipe below each screen. Benseal (bentonite) plugs set at the following depth intervals: 220'-240', 290'-300', 1100'-1120', 1170'-1190', 1920-1940.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 10 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on December 12, 1991 from the top of the outer casing.

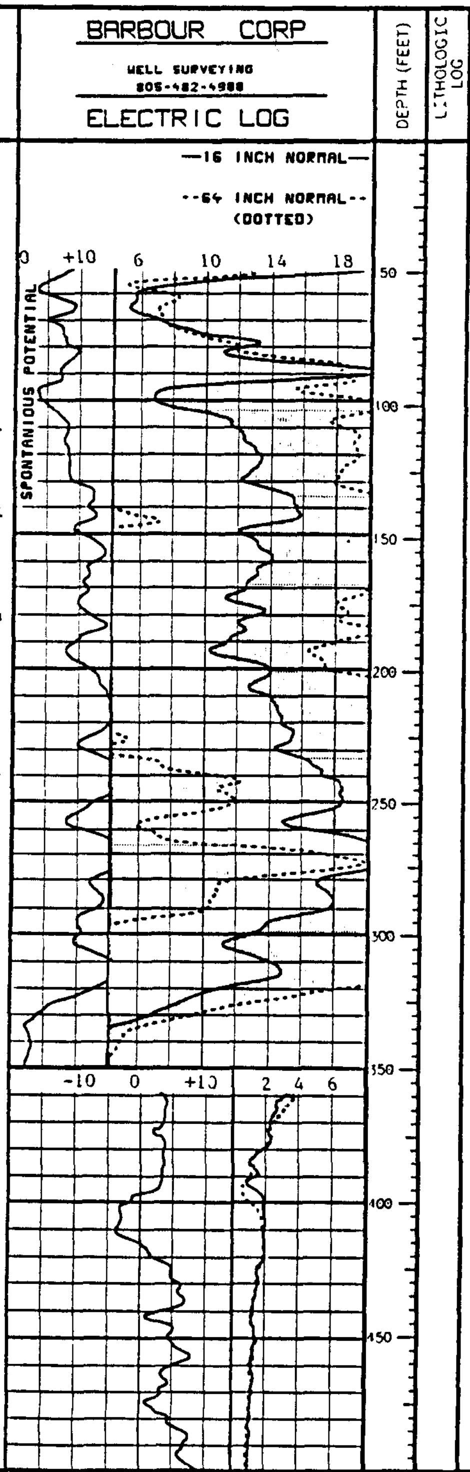
Screen Interval	Depth (Ft)
250'-270'	94.9
1130'-1150'	76.8
1960'-1980'	101.0

All depth to water measurements are available in an attachment to the Geohydrologic Appendix for this project.

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.004*
Medium	?
Deep	.05

*The shallow screen was probably damaged during installation by downward slumping of the shallow seal.



CONDENSED CUTTINGS DESCRIPTION

The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return. The grain size descriptors used in the description of the samples and in the log below are from the scale proposed by Wentworth.

GENERAL

The collected samples and drilling character indicate a non-cememted, alluvial fill from land surface to total depth. Fine gravel was the maximum grain size recovered.

Intervals are feet below land surface.

0-340 SAND
Medium to coarse sand.

- 10-30 Some gravel.
- 50-60 Fine to medium.
- 60-70 Few gravel.
- 80-90 Some gravel.
- 100-100 Few gravel.
- 130-170 Few gravel.
- 170-180 Fine to medium with some clay.
- 180-240 Some gravel.
  - 200-210 Fine to medium.
  - 210-220 Mostly gravel.
  - 230-240 Fine to medium.
- 260-270 Some gravel.
- 280-300 Mostly gravel.
- 310-320 Fine to medium.
- 320-340 Mostly gravel.

340-610 CLAY
Blue-green clay. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

- 370-450 Some fossils.
- 450-470 Blue to blue-gray.
- 480-510 Gray.
  - 490-510 Siltstone pieces.

USBR Drill Hole Completion and Data Log
Monitoring Well NR-1

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 2012 Ft.
PROJECT: Indian Wells Valley Groundwater Project (Water District Well) — COMPLETED DEPTH: 2001 Ft.
LOCATION: T.25 S., R.38 E., Sec. 25J — STATE: CA — BEGUN: 1-07-91
TYPE OF WELL: Observation — FINISHED: 2-06-91
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2275.7
COORDINATES: — TOP OF CASING ELEV.: 2278.6
HOLE LOGGED BY: Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES

WATER QUALITY:
Water analysis by:

Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

Depth: 270-290'

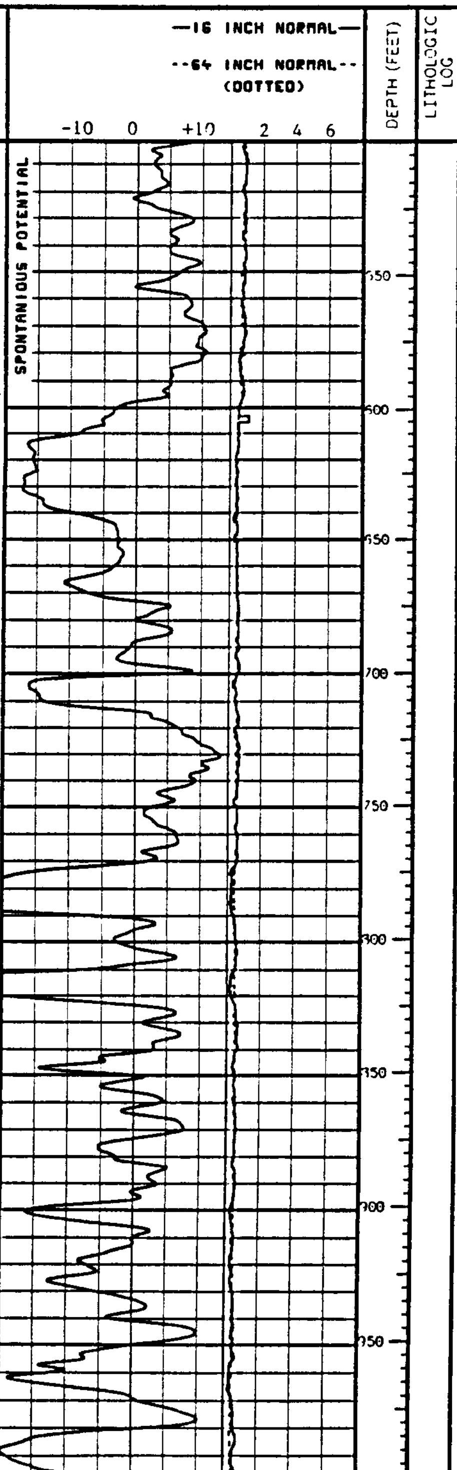
REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	1030.0
mg/L	Calcium (Ca)	221.1
mg/L	Magnesium (Mg)	116.2
mg/L	Sodium (NA)	456.8
mg/L	Potassium (K)	5.6
Total Cations	Meq/L Value: 40.6	
mg/L	Total Alkalinity (AS CaCO3)	370.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	451.4
mg/L*	Sulfate (SO4)	1094.7
mg/L*	Chloride (Cl)	290.7
mg/L	Nitrate (as NO3)	240.3
mg/L	Fluoride (F) Temp. Depend.	2.4
Total Anions	Meq/L Value: 41.7	
Std. Units	PH (Laboratory)	7.9
umho/cm**	Specific Conductance (E.C.)	3880.0
mg/L***	Total Filterable Residue at 180C	3405.6
Units	Apparent Color (Unfiltered)	< 3.0
TON	Odor Threshold at 60 C	1.0
NTU	Lab Turbidity	1.9
mg/L	MBAS	0.15

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	< 10
ug/L	Barium (Ba)	< 100
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	100
ug/L	Lead (Pb)	< 5
ug/L	Manganese (Mn)	80
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	170
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	< 50
ug/L	Aluminum	180

Depth: 1130-1150'

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	310.0
mg/L	Calcium (Ca)	32.0
mg/L	Magnesium (Mg)	55.9
mg/L	Sodium (NA)	1240.0
mg/L	Potassium (K)	14.6
Total Cations	Meq/L Value: 60.5	
mg/L	Total Alkalinity (AS CaCO3)	2184.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	2664.5
mg/L*	Sulfate (SO4)	125.4
mg/L*	Chloride (Cl)	245.0
mg/L	Nitrate (as NO3)	35.4
mg/L	Fluoride (F) Temp. Depend.	2.4
Total Anions	Meq/L Value: 51.9	
Std. Units	PH (Laboratory)	9.9
umho/cm**	Specific Conductance (E.C.)	6000
mg/L***	Total Filterable Residue at 180C	3660.0
Units	Apparent Color (Unfiltered)	70
TON	Odor Threshold at 60 C	4.0
NTU	Lab Turbidity	166.0
mg/L	MBAS	C.05

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	28
ug/L	Barium (Ba)	< 100
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	750
ug/L	Lead (Pb)	< 5
ug/L	Manganese (Mn)	40
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	40
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	< 50
ug/L	Aluminum	340



CONDENSED CUTTINGS DESCRIPTION

340-610 CLAY
Blue-green clay. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

510-580 Blue.
560-580 Some gravel.

590-610 Green-black to gray-black with sand, silt, and some fine gravel.

610-800 MUD
Green, black, and gray mud.

660-690 Green, black, and gray-blue clay.

700-730 Tuffaceous? material.

730-740 Clay.

740-760 Some sand and silt.

760-770 Some silt and clay.

770-780 Blue clay.

780-800 Some silt.

800-1250 CLAY
Black and gray-black clay. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

820-830 Some silt and siltstone.

830-840 Black-gray mud with some coarse sand.

900-910 Green-black with some siltstone.

910-940 Silty.

930-980 Some fossils.

980-990 Gray-black mud.

USBR Drill Hole Completion and Data Log
Monitoring Well NR-1

FEATURE: Drill Hole Completed with Nested Piezometers
DRILLED DEPTH: 2012 Ft.

PROJECT: Indian Wells Valley Groundwater Project (Water District Well)
COMPLETED DEPTH: 2001 Ft.

LOCATION: T.25 S., R.38 E., Sec. 25j
STATE: CA
BEGUN: 1-07-91

TYPE OF WELL: Observation
FINISHED: 2-06-91

PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity
GROUND ELEVATION: 2275.7

COORDINATES:
TOP OF CASING ELEV.: 2278.6

HOLE LOGGED BY: Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA
DEPTH TO WATER (DATE): See Notes

GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature
LAB ANALYSIS: Yes, See Notes
TDS: See Notes

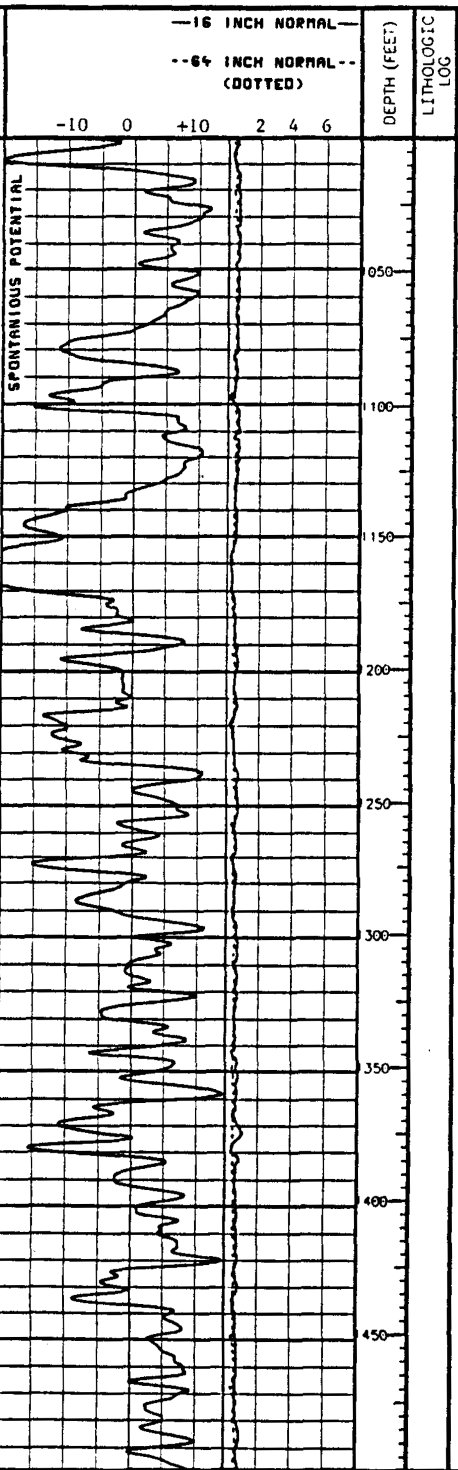
OTHER LOGS: Drilling Time
REVIEWED BY: Dennis Watt, USBR

NOTES

Depth: 1960-1980'

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
mg/L	Total Hardness (As CaCO3)	78.0
mg/L	Calcium (Ca)	12.8
mg/L	Magnesium (Mg)	11.2
mg/L	Sodium (NA)	1340.0
mg/L	Potassium (K)	6.4
Total Cations	Meq/L Value: 60.0	
mg/L	Total Alkalinity (AS CaCO3)	3460.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	3001.2
mg/L*	Sulfate (SO4)	304.8
mg/L*	Chloride (Cl)	246.7
mg/L	Nitrate (as NO3)	35.0
mg/L	Fluoride (F) Temp. Depend.	3.3
Total Anions	Meq/L Value: 63.2	
Std. Units	PH (Laboratory)	8.6
umho/cm**	Specific Conductance (E.C.)	5330.0
mg/L***	Total Filterable Residue at 180C	3251.3
Units	Apparent Color (Unfiltered)	50
TON	Odor Threshold at 60 C	2.0
NTU	Lab Turbidity	32.0
mg/L	MBAS	[illegible]

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ANALYSES RESULTS
ug/L	Arsenic (As)	130
ug/L	Barium (Ba)	< 100
ug/L	Cadmium (Cd)	< 1
ug/L	Chromium (Total Cr)	< 10
ug/L	Copper (Cu)	< 50
ug/L	Iron (Fe)	1180
ug/L	Lead (Pb)	< 5
ug/L	Manganese (Mn)	30
ug/L	Mercury (Hg)	< 1
ug/L	Selenium (Se)	15
ug/L	Silver (Ag)	< 10
ug/L	Zinc (Zn)	< 50
ug/L	Aluminum	1060



CONDENSED CUTTINGS DESCRIPTION

800-1250 CLAY
Black and gray-black clay. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

1080-1130 Green clay.

1250-1400 MUD
Black and gray mud. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

1270-1280 Some salt.

1310-1320 Black clay.

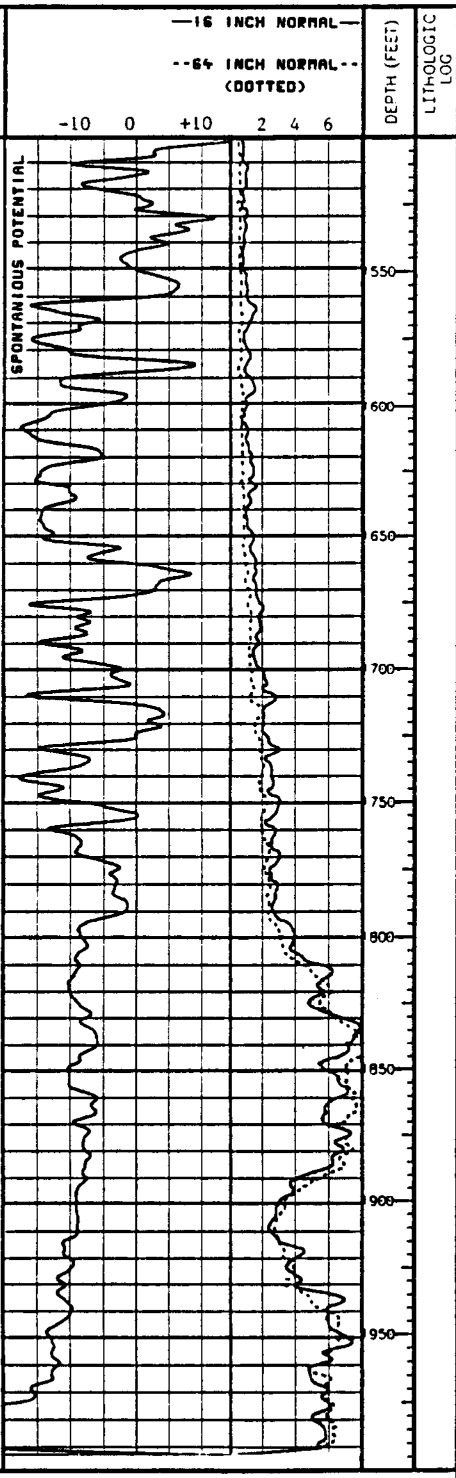
1400-1610 CLAY
Black and gray clay. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

1400-1510 Black.
1400-1450 Some silt.

USBR Drill Hole Completion and Data Log
Monitoring Well NR-1

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 2012 Ft.
PROJECT: Indian Wells Valley Groundwater Project (Water District Well) — COMPLETED DEPTH: 2001 Ft.
LOCATION: T.25 S., R.38 E., Sec. 25J — STATE: CA — BEGUN: 1-07-91
TYPE OF WELL: Observation — FINISHED: 2-06-91
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2275.7
COORDINATES: — TOP OF CASING ELEV.: 2278.6
HOLE LOGGED BY: Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES		DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION



1400-1610 CLAY
Black and gray clay. Occasional silt and sand noted in the sample descriptions is probably from thin layers of silt and fine sand.

1510-1560 Gray black.
1510-1520 Gray mud with silt.

1560-1610 Black.
1560-1600 Some sand.

1610-1680 MUD
Black and gray mud.

1610-1620 Siltstone pieces.

1640-1680 Siltstone pieces.

1680-1820 CLAY
Gray clay with siltstone pieces.

1690-1700 Green.

1720-1760 With sand and silt.

1770-1780 Siltstone pieces.

1790-1810 With sand and mudstone.

1820-2012 SAND
Medium sand.

1820-1840 Coarse.

USBR Drill Hole Completion and Data Log
Monitoring Well NR-2

FEATURE	Drill Hole Completed with Nested Piezometers	DRILLED DEPTH	1994 Ft.
PROJECT	Indian Wells Valley Groundwater Project (Water District Well)	COMPLETED DEPTH	1950 Ft.
LOCATION	T. 25 S., R. 38 E., Sec. 36g STATE CA	BEGUN	2-04-91
TYPE OF WELL	Observation	FINISHED	2-15-91
PURPOSE	Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity	GROUND ELEVATION	2314.7
COORDINATES		TOP OF CASING ELEV.	2317.7
HOLE LOGGED BY	Cutting Description by Dipti Barari, N. Amer, Chem., Co., Trona CA	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature	LAB ANALYSIS	Yes, See Notes
		TDS	See Notes
OTHER LOGS	Drilling Time	REVIEWED BY	Dennis Watt, USBR

NOTES	BARBOUR CORP WELL SURVEYING 805-482-4988 ELECTRIC LOG	DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

DRILL SITE:
The well is located in the southwest corner of the southwestern block of the Indian Wells Valley Water District's Neal Ranch property.

DRILLED BY:
Southern California Drilling Company of Lancaster CA.

DRILLING RIG:
Custom built small oil-field rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed three 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 330'-350', 1540'-1560', 1910'-1930'. Twenty feet of 2" pipe below each screen. Benseal (bentonite) plugs set at the following depth intervals: 250'-270', 450'-470', 1480'-1500', 1620'-1640'.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 10 gallons per minute.

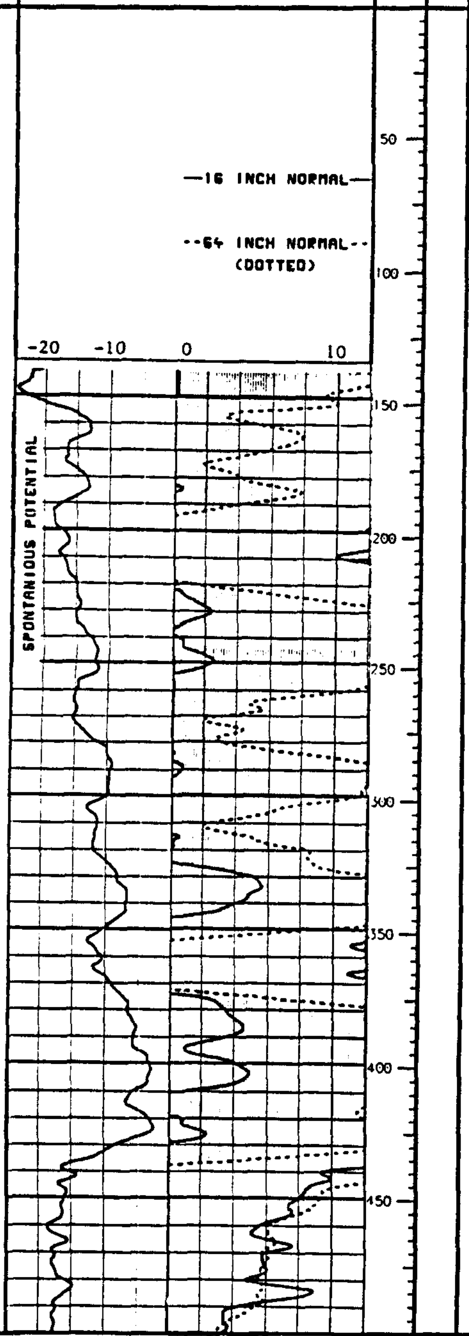
DEPTH TO WATER:
All depths reported below were measured on October 22, 1991 from the top of the outer casing.

Screen Interval	Depth (Ft)
330'-350'	133.1
1540'-1560'	140.3
1910'-1930'	140.0

All depth to water measurements are available in an attachment to the Geohydrologic Appendix for this project.

SLUG TEST RESULTS:
Estimated transmissivity (ft2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.48
Medium	.14
Deep	.12



CONDENSED CUTTINGS DESCRIPTION

The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.

GENERAL

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-440 SAND
Fine to coarse with scattered fine gravel.

- 90-100 Some fine gravel.
- 100-110 Silty.
- 140-170 Silty.
- 220-250 Very coarse.
- 300-310 Silty.
- 350-370 Blue clay with sand and gravel.
- 420-440 Black silty fine to coarse sand.

440-1480 CLAY
Blue, blue green, blue gray, green, and gray clay.

- 440-460 With sand and some mudstone pieces.
- 470-490 Silty.

USBR Drill Hole Completion and Data Log
Monitoring Well NR-2

FEATURE	Drill Hole Completed with Nested Piezometers	DRILLED DEPTH	1994 Ft.
PROJECT	Indian Wells Valley Groundwater Project (Water District Well)	COMPLETED DEPTH	1950 Ft.
LOCATION	T. 25 S., R. 38 E., Sec. 36g — STATE CA	BEGUN	2-04-91
TYPE OF WELL	Observation	FINISHED	2-15-91
PURPOSE	Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity	GROUND ELEVATION	2314.7
COORDINATES		TOP OF CASING ELEV.	2317.7
HOLE LOGGED BY	Cutting Description by Dipti Barari, N. Amer. Chem., Co., Trona CA	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature	LAB ANALYSIS	Yes, See Notes
		TDS	See Notes
OTHER LOGS	Drilling Time	REVIEWED BY	Dennis Watt, USBR

NOTES

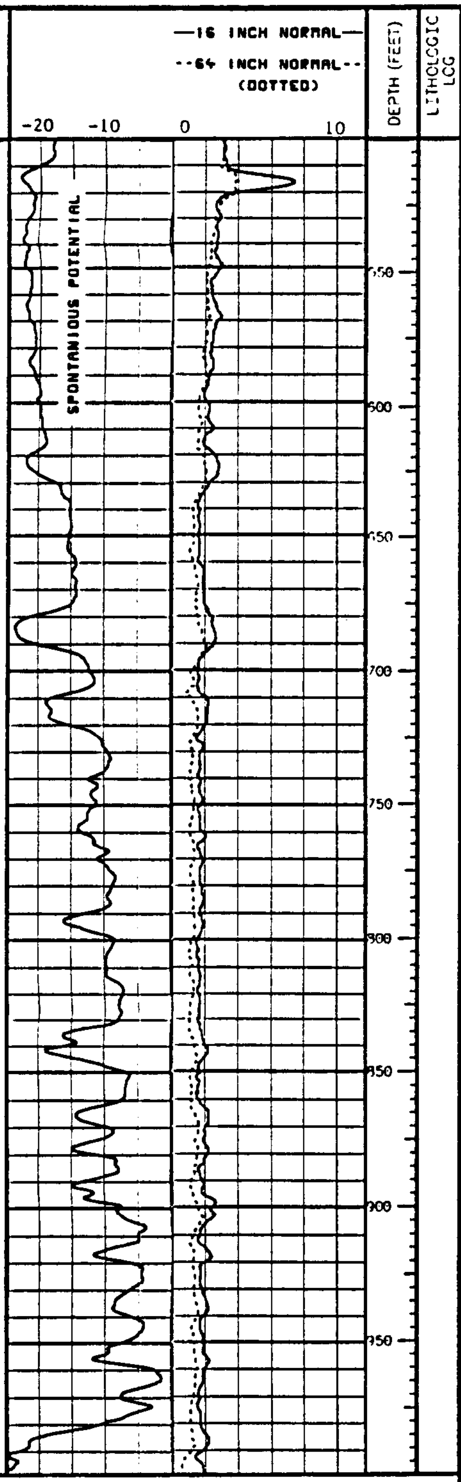
WATER QUALITY:
Water analysis by:

Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

DESCRIPTION OF SAMPLING POINT: NEAL RANCH #2 330-350

DATE/TIME COLLECTED: 2/26/91 0900

	RESULTS	MCL
TOTAL HARDNESS	241.2 mg/L	
CALCIUM HARDNESS	136.8 mg/L	
CALCIUM	54.8 mg/L	
MAGNESIUM	25.4 mg/L	
SODIUM	201.4 mg/L	
POTASSIUM	6.2 mg/L	
TOTAL ALKALINITY	295.6 mg/L	
HYDROXIDE	< 1.0 mg/L	
CARBONATE	< 1.0 mg/L	
BICARBONATE	340.6 mg/L	
SULFATE	232.8 mg/L	
CHLORIDE	85.0 mg/L	
NITRATE	25.6 mg/L	45
FLUORIDE	0.8 mg/L	
TOTAL ANIONS	13.61 mEq/L	
TOTAL CATIONS	13.73 mEq/L	
RPD ANIONS/CATIONS	0.60 PERCENT	
pH	8.3 STD UNITS	
E.C.	1370.0 umho/cm	
TDS	808.3 mg/L	
MBAS	< 0.02 mg/L	
MANGANESE	50 ug/L	50
COPPER	< 50 ug/l	1000
IRON	< 100 ug/L	300
ZINC	< 50 ug/L	5000
BARIUM	< 100 ug/L	1000
CHROMIUM	< 10 ug/L	50
CADMIUM	< 1 ug/L	10
LEAD	12 ug/l	50
ALUMINUM	< 100 ug/L	1000
MERCURY	< 1 ug/l	2
ARSENIC	< 10 ug/L	50
SELENIUM	10 ug/L	100
SILVER	< 10 ug/L	50
COLOR	< 5	
ODOR	1	
TURBIDITY	0.5 NTU	



CONDENSED CUTTINGS DESCRIPTION

440-1480 CLAY
Blue, blue green, blue gray, green, and gray clay.

510-530	Silty.
640-650	Gray mud.
650-680	Gray clay with siltstone chips and small fossils.
690-710	Small fossils.
720-730	Silty with small fossils.
750-770	Some sand.
790-800	Some fossils.
800-840	Sandy with few gravels.

USBR Drill Hole Completion and Data Log
Monitoring Well NR-2

FEATURE	Drill Hole Completed with Nested Piezometers
DRILLED DEPTH	1994 Ft.
PROJECT	Indian Wells Valley Groundwater Project (Water District Well)
COMPLETED DEPTH	1950 Ft.
LOCATION	T. 25 S., R. 38 E., Sec. 36g
STATE	CA
BEGUN	2-04-91
TYPE OF WELL	Observation
FINISHED	2-15-91
PURPOSE	Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity
GROUND ELEVATION	2314.7
COORDINATES	
TOP OF CASING ELEV.	2317.7
HOLE LOGGED BY	Cutting Description by Dipti Barari, N. Amer, Chem., Co., Trona CA
DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature
LAB ANALYSIS	Yes, See Notes
TDS	See Notes
OTHER LOGS	Drilling Time
REVIEWED BY	Dennis Watt, USBR

NOTES

DESCRIPTION OF SAMPLING POINT: NEAL RANCH #2 1540-1560

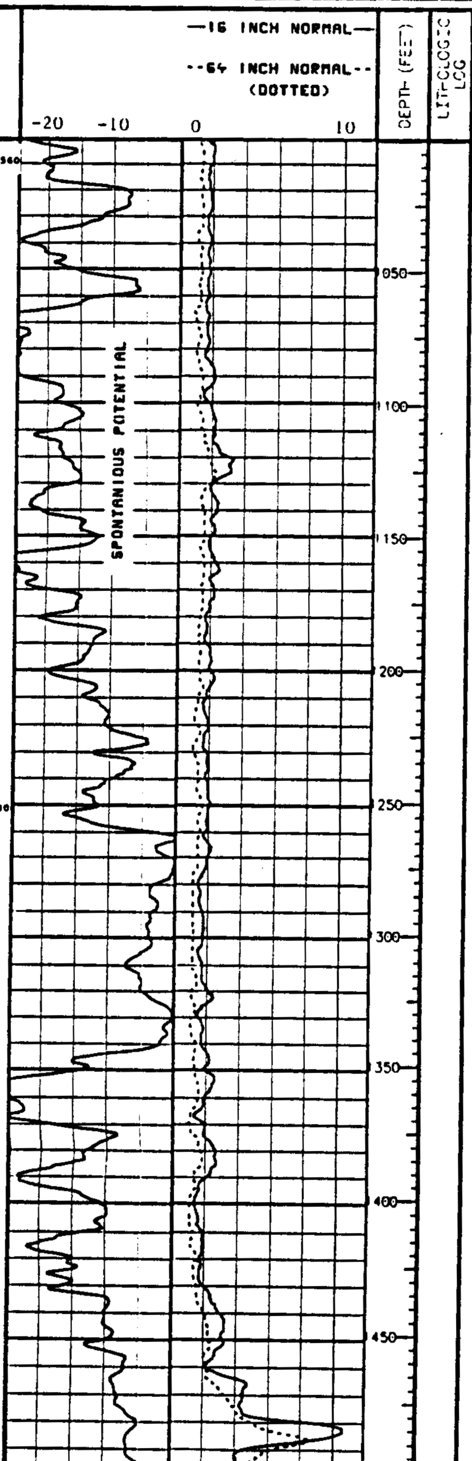
DATE/TIME COLLECTED: 2/26/91 0800

	RESULTS	MCL
TOTAL HARDNESS	457.2 mg/L	
CALCIUM HARDNESS	285.2 mg/L	
CALCIUM	114.2 mg/L	
MAGNESIUM	41.8 mg/L	
SODIUM	272.3 mg/L	
POTASSIUM	4.5 mg/L	
TOTAL ALKALINITY	310.0 mg/L	
HYDROXIDE	< 1.0 mg/L	
CARBONATE	< 1.0 mg/L	
BICARBONATE	378.2 mg/L	
SULFATE	467.7 mg/L	
CHLORIDE	159.9 mg/L	
NITRATE	107.1 mg/L	45
FLUORIDE	1.1 mg/L	
TOTAL ANIONS	22.33 mEq/L	
TOTAL CATIONS	21.09 mEq/L	
RPD ANIONS/CATIONS	3.55 PERCENT	
pH	8.0 STD UNITS	
E.C.	2240.0 umho/cm	
TDS	1366.0 mg/L	
MBAS	< 0.02 mg/L	
MANGANESE	< 30 ug/L	50
COPPER	< 50 ug/l	1000
IRON	< 100 ug/L	300
ZINC	< 50 ug/L	5000
BARIUM	< 100 ug/L	1000
CHROMIUM	< 10 ug/L	50
CADMIUM	< 1 ug/L	10
LEAD	< 5 ug/l	50
ALUMINUM	< 100 ug/L	1000
MERCURY	< 1 ug/l	2
ARSENIC	12 ug/L	50
SELENIUM	60 ug/L	100
SILVER	< 10 ug/L	50
COLOR	< 3	
ODOR	1	
TURBIDITY	1.2 NTU	

DESCRIPTION OF SAMPLING POINT: NEAL RANCH #2 1910-1930

DATE/TIME COLLECTED: 2/26/91 1000

	RESULTS	MCL
TOTAL HARDNESS	143.6 mg/L	
CALCIUM HARDNESS	42.8 mg/L	
CALCIUM	17.1 mg/L	
MAGNESIUM	24.5 mg/L	
SODIUM	1296.0 mg/L	
POTASSIUM	11.3 mg/L	
TOTAL ALKALINITY	2112.0 mg/L	
HYDROXIDE	< 1.0 mg/L	
CARBONATE	< 1.0 mg/L	
BICARBONATE	2576.6 mg/L	
SULFATE	226.4 mg/L	
CHLORIDE	230.6 mg/L	
NITRATE	38.2 mg/L	45
FLUORIDE	3.0 mg/L	
TOTAL ANIONS	54.43 mEq/L	
TOTAL CATIONS	59.50 mEq/L	
RPD ANIONS/CATIONS	5.84 PERCENT	
pH	8.4 STD UNITS	
E.C.	5330.0 umho/cm	
TDS	3304.6 mg/L	
MBAS	< 0.02 mg/L	
MANGANESE	80 ug/L	50
COPPER	< 50 ug/l	1000
IRON	250 ug/L	300
ZINC	< 50 ug/L	5000
BARIUM	< 100 ug/L	1000
CHROMIUM	< 10 ug/L	50
CADMIUM	< 1 ug/L	10
LEAD	< 5 ug/l	50
ALUMINUM	< 100 ug/L	1000
MERCURY	< 1 ug/l	2
ARSENIC	460 ug/L	50
SELENIUM	20 ug/L	100
SILVER	< 10 ug/L	50
COLOR	15	
ODOR	3	
TURBIDITY	4.5 NTU	



CONDENSED CUTTINGS DESCRIPTION

440-1480 CLAY
Blue, blue green, blue gray, green, and gray clay.

1260-1280 Silty.

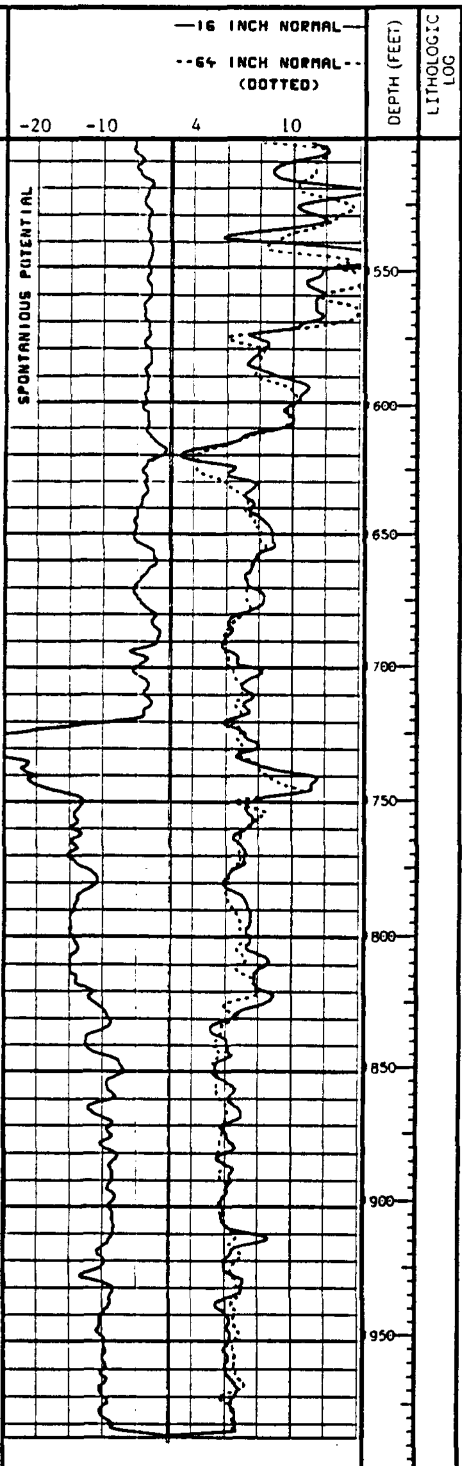
1330-1450 Black, gray black mud.
1370-1390 Few gravels.
1390-1420 Silty.

1480-1620 SAND
Mostly fine to coarse sand with finer interbeds. The depth of the top and bottom of this interval is based on the electric log. Log of cuttings shows an increasing sand content beginning at 1500 feet.

USBR Drill Hole Completion and Data Log
Monitoring Well NR-2

FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 1994 Ft.
PROJECT: Indian Wells Valley Groundwater Project (Water District Well) — COMPLETED DEPTH: 1950 Ft.
LOCATION: T. 25 S., R. 38 E., Sec. 36g — STATE: CA — BEGUN: 2-04-91
TYPE OF WELL: Observation — FINISHED: 2-15-91
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION: 2314.7
COORDINATES: — TOP OF CASING ELEV.: 2317.7
HOLE LOGGED BY: Cutting Description by Dipti Barari, N. Amer, Chem., Co., Trona CA — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drilling Time — REVIEWED BY: Dennis Watt, USBR

NOTES		CONDENSED CUTTINGS DESCRIPTION



1480-1620 SAND
Mostly fine to coarse sand with finer interbeds. The depth of the top and bottom of this interval is based on the electric log. Log of cuttings shows an increasing sand content beginning at 1500 feet.

1620-1635 CLAY
Mostly gray, black, green, or gray black clay.

1635-1985 INTERBEDDED SAND AND CLAY
Clays are green, gray and black. Sands are fine to coarse. About 50% of interval is clay.

USBR Drill Hole Completion and Data Log
Monitoring Well MW-32

FEATURE Drill Hole Completed with Nested Piezometers — DRILLED DEPTH 1968 Ft.
PROJECT Indian Wells Valley Groundwater Project (Water District Well) — COMPLETED DEPTH 1941 Ft.
LOCATION T.26 S., R.39 E., Sec. 27d — STATE CA — BEGUN 9-23-91
TYPE OF WELL Observation — FINISHED 10-8-91
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION
COORDINATES — TOP OF CASING ELEV. 2418.1
HOLE LOGGED BY Cuttings Description by Dipti Harari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS Yes, See Notes
TDS See Notes
OTHER LOGS — REVIEWED BY Dennis Watt, USBR

NOTES	ELECTRIC LOG	DEPTH (FEET)	LITHOLOGIC LOG	CONDENSED CUTTINGS DESCRIPTION

NOTES

DRILL SITE:
The well is located just north of the east west dirt road just to the east of the center of the Indian Wells Valley Water District's Victor Street property.

DRILLED BY:
Rottman Drilling Company of Lancaster CA.

DRILLING RIG:
Custom built small oil-field rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit from surface to total depth.

HOLE COMPLETION:
Installed four 2" diameter steel pipes with a 20' two inch diameter screen on the bottom of each. Screens are at the following depth intervals: 360'-380', 880'-900', 1240'-1260', 1900'-1920'. Twenty feet of 2" pipe below each screen. Benseal (bentonite) plugs set at the following depth intervals: 430'-450', 700'-720', 980'-1000', 1290'-1310', 1680'-1700'.

DEVELOPMENT:
Each piezometer was air-lifted for about 12 hours and discharged an estimated 5-15 gallons per minute. Water samples for lab analysis were collected at the end of development.

DEPTH TO WATER:
All depths reported below were measured on December 12, 1991 from the top of the outer casing.

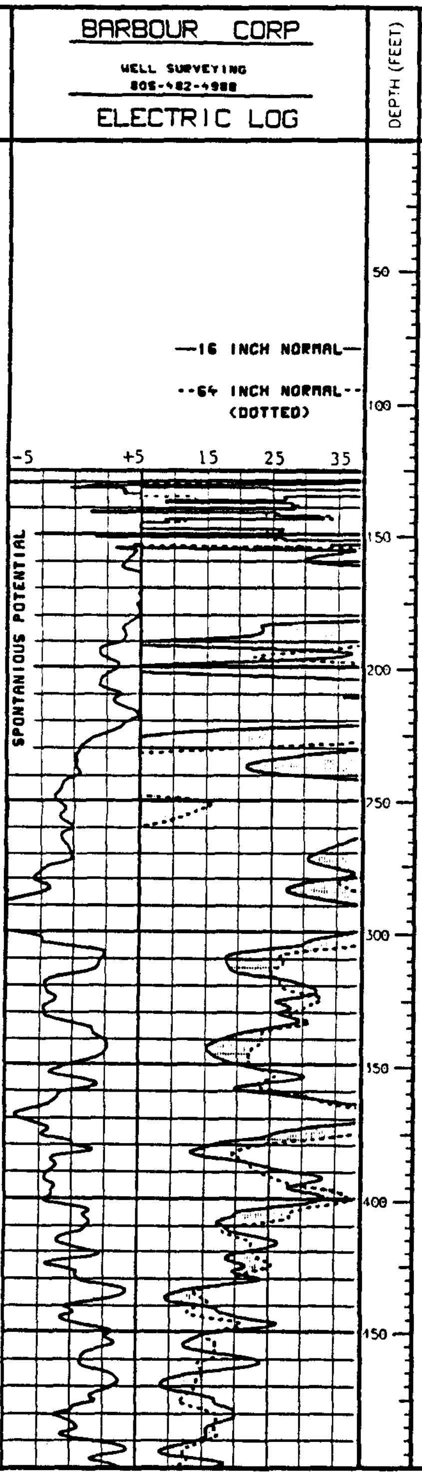
Screen Interval	Depth (Ft)
360'-380'	241.0
880'-900'	241.7
1240'-1260'	241.2
1900'-1920'	240.4

All depth to water measurements are available in an attachment to the Geohydrologic Appendix for this project.

SLUG TEST RESULTS:
Estimated transmissivity (ft^2/min) by the Cooper (1967) method for the 20 feet of aquifer at each screen.

Piezometer	T
Shallow	.009*
Shallow Medium	.31
Deep Medium	.23
Deep	.11

*Note - Too low. Poor development?



CONDENSED CUTTINGS DESCRIPTION

The interpretation below is reduced from a description of samples collected every 10 feet from the drilling mud return.

GENERAL

The collected samples and drilling character indicate a non-cemented alluvial fill from land surface to total depth.

Depth intervals are feet below land surface.

0-190 SAND
Light brown fine to medium sand.

90-100 About 10% coarse sand.

130-140 About 10% coarse sand.

190-220 CLAYEY SAND
Light brown, clayey fine to coarse sand.

190-200 About 50% clay.

200-210 About 20% clay.

210-220 About 10% clay.

220-350 SAND
Light brown fine to medium sand.

240-250 Fine sand.

350-360 SANDY CLAY
Light brown sandy clay.

360-410 CLAYEY SAND
Light brown clayey sand.

360-370 About 40% clay.

370-390 About 20% clay.

390-410 About 30% clay.

410-430 SANDY CLAY
Light brown sandy clay.

410-420 About 40% sand.

420-430 About 50% sand.

USBR Drill Hole Completion and Data Log
Monitoring Well MW-32

FEATURE Drill Hole Completed with Nested Piezometers — DRILLED DEPTH 1968 Ft.
PROJECT Indian Wells Valley Groundwater Project (Water District Well) — COMPLETED DEPTH 1941 Ft.
LOCATION T.26 S., R.39 E., Sec. 27d — STATE CA — BEGUN 9-23-91
TYPE OF WELL Observation — FINISHED 10-8-91
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION
COORDINATES — TOP OF CASING ELEV. 2418.1
HOLE LOGGED BY Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS Yes, See Note
TDS See Notes
OTHER LOGS — REVIEWED BY Dennis Watt, USBR

NOTES

WATER QUALITY:
Water analysis by:

Clinical Labs
1595 North "D" Street
San Bernardino CA 92405

Depth: 360'-380'

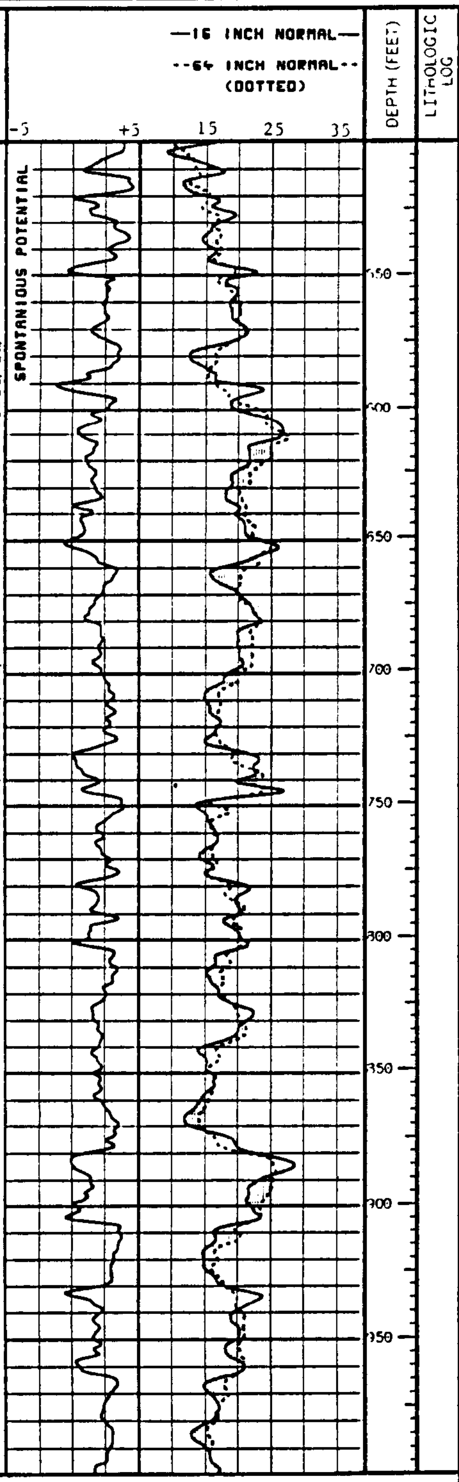
REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	86.0
mg/L	Calcium (Ca)	24.0
mg/L	Magnesium (Mg)	6.1
mg/L	Sodium (Na)	60.0
mg/L	Potassium (K)	4.4
Cations	Meq/L Value: 4.4	
mg/L	Total Alkalinity (AS CaCO3)	104.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	126.9
mg/L*	Sulfate (SO4)	57.0
mg/L*	Chloride (Cl)	40.2
mg/L	Nitrate (as NO3)	7.2
mg/L	Fluoride (F) Temp. Depend.	1.1
Anions	Meq/L Value: 4.6	
Std. Units	PH (Laboratory)	8.6
umho/cm**	Specific Conductance (E.C.)	450.0
mg/L***	Total Filterable Residue at 180C	252.4
Units	Apparent Color (Unfiltered)	< 3.0
TON	Odor Threshold at 60 C	1.0
NTU	Lab Turbidity	0.9
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	170.00
ug/L	Arsenic (As)	26.00
ug/L	Barium (Ba)	<100.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	<100.00
ug/L	Lead (Pb)	< 5.00
ug/L	Manganese (Mn)	50.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	< 50.00

Depth: 880'-900'

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	35.2
mg/L	Calcium (Ca)	10.4
mg/L	Magnesium (Mg)	2.2
mg/L	Sodium (Na)	49.2
mg/L	Potassium (K)	3.7
Cations	Meq/L Value: 2.9	
mg/L	Total Alkalinity (AS CaCO3)	84.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	102.5
mg/L*	Sulfate (SO4)	24.3
mg/L*	Chloride (Cl)	23.3
mg/L	Nitrate (as NO3)	16.9
mg/L	Fluoride (F) Temp. Depend.	0.8
Anions	Meq/L Value: 3.2	
Std. Units	PH (Laboratory)	8.3
umho/cm**	Specific Conductance (E.C.)	330.0
mg/L***	Total Filterable Residue at 180C	173.0
Units	Apparent Color (Unfiltered)	< 70.0
TON	Odor Threshold at 60 C	1.0
NTU	Lab Turbidity	30.0
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	120.00
ug/L	Arsenic (As)	36.00
ug/L	Barium (Ba)	<100.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	1000.0
ug/L	Lead (Pb)	< 5.00
ug/L	Manganese (Mn)	< 30.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	< 50.00



CONDENSED CUTTINGS DESCRIPTION

430-480 SANDY CLAY
Blue (on drillers log) sandy clay.

430-450 About 10% sand.

450-460 About 30% sand.

460-470 About 10% sand.

470-480 About 50% sand.

480-500 CLAYEY SAND
Blue clayey sand.

500-560 SAND
Light brown fine to medium sand with some clay.

540-560 Some coarse sand.

560-1960 SAND
Light brown fine to medium sand with about 10% clay.

USBR Drill Hole Completion and Data Log
Monitoring Well MW-32

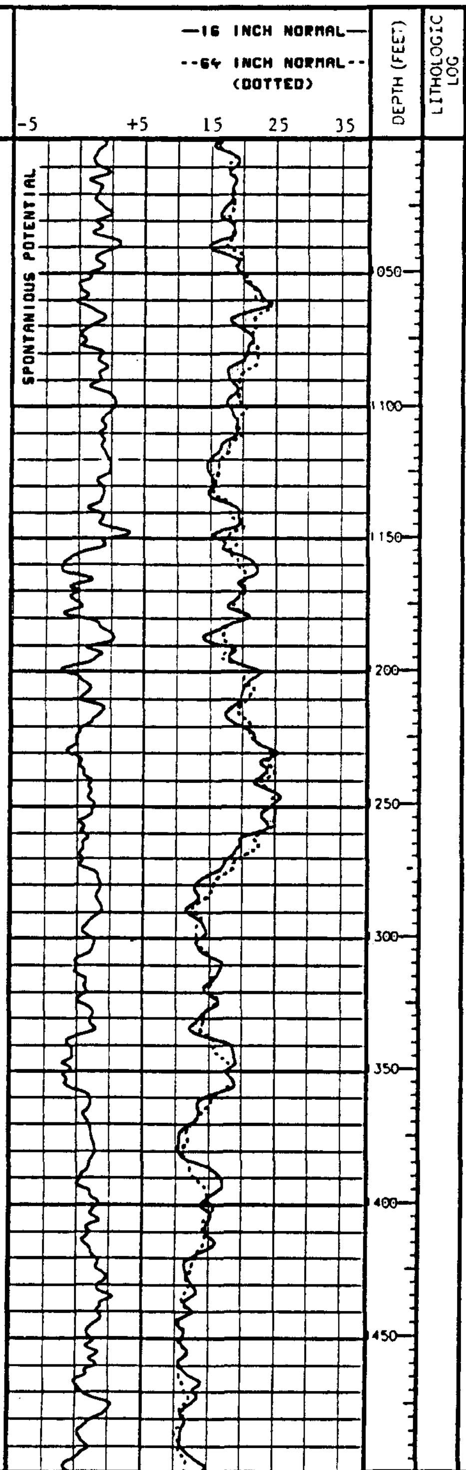
FEATURE: Drill Hole Completed with Nested Piezometers — DRILLED DEPTH: 1968 Ft.
PROJECT: Indian Wells Valley Groundwater Project (Water District Well) — COMPLETED DEPTH: 1941 Ft.
LOCATION: T.26 S., R.39 E., Sec. 27d — STATE: CA — BEGUN: 9-23-91
TYPE OF WELL: Observation — FINISHED: 10-8-91
PURPOSE: Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION:
COORDINATES: — TOP OF CASING ELEV.: 2418.1
HOLE LOGGED BY: Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS: Yes, See Note — TDS: See Notes
OTHER LOGS: — REVIEWED BY: Dennis Watt, USBR

NOTES

Depth: 1240'-1260'

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	28.0
mg/L	Calcium (Ca)	5.6
mg/L	Magnesium (Mg)	3.4
mg/L	Sodium (Na)	59.2
mg/L	Potassium (K)	2.0
Cations	Meq/L Value: 3.2	
mg/L	Total Alkalinity (AS CaCO3)	90.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	109.8
mg/L*	Sulfate (SO4)	22.6
mg/L*	Chloride (Cl)	26.1
mg/L	Nitrate (as NO3)	14.8
mg/L	Fluoride (F) Temp. Depend.	0.6
Anions	Meq/L Value: 3.3	
Std. Units	PH (Laboratory)	8.5
umho/cm**	Specific Conductance (E.C.)	340.0
mg/L***	Total Filterable Residue at 180C	179.3
Units	Apparent Color (Unfiltered)	< 70.0
TON	Odor Threshold at 60 C	4.0
NTU	Lab Turbidity	25.0
mg/L	MBAS	< 0.02

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	130.00
ug/L	Arsenic (As)	17.00
ug/L	Barium (Ba)	<100.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	4150.0
ug/L	Lead (Pb)	< 5.00
ug/L	Manganese (Mn)	100.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	< 50.00



CONDENSED CUTTINGS DESCRIPTION

560-1960 SAND
Light brown fine to medium sand with about 10% clay.

1320-1340 About 20% clay.

PAGE OF — DRILL HOLE MW-32 [Page 3]

USBR Drill Hole Completion and Data Log
Monitoring Well MW-32

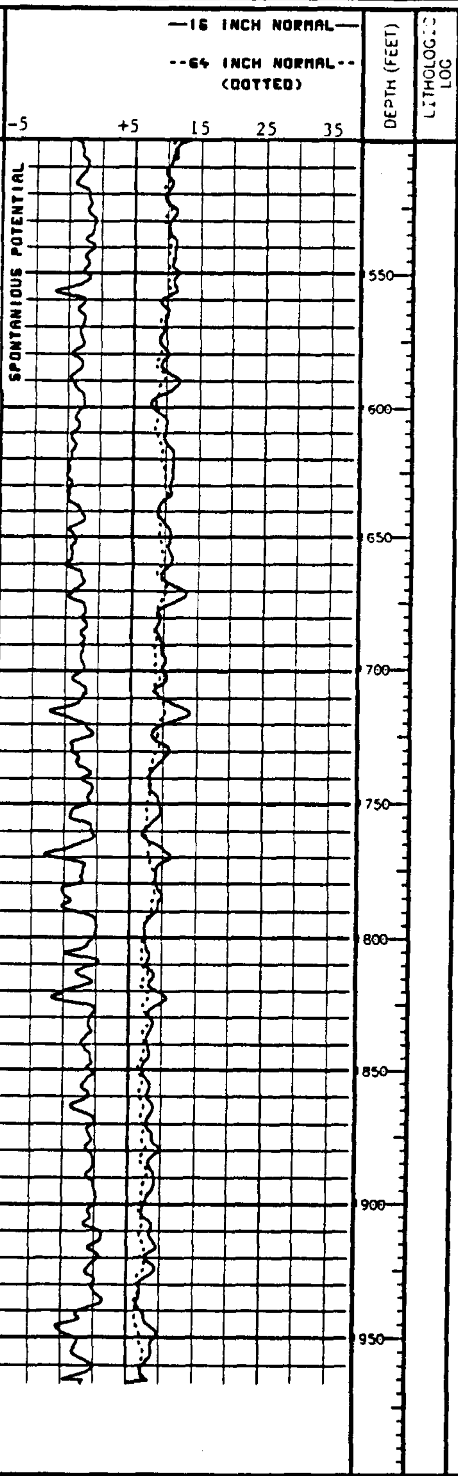
FEATURE Drill Hole Completed with Nested Piezometers — DRILLED DEPTH 1968 Ft.
PROJECT Indian Wells Valley Groundwater Project (Water District Well) — COMPLETED DEPTH 1941 Ft.
LOCATION T.26 S., R.39 E., Sec. 27d — STATE CA — BEGUN 9-23-91
TYPE OF WELL Observation — FINISHED 10-8-91
PURPOSE Lithology, Groundwater Quality, Piezometric Level, Hydraulic Conductivity — GROUND ELEVATION
COORDINATES — TOP OF CASING ELEV. 2418.1
HOLE LOGGED BY Cuttings Description by Dipti Barari, N. Amer. Chem. Co., Trona CA — DEPTH TO WATER (DATE) See Notes
GEOPHYSICAL LOGS Spontaneous Potential, 16 and 64 inch Resistivity, 6 Foot Lateral, Temperature — LAB ANALYSIS Yes, See Note
TDS See Notes
OTHER LOGS — REVIEWED BY Dennis Watt, USBR

NOTES

Depth: 1900'-1920'

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
mg/L	Total Hardness (as CaCO3)	26.0
mg/L	Calcium (Ca)	7.4
mg/L	Magnesium (Mg)	1.8
mg/L	Sodium (Na)	190.5
mg/L	Potassium (K)	4.1
Cations	Meq/L Value: [illegible]	
mg/L	Total Alkalinity (AS CaCO3)	198.0
mg/L	Hydroxide (OH)	< 1.0
mg/L	Carbonate (CO3)	< 1.0
mg/L	Bicarbonate (HCO3)	241.6
mg/L*	Sulfate (SO4)	128.2
mg/L*	Chloride (Cl)	76.8
mg/L	Nitrate (as NO3)	1.0
mg/L	Fluoride (F) Temp. Depend.	5.6
Anions	Meq/L Value: [illegible]	
Std. Units	PH (Laboratory)	8.6
umho/cm**	Specific Conductance (E.C.)	960.0
mg/L***	Total Filterable Residue at 180C	520.4
Units	Apparent Color (Unfiltered)	< 70.0
TON	Odor Threshold at 60 C	1.0
NTU	Lab Turbidity	74.0
mg/L	MBAS	< 0.03

REPORTING UNITS	CONSTITUENT	ANALYSES RESULTS
ug/L	Aluminum (Al)	615.00
ug/L	Arsenic (As)	61.00
ug/L	Barium (Ba)	<100.00
ug/L	Cadmium (Cd)	< 1.00
ug/L	Chromium (Total Cr)	< 10.00
ug/L	Copper (Cu)	< 50.00
ug/L	Iron (Fe)	1550.0
ug/L	Lead (Pb)	< 5.00
ug/L	Manganese (Mn)	100.00
ug/L	Mercury (Hg)	< 1.00
ug/L	Selenium (Se)	< 5.00
ug/L	Silver (Ag)	< 10.00
ug/L	Zinc (Zn)	< 50.00



CONDENSED CUTTINGS DESCRIPTION

560-1960 SAND
Light brown fine to medium sand with about 10% clay.

1570-1590 About 30% clay.

USBR Drill Hole Completion and Data Log
(Land Surface to 2,000 Feet)
Geothermal Test Well SNORT #1

FEATURE: Drill Hole Completed with Two "Shallow" Piezometers — DRILLED DEPTH: 7,394 Ft.
PROJECT: Indian Wells Valley Groundwater Project (Navy Geothermal Test Well) — COMPLETED DEPTH: See Notes
LOCATION: T. 25 S., R.39 E., Sec. 23 — STATE: CA — BEGUN: 9-8-91
TYPE OF WELL: Geothermal Test Well - Naval Air Warfare Station, Geothermal Office — FINISHED: 9-30-91
PURPOSE: Temperature Gradient, Lithology, Groundwater Quality, Piezometric Level — GROUND ELEVATION:
COORDINATES: — TOP OF CASING ELEV.:
HOLE LOGGED BY: Norm Wycoff and Doug Hosto — DEPTH TO WATER (DATE): See Notes
GEOPHYSICAL LOGS: Dual Induction (ILD, SFLA, CILD), Spontaneous Potential, Natural Gamma, Temperature — LAB ANALYSIS: Yes, See Notes
TDS: See Notes
OTHER LOGS: Drillling Time — REVIEWED BY:

NOTES	Schlumberger DUAL INDUCTION	DEPTH (FEET)	LITHOLOGIC LOG	LITHOLOGY SYMBOLS

The Indian Wells Valley Groundwater Project was allowed to complete two intervals in the upper section of SNORT #1, a geothermal test well on the Naval Air Warfare Station. Only the upper 2,000 feet is described by this log. Total drilled depth was 7,394 feet.

DRILL SITE:
West of the Range Access Road in the center of section 23 on the Naval Air Warfare Station. About one mile north of the north end of the SNORT.

DRILLED BY:
Welch and Howell Drilling of El Centro CA.

DRILLING RIG:
Mac double (106' total height) direct rotary rig.

DRILLING METHOD:
Direct rotary with bentonite mud. 12 1/4 inch roller cone bit to 597 feet. 8 1/2 inch bit to 2,464 feet.

HOLE COMPLETION:
9 5/8 inch steel casing set to 572 feet, geo. mix to surface; 7 inch casing set to 2442 feet, geo. mix to surface. Perforated 840'-880' and 1430'-1470' and set cement plug at 1000'-1100'. Access to 1430'-1470' perfs via 1 1/2 inch pipe through cement plug. Lower perforated intervals: 3,320'-3,340', 5,550'-5,570', 7,120'-7,140', and 7,400'. No flow from 1,430'-1,450' and 7,400'.

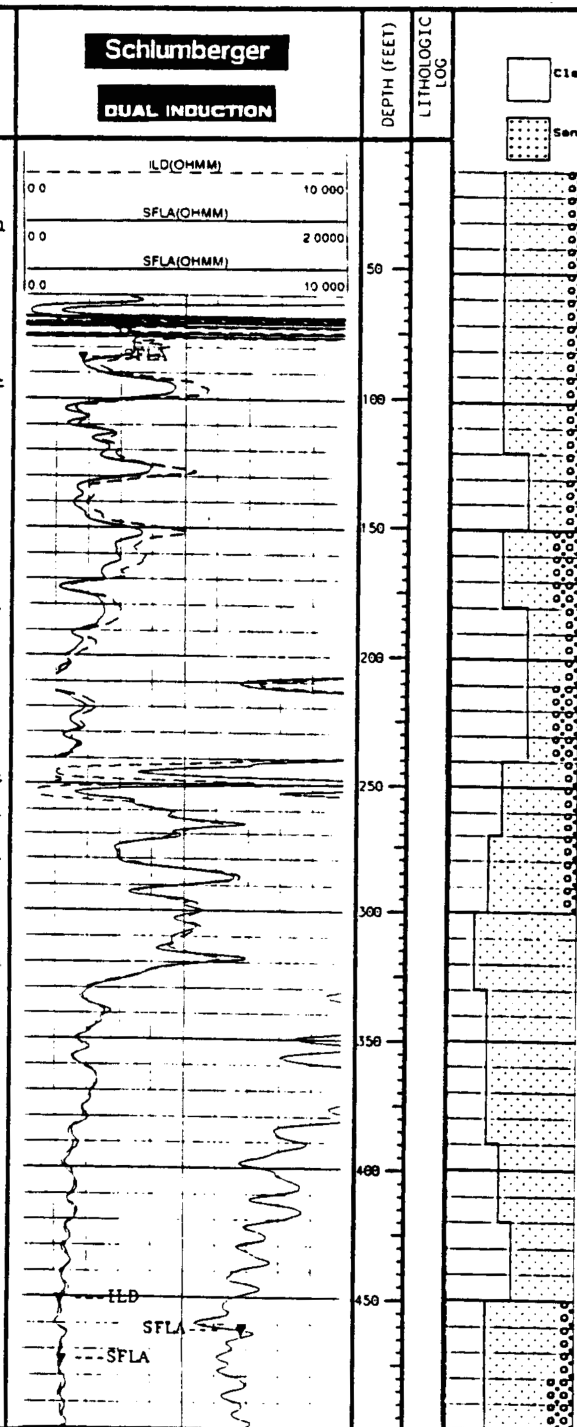
DEVELOPMENT:
Each perfed interval was nitrogen lifted. Water samples for lab analysis were collected at the end of development.

SLUG TEST RESULTS:
Slug test were not performed.

WATER QUALITY:
Laboratory water analysis by:

BC Laboratories
4100 Atlas Ct.
Bakersfield CA 93306

(See following pages)



Sand: clr to fros wht, occ orng yel, v hd, m to crs gr, ang to sbrnd, well srtd, tr calc cmt, tr mica.

Clay: lt tan to buff, hyd, sft, stky, sthy lust, smth tex, abnt calc cmt, tr mica.

Clay: lt gy to gy, sft, hyd, smth tex, sthy lust, abnt calc cmt, mnr mica.

Clay: lt gy to gy, sft, stky, hyd, smth tex, sthy lust, abnt calc cmt, mnr mica.

Sand: clr to fros wht, occ gn, hd, occ firm in fros wht gr, m to crs gr, m well srtd, tr calc cmt, good vis por.

Sand: glsy to fros wht, occ gn, hd, vf to m gr, m poor srtd, tr calc cmt, mod blk & gn lith frags, tr mica.

Sand: clr to fros wht, hd, f to m gr, sbang to sbrnd, pred sil mtx, sl slty, tr calc cmt, m vis por, mica.

Sand: clr to fros wht, occ gn & yel, tr bl gy, hd, f to crs gr, ang to sbrnd, poor to m srtd, tr calc cmt, m vis por, m mica.

USBR Drill Hole Completion and Data Log
(Land Surface to 2,000 Feet)
Geothermal Test Well SNORT #1

FEATURE	Drill Hole Completed with Two "Shallow" Piezometers	DRILLED DEPTH	7,394 Ft.
PROJECT	Indian Wells Valley Groundwater Project (Navy Geothermal Test Well)	COMPLETED DEPTH	See Notes
LOCATION	T. 25 S., R.39 E., Sec. 23 — STATE CA	BEGUN	9-8-91
TYPE OF WELL	Geothermal Test Well - Naval Air Warfare Station, Geothermal Office	FINISHED	9-30-91
PURPOSE	Temperature Gradient, Lithology, Groundwater Quality, Piezometric Level	GROUND ELEVATION	
COORDINATES		TOP OF CASING ELEV.	
HOLE LOGGED BY	Norm Wycoff and Doug Hosto	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Dual Induction (ILD, SFLA, CILD), Spontaneous Potential, Natural Gamma Temperature	LAB ANALYSIS	Yes, See Notes
		TDS	See Notes
OTHER LOGS	Drillling Time	REVIEWED BY	

NOTES

Depth: 850'-870'

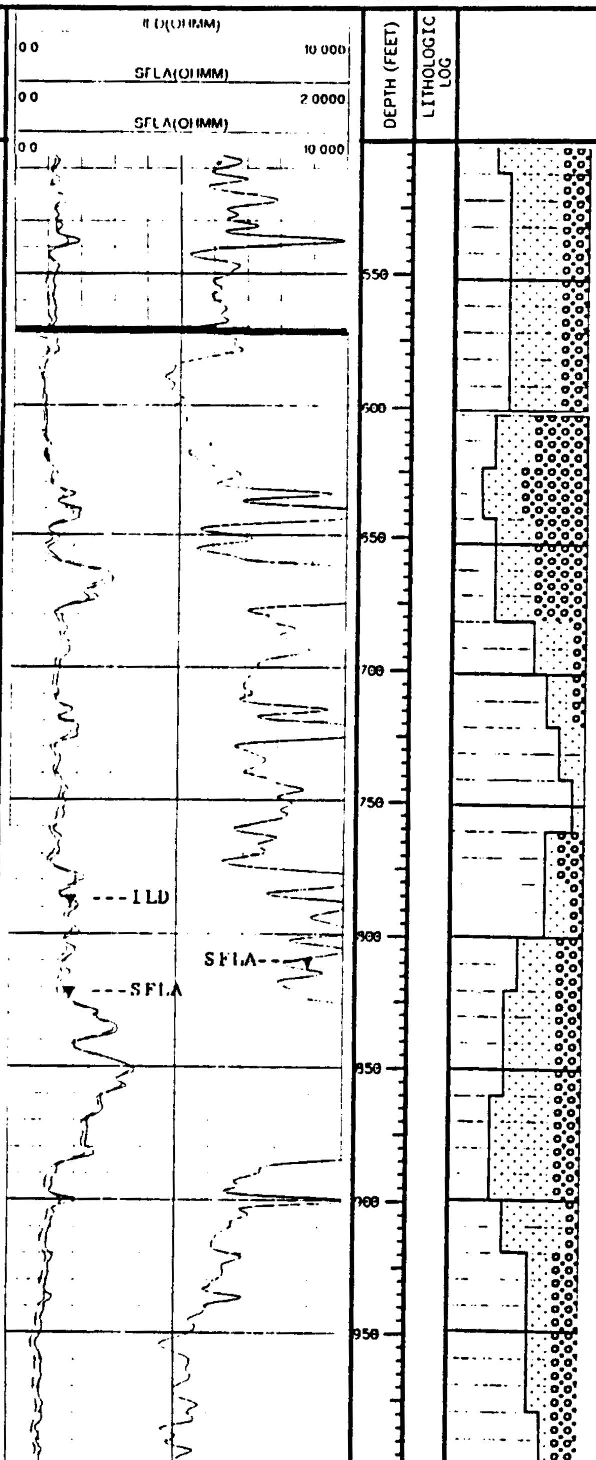
Constituents	Results	Units
Calcium	1.9	mg/L
Magnesium	1.0	mg/L
Sodium	3950.	mg/L
Potassium	25.	mg/L
Carbonate	1570.	mg/L
Bicarbonate	1950.	mg/L
Chloride	3040.	mg/L
Sulfate	46.	mg/L
Nitrate as NO3	None Detected	mg/L
Fluoride	27.	mg/L
Bromide	6.6	mg/L
pH	9.7	pH Units
Electrical Conductivity @ 25 C	15100.	umhos/cm
Total Dissolved Solids @ 180 C	9890.	mg/L
Ammonia as NH3	20.	mg/L
Nitrite Nitrogen	None Detected	mg/L
Ortho-phosphate	8.4	mg/L

Constituents	Results	Units
Aluminum	578.	µg/L
Antimony	None Detected	µg/L
Arsenic	5.2	µg/L
Boron	93.5	mg/L
Copper	None Detected	µg/L
Lithium	50.	µg/L
Manganese	36.	µg/L
Mercury	None Detected	µg/L
*Selenium	None Detected	µg/L
Si as SiO2	63.	mg/L
Strontium	72.	µg/L
Thallium	None Detected	µg/L
Zinc	54.	µg/L
Total Iron	1940.	µg/L

Depth: 3,300'-3,320'

Constituents	Results	Units
Calcium	35.	mg/L
Magnesium	6.9	mg/L
Sodium	3900.	mg/L
Potassium	14.5	mg/L
Carbonate	109.	mg/L
Bicarbonate	2530.	mg/L
Chloride	3420.	mg/L
Sulfate	1170.	mg/L
Nitrate as NO3	None Detected	mg/L
Fluoride	17.4	mg/L
Bromide	3.8	mg/L
pH	8.2	pH Units
Electrical Conductivity @ 25 C	15900.	umhos/cm
Total Dissolved Solids @ 180 C	9350.	mg/L
Ammonia as NH3	11.6	mg/L
Nitrite Nitrogen	None Detected	mg/L
Ortho-phosphate	0.84	mg/L

Constituents	Results	Units
Aluminum	1190.	µg/L
Antimony	None Detected	µg/L
Arsenic	62.	µg/L
Boron	52.5	mg/L
Copper	None Detected	µg/L
Lithium	1140.	µg/L
Manganese	57.	µg/L
Mercury	None Detected	µg/L
*Selenium	None Detected	µg/L
Si as SiO2	50.	mg/L
Strontium	1590.	µg/L
Thallium	None Detected	µg/L
Zinc	35.	µg/L
Total Iron	3480.	µg/L



Clay: brn gy to m tan, sft to sl fri, slty, m calc cmt, intbd w/ m to crs gr sbrnd sand, tr mica.

Clay: crm to ly gry, sft, stky, sthy lstr, smth tex, v calc, abnt vg ang qtz sd, tr crushed qtz pebbles.

Sandstone: clr to fros wht, frm to hd, vf to med grn, ang to sbrnd, w srtd, gd calc cmt, tr pyr, tr mica.

Clay: med gry, occ grn gry, sft to sli frm, stky to gmmy, sthy lstr, smth tex, v calc, tr mica.

Sandstone: clr to lt gry, frm to hd, sli fri, vf to f grn, ang to sbang, mod to w srtd, gd calc cmt, tr pyr, tr mica, tr lithic frags.

Clay: med gry to grn gry, sft to sli frm, stky to gmmy, sthy lstr, smth tex, v calc, tr crushed qtz pebbles.

USBR Drill Hole Completion and Data Log
(Land Surface to 2,000 Feet)
Geothermal Test Well SNORT #1

FEATURE	Drill Hole Completed with Two "Shallow" Piezometers	DRILLED DEPTH	7,394 Ft.
PROJECT	Indian Wells Valley Groundwater Project (Navy Geothermal Test Well)	COMPLETED DEPTH	See Notes
		STATE	CA
LOCATION	T. 25 S., R.39 E., Sec. 23	BEGUN	9-8-91
TYPE OF WELL	Geothermal Test Well - Naval Air Warfare Station, Geothermal Office	FINISHED	9-30-91
PURPOSE	Temperature Gradient, Lithology, Groundwater Quality, Piezometric Level	GROUND ELEVATION	
COORDINATES		TOP OF CASING ELEV.	
HOLE LOGGED BY	Norm Wycoff and Doug Hosto	DEPTH TO WATER (DATE)	See Notes
GEOPHYSICAL LOGS	Dual Induction (ILD, SFLA, CILD), Spontaneous Potential, Natural Gamma	LAB ANALYSIS	Yes, See Notes
	Temperature	TDS	See Notes
OTHER LOGS	Drillling Time	REVIEWED BY	

NOTES

Depth: 5,550'-5,570'

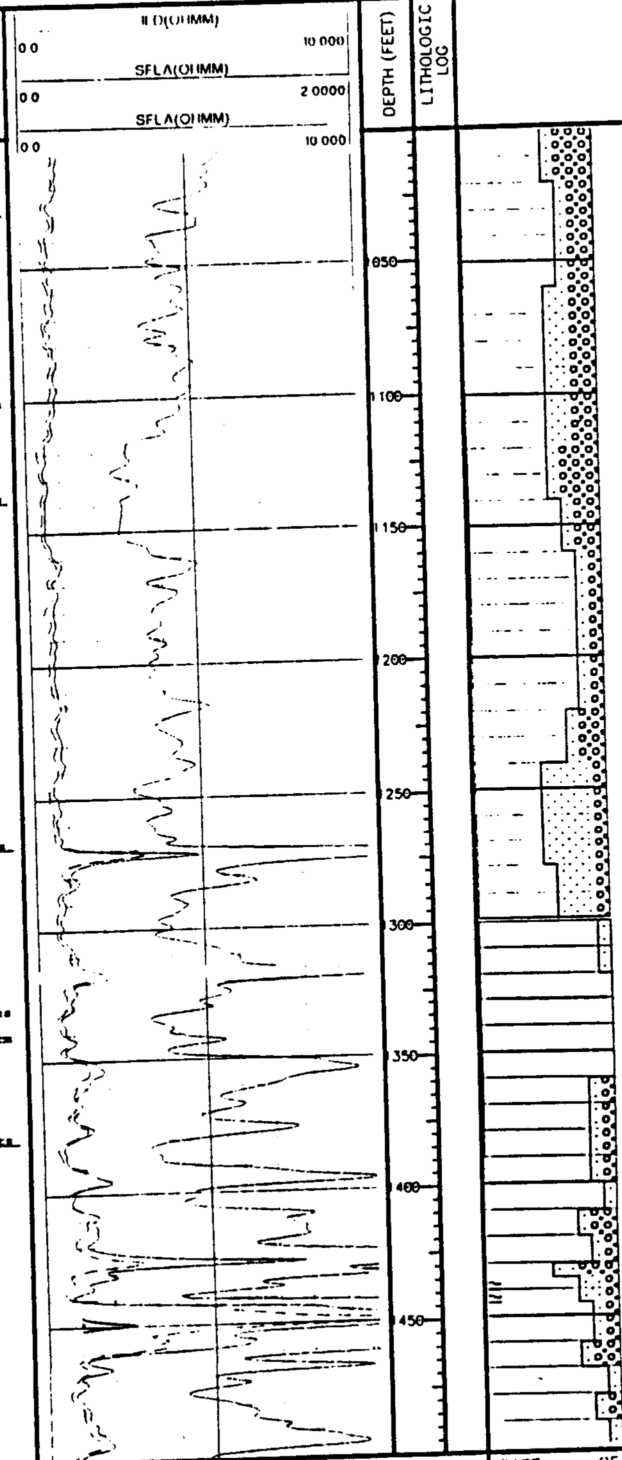
Constituents	Results	Units
Calcium	4.6	mg/L
Magnesium	3.2	mg/L
Sodium	4920.	mg/L
Potassium	22.	mg/L
Carbonate	77.0	mg/L
Bicarbonate	1270.	mg/L
Chloride	5100.	mg/L
Sulfate	2080.	mg/L
Nitrate as NO3	None Detected	mg/L
Fluoride	12.6	mg/L
Bromide	5.6	mg/L
pH	8.2	pH Units
Electrical Conductivity @ 25 C	24000.	umhos/cm
Total Dissolved Solids @ 180 C	12500.	mg/L
Ammonia as NH3	11.4	mg/L
Nitrite Nitrogen	None Detected	mg/L
Ortho-phosphate	0.44	mg/L

Constituents	Results	Units
Aluminum	741.	µg/L
Antimony	None Detected	µg/L
Arsenic	57.	µg/L
Boron	60.6	mg/L
Copper	None Detected	µg/L
Lithium	1550.	µg/L
Manganese	36.	µg/L
Mercury	None Detected	µg/L
• Selenium	None Detected	µg/L
Si as SiO2	45.	mg/L
Strontium	3100.	µg/L
Thallium	None Detected	µg/L
Zinc	19.	µg/L
Total Iron	806.	µg/L

Depth: 7,120'-7,140'

Constituents	Results	Units
Calcium	4.6	mg/L
Magnesium	3.2	mg/L
Sodium	3480.	mg/L
Potassium	9.3	mg/L
Carbonate	456.	mg/L
Bicarbonate	2620.	mg/L
Chloride	2460.	mg/L
Sulfate	910.	mg/L
Nitrate as NO3	None Detected	mg/L
Fluoride	24.	mg/L
Bromide	2.9	mg/L
pH	8.9	pH Units
Electrical Conductivity @ 25 C	13500.	umhos/cm
Total Dissolved Solids @ 180 C	8900.	mg/L
Ammonia as NH3	14.6	mg/L
Nitrite Nitrogen	None Detected	mg/L
Ortho-phosphate	0.24	mg/L

Constituents	Results	Units
Aluminum	1730.	µg/L
Antimony	None Detected	µg/L
Arsenic	80.	µg/L
Boron	52.9	mg/L
Copper	None Detected	µg/L
Lithium	560.	µg/L
Manganese	98.	µg/L
Mercury	None Detected	µg/L
• Selenium	None Detected	µg/L
Si as SiO2	43.	mg/L
Strontium	350.	µg/L
Thallium	None Detected	µg/L
Zinc	46.	µg/L
Total Iron	8960.	µg/L



Clay: med gry, sft, v stky, sthy lstr, smth tex, v calc, abnt blk cong frags, tr chlorite, tr pyr.

Clay: med gry to gn gry, sft to sli frm, v stky, sthy lstr, smth tex, v calc, tr crushed qtz pebbles, tr lithic frags.

Clay: dk gry to blk, sft, stky, sooty lstr, smth tex, v calc, strong hydrocarbon odor.

Sand: clr to fros wht, f to med grn, sbrnd to rnd, w srtd, pred uncons, occ wk slty calc cmt, fri, tr fe stn.

Clay: v dk gry to blk, sft to sli frm, stky, sooty lstr, sm tex, mod to v calc, tr vf gr qtz sd, hydrocarbon odor.

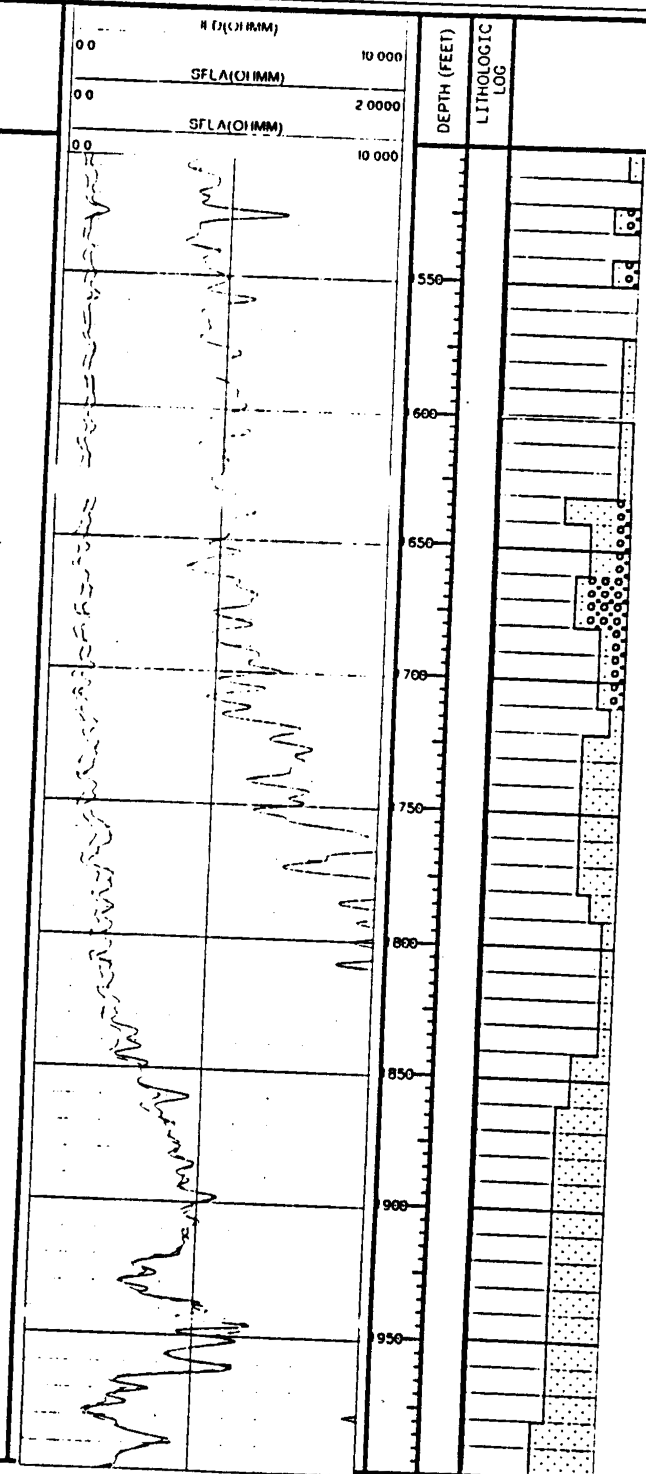
Clay: blk, occ mod dk gry, sft to sli frm, stky, sooty lstr, mod to v calc, hydrocarbon odor, tr crushed qtz pebbles.

Sand: clr to fros wht, vf to f grn, occ med to crs grn, grd to conglomerate, tr gd calc cmt, abnt qtz pebbles, tr lithic pebbles, tr lign.

Clay: dk gry, sft to sli frm, stky, sthy lstr, smth tex, mod to v calc, tr halite, tr crushed qtz pebbles, tr vf gr qtz sd.

USBR Drill Hole Completion and Data Log
(Land Surface to 2,000 Feet)
Geothermal Test Well SNORT #1

FEATURE: Drill Hole Completed with Two "Shallow" Piezometers
PROJECT: Indian Wells Valley Groundwater Project (Navy Geothermal Test Well) — DRILLED DEPTH: 7,394 Ft.
LOCATION: T. 25 S., R.39 E., Sec. 23 — COMPLETED DEPTH: See Notes
TYPE OF WELL: Geothermal Test Well - Naval Air Warfare Station, Geothermal Office — STATE: CA — BEGUN: 9-8-91
PURPOSE: Temperature Gradient, Lithology, Groundwater Quality, Piezometric Level — FINISHED: 9-30-91
COORDINATES: — GROUND ELEVATION:
HOLE LOGGED BY: Norm Wycoff and Doug Hosto — TOP OF CASING ELEV.:
GEOPHYSICAL LOGS: Dual Induction (ILD, SFLA, CILD), Spontaneous Potential, Natural Gamma, Temperature — DEPTH TO WATER (DATE): See Notes
LAB ANALYSIS: Yes, See Notes
OTHER LOGS: Drillling Time — TDS: See Notes
REVIEWED BY:

NOTES		
		

Clay: dk gry to lt gry, sli sft to v frm, stky to gmmy, sthy lstr, smth tex, mod to v calc, tr halite, tr vf qtz sd, tr crushed qtz pebbles, tr lithic frags.

Clay: blk to blue blk, sft to sli frm, stky, sooty lstr, smth tex, v calc, tr vf grn qtz sd.

Sand: clr to sl fros, crs to m gr, sbang to sbrnd gr, intbd w/ gy sol cly, tr pyr.

Clay: lt tan to dk gy, fri to firm, occ soft, calc, + mica in prt, tr pyr in dk slty frags.

Carbide Lag @ 1836ft: 15.87 Min, 107 SPM, 36 Vis, 5X over Calc Lag.

Sandstone: wh to clr, occ gn, fri to firm, clr to fros qtz gr, vf to m gr, sbrnd, m well srtd, abnt calc cmt, mica in vf sand mtx.

APPENDIX VIII

Water Quality Analyses

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 03/18/91 Sample ID No.911862
Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO
Signature Lab Director: C. Jolly
Name of Sampler: GAIL MOULTON Employed By: NAC 615'-635'
Date/Time Sample Collected: 91/03/02/0900 Date/Time Sample Received @ Lab: 91/03/02/0900 Date Analyses Completed: 91/03/18

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE System Number: 36-042
Name or Number of Sample Source: BOR #1

* Water Type: (G/S) |S| Station Number: 036/042-BOR#1
* Date/Time of Sample: |91|03|02|0900| (YY MM DD HHMM) User ID: TAN
* Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|18| (YY MM DD)
* Submitted by:________ Phone #:________

Place an 'X' in box to delete all data for this station/date/time. |_|

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	22.4		
mg/L	Calcium (Ca)	00916	6.4		
mg/L	Magnesium (Mg)	00927	1.6		30.0
mg/L	Sodium (NA)	00929	79.2		
mg/L	Potassium (K)	00937	3.5		
Total Cations	Meq/L Value: 4.0				
mg/L	Total Alkalinity (AS CaCO3)	00410	124.8		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	152.3		
mg/L*	Sulfate (SO4)	00945	27.9		
mg/L*	Chloride (Cl)	00940	17.1		
mg/L	Nitrate (as NO3)	71850	9.8	45	
mg/L	Fluoride (F) Temp. Depend.	00951	1.4	****	0.1
Total Anions	Meq/L Value: 3.8				
Std. Units	PH (Laboratory)	00403	8.7		
umho/cm**	Specific Conductance (E.C.)	00095	380.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	212.8		
Units	Apparent Color (Unfiltered)	00081	> 70		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	170.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

BR-1 Shallow

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	< 100	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	< 30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	< 100	1000	100
	ORGANIC CHEMICALS				
ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	
	ADDITIONAL ANALYSES				
NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.05
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

Clinical Laboratory of San Bernardino, Inc.

1595 N. "D" St., San Bernardino, CA 92405
Phone (714) 885-3216
P. O. Box 329
San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report:	Lab Sample ID No. 91-1862
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: C. Jolliff
Name of Sampler: Gail Moulton	Sampler Employed By: North American Chemical Co.
Date/Time Sample Collected: 91/03/02 09:00	Date/Time Sample Received @ Lab: 91/03/14 — Were Holding Times Observed: Yes
System Name: North American Chemical Co.	System Number:
Description of Sampling Point:	
Name/No. of Sample Source: 615 - 635 I.W.V. Test Well #2 Bor #1	Station Number:
Date & of Time Sample: 9 1 0 3 0 2 0 9 0 0 (Y Y M M D D T T T T)	Water Type: (G/S) — User ID: — Submitted to SWQIS By:

MCL REPORTING UNITS		CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	910318 (YYMMDD)
5	pC/l	Total Alpha		1501	3.6
	PC/l	Total Alpha Counting Error		1502	1.6
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

BR-1 Shallow

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 03/18/91 Sample ID No, 911863

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: C. Jolliff

Name of Sampler: GAIL MOULTON Employed By: NAC 1040'-1060'

Date/Time Sample Collected: 91/03/02/0900 Date/Time Sample Received @ Lab: 91/03/02/0900 Date Analyses Completed: 91/03/18

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE System Number: 36-042

Name or Number of Sample Source: BOR #1

* Water Type: (G/S) |S| Station Number: 036/042-BOR#1
* Date/Time of Sample: |91|03|02|0900| (YY MM DD HHMM) User ID: TAN
* Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|18| (YY MM DD)
* Submitted by:__________ Phone #:__________

Place an 'X' in box to delete all data for this station/date/time. | |

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	12.8		
mg/L	Calcium (Ca)	00916	3.2		
mg/L	Magnesium (Mg)	00927	1.2		30.0
mg/L	Sodium (NA)	00929	95.0		
mg/L	Potassium (K)	00937	1.5		
Total Cations	Meq/L Value: 4.4				
mg/L	Total Alkalinity (AS CaCO3)	00410	183.2		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	223.5		
mg/L*	Sulfate (SO4)	00945	16.0		
mg/L*	Chloride (Cl)	00940	9.4		
mg/L	Nitrate (as NO3)	71850	8.7	45	
mg/L	Fluoride (F) Temp. Depend.	00951	0.7	****	0.1
Total Anions	Meq/L Value: 4.4				
Std. Units	PH (Laboratory)	00403	9.1		
umho/cm**	Specific Conductance (E.C.)	00095	420.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	243.6		
Units	Apparent Color (Unfiltered)	00081	20.0		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	61.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

BR-1 Shal Med

911863

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	< 100	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	< 30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	< 100	1000	100

ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.05
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

Clinical Laboratory of San Bernardino, Inc.

1595 N. "D" St., San Bernardino, CA 92405
Phone (714) 885-3216
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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report:	Lab Sample ID No. 91-1863
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: C. Jolliff
Name of Sampler: Gail Moulton	Sampler Employed By: North American Chemical Co.
Date/Time Sample Collected: 91/03/02 09:00	Date/Time Sample Received @ Lab: 91/03/14 — Were Holding Times Observed: Yes
System Name: North American Chemical Co.	System Number:
Description of Sampling Point:	
Name/No. of Sample Source: IWV Test Well #1 BOR #1 1040' - 1060'	Station Number:
Date & of Time Sample: 9 1 0 3 0 2 0 9 0 0 (YYMMDDTTTT) — Water Type: (G/S)	User ID: — Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	910318 (YYMMDD)
5	pC/l	Total Alpha		1501	2.0
	PC/l	Total Alpha Counting Error		1502	1.3
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

CLINICAL LABS/SAN BERNARDINO
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SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 03/18/91 — Sample ID No.911864
Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO — Signature Lab Director: C. Jolliff
Name of Sampler: GAIL MOULTON — Employed By: NAC 1500'-1520'
Date/Time Sample Collected: 91/03/02/0900 — Date/Time Sample Received @ Lab: 91/03/02/0900 — Date Analyses Completed: 91/03/18

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE — System Number: 36-042
Name or Number of Sample Source: BOR #1

Water Type: (G/S) |S| — Station Number: 036/042-BOR#1
Date/Time of Sample: |91|03|02|0900| (YY MM DD HHMM) — User ID: TAN
Analyzing Agency Code: 3761 — Date Analysis Completed: |91|03|18| (YY MM DD)
Submitted by: ______ — Phone #: ______

Place an 'X' in box to delete all data for this station/date/time. |_|

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	72.0		
mg/L	Calcium (Ca)	00916	20.0		
mg/L	Magnesium (Mg)	00927	5.3		30.0
mg/L	Sodium (NA)	00929	110.2		
mg/L	Potassium (K)	00937	7.9		
Total Cations	Meq/L Value: 6.4				
mg/L	Total Alkalinity (AS CaCO3)	00410	248.8		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	303.5		
mg/L*	Sulfate (SO4)	00945	25.3		
mg/L*	Chloride (Cl)	00940	14.3		
mg/L	Nitrate (as NO3)	71850	9.1	45	
mg/L	Fluoride (F) Temp. Depend.	00951	2.3	****	0.1
Total Anions	Meq/L Value: 6.2				
Std. Units	PH (Laboratory)	00403	8.8		
umho/cm**	Specific Conductance (E.C.)	00095	610.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	353.8		
Units	Apparent Color (Unfiltered)	00081	> 70.0		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	> 200.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

BR-1 Deep Med

911864

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	< 100	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	< 30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	150	5000	50
ug/L	Aluminum	01105	< 100	1000	100

ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.C
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.05
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

BR-1 Deep Med

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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: 3/21/91		Lab Sample ID No. 91-1864	
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO		Signature of Lab Director: C. Jolly	
Name of Sampler: Moulton		Sampler Employed By: North American Chemical Co.	
Date/Time Sample Collected: 91/03/02 09:00	Date/Time Sample Received @ Lab: 91/03/14		Were Holding Times Observed: Yes

System Name: North American Chemical Co.			System Number:
Description of Sampling Point:			
Name/No. of Sample Source: IWV Test Well #1 BOR #1 1500' - 1520'		Station Number:	
Date & of Time Sample: 9 1 0 3 0 2 0 9 0 0 (Y Y M M D D T T T T)	Water Type: G/S	User ID:	Submitted to SWQIS By:

MCL REPORTING UNITS		CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
Analyzing Agency				28	3761
Date Analyses Completed				73672	910321 (YYMMDD)
5	pC/l	Total Alpha		1501	19.3
	PC/l	Total Alpha Counting Error		1502	2.0
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

BR-1 Deep Med

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 03/18/91 Sample ID No.911865
Laboratory Signature Lab
Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. Jolley
Name of Sampler:GAIL MOULTON Employed By:NAC 1750'-1770'
Date/Time Sample Collected: 91/03/02/0900 Date/Time Sample Received @ Lab: 91/03/02/0900 Date Analyses Completed: 91/03/18

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE System Number: 36-042
Name or Number of Sample Source: BOR #1

Water Type: (G/S) |S| Station Number: 036/042-BOR#1
Date/Time of Sample: |91|03|02|0900| (YY MM DD HHMM) User ID: TAN

Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|18| (YY MM DD)

Submitted by:__________ Phone #:__________

Place an 'X' in box to delete all data for this station/date/time. |_|

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	32.0		
mg/L	Calcium (Ca)	00916	9.6		
mg/L	Magnesium (Mg)	00927	1.9		30.0
mg/L	Sodium (NA)	00929	107.9		
mg/L	Potassium (K)	00937	4.8		
Total Cations	Meq/L Value: 5.4				
mg/L	Total Alkalinity (AS CaCO3)	00410	218.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	266.0		
mg/L*	Sulfate (SO4)	00945	16.6		
mg/L*	Chloride (Cl)	00940	10.2		
mg/L	Nitrate (as NO3)	71850	7.1	45	
mg/L	Fluoride (F) Temp. Depend.	00951	3.3	****	0.1
Total Anions	Meq/L Value: 5.3				
Std. Units	PH (Laboratory)	00403	8.7		
umho/cm**	Specific Conductance (E.C.)	00095	500.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	285.0		
Units	Apparent Color (Unfiltered)	00081	> 70.0		
TON	Odor Threshold at 60 C	00086	1.0		1.0
NTU	Lab Turbidity	82079	> 200.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

BR-1 Deep

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #		ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	<	10	50	10
ug/L	Barium (Ba)	01007	<	100	1000	100
ug/L	Cadmium (Cd)	01027	<	1	10	1
ug/L	Chromium (Total Cr)	01034	<	10	50	10
ug/L	Copper (Cu)	01042	<	50	1000	50
ug/L	Iron (Fe)	01045	<	100	300	100
ug/L	Lead (Pb)	01051	<	5	50	5
ug/L	Manganese (Mn)	01055	<	30	50	30
ug/L	Mercury (Hg)	71900	<	1	2	1
ug/L	Selenium (Se)	01147	<	5	10	5
ug/L	Silver (Ag)	01077	<	10	50	10
ug/L	Zinc (Zn)	01092		50	5000	50
ug/L	Aluminum	01105	<	100	1000	100

ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390			0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340			4	0.4
ug/L	Methoxychlor	39480			100	10.0
ug/L	Toxaphene	39400			5	0.5
ug/L	2,4-D	39730			100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045			10	

ADDITIONAL ANALYSES

NTU	Field Turbidity	82078				0.1
C	Source Temperature C	00010				
	Langelier Index Source Temp.	71814				
	Langelier Index at 60 C	71813				
Std. Units	Field PH	00400				
	Agressiveness Index	82383				
mg/L	Silica	00955				
mg/L	Phosphate	00650				
mg/L	Iodide	71865				
	Sodium Absorption Ratio	00931				
	Asbestos	81855				
mg/L	Ammonia (NH3-N)	00612				
mg/L	Nitrite Nitrogen (NO2-N)	00615				
mg/L	Nitrate Nitrogen (NO3-N)	00618				1.0
mg/L	Nitrite (N)	00620				
mg/L	Beryllium	01012				
mg/L	Boron	01020				
mg/L	Thallium	01059				
mg/L	Nickel	01067				
mg/L	Antimony	01097				0.05
mg/L	Lithium	01132				
mg/L	Cyanide	01291				

Clinical Laboratory of San Bernardino, Inc.

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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: 3/21/91 | Lab Sample ID No. 91-1865

Laboratory Name: CLINICAL LAB OF SAN BERNARDINO | Signature of Lab Director: C. Jolley

Name of Sampler: Moulton | Sampler Employed By: North American Chemical

Date/Time Sample Collected: 91/03/02 09:00 | Date/Time Sample Received @ Lab: 91/03/14 | Were Holding Times Observed: Yes

System Name: North American Chemical Co. | System Number:

Description of Sampling Point:

Name/No. of Sample Source: IWV Test Well #1 BOR #1 1750' - 1770' | Station Number:

Date & of Time Sample: 9 1 0 3 0 2 0 9 0 0 (Y Y M M D D T T T T) | Water Type: G/S | User ID: | Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	910321 (YYMMDD)
5	pC/l	Total Alpha		1501	5.8
	PC/l	Total Alpha Counting Error		1502	1.2
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

Clinical Laboratory of San Bernardino, Inc. 1048

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San Bernardino, California 92402

Phone (714) 885-3216

TITLE 22 CHEMICAL ANALYSES

G,I,L,97

Date Of Report: 11/09/1990	Lab Sample I.D. Number: 90/C/5174
Laboratory Name: Clinical Laboratory of San Bernardino, Inc.	Signature Lab Director: C. Jolliff
Name of Sampler: MOULTON	Sampler Employed By: Kerr McGee Chemical Corporation
Date/Time Sample Collected: 10/30/1990 16:00	Date / Time Sample Received at Lab.: 10/31/1990
Were Holding Times Observed? Yes	
System Name: Kerr McGee Chemical Corporation	System Number:
Description of Sampling Point:	
Name/Number of Sample Source: BOR WELL 2 MID ZONE	Station Number:
Date and Time of Sample: 9 0 1 0 3 0 1 6 0 0 (Y Y M M D D T T T T)	Water Type: G/S
User I.D.:	Submitted to SWOIS By:

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
		Analyzing Agency (Laboratory)		28	3761
	mg/L	Total Hardness (as CaCO3)		900	22.0
	mg/L	Calcium (Ca)		916	4.0
	mg/L	Magnesium (mg)		927	2.9
	mg/L	Sodium (Na)		929	75.1
	mg/L	Potassium (K)		937	3.2
Total Cations	meg/L	Value: 3.8			

(Cations,Anions) 4.4 % Meq Difference.

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
	mg/L	Total Alkalinity (as CaCO3)		410	118.0
	mg/L	Hydroxide (OH)		71830	<1.0
	mg/L	Carbonate (CO3)		445	<1.0
	mg/L	Bicarbonate (HCO3)		440	144.0
*	mg/L +	Sulfate (SO4)		945	27.6
*	mg/L +	Chloride (Cl)		940	20.8
45	mg/L	Nitrate (NO3)		71850	1.6
1.4 - 2.4	mg/L	Fluoride(F) Temp. Depend.		951	1.4
Total Anions	meg/L	Value: 3.6			

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
	Std UNITS	pH(Laboratory)		403	9.90
**	umho/cm +	Specific Conductance(E.C.)		95	400
***	mg/L +	Total Filterable Residue at 180°C (TDS)		70300	240.0
	UNITS	Apparent Color (Unfiltered)		81	
	TON	Odor Threshold at 60°C		86	
	NTU	Lab Turbidity		82079	
0.5	mg/L +	MBAS		38260	<0.02

* 250-500-600   ** 900-1600-2200   *** 500-1000-1500

DHS 8351(11/86)

BR-2 Medium

SYSTEM NAME AND NUMBER Kerr McGee Chemical Corporation No Entry

90/C/5174

• THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L •

MCL Reporting Units		Constituent	TT	Storet Code	Analyses Results
50	ug/L	Arsenic(As)		1002	17
1000	ug/L	Barium(Ba)		1007	< 100
10	ug/L	Cadmium(Cd)		1027	2
50	ug/L	Chromium(Total Cr)		1034	< 10
1000	ug/L+	Copper(Cu)		1042	< 50
300	ug/L+	Iron(Fe)		1045	1610
50	ug/L	Lead(Pb)		1051	11
50	ug/L+	Manganese(Mn)		1055	70
2	ug/L	Mercury(Hg)		71900	< 1
10	ug/L	Selenium(Se)		1147	< 5
50	ug/L	Silver(Ag)		1077	< 10
5000	ug/L	Zinc(Zn)		1092	100

ORGANIC CHEMICALS

0.2	ug/L	Endrin		39390	
4	ug/L	Lindane		39340	
100	ug/L	Methoxychlor		39480	
5	ug/L	Toxaphene		39400	
100	ug/L	2,4-D		39730	
10	ug/L	2,4,5-TP Silvex		39045	
Date ORGANIC Analysis Completed				73672	
					Y Y M M D D

ADDITIONAL ANALYSES

	NTU	Field Turbidity		82078	
	C	Source Temperture		10	36.1
		Langlier Index Source Temp.		71814	1.37
		Langelier Index at 60°C		71813	1.74
	Std. Units	Field pH		00400	9.90
		Aggressive Index		82383	13.0
	mg/L	Silica		00955	
	mg/L	Phosphate		00650	
		DISSOLVED ALUMINUM			0.79

RADIOLOGICAL

5	pC/L	Gross Alpha		1501	
	pC/L	Counting Error 95%		1502	
50	pC/L	Gross Beta		3501	
	pC/L	Counting Error 95%		3502	

+ indicates Secondary Drinking Water Standards

BR-2 Medium

Clinical Laboratory of San Bernardino, Inc.

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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: NOV 0 8 1990	Lab Sample I.D No. 90/C/5174
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: C. Jolliff
Name of Sampler: Moulton	Sampler Employed By: Kerr Mc Gee Chemical Corp.

Date/Time Sample Collected: 10/30/90 15:00	Date/Time Sample Received @ Lab: 10/31/90	Were Holding Times Observed: Yes

System Name: Kerr McGee Chemical Corporation	System Number:
Description of Sampling Point:	
Name/No. of Sample Source: BOR Well 2. MID ZONE	Station Number:

Date & of Time Sample: 9 0 1 0 3 0 1 5 0 0 (Y Y M M D D T T T T)	Water Type: G/S	User ID:	Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	901107 (YYMMDD)
5	pC/l	Total Alpha		1501	9.2
	PC/l	Total Alpha Counting Error		1502	2.7
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

BR-2 Medium

Clinical Laboratory of San Bernardino, Inc.

1048

Post Office Box 329
1595 North " D " Street
San Bernardino, California 92402

Phone (714) 885-3216

TITLE 22 CHEMICAL ANALYSES

G,I,L 110F

Date Of Report: 11/09/1990	Lab Sample I.D. Number: 90/C/5175	
Laboratory Name: Clinical Laboratory of San Bernardino, Inc.	Signature Lab Director: C. Jolliff	
Name of Sampler: MOULTON	Sampler Employed By: Kerr McGee Chemical Corporation	
Date/Time Sample Collected: 10/30/1990 15:00	Date / Time Sample Received at Lab.: 10/31/1990	Were Holding Times Observed? Yes
System Name: Kerr McGee Chemical Corporation	System Number:	
Description of Sampling Point:		
Name/Number of Sample Source: BOR WELL #2 LOWER ZONR	Station Number:	
Date and Time of Sample: 9 0 1 0 3 0 1 5 0 0 (Y Y M M D D T T T T)	Water Type: G/S	User I.D.:
Submitted to SWQIS By:		

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
		Analyzing Agency (Laboratory)		28	3761
	mg/L	Total Hardness (as CaCO3)		900	42.0
	mg/L	Calcium (Ca)		916	13.1
	mg/L	Magnesium (mg)		927	2.2
	mg/L	Sodium (Na)		929	105.4
	mg/L	Potassium (K)		937	4.5
Total Cations	meq/L	Value: 5.5			

(Cations,Anions) 2.5 % Meq Difference.

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
	mg/L	Total Alkalinity (as CaCO3)		410	86.0
	mg/L	Hydroxide (OH)		71830	<1.0
	mg/L	Carbonate (CO3)		445	<1.0
	mg/L	Bicarbonate (HCO3)		440	104.9
*	mg/L +	Sulfate (SO4)		945	81.3
*	mg/L +	Chloride (Cl)		940	52.0
45	mg/L	Nitrate (NO3)		71850	4.8
1.4 - 2.4	mg/L	Fluoride(F) Temp. Depend.		951	8.4
Total Anions	meq/L	Value: 5.4			

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
	Std UNITS	pH(Laboratory)		403	8.60
**	umho/cm +	Specific Conductance(E.C.)		95	580
***	mg/L +	Total Filterable Residue at 180°C (TDS)		70300	353.8
	UNITS	Apparent Color (Unfiltered)		81	
	TON	Odor Threshold at 60°C		86	
	NTU	Lab Turbidity		82079	
0.5	mg/L +	MBAS		38260	<0.02

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500

DHS 8351(11/86)

BR-2 Deep

SYSTEM NAME AND NUMBER Kerr McGee Chemical Corporation — No Entry

90/C/5175

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
50	ug/L	Arsenic(As)		1002	14
1000	ug/L	Barium(Ba)		1007	<100
10	ug/L	Cadmium(Cd)		1027	<1
50	ug/L	Chromium(Total Cr)		1034	<10
1000	ug/L+	Copper(Cu)		1042	<50
300	ug/L+	Iron(Fe)		1045	1500
50	ug/L	Lead(Pb)		1051	15
50	ug/L+	Manganese(Mn)		1055	250
2	ug/L	Mercury(Hg)		71900	<1
10	ug/L	Selenium(Se)		1147	<5
50	ug/L	Silver(Ag)		1077	<10
5000	ug/L	Zinc(Zn)		1092	90

ORGANIC CHEMICALS

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
0.2	ug/L	Endrin		39390	
4	ug/L	Lindane		39340	
100	ug/L	Methoxychlor		39480	
5	ug/L	Toxaphene		39400	
100	ug/L	2,4-D		39730	
10	ug/L	2,4,5-TP Silvex		39045	
		Date ORGANIC Analysis Completed		73672	Y Y M M D D

ADDITIONAL ANALYSES

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
	NTU	Field Turbidity		82078	
	C	Source Temperture		10	43.3
		Langlier Index Source Temp.		71814	0.54
		Langelier Index at 60°C		71813	0.79
	Std. Units	Field pH		00400	8.60
		Aggressive Index		82383	12.1
	mg/L	Silica		00955	
	mg/L	Phosphate		00650	
		DISSOLVED ALUMINUM			0.26

RADIOLOGICAL

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
5	pC/L	Gross Alpha		1501	
	pC/L	Counting Error 95%		1502	
50	pC/L	Gross Beta		3501	
	pC/L	Counting Error 95%		3502	

\+ Indicates Secondary Drinking Water Standards

BR-2 Deep

Clinical Laboratory of San Bernardino, Inc.

1595 N. "D" St., San Bernardino, CA 92405
Phone (714) 885-3216
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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: NOV 08 1990	Lab Sample ID No. 90/C/5175
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: C. Jolliff
Name of Sampler: Moulton	Sampler Employed By: Kerr McGeee Chemical Corp.

Date/Time Sample Collected: 10/30/90 03:00	Date/Time Sample Received @ Lab: 10/31/90	Were Holding Times Observed: Yes

System Name: Kerr McGeee Chemical Corporation	System Number:
Description of Sampling Point:	
Name/No. of Sample Source: BOR WELL 2 LOWER ZONE	Station Number:

Date & of Time Sample: 9 0 1 0 3 0 0 3 0 0 (Y Y M M D D T T T T)	Water Type: (G/S)	User ID:	Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	901107 (YYMMDD)
5	pC/l	Total Alpha		1501	5.1
	PC/l	Total Alpha Counting Error		1502	1.2
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

BR-2 Deep

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 04/03/91 Sample ID No.912079
Laboratory
Name: CLINICAL LABORATORIES OF SAN BERNARDINO
Signature Lab Director: C. Jolly
Name of Sampler:MOULTON Employed By:NAC ~~1850 1870 FEET~~
Date/Time Sample Collected: 91/03/18/1400 Date/Time Sample Received @ Lab: 91/03/18/1400 Date Analyses Completed: 91/04/03

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE System Number: 36-042
Name or Number of Sample Source: BOR #1 Well 3

- Water Type: (G/S) |S| Station Number: 036/042-BOR#1
- Date/Time of Sample: |91|03|18|1400| (YY MM DD HHMM) User ID: TAN
- Analyzing Agency Code: 3761 Date Analysis Completed: |91|04|03| (YY MM DD)
- Submitted by: ______ Phone #: ______

Place an 'X' in box to delete all data for this station/date/time. |_|

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	96.0		
mg/L	Calcium (Ca)	00916	17.6		
mg/L	Magnesium (Mg)	00927	12.6		30.0
mg/L	Sodium (NA)	00929	91.4		
mg/L	Potassium (K)	00937	5.9		
	Total Cations Meq/L Value: 6.0				
mg/L	Total Alkalinity (AS CaCO3)	00410	132.8		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	162.0		
mg/L*	Sulfate (SO4)	00945	78.5		
mg/L*	Chloride (Cl)	00940	47.3		
mg/L	Nitrate (as NO3)	71850	11.1	45	
mg/L	Fluoride (F) Temp. Depend.	00951	0.5	****	0.1
	Total Anions Meq/L Value: 5.8				
Std. Units	PH (Laboratory)	00403	8.4		
umho/cm**	Specific Conductance (E.C.)	00095	600.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	360.0		
Units	Apparent Color (Unfiltered)	00081	70.0		
TON	Odor Threshold at 60 C	00086	1.0		1.0
NTU	Lab Turbidity	82079	71.0		
mg/L	MBAS	38260	< 0.02	0.5	0.02

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

BR-3 Shallow

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #		ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	<	10	50	10
ug/L	Barium (Ba)	01007	<	100	1000	100
ug/L	Cadmium (Cd)	01027	<	1	10	1
ug/L	Chromium (Total Cr)	01034	<	10	50	10
ug/L	Copper (Cu)	01042	<	50	1000	50
ug/L	Iron (Fe)	01045		4550	300	100
ug/L	Lead (Pb)	01051		130	50	5
ug/L	Manganese (Mn)	01055	<	30	50	30
ug/L	Mercury (Hg)	71900	<	1	2	1
ug/L	Selenium (Se)	01147	<	5	10	5
ug/L	Silver (Ag)	01077	<	10	50	10
ug/L	Zinc (Zn)	01092	<	50	5000	50
ug/L	Aluminum	01105		870	1000	100

ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390			0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340			4	0.4
ug/L	Methoxychlor	39480			100	10.0
ug/L	Toxaphene	39400			5	0.5
ug/L	2,4-D	39730			100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045			10	

ADDITIONAL ANALYSES

NTU	Field Turbidity	82078				0.1
C	Source Temperature C	00010				
	Langelier Index Source Temp.	71814				
	Langelier Index at 60 C	71813				
Std. Units	Field PH	00400				
	Agressiveness Index	82383				
mg/L	Silica	00955				
mg/L	Phosphate	00650				
mg/L	Iodide	71865				
	Sodium Absorption Ratio	00931				
	Asbestos	81855				
mg/L	Ammonia (NH3-N)	00612				
mg/L	Nitrite Nitrogen (NO2-N)	00615				
mg/L	Nitrate Nitrogen (NO3-N)	00618				1.0
mg/L	Nitrite (N)	00620				
mg/L	Beryllium	01012				
mg/L	Boron	01020				
mg/L	Thallium	01059				
mg/L	Nickel	01067				
mg/L	Antimony	01097				0.05
mg/L	Lithium	01132				
mg/L	Cyanide	01291				

Clinical Laboratory of San Bernardino, Inc.

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Phone (714) 885-3216
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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: 4/3/91	Lab Sample ID No. 91-2079
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: Mehdi [signature]
Name of Sampler: Moulton	Sampler Employed By: North American Chemical

Date/Time Sample Collected: 91/03/18 11:00	Date/Time Sample Received @ Lab: 91/03/18	Were Holding Times Observed: Yes

System Name: North American Chemical | System Number:

Description of Sampling Point:

Name/No. of Sample Source: BOR WELL 3 IWV Study ~~1850 1870~~ | Station Number:

Date & of Time Sample: Y Y M M D D T T T T | Water Type: G/S | User ID: | Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	910402 (YYMMDD)
5	pC/l	Total Alpha		1501	1.8
	PC/l	Total Alpha Counting Error		1502	1.5
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

BR-3 Shallow

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 04/03/91 — Sample ID No.912080

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO — Signature Lab Director: C. Jolliff

Name of Sampler: MOULTON — Employed By: NAC ~~650 670 FEET~~

Date/Time Sample Collected: 91/03/18/1000 — Date/Time Sample Received @ Lab: 91/03/18/1000 — Date Analyses Completed: 91/04/03

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE — System Number: 36-042

Name or Number of Sample Source: BOR #1 Well 3

* Water Type: (G/S) |S| — Station Number: 036/042-BOR#1
* Date/Time of Sample: |91|03|18|1000| (YY MM DD HHMM) — User ID: TAN
* Analyzing Agency Code: 3761 — Date Analysis Completed: |91|04|03| (YY MM DD)
* Submitted by: ____________ Phone #: ____________

Place an 'X' in box to delete all data for this station/date/time. [ ]

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	128.0		
mg/L	Calcium (Ca)	00916	38.4		
mg/L	Magnesium (Mg)	00927	7.8		30.0
mg/L	Sodium (NA)	00929	255.9		
mg/L	Potassium (K)	00937	7.9		
Total Cations	Meq/L Value: 13.9				
mg/L	Total Alkalinity (AS CaCO3)	00410	113.2		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	138.1		
mg/L*	Sulfate (SO4)	00945	65.6		
mg/L*	Chloride (Cl)	00940	372.0		
mg/L	Nitrate (as NO3)	71850	< 1.0	45	
mg/L	Fluoride (F) Temp. Depend.	00951	1.1	****	0.1
Total Anions	Meq/L Value: 14.2				
Std. Units	PH (Laboratory)	00403	7.4		
umho/cm**	Specific Conductance (E.C.)	00095	1540.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	954.8		
Units	Apparent Color (Unfiltered)	00081	70.0		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	5.9		
mg/L	MBAS	38260	< 0.02	0.5	0.02

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

BR-3 Medium

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	120	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	2290	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	100	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	1550	1000	100

ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.05
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

Clinical Laboratory of San Bernardino, Inc.

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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: 4/3/91
Lab Sample ID No. 91-2080
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO
Signature of Lab Director: Mehdi [signature]
Name of Sampler: Moulton
Sampler Employed By: North American Chemical
Date/Time Sample Collected: 91/03/18 10:00
Date/Time Sample Received @ Lab: 91/03/18
Were Holding Times Observed: Yes
System Name: North American Chemical
System Number:
Description of Sampling Point:
Name/No. of Sample Source: BOR WELL 3 IWV Study ~~650 670~~
Station Number:
Date & of Time Sample: Y Y M M D D T T T T
Water Type: G/S
User ID:
Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	910402 (YYMMDD)
5	pC/l	Total Alpha		1501	0.7
	PC/l	Total Alpha Counting Error		1502	1.6
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

BR-3 Medium

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 04/04/91 Sample ID No.912078
Laboratory Signature Lab
Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. Jolly
Name of Sampler:MOULTON Employed By:NAC ~~1320 1340~~
Date/Time Sample Collected: 91/03/18/1400 Date/Time Sample Received @ Lab: 91/03/18/1400 Date Analyses Completed: 91/04/04

==

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE System Number: 36-042
Name or Number of Sample Source: BOR #1 Well 3

****

* Water Type: (G/S) |S| Station Number: 036/042-BOR#1 *
* Date/Time of Sample: |91|03|18|1400| User ID: TAN *
* YY MM DD HHMM *
*
* Analyzing Agency Code: 3761 Date Analysis Completed: |91|04|04| *
* YY MM DD *
* Submitted by:______________________ Phone #:__________________ *

****

Place an 'X' in box to delete all data for this station/date/time. |_|

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	1400.0		
mg/L	Calcium (Ca)	00916	496.6		
mg/L	Magnesium (Mg)	00927	38.9		30.(
mg/L	Sodium (NA)	00929	1536.4		
mg/L	Potassium (K)	00937	14.6		
Total Cations	Meq/L Value: 95.2				
mg/L	Total Alkalinity (AS CaCO3)	00410	32.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	39.0		
mg/L*	Sulfate (SO4)	00945	257.5		
mg/L*	Chloride (Cl)	00940	3200.0		
mg/L	Nitrate (as NO3)	71850	38.1	45	
mg/L	Fluoride (F) Temp. Depend.	00951	5.4	****	0.:
Total Anions	Meq/L Value: 97.0				
Std. Units	PH (Laboratory)	00403	7.2		
umho/cm**	Specific Conductance (E.C.)	00095	10700.		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	6634.0		
Units	Apparent Color (Unfiltered)	00081	40.0		
TON	Odor Threshold at 60 C	00086	3.0		1.(
NTU	Lab Turbidity	82079	71.0		
mg/L	MBAS	38260	< 0.02	0.5	0.0:

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

BR-3 Deep

912078

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	< 10	50	10
ug/L	Barium (Ba)	01007	100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	780	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	280	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	< 5	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	240	1000	100

ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	

ADDITIONAL ANALYSES

NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.0
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0.05
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

Clinical Laboratory of San Bernardino, Inc.

Post Office Box 329
1595 North " D " Street
San Bernardino, California 92402

Phone (714) 885-3216

TITLE 22 CHEMICAL ANALYSES

G,I,L 90F

Date Of Report: 11/09/1990	Lab Sample I.D. Number: 90/C/5176
Laboratory Name: Clinical Laboratory of San Bernardino, Inc.	Signature Lab Director: C. Jolliff
Name of Sampler: MOULTON	Sampler Employed By: Kerr McGee Chemical Corporation

Date/Time Sample Collected: 10/30/1990 12:30	Date / Time Sample Received at Lab.: 10/31/1990	Were Holding Times Observed? Yes

System Name: Kerr McGee Chemical Corporation	System Number:

Description of Sampling Point:

Name/Number of Sample Source: BOR WELL 4 SEC 25 T26S R39E	Station Number:

Date and Time of Sample (YYMMDDTTTT)	Water Type (G/S)	User I.D.	Submitted to SWQIS By
9 0 1 0 3 0 1 2 3 0			

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
		Analyzing Agency (Laboratory)		28	3761
	mg/L	Total Hardness (as CaCO3)		900	9.6
	mg/L	Calcium (Ca)		916	1.3
	mg/L	Magnesium (mg)		927	1.6
	mg/L	Sodium (Na)		929	65.3
	mg/L	Potassium (K)		937	0.4
Total Cations	meq/L	Value: 3.0			

(Cations,Anions) 3.7 % Meq Difference.

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
	mg/L	Total Alkalinity (as CaCO3)		410	112.0
	mg/L	Hydroxide (OH)		71830	< 1.0
	mg/L	Carbonate (CO3)		445	< 1.0
	mg/L	Bicarbonate (HCO3)		440	136.6
*	mg/L +	Sulfate (SO4)		945	19.1
*	mg/L +	Chloride (Cl)		940	15.9
45	mg/L	Nitrate (NO3)		71850	< 1.0
1.4 - 2.4	mg/L	Fluoride(F) Temp. Depend.		951	1.1
Total Anions	meq/L	Value: 3.2			

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
	Std UNITS	pH(Laboratory)		403	8.80
**	umho/cm +	Specific Conductance(E.C.)		95	310
***	mg/L +	Total Filterable Residue at 180°C (TDS)		70300	182.9
	UNITS	Apparent Color (Unfiltered)		81	
	TON	Odor Threshold at 60°C		86	
	NTU	Lab Turbidity		82079	
0.5	mg/L +	MBAS		38260	< 0.02

* 250-500-600   ** 900-1600-2200   *** 500-1000-1500

DHS 8351(11/86)

SYSTEM NAME AND NUMBER Kerr McGee Chemical Corporation — No Entry

90/C/5176

*** THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L ***

MCL	Reporting Units	Constituent	TT	Storet Code	Analyses Results
50	ug/L	Arsenic(As)		1002	15
1000	ug/L	Barium(Ba)		1007	<100
10	ug/L	Cadmium(Cd)		1027	<1
50	ug/L	Chromium(Total Cr)		1034	<10
1000	ug/L+	Copper(Cu)		1042	<50
300	ug/L+	Iron(Fe)		1045	360
50	ug/L	Lead(Pb)		1051	<2
50	ug/L+	Manganese(Mn)		1055	<30
2	ug/L	Mercury(Hg)		71900	<1
10	ug/L	Selenium(Se)		1147	<5
50	ug/L	Silver(Ag)		1077	<10
5000	ug/L	Zinc(Zn)		1092	70

ORGANIC CHEMICALS

0.2	ug/L	Endrin		39390	
4	ug/L	Lindane		39340	
100	ug/L	Methoxychlor		39480	
5	ug/L	Toxaphene		39400	
100	ug/L	2,4-D		39730	
10	ug/L	2,4,5-TP Silvex		39045	
		Date ORGANIC Analysis Completed		73672	(Y Y M M D D)

ADDITIONAL ANALYSES

NTU	Field Turbidity		82078	
C	Source Temperture		10	32.2
	Langlier Index Source Temp.		71814	7.49
	Langelier Index at 60°C		71813	7.93
Std. Units	Field pH		00400	8.80
	Aggressive Index		82383	11.4
mg/L	Silica		00955	
mg/L	Phosphate		00650	
	DISSOLVED ALUMINUM			0.49

RADIOLOGICAL

5	pC/L	Gross Alpha		1501	
	pC/L	Counting Error 95%		1502	
50	pC/L	Gross Beta		3501	
	pC/L	Counting Error 95%		3502	

\+ Indicates Secondary Drinking Water Standards

Clinical Laboratory of San Bernardino, Inc.

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Phone (714) 885-3216
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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: NOV 08 1990	Lab Sample ID No. 90/C/5176
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: C. Jolly
Name of Sampler: Moulton	Sampler Employed By: Kerr McGee Chemical Corp.

Date/Time Sample Collected: 10/30/90 12:30	Date/Time Sample Received @ Lab: 10/31/90	Were Holding Times Observed: Yes

System Name: Kerr McGee Chemical Corporation	System Number:
Description of Sampling Point:	
Name/No. of Sample Source: BOR WELL Wec.25 T26S R39E	Station Number:

Date & of Time Sample: 9 0 1 0 3 0 1 2 3 0 (Y Y M M D D T T T T)	Water Type: (G/S)	User ID:	Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	901107 (YYMMDD)
5	pC/l	Total Alpha		1501	0.8
	PC/l	Total Alpha Counting Error		1502	0.7
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

Clinical Laboratory of San Bernardino, Inc.

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RADIOACTIVITY ANALYSES

Date of Report: 4/3/91	Lab Sample ID No. 91-2078
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: Mehdi Graini
Name of Sampler: Moulton	Sampler Employed By: North American Chemical

Date/Time Sample Collected: 91/03/18 14:00	Date/Time Sample Received @ Lab: 91/03/18	Were Holding Times Observed: Yes

System Name: North American Chemical	System Number:
Description of Sampling Point:	
Name/No. of Sample Source: IWV Study BOR WELL 3 1320 - 1340	Station Number:

Date & of Time Sample: Y Y M M D D T T T T	Water Type: G/S	User ID:	Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	910402 (YYMMDD)
5	pC/l	Total Alpha		1501	11.4
	PC/l	Total Alpha Counting Error		1502	7.2
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

BR-3 Deep

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 01/15/92 Sample ID No. 92-0122

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: [signature]

Name of Sampler: M. STONER Employed By: U.S. NAVY

Date/Time Sample Collected: 92/01/06/1000 Date/Time Sample Received @ Lab: 92/01/08/1700 Date Analyses Completed: 92/01/14

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: IWV MONITORING WELL #5 840' TO 860'

User ID: CYA Station Number:

Date/Time of Sample: |92|01|06|1000| (YY MM DD TTTT) Laboratory Code: 3761

Date Analysis Completed: |92|01|14| (YY MM DD)

Submitted by: ____ Phone #: ____

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	128.0	
	mg/L	Calcium (Ca)	00916	20.8	
	mg/L	Magnesium (Mg)	00927	18.5	
	mg/L	Sodium (Na)	00929	154.6	
	mg/L	Potassium (K)	00937	9.4	
Total Cations		Meq/L Value: 9.5			
	mg/L	Total Alkalinity (AS CaCO3)	00410	186.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	226.9	
*	mg/L*	Sulfate (SO4)	00945	149.6	
*	mg/L*	Chloride (Cl)	00940	85.5	
45	mg/L	Nitrate (as NO3)	71850	< 1.0	
****	mg/L	Fluoride (F) Temp. Depend.	00951	1.1	0.1
Total Anions		Meq/L Value: 9.3			
	Std. Units	PH (Laboratory)	00403	8.5	
**	umho/cm**	Specific Conductance (E.C.)	00095	1000.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	533.5	
	Units	Apparent Color (Unfiltered)	00081	< 70.0	
	TON	Odor Threshold at 60 C	00086	2.0	
	NTU	Lab Turbidity	82079	58.0	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

BR-5 Shallow

INORGANIC CHEMICALS

92-0122

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	210.00	100.0
50	ug/L	Arsenic (As)	01002	17.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	2655.0	100.0
50	ug/L	Lead (Pb)	01051	11.00	5.0
50	ug/L	Manganese (Mn)	01055	175.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

RADIOACTIVITY ANALYSIS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

BR-5 Shallow

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

RADIOACTIVITY ANALYSIS

Date of Report: 01/17/92 Sample ID No. 92-0122
Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO
Signature Lab Director: [signature]
Name of Sampler: M. STONER Employed By: INDIAN WELLS VALEY CWD
Date/Time Sample Collected: 92/01/06/1000 Date/Time Sample Received @ Lab: 92/01/08/1700 Date Analyses Completed: 92/01/17

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017
Name or Number of Sample Source: IWV MONITORING WELL #5 840' TO 860'

* User ID: CYA Station Number:
* Date/Time of Sample: |92|01|06|1000| (YY MM DD TTTT) Laboratory Code: 3761
* Date Analysis Completed: |92|01|17| (YY MM DD)
* Submitted by: ______ Phone #: ______

MCL REPORT UNITS		CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15	pCi/l	Total Alpha	01501	4.0	
	pCi/l	Total Alpha Counting Error	01502	2.4	
50	pCi/l	Total Beta	03501		4.0
	pCi/l	Total Beta Counting Error	03502		
20	pCi/l	Natural Uranium	28012		2.0
	pCi/l	Total Radium 226	09501		.5
	pCi/l	Total Radium 226 Counting Error	09502		
	pCi/l	Total Radium 228	11501		.5
	pCi/l	Total Radium 228 Counting Error	11502		
5	pCi/l	Ra 226 + Ra 228	11503		
	pCi/l	Ra 226 + Ra 228 Counting Error	11504		
20000	pCi/l	Total Tritium	07000		1.0
	pCi/l	Total Tritium Counting Error	07001		
8	pCi/l	Total Strontium - 90	13501		2.0
	pCi/l	Total Strontium - 90 Counting Error	13502		
	pCi/l	Total Radon 222	82303		100.0
	pCi/l	Total Radon 222 Counting Error	82302		

BR-5 Shallow

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 01/15/92 Sample ID No.92-0123

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: [signature]

Name of Sampler:M. STONEREmployed By:U.S. NAVY

Date/Time Sample Collected: 92/01/06/1000 Date/Time Sample Received @ Lab: 92/01/08/1700 Date Analyses Completed: 92/01/14

===

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: IWV MONITORING WELL #5 1580' - 1600'

****

* User ID: CYA Station Number: *
* Date/Time of Sample: |92|01|06|1000| Laboratory Code: 3761 *
* YY MM DD TTTT *
* Date Analysis Completed: |92|01|14| *
* YY MM DD *
* Submitted by:__________ Phone #:__________ *

****

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	80.0	
	mg/L	Calcium (Ca)	00916	20.8	
	mg/L	Magnesium (Mg)	00927	6.8	
	mg/L	Sodium (Na)	00929	346.0	
	mg/L	Potassium (K)	00937	9.0	
Total Cations		Meq/L Value: 16.9			
	mg/L	Total Alkalinity (AS CaCO3)	00410	626.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	763.7	
*	mg/L*	Sulfate (SO4)	00945	65.5	
*	mg/L*	Chloride (Cl)	00940	72.7	
45	mg/L	Nitrate (as NO3)	71850	< 1.0	
****	mg/L	Fluoride (F) Temp. Depend.	00951	2.1	0.1
Total Anions		Meq/L Value: 16.0			
	Std. Units	PH (Laboratory)	00403	8.7	
**	umho/cm**	Specific Conductance (E.C.)	00095	1880.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	836.9	
	Units	Apparent Color (Unfiltered)	00081	> 70.0	
	TON	Odor Threshold at 60 C	00086	1.0	
	NTU	Lab Turbidity	82079	> 200.0	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

BR-5 Medium

INORGANIC CHEMICALS

92-0123

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	460.00	100.0
50	ug/L	Arsenic (As)	01002	80.00	10.0
1000	ug/L	Barium (Ba)	01007	170.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	1520.0	100.0
50	ug/L	Lead (Pb)	01051	6.00	5.0
50	ug/L	Manganese (Mn)	01055	165.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

RADIOACTIVITY ANALYSIS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

RADIOACTIVITY ANALYSIS

Date of Report: 01/17/92 Sample ID No.92-0123
Laboratory Signature Lab
Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: [signature]
Name of Sampler:M. STONEREmployed By:INDIAN WELLS VALEY CWD
Date/Time Sample Collected: 92/01/06/1000 Date/Time Sample Received @ Lab: 92/01/08/1700 Date Analyses Completed: 92/01/17

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017
Name or Number of Sample Source: IWV MONITORING WELL #5 1580' - 1600'

User ID: CYA Station Number:
Date/Time of Sample: |92|01|06|1000| (YY MM DD TTTT) Laboratory Code: 3761
Date Analysis Completed: |92|01|17| (YY MM DD)
Submitted by: ______ Phone #: ______

MCL	REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15	pCi/l	Total Alpha	01501	9.8	
	pCi/l	Total Alpha Counting Error	01502	2.3	
50	pCi/l	Total Beta	03501		4.0
	pCi/l	Total Beta Counting Error	03502		
20	pCi/l	Natural Uranium	28012		2.0
	pCi/l	Total Radium 226	09501		.5
	pCi/l	Total Radium 226 Counting Error	09502		
	pCi/l	Total Radium 228	11501		.5
	pCi/l	Total Radium 228 Counting Error	11502		
5	pCi/l	Ra 226 + Ra 228	11503		
	pCi/l	Ra 226 + Ra 228 Counting Error	11504		
20000	pCi/l	Total Tritium	07000		1.0
	pCi/l	Total Tritium Counting Error	07001		
8	pCi/l	Total Strontium - 90	13501		2.0
	pCi/l	Total Strontium - 90 Counting Error	13502		
	pCi/l	Total Radon 222	82303		100.0
	pCi/l	Total Radon 222 Counting Error	82302		

BR-5 Medium

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 01/15/92 Sample ID No.92-0124

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: [signature]

Name of Sampler:M. STONEREmployed By:U.S. NAVY

Date/Time Sample Collected: 92/01/06/1000 Date/Time Sample Received @ Lab: 92/01/08/1700 Date Analyses Completed: 92/01/14

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: IWY MONITORING WELL #5 1970' - 1990'

User ID: CYA Station Number:

Date/Time of Sample: |92|01|06|1000| (YY MM DD TTTT) Laboratory Code: 3761

Date Analysis Completed: |92|01|14| (YY MM DD)

Submitted by:________ Phone #:________

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	108.0	
	mg/L	Calcium (Ca)	00916	14.4	
	mg/L	Magnesium (Mg)	00927	17.5	
	mg/L	Sodium (Na)	00929	334.9	
	mg/L	Potassium (K)	00937	8.7	
Total Cations		Meq/L Value: 16.9			
	mg/L	Total Alkalinity (AS CaCO3)	00410	708.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	863.8	
*	mg/L*	Sulfate (SO4)	00945	90.0	
*	mg/L*	Chloride (Cl)	00940	68.6	
45	mg/L	Nitrate (as NO3)	71850	< 1.0	
****	mg/L	Fluoride (F) Temp. Depend.	00951	1.5	0.1
Total Anions		Meq/L Value: 18.0			
	Std. Units	PH (Laboratory)	00403	8.7	
**	umho/cm**	Specific Conductance (E.C.)	00095	1870.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	890.6	
	Units	Apparent Color (Unfiltered)	00081	> 70.0	
	TON	Odor Threshold at 60 C	00086	1.0	
	NTU	Lab Turbidity	82079	> 200.0	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

BR-5 Deep

INORGANIC CHEMICALS

92-0124

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	260.00	100.0
50	ug/L	Arsenic (As)	01002	25.00	10.0
1000	ug/L	Barium (Ba)	01007	200.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	1165.0	100.0
50	ug/L	Lead (Pb)	01051	11.00	5.0
50	ug/L	Manganese (Mn)	01055	175.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

RADIOACTIVITY ANALYSIS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

RADIOACTIVITY ANALYSIS

Date of Report: 01/17/92 Sample ID No.92-0124
Laboratory Signature Lab
Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director:
Name of Sampler:M. STONEREmployed By:INDIAN WELLS VALEY CWD
Date/Time Sample Collected: 92/01/06/1000 Date/Time Sample Received @ Lab: 92/01/08/1700 Date Analyses Completed: 92/01/17

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017
Name or Number of Sample Source: IWY MONITORING WELL #5 1970' - 1990'

* User ID: CYA Station Number:
* Date/Time of Sample: |92|01|06|1000| Laboratory Code: 3761
YY MM DD TTTT
Date Analysis Completed: |92|01|17|
YY MM DD
* Submitted by:______________ Phone #:______________

MCL	REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15	pCi/l	Total Alpha	01501	14.0	
	pCi/l	Total Alpha Counting Error	01502	3.7	
50	pCi/l	Total Beta	03501		4.0
	pCi/l	Total Beta Counting Error	03502		
20	pCi/l	Natural Uranium	28012		2.0
	pCi/l	Total Radium 226	09501		.5
	pCi/l	Total Radium 226 Counting Error	09502		
	pCi/l	Total Radium 228	11501		.5
	pCi/l	Total Radium 228 Counting Error	11502		
5	pCi/l	Ra 226 + Ra 228	11503		
	pCi/l	Ra 226 + Ra 228 Counting Error	11504		
20000	pCi/l	Total Tritium	07000		1.0
	pCi/l	Total Tritium Counting Error	07001		
8	pCi/l	Total Strontium - 90	13501		2.0
	pCi/l	Total Strontium - 90 Counting Error	13502		
	pCi/l	Total Radon 222	82303		100.0
	pCi/l	Total Radon 222 Counting Error	82302		

BR-5 Deep

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 02/06/92 Sample ID No.92-0736

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: [signature]

Name of Sampler:UNKNOWNEmployed By:UNKNOWN

Date/Time Sample Collected: 92/01/10/0000 Date/Time Sample Received @ Lab: 92/01/29/1700 Date Analyses Completed: 92/02/05

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System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: BOR WELL 6 330 - 350

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* User ID: CYA Station Number: *
* Date/Time of Sample: |92|01|10|0000| Laboratory Code: 3761 *
* YY MM DD TTTT *
* Date Analysis Completed: |92|02|05| *
* YY MM DD *
* Submitted by:______________________ Phone #:________________ *
****

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	100.0	
	mg/L	Calcium (Ca)	00916	24.0	
	mg/L	Magnesium (Mg)	00927	9.7	
	mg/L	Sodium (Na)	00929	198.7	
	mg/L	Potassium (K)	00937	13.9	
Total Cations	Meq/L	Value: 11.0			
	mg/L	Total Alkalinity (AS CaCO3)	00410	192.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	234.2	
*	mg/L*	Sulfate (SO4)	00945	168.0	
*	mg/L*	Chloride (Cl)	00940	76.0	
45	mg/L	Nitrate (as NO3)	71850	6.3	
****	mg/L	Fluoride (F) Temp. Depend.	00951	3.7	0.1
Total Anions	Meq/L	Value: 9.8			
	Std. Units	PH (Laboratory)	00403	8.9	
**	umho/cm**	Specific Conductance (E.C.)	00095	1030.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	596.3	
	Units	Apparent Color (Unfiltered)	00081	15.0	
	TON	Odor Threshold at 60 C	00086	2.0	
	NTU	Lab Turbidity	82079	180.0	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

BR-6 Shallow

INORGANIC CHEMICALS

92-0736

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	1605.0	100.0
50	ug/L	Arsenic (As)	01002	195.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	12300.	100.0
50	ug/L	Lead (Pb)	01051	7.00	5.0
50	ug/L	Manganese (Mn)	01055	510.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	90.00	50.0

RADIOACTIVITY ANALYSIS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

BR-6 Shallow

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 02/06/92 Sample ID No.92-0734

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: [signature]

Name of Sampler:UNKNOWN Employed By:UNKNOWN

Date/Time Sample Collected: 92/01/10/0000 Date/Time Sample Received @ Lab: 92/01/29/1700 Date Analyses Completed: 92/02/05

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System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: BOR WELL 6 1190- 1210

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* User ID: CYA Station Number: *
* Date/Time of Sample: |92|01|10|0000| Laboratory Code: 3761 *
* YY MM DD TTTT *
* Date Analysis Completed: |92|02|05| *
* YY MM DD *
* Submitted by:______________________ Phone #:______________ *

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MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	80.0	
	mg/L	Calcium (Ca)	00916	4.8	
	mg/L	Magnesium (Mg)	00927	16.5	
	mg/L	Sodium (Na)	00929	188.6	
	mg/L	Potassium (K)	00937	8.6	
Total Cations		Meq/L Value: 10.0			
	mg/L	Total Alkalinity (AS CaCO3)	00410	380.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	463.6	
*	mg/L*	Sulfate (SO4)	00945	34.6	
*	mg/L*	Chloride (Cl)	00940	33.3	
45	mg/L	Nitrate (as NO3)	71850	1.7	
****	mg/L	Fluoride (F) Temp. Depend.	00951	3.3	0.1
Total Anions		Meq/L Value: 9.5			
	Std. Units	PH (Laboratory)	00403	9.1	
**	umho/cm**	Specific Conductance (E.C.)	00095	950.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	481.4	
	Units	Apparent Color (Unfiltered)	00081	5.0	
	TON	Odor Threshold at 60 C	00086	2.0	
	NTU	Lab Turbidity	82079	85.0	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

BR-6 Medium

 INORGANIC CHEMICALS 92-0734

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	865.00	100.0
50	ug/L	Arsenic (As)	01002	135.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	4535.0	100.0
50	ug/L	Lead (Pb)	01051	6.00	5.0
50	ug/L	Manganese (Mn)	01055	140.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

RADIOACTIVITY ANALYSIS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

RADIOACTIVITY ANALYSIS

Date of Report: 02/06/92 Sample ID No.92-0734
Laboratory Signature Lab
Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: [signature]
Name of Sampler:UNKNOWN Employed By:UNKNOWN
Date/Time Sample Collected: 92/01/29/0000 Date/Time Sample Received @ Lab: 92/01/29/1700 Date Analyses Completed: 92/02/05

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System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017
Name or Number of Sample Source: BOR WELL 6 1190- 1210

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* User ID: CYA Station Number: *
* Date/Time of Sample: |92|01|29|0000| Laboratory Code: 3761 *
* YY MM DD TTTT *
* Date Analysis Completed: |92|02|05| *
* YY MM DD *
* Submitted by:________________ Phone #:____________ *
****

MCL	REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15	pCi/l	Total Alpha	01501	4.3	
	pCi/l	Total Alpha Counting Error	01502	1.7	
50	pCi/l	Total Beta	03501		4.0
	pCi/l	Total Beta Counting Error	03502		
20	pCi/l	Natural Uranium	28012		2.0
	pCi/l	Total Radium 226	09501		.5
	pCi/l	Total Radium 226 Counting Error	09502		
	pCi/l	Total Radium 228	11501		.5
	pCi/l	Total Radium 228 Counting Error	11502		
5	pCi/l	Ra 226 + Ra 228	11503		
	pCi/l	Ra 226 + Ra 228 Counting Error	11504		
20000	pCi/l	Total Tritium	07000		1.0
	pCi/l	Total Tritium Counting Error	07001		
8	pCi/l	Total Strontium - 90	13501		2.0
	pCi/l	Total Strontium - 90 Counting Error	13502		
	pCi/l	Total Radon 222	82303		100.0
	pCi/l	Total Radon 222 Counting Error	82302		

BR-6 Medium

CLINICAL LABORATORY OF SAN BERNARDINO
1595 NORTH "D"STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 02/06/92 Sample ID No.92-0735

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: [signature]

Name of Sampler:UNKNOWNEmployed By:UNKNOWN

Date/Time Sample Collected: 92/01/10/0000 Date/Time Sample Received @ Lab: 92/01/29/1700 Date Analyses Completed: 92/02/05

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: BOR WELL 6 1640 - 1660

User ID: CYA Station Number:

Date/Time of Sample: |92|01|10|0000| (YY MM DD TTTT) Laboratory Code: 3761

Date Analysis Completed: |92|02|05| (YY MM DD)

Submitted by:______________________ Phone #:__________________

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	76.0	
	mg/L	Calcium (Ca)	00916	5.8	
	mg/L	Magnesium (Mg)	00927	15.0	
	mg/L	Sodium (Na)	00929	223.4	
	mg/L	Potassium (K)	00937	7.4	
Total Cations		Meq/L Value: 11.4			
	mg/L	Total Alkalinity (AS CaCO3)	00410	440.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	536.8	
*	mg/L*	Sulfate (SO4)	00945	37.5	
*	mg/L*	Chloride (Cl)	00940	29.4	
45	mg/L	Nitrate (as NO3)	71850	< 1.0	
****	mg/L	Fluoride (F) Temp. Depend.	00951	1.7	0.:
Total Anions		Meq/L Value: 10.5			
	Std. Units	PH (Laboratory)	00403	8.9	
**	umho/cm**	Specific Conductance (E.C.)	00095	980.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	540.1	
	Units	Apparent Color (Unfiltered)	00081	40.0	
	TON	Odor Threshold at 60 C	00086	2.0	
	NTU	Lab Turbidity	82079	140.0	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

BR-6 Deep

INORGANIC CHEMICALS

92-0735

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	1325.0	100.0
50	ug/L	Arsenic (As)	01002	75.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	3925.0	100.0
50	ug/L	Lead (Pb)	01051	< 5.00	5.0
50	ug/L	Manganese (Mn)	01055	160.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

RADIOACTIVITY ANALYSIS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

BR-6 Deep

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2862
China Lake, CA 93555-6001
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/16/92
Date Received: 09/02/92
Laboratory No.: 7880-1

Sample Description: BOR-10 640. SAMPLE WAS TAKEN ON 09-01-92 @ 3:00AM BY HASTING.

WATER ANALYSIS
(GENERAL CHEMISTRY)

Constituents		Results	Units	D.L.R. *	Method
Calcium		21.	mg/L	0.1	SW-7140
Magnesium		19.0	mg/L	0.01	SW-7450
Sodium		295.	mg/L	0.1	SW-7770
Potassium		24.	mg/L	0.1	SW-7610
Total Cations		16.1	meq/L	0.01	Calculated
Hydroxide	<	0.8	mg/L	0.8	SM-403
Carbonate		40.2	mg/L	2.6	SM-403
Bicarbonate		300.	mg/L	2.6	SM-403
Chloride		176.	mg/L	1.8	EPA-300.0
Sulfate		225.	mg/L	5.	EPA-300.0
Nitrate/Nitrite as NO3		2.7	mg/L	0.4	EPA-353.2
Fluoride		1.3	mg/L	0.05	EPA-340.2
Bromide		0.45	mg/L	0.05	EPA-300.0
Total Anions		16.0	meq/L	0.01	Calculated
pH		8.7	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C		1570.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C		1000.	mg/L	10.	EPA-160.1
Color		10.	Color Units	1.0	EPA-110.2
Odor		2.	Odor Units	NA	EPA-140.1
Turbidity		31.	NT Units	0.05	EPA-180.1
MBAS		0.40	mg/L	0.02	EPA-425.1
Hardness as CaCO3		131.	mg/L	0.3	Calculated
Alkalinity as CaCO3		313.	mg/L	3.0	Calc
Ammonia as NH3	<	0.02	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	<	0.1	mg/L	0.1	EPA-353.2
Ortho-phosphate		0.36	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:

EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

M. Atencio
Department Supervisor

cc: GEOTHERMAL PROGRAM

BR-10 Shallo

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2862
China Lake, CA 93555-6001
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/16/92
Date Received: 09/02/92
Laboratory No.: 7880-1

Sample Description: BOR-10 640. SAMPLE WAS TAKEN ON 09-01-92 @ 3:00AM BY HASTING.

WATER ANALYSIS
(METALS)

Constituents	Results	Units	D.L.R.	Method
Aluminum	2790.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	16.	µg/L	2.	SW-7060
Barium	None Detected	µg/L	100.	SW-6010
Boron	4.9	mg/L	0.10	SW-6010
Cadmium	None Detected	µg/L	1.	SW-7131
Chromium	None Detected	µg/L	10.	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lead	None Detected	µg/L	5.	SW-7421
Lithium	250.	µg/L	10.	SW-7430
Manganese	285.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
Selenium	2.7	µg/L	2.	SW-7740
Si as SiO2	48.	mg/L	0.2	SW-6010
Silver	None Detected	µg/L	10.	SW-6010
Strontium	399.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	None Detected	µg/L	10.	SW-6010
Total Iron	3530.	µg/L	50.	SW-6010

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

cc: GEOTHERMAL PROGRAM

4100 Atlas Ct. · Bakersfield, CA 93308 · (805) 327-4911 · FAX (805) 327-1918 BR-10 Shallow

BC
3ORATORIES

Naval Air Warfare Center
Weapons Division
Code 2862
China Lake, CA 93555-6001
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92
Date Received: 09/02/92
Laboratory No.: 7880-2

Sample Description: BOR-10 1180. SAMPLE WAS TAKEN ON 09-01-92 @ 12:00PM BY HASTING.

WATER ANALYSIS
(GENERAL CHEMISTRY)

Constituents	Results	Units	D.L.R.	Method
Calcium	8.3	mg/L	0.1	SW-7140
Magnesium	2.7	mg/L	0.01	SW-7450
Sodium	200.	mg/L	0.1	SW-7770
Potassium	11.5	mg/L	0.1	SW-7610
Total Cations	9.63	meq/L	0.01	Calculated
Hydroxide	< 0.8	mg/L	0.8	SM-403
Carbonate	11.1	mg/L	2.6	SM-403
Bicarbonate	60.0	mg/L	2.6	SM-403
Chloride	139.	mg/L	1.8	EPA-300.0
Sulfate	193.	mg/L	5.	EPA-300.0
Nitrate/Nitrite as NO3	1.8	mg/L	0.4	EPA-353.2
Fluoride	1.9	mg/L	0.05	EPA-340.2
Bromide	0.36	mg/L	0.05	EPA-300.0
Total Anions	9.42	meq/L	0.01	Calculated
pH	8.7	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	1040.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	580.	mg/L	10.	EPA-160.1
Color	20.	Color Units	1.0	EPA-110.2
Odor	4.	Odor Units	NA	EPA-140.1
Turbidity	15.	NT Units	0.05	EPA-180.1
MBAS	0.72	mg/L	0.02	EPA-425.1
Hardness as CaCO3	31.8	mg/L	0.3	Calculated
Alkalinity as CaCO3	67.7	mg/L	3.0	Calc
Ammonia as NH3	0.38	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	< 0.1	mg/L	0.1	EPA-353.2
Ortho-phosphate	< 0.10	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

M. Atencio
Department Supervisor

cc: GEOTHERMAL PROGRAM

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2862
China Lake, CA 93555-6001
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92
Date Received: 09/02/92
Laboratory No.: 7880-2

Sample Description: BOR-10 1180. SAMPLE WAS TAKEN ON 09-01-92 @ 12:00PM BY HASTING.

WATER ANALYSIS
(METALS)

Constituents	Results	Units	D.L.R.	Method
Aluminum	742.	μg/L	50.	SW-6010
Antimony	None Detected	μg/L	100.	SW-6010
Arsenic	2.7	μg/L	2.	SW-7060
Barium	None Detected	μg/L	100.	SW-6010
Boron	1.3	mg/L	0.10	SW-6010
Cadmium	None Detected	μg/L	1.	SW-7131
Chromium	None Detected	μg/L	10.	SW-6010
Copper	None Detected	μg/L	10.	SW-6010
Lead	None Detected	μg/L	5.	SW-7421
Lithium	None Detected	μg/L	10.	SW-7430
Manganese	69.	μg/L	10.	SW-6010
Mercury	None Detected	μg/L	0.2	EPA-245.1
Selenium	2.4	μg/L	2.	SW-7740
Si as SiO2	12.	mg/L	0.2	SW-6010
Silver	None Detected	μg/L	10.	SW-6010
Strontium	84.	μg/L	10.	SW-6010
Thallium	None Detected	μg/L	5.	SW-7841
Zinc	None Detected	μg/L	10.	SW-6010
Total Iron	1830.	μg/L	50.	SW-6010

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

cc: GEOTHERMAL PROGRAM

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2862
China Lake, CA 93555-6001
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92
Date Received: 09/02/92
Laboratory No.: 7880-3

Sample Description: BOR-10 1560. SAMPLE WAS TAKEN ON 09-01-92 @ 16:00PM BY HASTING.

WATER ANALYSIS
(GENERAL CHEMISTRY)

Constituents	Results	Units	D.L.R.	Method
Calcium	47.	mg/L	0.1	SW-7140
Magnesium	105.	mg/L	0.01	SW-7450
Sodium	254.	mg/L	0.1	SW-7770
Potassium	32.	mg/L	0.1	SW-7610
Total Cations	22.8	meq/L	0.01	Calculated
Hydroxide	< 0.8	mg/L	0.8	SM-403
Carbonate	< 2.6	mg/L	2.6	SM-403
Bicarbonate	1130.	mg/L	2.6	SM-403
Chloride	49.5	mg/L	1.8	EPA-300.0
Sulfate	156.	mg/L	5.	EPA-300.0
Nitrate/Nitrite as NO3	0.9	mg/L	0.4	EPA-353.2
Fluoride	0.56	mg/L	0.05	EPA-340.2
Bromide	0.12	mg/L	0.05	EPA-300.0
Total Anions	23.2	meq/L	0.01	Calculated
pH	7.9	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	1910.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	1220.	mg/L	10.	EPA-160.1
Color	30.	Color Units	1.0	EPA-110.2
Odor	4.	Odor Units	NA	EPA-140.1
Turbidity	27.	NT Units	0.05	EPA-180.1
MBAS	0.66	mg/L	0.02	EPA-425.1
Hardness as CaCO3	550.	mg/L	0.3	Calculated
Alkalinity as CaCO3	926.	mg/L	3.0	Calc
Ammonia as NH3	0.17	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	< 0.1	mg/L	0.1	EPA-353.2
Ortho-phosphate	0.48	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

M. Atencio
Department Supervisor

cc: GEOTHERMAL PROGRAM

LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2862
China Lake, CA 93555-6001
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92
Date Received: 09/02/92
Laboratory No.: 7880-3

Sample Description: BOR-10 1560. SAMPLE WAS TAKEN ON 09-01-92 @ 16:00PM BY HASTING.

WATER ANALYSIS
(METALS)

Constituents	Results	Units	D.L.R.	Method
Aluminum	None Detected	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	7.8	µg/L	2.	SW-7060
Barium	None Detected	µg/L	100.	SW-6010
Boron	1.1	mg/L	0.10	SW-6010
Cadmium	None Detected	µg/L	1.	SW-7131
Chromium	None Detected	µg/L	10.	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lead	None Detected	µg/L	5.	SW-7421
Lithium	250.	µg/L	10.	SW-7430
Manganese	95.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
Selenium	None Detected	µg/L	2.	SW-7740
Si as SiO2	81.	mg/L	0.2	SW-6010
Silver	None Detected	µg/L	10.	SW-6010
Strontium	678.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	None Detected	µg/L	10.	SW-6010
Total Iron	6910.	µg/L	50.	SW-6010

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

cc: GEOTHERMAL PROGRAM

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2862
China Lake, CA 93555-6001
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92
Date Received: 09/02/92
Laboratory No.: 7880-4

Sample Description: BOR-10 1930. SAMPLE WAS TAKEN ON 09-02-92 @ 3:00AM BY HASTING.

WATER ANALYSIS
(GENERAL CHEMISTRY)

Constituents		Results	Units	D.L.R.	Method
Calcium		30.	mg/L	0.1	SW-7140
Magnesium		121.	mg/L	0.01	SW-7450
Sodium		320.	mg/L	0.1	SW-7770
Potassium		44.	mg/L	0.1	SW-7610
Total Cations		26.5	meq/L	0.01	Calculated
Hydroxide	<	0.8	mg/L	0.8	SM-403
Carbonate	<	2.6	mg/L	2.6	SM-403
Bicarbonate		1280.	mg/L	2.6	SM-403
Chloride		58.2	mg/L	1.8	EPA-300.0
Sulfate		171.	mg/L	5.	EPA-300.0
Nitrate/Nitrite as NO3		0.9	mg/L	0.4	EPA-353.2
Fluoride		0.8	mg/L	0.05	EPA-340.2
Bromide		0.18	mg/L	0.05	EPA-300.0
Total Anions		26.2	meq/L	0.01	Calculated
pH		8.1	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C		2400.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C		1330.	mg/L	10.	EPA-160.1
Color		30.	Color Units	1.0	EPA-110.2
Odor		4.	Odor Units	NA	EPA-140.1
Turbidity		27.	NT Units	0.05	EPA-180.1
MBAS		0.96	mg/L	0.02	EPA-425.1
Hardness as CaCO3		576.	mg/L	0.3	Calculated
Alkalinity as CaCO3		1050.	mg/L	3.0	Calc
Ammonia as NH3		0.05	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	<	0.1	mg/L	0.1	EPA-353.2
Ortho-phosphate		0.39	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

M. Atencio
Department Supervisor

cc: GEOTHERMAL PROGRAM

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2862
China Lake, CA 93555-6001
Attn.: Disbursing Officer 619-939-2116

Date Reported: 09/15/92
Date Received: 09/02/92
Laboratory No.: 7880-4

Sample Description: BOR-10 1930. SAMPLE WAS TAKEN ON 09-02-92 @ 3:00AM BY HASTING.

WATER ANALYSIS
(METALS)

Constituents	Results	Units	D.L.R.	Method
Aluminum	None Detected	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	9.8	µg/L	2.	SW-7060
Barium	None Detected	µg/L	100.	SW-6010
Boron	1.6	mg/L	0.10	SW-6010
Cadmium	None Detected	µg/L	1.	SW-7131
Chromium	None Detected	µg/L	10.	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lead	None Detected	µg/L	5.	SW-7421
Lithium	180.	µg/L	10.	SW-7430
Manganese	286.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
Selenium	None Detected	µg/L	2.	SW-7740
Si as SiO2	59.	mg/L	0.2	SW-6010
Silver	None Detected	µg/L	10.	SW-6010
Strontium	554.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	None Detected	µg/L	10.	SW-6010
Total Iron	5820.	µg/L	50.	SW-6010

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

cc: GEOTHERMAL PROGRAM

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 02/26/91 Sample ID No.910945
Laboratory Signature Lab
Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. Jolliff
Name of Sampler: MOULTON Employed By: PURVEYOR
Date/Time Sample Collected: 91/02/02/1200 Date/Time Sample Received @ Lab: 91/02/02/1200 Date Analyses Completed: 91/02/26

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE System Number: 36-042
Name or Number of Sample Source: NEAL RANCH #1 250-270

* Water Type: (G/S) |S| Station Number: 036/042-001
* Date/Time of Sample: |91|02|02|1200| User ID: TAN
YY MM DD HHMM
* Analyzing Agency Code: 3761 Date Analysis Completed: |91|02|26|
YY MM DD
* Submitted by:__________ Phone #:__________

Place an 'X' in box to delete all data for this station/date/time. |_|

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	1030.0		
mg/L	Calcium (Ca)	00916	221.1		
mg/L	Magnesium (Mg)	00927	116.2		30.0
mg/L	Sodium (NA)	00929	456.8		
mg/L	Potassium (K)	00937	5.6		
Total Cations	Meq/L Value: 40.6				
mg/L	Total Alkalinity (AS CaCO3)	00410	370.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	451.4		
mg/L*	Sulfate (SO4)	00945	1094.7		
mg/L*	Chloride (Cl)	00940	290.7		
mg/L	Nitrate (as NO3)	71850	260.3	45	
mg/L	Fluoride (F) Temp. Depend.	00951	2.4	****	0.1
Total Anions	Meq/L Value: 42.7				
Std. Units	PH (Laboratory)	00403	7.9		
umho/cm**	Specific Conductance (E.C.)	00095	3880.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	2405.6		
Units	Apparent Color (Unfiltered)	00081	< 3.0		
TON	Odor Threshold at 60 C	00086	1.0		1.0
NTU	Lab Turbidity	82079	1.9		
mg/L	MBAS	38260	0.18	0.5	0.02

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

NR-1 Shallow

 910945

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #		ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	<	10	50	10
ug/L	Barium (Ba)	01007	<	100	1000	100
ug/L	Cadmium (Cd)	01027	<	1	10	1
ug/L	Chromium (Total Cr)	01034	<	10	50	10
ug/L	Copper (Cu)	01042	<	50	1000	50
ug/L	Iron (Fe)	01045		100	300	100
ug/L	Lead (Pb)	01051	<	5	50	5
ug/L	Manganese (Mn)	01055		80	50	30
ug/L	Mercury (Hg)	71900	<	1	2	1
ug/L	Selenium (Se)	01147		170	10	5
ug/L	Silver (Ag)	01077	<	10	50	10
ug/L	Zinc (Zn)	01092	<	50	5000	50
ug/L	Aluminum	01105		180	1000	100

ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390			0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340			4	0.4
ug/L	Methoxychlor	39480			100	10.0
ug/L	Toxaphene	39400			5	0.5
ug/L	2,4-D	39730			100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045			10	

ADDITIONAL ANALYSES

NTU	Field Turbidity	82078				0.1
C	Source Temperature C	00010				
	Langelier Index Source Temp.	71814				
	Langelier Index at 60 C	71813				
Std. Units	Field PH	00400				
	Agressiveness Index	82383				
mg/L	Silica	00955				
mg/L	Phosphate	00650				
mg/L	Iodide	71865				
	Sodium Absorption Ratio	00931				
	Asbestos	81855				
mg/L	Ammonia (NH3-N)	00612				
mg/L	Nitrite Nitrogen (NO2-N)	00615				
mg/L	Nitrate Nitrogen (NO3-N)	00618				1.(
mg/L	Nitrite (N)	00620				
mg/L	Beryllium	01012				
mg/L	Boron	01020				
mg/L	Thallium	01059				
mg/L	Nickel	01067				
mg/L	Antimony	01097				0.
mg/L	Lithium	01132				
mg/L	Cyanide	01291				

NR-1 Shallow

Clinical Laboratory of San Bernardino, Inc.

1595 N. "D" St., San Bernardino, CA 92405
Phone (714) 885-3216
P. O. Box 329
San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: FEB 2 9 1991	Lab Sample ID No. 91-0945
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: C. Jolley
Name of Sampler: Moulton	Sampler Employed By: North American Chemical
Date/Time Sample Collected: 91/02/02/ 12:00	Date/Time Sample Received @ Lab: 91/02/02 — Were Holding Times Observed: Yes
System Name: North American Chemical	System Number:
Description of Sampling Point: I.W.V. Test Well	
Name/No. of Sample Source: Neal Ranch #1 250-270	Station Number:
Date & of Time Sample: 9 1 0 2 0 2 1 2 0 0 (Y Y M M D D T T T T) — Water Type: G/S	User ID: — Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	910220 (YYMMDD)
5	pC/l	Total Alpha		1501	119.9
	PC/l	Total Alpha Counting Error		1502	9.8
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

NR-1 Shallow

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 02/26/91 Sample ID No.910946

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: C. Jolliff

Name of Sampler: MOULTON Employed By: PURVEYOR

Date/Time Sample Collected: 91/02/02/1300 Date/Time Sample Received @ Lab: 91/02/02/1300 Date Analyses Completed: 91/02/26

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE System Number: 36-042

Name or Number of Sample Source: NEAL RANCH #1 1130-1150

* Water Type: (G/S) |S| Station Number: 036/042-002
* Date/Time of Sample: |91|02|02|1300| (YY MM DD HHMM) User ID: TAN
* Analyzing Agency Code: 3761 Date Analysis Completed: |91|02|26| (YY MM DD)
* Submitted by:________ Phone #:________

Place an 'X' in box to delete all data for this station/date/time. |_|

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	310.0		
mg/L	Calcium (Ca)	00916	32.0		
mg/L	Magnesium (Mg)	00927	55.9		30.0
mg/L	Sodium (NA)	00929	1240.0		
mg/L	Potassium (K)	00937	14.6		
Total Cations	Meq/L Value: 60.5				
mg/L	Total Alkalinity (AS CaCO3)	00410	2184.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	2664.5		
mg/L*	Sulfate (SO4)	00945	125.4		
mg/L*	Chloride (Cl)	00940	245.0		
mg/L	Nitrate (as NO3)	71850	35.4	45	
mg/L	Fluoride (F) Temp. Depend.	00951	2.4	****	0.1
Total Anions	Meq/L Value: 53.9				
Std. Units	PH (Laboratory)	00403	9.9		
umho/cm**	Specific Conductance (E.C.)	00095	6000		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	3660.0		
Units	Apparent Color (Unfiltered)	00081	70		
TON	Odor Threshold at 60 C	00086	4.0		1.0
NTU	Lab Turbidity	82079	166.0		
mg/L	MBAS	38260	0.45	0.5	0.02

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

NR-1 Medium

910946

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #		ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002		28	50	10
ug/L	Barium (Ba)	01007	<	100	1000	100
ug/L	Cadmium (Cd)	01027	<	1	10	1
ug/L	Chromium (Total Cr)	01034	<	10	50	10
ug/L	Copper (Cu)	01042	<	50	1000	50
ug/L	Iron (Fe)	01045		750	300	100
ug/L	Lead (Pb)	01051	<	5	50	5
ug/L	Manganese (Mn)	01055		40	50	30
ug/L	Mercury (Hg)	71900	<	1	2	1
ug/L	Selenium (Se)	01147		40	10	5
ug/L	Silver (Ag)	01077	<	10	50	10
ug/L	Zinc (Zn)	01092	<	50	5000	50
ug/L	Aluminum	01105		240	1000	100

ORGANIC CHEMICALS

ug/L	Endrin (Hexadrin)	39390			0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340			4	0.4
ug/L	Methoxychlor	39480			100	10.0
ug/L	Toxaphene	39400			5	0.5
ug/L	2,4-D	39730			100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045			10	

ADDITIONAL ANALYSES

NTU	Field Turbidity	82078				0.1
C	Source Temperature C	00010				
	Langelier Index Source Temp.	71814				
	Langelier Index at 60 C	71813				
Std. Units	Field PH	00400				
	Agressiveness Index	82383				
mg/L	Silica	00955				
mg/L	Phosphate	00650				
mg/L	Iodide	71865				
	Sodium Absorption Ratio	00931				
	Asbestos	81855				
mg/L	Ammonia (NH3-N)	00612				
mg/L	Nitrite Nitrogen (NO2-N)	00615				
mg/L	Nitrate Nitrogen (NO3-N)	00618				1.0
mg/L	Nitrite (N)	00620				
mg/L	Beryllium	01012				
mg/L	Boron	01020				
mg/L	Thallium	01059				
mg/L	Nickel	01067				
mg/L	Antimony	01097				0.05
mg/L	Lithium	01132				
mg/L	Cyanide	01291				

Clinical Laboratory of San Bernardino, Inc.

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Phone (714) 885-3216
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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: FEB 2 0 1991	Lab Sample ID No. 91-0946
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: C. Jolly
Name of Sampler: Moulton	Sampler Employed By: North American Chemical

Date/Time Sample Collected: 91/02/02 13:00	Date/Time Sample Received @ Lab: 91/02/02	Were Holding Times Observed: Yes

System Name: North American Chemical	System Number:
Description of Sampling Point: I.W.V. Test Well	
Name/No. of Sample Source: Neal Ranch #1 1130 - 1150	Station Number:

Date & of Time Sample: 9 1 0 2 0 2 1 1 5 0 (Y Y M M D D T T T T)	Water Type: (G/S)	User ID:	Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	910220 (YYMMDD)
5	pC/l	Total Alpha		1501	142.4
	PC/l	Total Alpha Counting Error		1502	28.7
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

TITLE 22 CHEMICAL ANALYSIS

Date of Report: 02/26/91 Sample ID No.910947

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO

Signature Lab Director: C. Jolliff

Name of Sampler: MOULTON Employed By: PURVEYOR

Date/Time Sample Collected: 91/02/02/1100 Date/Time Sample Received @ Lab: 91/02/02/1100 Date Analyses Completed: 91/02/26

==

System Name: NORTH AMERICAN CHEMICAL - AKA KERR MCGEE System Number: 36-042

Name or Number of Sample Source: NEAL RANCH #1 1960-1980

****

* Water Type: (G/S) |S| Station Number: 036/042-003 *
* Date/Time of Sample: |91|02|02|1100| User ID: TAN *
* YY MM DD HHMM *
* *
* Analyzing Agency Code: 3761 Date Analysis Completed: |91|02|26| *
* YY MM DD *
* Submitted by:______________________ Phone #:________________ *

****

Place an 'X' in box to delete all data for this station/date/time. |_|

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
mg/L	Total Hardness (as CaCO3)	00900	78.0		
mg/L	Calcium (Ca)	00916	12.8		
mg/L	Magnesium (Mg)	00927	11.2		30.0
mg/L	Sodium (NA)	00929	1340.0		
mg/L	Potassium (K)	00937	6.4		
Total Cations	Meq/L Value: 60.0				
mg/L	Total Alkalinity (AS CaCO3)	00410	2460.0		
mg/L	Hydroxide (OH)	71830	< 1.0		
mg/L	Carbonate (CO3)	00445	< 1.0		
mg/L	Bicarbonate (HCO3)	00440	3001.2		
mg/L*	Sulfate (SO4)	00945	304.8		
mg/L*	Chloride (Cl)	00940	246.7		
mg/L	Nitrate (as NO3)	71850	35.0	45	
mg/L	Fluoride (F) Temp. Depend.	00951	3.3	****	0.1
Total Anions	Meq/L Value: 63.2				
Std. Units	PH (Laboratory)	00403	8.6		
umho/cm**	Specific Conductance (E.C.)	00095	5330.0		
mg/L***	Total Filterable Residue at 180C (TDS)	70300	3251.3		
Units	Apparent Color (Unfiltered)	00081	50		
TON	Odor Threshold at 60 C	00086	2.0		1.0
NTU	Lab Turbidity	82079	32.0		
mg/L	MBAS	38260	0.20	0.5	0.02

* 250-500-600 ** 900-1600-2200 *** 500-100-1500 **** 1.4-2.4

NR-1 Deep

* THE FOLLOWING CONSTITUENTS ARE REPORTED IN UG/L *

REPORTING UNITS	CONSTITUENT ALL CONSTITUENTS REPORTED uG/L	ENTRY #	ANALYSES RESULTS	MCL	DLR
ug/L	Arsenic (As)	01002	130	50	10
ug/L	Barium (Ba)	01007	< 100	1000	100
ug/L	Cadmium (Cd)	01027	< 1	10	1
ug/L	Chromium (Total Cr)	01034	< 10	50	10
ug/L	Copper (Cu)	01042	< 50	1000	50
ug/L	Iron (Fe)	01045	1180	300	100
ug/L	Lead (Pb)	01051	< 5	50	5
ug/L	Manganese (Mn)	01055	30	50	30
ug/L	Mercury (Hg)	71900	< 1	2	1
ug/L	Selenium (Se)	01147	15	10	5
ug/L	Silver (Ag)	01077	< 10	50	10
ug/L	Zinc (Zn)	01092	< 50	5000	50
ug/L	Aluminum	01105	1060	1000	100
	ORGANIC CHEMICALS				
ug/L	Endrin (Hexadrin)	39390		0.2	0.02
ug/L	Gamma-BHC (Lindane)	39340		4	0.4
ug/L	Methoxychlor	39480		100	10.0
ug/L	Toxaphene	39400		5	0.5
ug/L	2,4-D	39730		100	10.0
ug/L	2,4,5-TP (Silvex) (WEED-B-GON)	39045		10	
	ADDITIONAL ANALYSES				
NTU	Field Turbidity	82078			0.1
C	Source Temperature C	00010			
	Langelier Index Source Temp.	71814			
	Langelier Index at 60 C	71813			
Std. Units	Field PH	00400			
	Agressiveness Index	82383			
mg/L	Silica	00955			
mg/L	Phosphate	00650			
mg/L	Iodide	71865			
	Sodium Absorption Ratio	00931			
	Asbestos	81855			
mg/L	Ammonia (NH3-N)	00612			
mg/L	Nitrite Nitrogen (NO2-N)	00615			
mg/L	Nitrate Nitrogen (NO3-N)	00618			1.
mg/L	Nitrite (N)	00620			
mg/L	Beryllium	01012			
mg/L	Boron	01020			
mg/L	Thallium	01059			
mg/L	Nickel	01067			
mg/L	Antimony	01097			0
mg/L	Lithium	01132			
mg/L	Cyanide	01291			

Clinical Laboratory of San Bernardino, Inc.

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Phone (714) 885-3216
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San Bernardino, CA 92402

RADIOACTIVITY ANALYSES

Date of Report: FEB 2 0 1991	Lab Sample ID No. 91-0947
Laboratory Name: CLINICAL LAB OF SAN BERNARDINO	Signature of Lab Director: C. Jolley
Name of Sampler: Moulton	Sampler Employed By: North American Chemical
Date/Time Sample Collected: 91/02/02 11:00 / Date/Time Sample Received @ Lab: 91/02/02	Were Holding Times Observed: Yes
System Name: North American Chemical	System Number:
Description of Sampling Point: I.W.V. Test Well	
Name/No. of Sample Source: Near Ranch #1 1960 - 1980	Station Number:
Date & of Time Sample: 9 1 0 2 0 2 1 1 0 0 (Y Y M M D D T T T T) / Water Type: (G/S)	User ID: / Submitted to SWQIS By:

MCL	REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSES RESULTS
		Analyzing Agency		28	3761
		Date Analyses Completed		73672	910220 (YYMMDD)
5	pC/l	Total Alpha		1501	32.9
	PC/l	Total Alpha Counting Error		1502	5.2
50	pC/l	Total Beta		3501	
	pC/l	Total Beta Counting Error		3502	
	pC/l	Natural Uranium		28012	
3	pC/l	Total Radium 226		9501	
	pC/l	Total Radium 226 Counting Error		9502	
	pC/l	Total Radium 228		11501	
	pC/l	Total Radium 228 Counting Error		11502	
5	pC/l	Ra 226 + Ra 228		11503	
	pC/l	Ra 226 + Ra 228 Counting Error		11504	
20,000	pC/l	Total Tritium		7000	
	pC/l	Total Tritium Counting Error		7001	
8	pC/l	Total Strontium-90		13501	
	pC/l	Total Strontium-90 Counting Error		13502	

NR-1 Deep

Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329
1595 North "D" Street
San Bernardino, California 92405
(714) 885-3216

PURVEYOR: INDIAN WELLS VALLEY WATER   SAMPLE I.D.#: 911534

STREET ADDRESS: DATE OF REPORT: 3/6/91

CITY,STATE,ZIP:

DESCRIPTION OF SAMPLING POINT: NEAL RANCH #2 330-350 upper

DATE/TIME COLLECTED: 2/26/91 0900   NAME OF SAMPLER: MOULTON

	RESULTS	MCL
TOTAL HARDNESS	241.2 mg/L	
CALCIUM HARDNESS	136.8 mg/L	
CALCIUM	54.8 mg/L	
MAGNESIUM	25.4 mg/L	
SODIUM	201.4 mg/L	
POTASSIUM	6.2 mg/L	
TOTAL ALKALINITY	295.6 mg/L	
HYDROXIDE	< 1.0 mg/L	
CARBONATE	< 1.0 mg/L	
BICARBONATE	360.6 mg/L	
SULFATE	232.8 mg/L	
CHLORIDE	85.0 mg/L	
NITRATE	25.6 mg/L	45
FLUORIDE	0.8 mg/L	
TOTAL ANIONS	13.61 mEq/L	
TOTAL CATIONS	13.73 mEq/L	
RPD ANIONS/CATIONS	0.60 PERCENT	
pH	8.3 STD UNITS	
E.C.	1370.0 umho/cm	
TDS	808.3 mg/L	
MBAS	< 0.02 mg/L	

	RESULTS	MCL
MANGANESE	50 ug/L	50
COPPER	< 50 ug/l	1000
IRON	< 100 ug/L	300
ZINC	< 50 ug/L	5000
BARIUM	< 100 ug/L	1000
CHROMIUM	< 10 ug/L	50
CADMIUM	< 1 ug/L	10
LEAD	12 ug/l	50
ALUMINUM	< 100 ug/L	1000
MERCURY	< 1 ug/l	2
ARSENIC	< 10 ug/L	50
SELENIUM	10 ug/L	100
SILVER	< 10 ug/L	50
COLOR	< 3	
ODOR	1	
TURBIDITY	0.5 NTU	

DATE(S) RECEIVED: 2/28/91   STARTED: 2/28/91   COMPLETED: 3/6/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST:______________   DIRECTOR: C. Jolliff

NR-2 Shallow

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO,CA 92405

RADIOACTIVITY ANALYSIS

Date of Report: 03/08/91 Sample ID No.91-1534
Laboratory Signature Lab
Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. Jolly
Name of Sampler:MOULTON Employed By:INDIAN WELLS VALLEY CWD
Date/Time Sample Collected: 91/02/26/0900 Date/Time Sample Received @ Lab: 91/02/26/0900 Date Analyses Completed: 91/03/08

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017
Name or Number of Sample Source: WELL 25 (NEAL 02) 330 - 350 (TEST WELL)

Water Type: (G/S) |G| Station Number: 25S/39E-31C01 M
Date/Time of Sample: |91|02|26|0900| User ID: CYA
YY MM DD HHMM

Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|08|
YY MM DD

Submitted by:________ Phone #:________

Place an 'X' in box to delete all data for this station/date/time. [ ]

MCL	REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15	pC/l	Total Alpha	01501	13.6	
	pC/l	Total Alpha Counting Error	01502	3.2	
50	pC/l	Total Beta	03501		4.0
	pC/l	Total Beta Counting Error	03502		
20	pC/l	Natural Uranium	28012		2.0
	pC/l	Total Radium 226	09501		.5
	pC/l	Total Radium 226 Counting Error	09502		
	pC/l	Total Radium 228	11501		.5
	pC/l	Total Radium 228 Counting Error	11502		
5	pC/l	Ra 226 + Ra 228	11503		
	pC/l	Ra 226 + Ra 228 Counting Error	11504		
20000	pC/l	Total Tritium	07000		1.0
	pC/l	Total Tritium Counting Error	07001		
8	pC/l	Total Strontium - 90	13501		2.0
	pC/l	Total Strontium - 90 Counting Error	13502		
	pC/l	Total Radon 222 Counting Error	82302		
	pC/l	Total Radon 222	82303		100.0

NR-2 Shallow

Clinical Laboratory of San Bernardino, Inc.

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1595 North "D" Street
San Bernardino, California 92405
(714) 885-3216

PURVEYOR: INDIAN WELLS VALLEY WATER — SAMPLE I.D.#: 911535

STREET ADDRESS: — DATE OF REPORT: 3/6/91

CITY,STATE,ZIP:

DESCRIPTION OF SAMPLING POINT: NEAL RANCH #2 1540-1560 mid

DATE/TIME COLLECTED: 2/26/91 0800 — NAME OF SAMPLER: MOULTON

	RESULTS		MCL
TOTAL HARDNESS	457.2	mg/L	
CALCIUM HARDNESS	285.2	mg/L	
CALCIUM	114.2	mg/L	
MAGNESIUM	41.8	mg/L	
SODIUM	272.3	mg/L	
POTASSIUM	4.5	mg/L	
TOTAL ALKALINITY	310.0	mg/L	
HYDROXIDE	< 1.0	mg/L	
CARBONATE	< 1.0	mg/L	
BICARBONATE	378.2	mg/L	
SULFATE	467.7	mg/L	
CHLORIDE	159.9	mg/L	
NITRATE	107.1	mg/L	45
FLUORIDE	1.1	mg/L	
TOTAL ANIONS	22.23	mEq/L	
TOTAL CATIONS	21.09	mEq/L	
RPD ANIONS/CATIONS	3.55	PERCENT	
pH	8.0	STD UNITS	
E.C.	2240.0	umho/cm	
TDS	1366.8	mg/L	
MBAS	< 0.02	mg/L	

	RESULTS		MCL
MANGANESE	< 30	ug/L	50
COPPER	< 50	ug/l	1000
IRON	< 100	ug/L	300
ZINC	< 50	ug/L	5000
BARIUM	< 100	ug/L	1000
CHROMIUM	< 10	ug/L	50
CADMIUM	< 1	ug/L	10
LEAD	< 5	ug/l	50
ALUMINUM	< 100	ug/L	1000
MERCURY	< 1	ug/l	2
ARSENIC	12	ug/L	50
SELENIUM	60	ug/L	100
SILVER	< 10	ug/L	50
COLOR	<3		
ODOR	1		
TURBIDITY	1.2 NTU		

DATE(S) RECEIVED: 2/28/91 STARTED: 2/28/91 COMPLETED: 3/6/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST:__________ DIRECTOR: C. Jolley NR-2 Mediur

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO,CA 92405

RADIOACTIVITY ANALYSIS

Date of Report: 03/08/91 Sample ID No.91-1535
Laboratory Signature Lab
Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C.Jolley
Name of Sampler:MOULTON Employed By:INDIAN WELLS VALLEY CWD
Date/Time Sample Date/Time Sample Date Analyses
Collected: 91/02/26/0800 Received @ Lab: 91/02/26/0800 Completed: 91/03/08

System
Name: INDIAN WELLS VALLEY CWD - RIDGECREST
System
Number: 15-017
Name or Number of Sample Source: WELL 25 (NEAL 02) **1540 - 1560 (TEST WELL)**

Water Type: (G/S) (G) Station Number: 26S/39E-31C01 M
Date/Time of Sample: |91|02|26|0800| User ID: CYA
YY MM DD HHMM

Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|08|
YY MM DD

Submitted by:__________ Phone #:__________

Place an 'X' in box to delete all data for this station/date/time. [_]

MCL	REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15	pC/l	Total Alpha	01501	53.6	
	pC/l	Total Alpha Counting Error	01502	5.0	
50	pC/l	Total Beta	03501		4.0
	pC/l	Total Beta Counting Error	03502		
20	pC/l	Natural Uranium	28012		2.0
	pC/l	Total Radium 226	09501		.5
	pC/l	Total Radium 226 Counting Error	09502		
	pC/l	Total Radium 228	11501		.5
	pC/l	Total Radium 228 Counting Error	11502		
5	pC/l	Ra 226 + Ra 228	11503		
	pC/l	Ra 226 + Ra 228 Counting Error	11504		
20000	pC/l	Total Tritium	07000		1.0
	pC/l	Total Tritium Counting Error	07001		
8	pC/l	Total Strontium - 90	13501		2.0
	pC/l	Total Strontium - 90 Counting Error	13502		
	pC/l	Total Radon 222 Counting Error	82302		
	pC/l	Total Radon 222	82303		100.0

NR-2 Medium

Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329
1595 North "D" Street
San Bernardino, California 92405
(714) 885-3216

PURVEYOR: INDIAN WELLS VALLEY WATER SAMPLE I.D.#: 911536

STREET ADDRESS: DATE OF REPORT: 3/6/91

CITY,STATE,ZIP:

DESCRIPTION OF SAMPLING POINT: NEAL RANCH #2 1910-1930 Lower

DATE/TIME COLLECTED: 2/26/91 1000 NAME OF SAMPLER: MOULTON

	RESULTS	MCL
TOTAL HARDNESS	143.6 mg/L	
CALCIUM HARDNESS	42.8 mg/L	
CALCIUM	17.1 mg/L	
MAGNESIUM	24.5 mg/L	
SODIUM	1296.0 mg/L	
POTASSIUM	11.3 mg/L	
TOTAL ALKALINITY	2112.0 mg/L	
HYDROXIDE	< 1.0 mg/L	
CARBONATE	< 1.0 mg/L	
BICARBONATE	2576.6 mg/L	
SULFATE	236.4 mg/L	
CHLORIDE	230.6 mg/L	
NITRATE	38.2 mg/L	45
FLUORIDE	3.0 mg/L	
TOTAL ANIONS	54.43 mEq/L	
TOTAL CATIONS	59.50 mEq/L	
RPD ANIONS/CATIONS	5.84 PERCENT	
pH	8.4 STD UNITS	
E.C.	5330.0 umho/cm	
TDS	3304.6 mg/L	
MBAS	< 0.02 mg/L	

	RESULTS	MCL
MANGANESE	80 ug/L	50
COPPER	< 50 ug/l	1000
IRON	250 ug/L	300
ZINC	< 50 ug/L	5000
BARIUM	< 100 ug/L	1000
CHROMIUM	< 10 ug/L	50
CADMIUM	< 1 ug/L	10
LEAD	< 5 ug/l	50
ALUMINUM	< 100 ug/L	1000
MERCURY	< 1 ug/l	2
ARSENIC	460 ug/L	50
SELENIUM	20 ug/L	100
SILVER	< 10 ug/L	50
COLOR	15	
ODOR	3	
TURBIDITY	4.5 NTU	

DATE(S) RECEIVED: 2/28/91 STARTED: 2/28/91 COMPLETED: 3/6/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

NALYST: ________ DIRECTOR: C. Jolley NR-2 Deep

CLINICAL LABS/SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO,CA 92405

RADIOACTIVITY ANALYSIS

Date of Report: 03/08/91 Sample ID No.91-1536

Laboratory Signature Lab
Name: CLINICAL LABORATORIES OF SAN BERNARDINO Director: C. Jolley

Name of Sampler:MOULTON Employed By:INDIAN WELLS VALLEY CWD

Date/Time Sample Collected: 91/02/26/1000 Date/Time Sample Received @ Lab: 91/02/26/1000 Date Analyses Completed: 91/03/08

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: WELL 25 (NEAL 02) **1910 - 1930 (TEST WELL)**

****

* Water Type: (G/S) |G| Station Number: 25S/39E-31C01 M
* Date/Time of Sample: |91|02|26|1000| User ID: CYA
* YY MM DD HHMM
*
* Analyzing Agency Code: 3761 Date Analysis Completed: |91|03|08|
* YY MM DD
* Submitted by:______________________ Phone #:______________________

****

Place an 'X' in box to delete all data for this station/date/time. [ ]

MCL	REPORT UNITS	CONSTITUENT	STORET CODE	ANALYSES RESULTS	DLR
15	pC/l	Total Alpha	01501	24.3	
	pC/l	Total Alpha Counting Error	01502	4.5	
50	pC/l	Total Beta	03501		4.0
	pC/l	Total Beta Counting Error	03502		
20	pC/l	Natural Uranium	28012		2.0
	pC/l	Total Radium 226	09501		.5
	pC/l	Total Radium 226 Counting Error	09502		
	pC/l	Total Radium 228	11501		.5
	pC/l	Total Radium 228 Counting Error	11502		
5	pC/l	Ra 226 + Ra 228	11503		
	pC/l	Ra 226 + Ra 228 Counting Error	11504		
20000	pC/l	Total Tritium	07000		1.0
	pC/l	Total Tritium Counting Error	07001		
8	pC/l	Total Strontium - 90	13501		2.0
	pC/l	Total Strontium - 90 Counting Error	13502		
	pC/l	Total Radon 222 Counting Error	82302		
	pC/l	Total Radon 222	82303		100.0

NR-2 Deep

CLINICAL\LABS SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 10/25/91 Sample ID No. 91-9450

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO

Signature Lab Director: [signature]

Name of Sampler: MIKE C. Employed By: ROTTMAN DRILLING CO.

Date/Time Sample Collected: 91/10/17/2350 Date/Time Sample Received @ Lab: 91/10/21/1700 Date Analyses Completed: 91/10/25

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: W32 P-1 (380') (This sample was filtered)

User ID: CYA Station Number: 000/000-00X00 2

Date/Time of Sample: |91|10|17|2350| (YY MM DD TTTT) Laboratory Code: 3761

Date Analysis Completed: |91|10|25| (YY MM DD)

Submitted by: ______ Phone #: ______

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	86.0	
	mg/L	Calcium (Ca)	00916	24.0	
	mg/L	Magnesium (Mg)	00927	6.3	
	mg/L	Sodium (Na)	00929	60.0	
	mg/L	Potassium (K)	00937	4.6	
Total Cations		Meq/L Value: 4.4			
	mg/L	Total Alkalinity (AS CaCO3)	00410	104.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	126.9	
*	mg/L*	Sulfate (SO4)	00945	57.0	
*	mg/L*	Chloride (Cl)	00940	40.2	
45	mg/L	Nitrate (as NO3)	71850	7.2	
****	mg/L	Fluoride (F) Temp. Depend.	00951	1.1	0.1
Total Anions		Meq/L Value: 4.6			
	Std. Units	PH (Laboratory)	00403	8.6	
**	umho/cm**	Specific Conductance (E.C.)	00095	450.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	252.4	
	Units	Apparent Color (Unfiltered)	00081	< 3.0	
	TON	Odor Threshold at 60 C	00086	1.0	
	NTU	Lab Turbidity	82079	0.9	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

MW-32 Shallow

INORGANIC CHEMICALS

91-9450

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	170.00	100.0
50	ug/L	Arsenic (As)	01002	26.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	<100.00	100.0
50	ug/L	Lead (Pb)	01051	< 5.00	5.0
50	ug/L	Manganese (Mn)	01055	50.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

RADIOACTIVITY ANALYSIS

15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329
1595 North "D" Street
San Bernardino, California 92405
(714) 885-3216

PURVEYOR: KRIEGER AND STEWART (IWVWD) SAMPLE I.D.#: 91-9450

STREET ADDRESS: DATE OF REPORT:

CITY,STATE,ZIP: ANALYSING AGENCY: 3761

DESCRIPTION OF SAMPLING POINT: W 32 P-1 (380') (SUPERNATE AFTER SETTLEING)

DATE/TIME COLLECTED: 10/17/91 23:50 NAME OF SAMPLER: UNKNOWN

CONSTITUENT	RESULTS	UNITS	MCL
SILVER	< 10	ug/L	50
ARSENIC	17	ug/L	50
ALUMINUM	705	ug/L	1000
SELENIUM	< 5	ug/L	10
CHROMIUM	< 10	ug/L	50
CADMIUM	< 1	ug/L	2
LEAD	17	ug/L	50
BARIUM	< 100	ug/L	1000
MERCURY	< 1	ug/L	2
IRON	1970	ug/L	300
MANGANESE	280	ug/L	50
ZINC	80	µg/L	5000

DATE(S) RECEIVED: 10/21/91 STARTED: 10/21/91 COMPLETED: 10/28/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: ______________ DIRECTOR: Mehdi [illegible]

MW-32 Shallo

Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329
1595 North "D" Street
San Bernardino, California 92405
(714) 885-3216

PURVEYOR: KRIEGER AND STEWART (IWVWD) SAMPLE I.D.#: 91-9450

STREET ADDRESS: DATE OF REPORT:

CITY,STATE,ZIP: ANALYSING AGENCY: 3761

DESCRIPTION OF SAMPLING POINT: W 32 P-1 (380') (SAMPLE MIXED AND DIGESTED)

DATE/TIME COLLECTED: 10/17/91 23:50 NAME OF SAMPLER: UNKNOWN

CONSTITUENT	RESULTS	UNITS	MCL
SILVER	< 10	ug/L	50
ARSENIC	65	ug/L	50
ALUMINUM	19530	ug/L	1000
SELENIUM	6	ug/L	10
CHROMIUM	75	ug/L	50
CADMIUM	1.2	ug/L	2
LEAD	28	ug/L	50
BARIUM	180	ug/L	1000
MERCURY	< 1	ug/L	2
IRON	30400	ug/L	300
MANGANESE	520	ug/L	50
ZINC	220	µg/L	5000

DATE(S) RECEIVED: 10/21/91 STARTED: 10/21/91 COMPLETED: 10/28/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST: ______________________ DIRECTOR: ______________________

MW-32 Shallow

CLINICAL\LABS SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 10/25/91 Sample ID No.91-9451

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: Carol Jolly

Name of Sampler:LEROY JONES"DRILLER" Employed By:ROTTMAN DRILLING CO.

Date/Time Sample Collected: 91/10/18/2400 Date/Time Sample Received @ Lab: 91/10/21/1700 Date Analyses Completed: 91/10/25

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: W32 P-2 (900')

User ID: CYA Station Number: 000/000-00X00 3

Date/Time of Sample: |91|10|18|2400| (YY MM DD TTTT) Laboratory Code: 3761

Date Analysis Completed: |91|10|25| (YY MM DD)

Submitted by:________________ Phone #:________________

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	35.2	
	mg/L	Calcium (Ca)	00916	10.4	
	mg/L	Magnesium (Mg)	00927	2.2	
	mg/L	Sodium (Na)	00929	49.2	
	mg/L	Potassium (K)	00937	3.7	
Total Cations	Meq/L	Value: 2.9			
	mg/L	Total Alkalinity (AS CaCO3)	00410	84.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	102.5	
*	mg/L*	Sulfate (SO4)	00945	24.3	
*	mg/L*	Chloride (Cl)	00940	23.3	
45	mg/L	Nitrate (as NO3)	71850	16.9	
****	mg/L	Fluoride (F) Temp. Depend.	00951	0.8	0.1
Total Anions	Meq/L	Value: 3.2			
	Std. Units	PH (Laboratory)	00403	8.3	
**	umho/cm**	Specific Conductance (E.C.)	00095	330.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	172.8	
	Units	Apparent Color (Unfiltered)	00081	< 70.0	
	TON	Odor Threshold at 60 C	00086	3.0	
	NTU	Lab Turbidity	82079	20.0	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

MW-32 Shal Med

INORGANIC CHEMICALS

91-9451

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	120.00	100.C
50	ug/L	Arsenic (As)	01002	36.00	10.C
1000	ug/L	Barium (Ba)	01007	<100.00	100.C
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.C
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.C
1000	ug/L	Copper (Cu)	01042	< 50.00	50.C
300	ug/L	Iron (Fe)	01045	1880.0	100.C
50	ug/L	Lead (Pb)	01051	< 5.00	5.C
50	ug/L	Manganese (Mn)	01055	< 30.00	30.C
2	ug/L	Mercury (Hg)	71900	< 1.00	1.C
10	ug/L	Selenium (Se)	01147	< 5.00	5.C
50	ug/L	Silver (Ag)	01077	< 10.00	10.C
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.C

RADIOACTIVITY ANALYSIS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.(
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.(
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.(
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.(
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.(
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	NTU	Field Turbidity	82078		0.:
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

Clinical Laboratory of San Bernardino, Inc.

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San Bernardino, California 92405
(714) 885-3216

PURVEYOR: KREIGER & STEWART (IWVWD) SAMPLE I.D.#: 91-9451

STREET ADDRESS: DATE OF REPORT: 11/6/91

CITY,STATE,ZIP:

DESCRIPTION OF SAMPLING POINT: W 32 P-2 (900') ** FILTERED **

DATE/TIME COLLECTED: 10/18/91 14:00 NAME OF SAMPLER: UNKNOWN

GENERAL MINERAL	RESULTS	UNITS	MCL
TOTAL HARDNESS	33.2	mg/L	
CALCIUM HARDNESS	26.4	mg/L	
CALCIUM	10.6	mg/L	
MAGNESIUM	1.7	mg/L	
SODIUM	48.2	mg/L	
POTASSIUM	3.3	mg/L	
TOTAL ALKALINITY	82.0	mg/L	
HYDROXIDE	< 1.0	mg/L	
CARBONATE	< 1.0	mg/L	
BICARBONATE	100.0	mg/L	
SULFATE	24.0	mg/L	
CHLORIDE	22.4	mg/L	
NITRATE	16.7	mg/L	45
FLUORIDE	0.8	mg/L	
TOTAL ANIONS	3.1	mEq/L	
TOTAL CATIONS	2.8	mEq/L	
RPD ANIONS/CATIONS	2.0	PERCENT	
pH	8.1	STD UNITS	
E.C.	330.0	umho/cm	
TDS	168.6	mg/L	
MBAS	< 0.02	mg/L	

G.M. CONT	RESULTS	UNITS	MCL
MANGANESE	< 30	ug/L	50
COPPER	< 50	ug/l	1000
IRON	1210	ug/L	300
ZINC	< 50	ug/L	5000

INORGANICS	RESULTS	UNITS	MCL
BARIUM	< 100	ug/L	1000
CHROMIUM	< 10	ug/L	50
CADMIUM	< 1	ug/L	10
LEAD	< 5	ug/l	50
ALUMINUM	< 100	ug/L	1000
MERCURY	< 1	ug/l	2
ARSENIC	25	ug/L	50
SELENIUM	< 5	ug/L	100
SILVER	< 10	ug/L	50

DATE(S) RECEIVED: 10/21/91 STARTED: 11/1/91 COMPLETED: 11/5/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST:__________________ DIRECTOR: Carol Jallow

MW-32 Shal Med

CLINICAL\LABS SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 10/25/91 Sample ID No.91-9499

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: [signature]

Name of Sampler: MICHAEL Employed By: ROTTMAN DRILLING CO.

Date/Time Sample Collected: 91/10/21/0300 Date/Time Sample Received @ Lab: 91/10/23/1700 Date Analyses Completed: 91/10/25

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: W32 P-3 (1200 FT.)

User ID: CYA Station Number: 000/000-00X00 5

Date/Time of Sample: |91|10|21|0300| (YY MM DD TTTT) Laboratory Code: 3761

Date Analysis Completed: |91|10|25| (YY MM DD)

Submitted by:__________ Phone #:__________

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	28.0	
	mg/L	Calcium (Ca)	00916	5.6	
	mg/L	Magnesium (Mg)	00927	3.4	
	mg/L	Sodium (Na)	00929	59.2	
	mg/L	Potassium (K)	00937	2.0	
Total Cations		Meq/L Value: 3.2			
	mg/L	Total Alkalinity (AS CaCO3)	00410	90.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	109.8	
*	mg/L*	Sulfate (SO4)	00945	22.6	
*	mg/L*	Chloride (Cl)	00940	26.1	
45	mg/L	Nitrate (as NO3)	71850	14.8	
****	mg/L	Fluoride (F) Temp. Depend.	00951	0.6	0.1
Total Anions		Meq/L Value: 3.3			
	Std. Units	PH (Laboratory)	00403	8.5	
**	umho/cm**	Specific Conductance (E.C.)	00095	340.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	179.3	
	Units	Apparent Color (Unfiltered)	00081	< 70.0	
	TON	Odor Threshold at 60 C	00086	4.0	
	NTU	Lab Turbidity	82079	25.0	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

MW-32 Deep Med

INORGANIC CHEMICALS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	130.00	100.0
50	ug/L	Arsenic (As)	01002	17.00	10.0
1000	ug/L	Barium (Ba)	01007	<100.00	100.0
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.0
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.0
1000	ug/L	Copper (Cu)	01042	< 50.00	50.0
300	ug/L	Iron (Fe)	01045	4150.0	100.0
50	ug/L	Lead (Pb)	01051	< 5.00	5.0
50	ug/L	Manganese (Mn)	01055	100.00	30.0
2	ug/L	Mercury (Hg)	71900	< 1.00	1.0
10	ug/L	Selenium (Se)	01147	< 5.00	5.0
50	ug/L	Silver (Ag)	01077	< 10.00	10.0
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.0

RADIOACTIVITY ANALYSIS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.0
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.0
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.0
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.0
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.0
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329
1595 North "D" Street
San Bernardino, California 92405
(714) 885-3216

PURVEYOR: KREIGER & STEWART (IWVWD) SAMPLE I.D.#: 91-9499

STREET ADDRESS: DATE OF REPORT: 11/6/91

CITY,STATE,ZIP:

DESCRIPTION OF SAMPLING POINT: W 32 P-3 (1200') ** FILTERED **

DATE/TIME COLLECTED: 10/21/91 15:00 NAME OF SAMPLER: UNKNOWN

GENERAL MINERAL	RESULTS	UNITS	MCL
TOTAL HARDNESS	26.0	mg/L	
CALCIUM HARDNESS	16.0	mg/L	
CALCIUM	6.4	mg/L	
MAGNESIUM	2.4	mg/L	
SODIUM	58.2	mg/L	
POTASSIUM	2.0	mg/L	
TOTAL ALKALINITY	90.0	mg/L	
HYDROXIDE	< 1.0	mg/L	
CARBONATE	< 1.0	mg/L	
BICARBONATE	109.8	mg/L	
SULFATE	22.1	mg/L	
CHLORIDE	24.9	mg/L	
NITRATE	14.6	mg/L	45
FLUORIDE	0.7	mg/L	
TOTAL ANIONS	3.1	mEq/L	
TOTAL CATIONS	3.2	mEq/L	
RPD ANIONS/CATIONS	1.0	PERCENT	
pH	8.3	STD UNITS	
E.C.	330.0	umho/cm	
TDS	176.3	mg/L	
MBAS	< 0.02	mg/L	

G.M. CONT	RESULTS	UNITS	MCL
MANGANESE	65	ug/L	50
COPPER	< 50	ug/l	1000
IRON	3350	ug/L	300
ZINC	< 50	ug/L	5000

INORGANICS	RESULTS	UNITS	MCL
BARIUM	< 100	ug/L	1000
CHROMIUM	< 10	ug/L	50
CADMIUM	< 1	ug/L	10
LEAD	< 5	ug/l	50
ALUMINUM	< 100	ug/L	1000
MERCURY	< 1	ug/l	2
ARSENIC	< 10	ug/L	50
SELENIUM	< 5	ug/L	100
SILVER	< 10	ug/L	50

DATE(S) RECEIVED: 10/23/91 STARTED: 11/1/91 COMPLETED: 11/5/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST:__________ DIRECTOR: Carol Jolley

MW-32 Deep Med

CLINICAL\LABS SAN BERNARDINO
1595 NORTH "D" STREET
SAN BERNARDINO, CA. 92405

GENERAL MINERAL & PHYSICAL, INORGANIC, & RADIOLOGICAL CHEMICAL ANALYSIS

Date of Report: 10/25/91 Sample ID No. 91-9498

Laboratory Name: CLINICAL LABORATORIES OF SAN BERNARDINO Signature Lab Director: [signature]

Name of Sampler: BILL B. Employed By: ROTTMAN DRILLING CO.

Date/Time Sample Collected: 91/10/21/2200 Date/Time Sample Received @ Lab: 91/10/23/1700 Date Analyses Completed: 91/10/25

System Name: INDIAN WELLS VALLEY CWD - RIDGECREST System Number: 15-017

Name or Number of Sample Source: W32 P4 (1900 FT.)

* User ID: CYA Station Number: 000/000-00X00 4 *
* Date/Time of Sample: |91|10|21|2200| Laboratory Code: 3761 *
YY MM DD TTTT
* Date Analysis Completed: |91|10|25| *
YY MM DD
* Submitted by: ____________ Phone #: ____________ *

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	mg/L	Total Hardness (as CaCO3)	00900	26.0	
	mg/L	Calcium (Ca)	00916	7.4	
	mg/L	Magnesium (Mg)	00927	1.8	
	mg/L	Sodium (Na)	00929	190.5	
	mg/L	Potassium (K)	00937	4.1	
Total Cations		Meq/L Value: 8.9			
	mg/L	Total Alkalinity (AS CaCO3)	00410	198.0	
	mg/L	Hydroxide (OH)	71830	< 1.0	
	mg/L	Carbonate (CO3)	00445	< 1.0	
	mg/L	Bicarbonate (HCO3)	00440	241.6	
*	mg/L*	Sulfate (SO4)	00945	138.2	
*	mg/L*	Chloride (Cl)	00940	78.8	
45	mg/L	Nitrate (as NO3)	71850	1.0	
****	mg/L	Fluoride (F) Temp. Depend.	00951	5.6	0.1
Total Anions		Meq/L Value: 9.4			
	Std. Units	PH (Laboratory)	00403	8.6	
**	umho/cm**	Specific Conductance (E.C.)	00095	960.0	
***	mg/L***	Total Filterable Residue at 180C (TDS)	70300	526.4	
	Units	Apparent Color (Unfiltered)	00081	< 70.0	
	TON	Odor Threshold at 60 C	00086	1.0	
	NTU	Lab Turbidity	82079	74.0	
0.5	mg/L	MBAS	38260	< 0.02	

* 250-500-600 ** 900-1600-2200 *** 500-1000-1500 **** 1.4-2.4

MW-32 Deep

INORGANIC CHEMICALS

91-9498

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
1000	ug/L	Aluminum (Al)	01105	635.00	100.C
50	ug/L	Arsenic (As)	01002	61.00	10.C
1000	ug/L	Barium (Ba)	01007	<100.00	100.C
10	ug/L	Cadmium (Cd)	01027	< 1.00	1.C
50	ug/L	Chromium (Total Cr)	01034	< 10.00	10.C
1000	ug/L	Copper (Cu)	01042	< 50.00	50.C
300	ug/L	Iron (Fe)	01045	1550.0	100.C
50	ug/L	Lead (Pb)	01051	< 5.00	5.C
50	ug/L	Manganese (Mn)	01055	100.00	30.C
2	ug/L	Mercury (Hg)	71900	< 1.00	1.C
10	ug/L	Selenium (Se)	01147	< 5.00	5.C
50	ug/L	Silver (Ag)	01077	< 10.00	10.C
5000	ug/L	Zinc (Zn)	01092	< 50.00	50.C

RADIOACTIVITY ANALYSIS

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
15	PCi/L	Total Alpha	01501		
	PCi/L	Total Alpha Counting Error	01502		
50	PCi/L	Total Beta	03501		4.C
	PCi/L	Total Beta Counting Error	03502		
20	PCi/L	Natural Uranium	28012		2.C
	PCi/L	Total Radium 226	09501		0.5
	PCi/L	Total Radium 226 Counting Error	09502		
	PCi/L	Total Radium 228	11501		0.5
	PCi/L	Total Radium 228 Counting Error	11502		
5	PCi/L	Ra 226 + Ra 228	11503		
	PCi/L	Ra 226 + Ra 228 Counting Error	11504		
	PCi/L	Radon 222	82303		100.C
	PCi/L	Radon 222 Counting Error	82302		
20000	PCi/L	Total Tritium	07000		1.C
	PCi/L	Total Tritium Counting Error	07001		
8	PCi/L	Total Strontium - 90	13501		2.C
	PCi/L	Total Strontium - 90 Counting Error	13502		

ADDITIONAL ANALYSES

MCL	REPORTING UNITS	CONSTITUENT	ENTRY #	ANALYSES RESULTS	DLR
	NTU	Field Turbidity	82078		0.1
	C	Source Temperature C	00010		
		Langelier Index Source Temp.	71814		
		Langelier Index at 60 C	71813		
	Std. Units	Field PH	00400		
		Agressiveness Index	82383		
	mg/L	Silica	00955		
	mg/L	Phosphate	00650		
	mg/L	Iodide	71865		
		Sodium Absorption Ratio	00931		
		Asbestos	81855		
	mg/L	Boron	01020		

Clinical Laboratory of San Bernardino, Inc.

P. O. Box 329
1595 North "D" Street
San Bernardino, California 92405
(714) 885-3216

PURVEYOR: KRIEGER AND STEWART (IWVWD) SAMPLE I.D.#: SEE BELOW

STREET ADDRESS: DATE OF REPORT:10/31/91

CITY,STATE,ZIP:

DESCRIPTION OF SAMPLING POINT: SEE BELOW

DATE COLLECTED: 10/6/91 NAME OF SAMPLER: BILLY BONCHAIS

SAMPLE I.D.	SUPERNATE	MIXED	UNITS	MCL
91-9065	Fe = 460	Fe = 7740	mg/L	300
W32 P-1	Mn = <30	Mn = 3100	mg/L	50
(381')	Al = 1000	Al = 3699	mg/L	1000
91-9066	Fe = 1179	Fe = 1755	mg/L	300
W32 P-2	Mn = 35	Mn = 35	mg/L	50
(901')	Al = <100		mg/L	1000
91-9067	Fe = 818	Fe = 2852	mg/L	300
W32 P-3	Mn = 69	Mn = 51	mg/L	50
(1261')	Al = <100		mg/L	1000
91-9068	Fe = 1137	Fe = 3790	mg/L	300
P-4	Mn = 127	Mn = 226	mg/L	50

DATE(S) RECEIVED: 10/6/91 STARTED: 10/18/91 COMPLETED: 10/30/91

ALL ANALYSES ARE PERFORMED IN ACCORDANCE WITH APHA'S STANDARD METHODS, (17TH EDITION) OR EPA'S METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTE

ANALYST:______________________ DIRECTOR: Mehdi [signature]

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2606
China Lake, CA 93555-6001
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92
Date Received: 08/26/92
Laboratory No.: 7640-4

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-5, 08-25-92 @ 14:00
COLLECTED BY HASTING

SNO' ...
WA' ANALYSIS
(GENE... CHEMISTRY)

Constituents	Results	Units	D.L.R.	Method
Calcium	1.9	mg/L	0.1	SW-7140
Magnesium	1.0	mg/L	0.01	SW-7450
Sodium	3950.	mg/L	0.1	SW-7770
Potassium	25.	mg/L	0.1	SW-7610
Carbonate	1570.	mg/L	2.6	SM-403
Bicarbonate	1950.	mg/L	2.6	SM-403
Chloride	3040.	mg/L	1.8	EPA-300.0
Sulfate	46.	mg/L	5.	EPA-300.0
Nitrate as NO3	None Detected	mg/L	0.4	EPA-353.2
Fluoride	27.	mg/L	0.05	EPA-340.2
Bromide	6.6	mg/L	0.05	EPA-300.0
pH	9.7	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	15100.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	9890.	mg/L	10.	EPA-160.1
Ammonia as NH3	28.	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	None Detected	mg/L	0.10	EPA-353.2
Ortho-phosphate	8.4	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

M. Alencia
Department Supervisor

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2606
China Lake, CA 93555-6001
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92
Date Received: 08/26/92
Laboratory No.: 7640-4

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-5, 08-25-92 @ 14:00
COLLECTED BY HASTING

SNORT 850'-870'
WATER ANALYSIS
(METALS)

Constituents	Results	Units	D.L.R.	Method
Aluminum	578.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	5.2	µg/L	2.	SW-7060
Boron	93.5	mg/L	0.10	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lithium	50.	µg/L	10.	SW-7430
Manganese	36.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
* Selenium	None Detected	µg/L	10.	SW-7740
Si as SiO2	63.	mg/L	0.2	SW-6010
Strontium	72.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	54.	µg/L	10.	SW-6010
Total Iron	1940.	µg/L	50.	SW-6010

* Detection limit increased due to matrix interferences.

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2606
China Lake, CA 93555-6001
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92
Date Received: 08/26/92
Laboratory No.: 7640-3

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-4, 08-25-92 @ 8:00
COLLECTED BY HASTING

SNORT 3,300'-3,320'
WATER ANALYSIS
(GENERAL CHEMISTRY)

Constituents	Results	Units	D.L.R.	Method
Calcium	35.	mg/L	0.1	SW-7140
Magnesium	6.9	mg/L	0.01	SW-7450
Sodium	3900.	mg/L	0.1	SW-7770
Potassium	14.5	mg/L	0.1	SW-7610
Carbonate	109.	mg/L	2.6	SM-403
Bicarbonate	2530.	mg/L	2.6	SM-403
Chloride	3420.	mg/L	1.8	EPA-300.0
Sulfate	1170.	mg/L	5.	EPA-300.0
Nitrate as NO3	None Detected	mg/L	0.4	EPA-353.2
Fluoride	17.4	mg/L	0.05	EPA-340.2
Bromide	3.8	mg/L	0.05	EPA-300.0
pH	8.2	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	15900.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	9350.	mg/L	10.	EPA-160.1
Ammonia as NH3	11.6	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	None Detected	mg/L	0.10	EPA-353.2
Ortho-phosphate	0.84	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

M. Atencio
Department Supervisor

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2606
China Lake, CA 93555-6001
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92
Date Received: 08/26/92
Laboratory No.: 7640-3

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-4, 08-25-92 @ 8:00
COLLECTED BY HASTING

SNORT 3,300'-3,320'
WATER ANALYSIS
(METALS)

Constituents	Results	Units	D.L.R.	Method
Aluminum	1190.	μg/L	50.	SW-6010
Antimony	None Detected	μg/L	100.	SW-6010
Arsenic	62.	μg/L	2.	SW-7060
Boron	52.5	mg/L	0.10	SW-6010
Copper	None Detected	μg/L	10.	SW-6010
Lithium	1140.	μg/L	10.	SW-7430
Manganese	57.	μg/L	10.	SW-6010
Mercury	None Detected	μg/L	0.2	EPA-245.1
*Selenium	None Detected	μg/L	10.	SW-7740
Si as SiO_2	50.	mg/L	0.2	SW-6010
Strontium	1590.	μg/L	10.	SW-6010
Thallium	None Detected	μg/L	5.	SW-7841
Zinc	35.	μg/L	10.	SW-6010
Total Iron	3480.	μg/L	50.	SW-6010

* Detection limit increased due to matrix interferences.

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2606
China Lake, CA 93555-6001
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92
Date Received: 08/26/92
Laboratory No.: 7640-2

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-3, 08-24-92 @ 15:00
COLLECTED BY HASTING

SNORT 5,550'-5,570'
WATER ANALYSIS
(GENERAL CHEMISTRY)

Constituents	Results	Units	D.L.R.	Method
Calcium	4.6	mg/L	0.1	SW-7140
Magnesium	3.2	mg/L	0.01	SW-7450
Sodium	4920.	mg/L	0.1	SW-7770
Potassium	22.	mg/L	0.1	SW-7610
Carbonate	77.0	mg/L	2.6	SM-403
Bicarbonate	1270.	mg/L	2.6	SM-403
Chloride	5100.	mg/L	1.8	EPA-300.0
Sulfate	2080.	mg/L	5.	EPA-300.0
Nitrate as NO3	None Detected	mg/L	0.4	EPA-353.2
Fluoride	12.6	mg/L	0.05	EPA-340.2
Bromide	5.6	mg/L	0.05	EPA-300.0
pH	8.2	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	24000.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	12500.	mg/L	10.	EPA-160.1
Ammonia as NH3	11.4	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	None Detected	mg/L	0.10	EPA-353.2
Ortho-phosphate	0.44	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

[signature]
Department Supervisor

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2606
China Lake, CA 93555-6001
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92
Date Received: 08/26/92
Laboratory No.: 7640-2

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-3, 08-24-92 @ 15:00
COLLECTED BY HASTING

SNORT 5,550'-5,570'
WATER ANALYSIS
(METALS)

Constituents	Results	Units	D.L.R.	Method
Aluminum	741.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	57.	µg/L	2.	SW-7060
Boron	60.6	mg/L	0.10	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lithium	1550.	µg/L	10.	SW-7430
Manganese	36.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
* Selenium	None Detected	µg/L	10.	SW-7740
Si as SiO2	45.	mg/L	0.2	SW-6010
Strontium	3100.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	19.	µg/L	10.	SW-6010
Total Iron	806.	µg/L	50.	SW-6010

* Detection limit increased due to matrix interferences.

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

BC LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2606
China Lake, CA 93555-6001
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92
Date Received: 08/26/92
Laboratory No.: 7640-1

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-2, 08-24-92 @ 8:30
COLLECTED BY HASTING (P-2, 7,120-7140')

SNORT 7,120'-7,140'
WATER ANALYSIS
(GENERAL CHEMISTRY)

Constituents	Results	Units	D.L.R.	Method
Calcium	4.6	mg/L	0.1	SW-7140
Magnesium	3.2	mg/L	0.01	SW-7450
Sodium	3480.	mg/L	0.1	SW-7770
Potassium	9.3	mg/L	0.1	SW-7610
Carbonate	456.	mg/L	2.6	SM-403
Bicarbonate	2620.	mg/L	2.6	SM-403
Chloride	2460.	mg/L	1.8	EPA-300.0
Sulfate	910.	mg/L	5.	EPA-300.0
Nitrate as NO3	None Detected	mg/L	0.4	EPA-353.2
Fluoride	24.	mg/L	0.05	EPA-340.2
Bromide	2.9	mg/L	0.05	EPA-300.0
pH	8.9	pH Units	0.1	SW-9040
Electrical Conductivity @ 25 C	13500.	umhos/cm	1.	SW-9050
Total Dissolved Solids @ 180 C	8900.	mg/L	10.	EPA-160.1
Ammonia as NH3	14.6	mg/L	0.02	EPA-350.1
Nitrite Nitrogen	None Detected	mg/L	0.10	EPA-353.2
Ortho-phosphate	0.24	mg/L	0.10	EPA-365.1

D.L.R. = Detection Limit for Reporting purposes.

REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SM = "Standard Methods for Examination of Water and Wastewater", 16th Edition 1986.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

LABORATORIES

Naval Air Warfare Center
Weapons Division
Code 2606
China Lake, CA 93555-6001
Attn.: DR. MONASTERO 619-939-2700

Date Reported: 09/09/92
Date Received: 08/26/92
Laboratory No.: 7640-1

Sample Description: GEOTHERMAL PROGRAM - PROJECT #1 SNORT: SDW-1, P-2, 08-24-92 @ 8:30
COLLECTED BY HASTING

SNORT 7,120'-7,140'
WATER ANALYSIS
(METALS)

Constituents	Results	Units	D.L.R.	Method
Aluminum	1730.	µg/L	50.	SW-6010
Antimony	None Detected	µg/L	100.	SW-6010
Arsenic	80.	µg/L	2.	SW-7060
Boron	52.9	mg/L	0.10	SW-6010
Copper	None Detected	µg/L	10.	SW-6010
Lithium	560.	µg/L	10.	SW-7430
Manganese	98.	µg/L	10.	SW-6010
Mercury	None Detected	µg/L	0.2	EPA-245.1
* Selenium	None Detected	µg/L	10.	SW-7740
Si as SiO2	43.	mg/L	0.2	SW-6010
Strontium	350.	µg/L	10.	SW-6010
Thallium	None Detected	µg/L	5.	SW-7841
Zinc	46.	µg/L	10.	SW-6010
Total Iron	8960.	µg/L	50.	SW-6010

* Detection limit increased due to matrix interferences.

D.L.R. = Detection Limit for Reporting purposes.

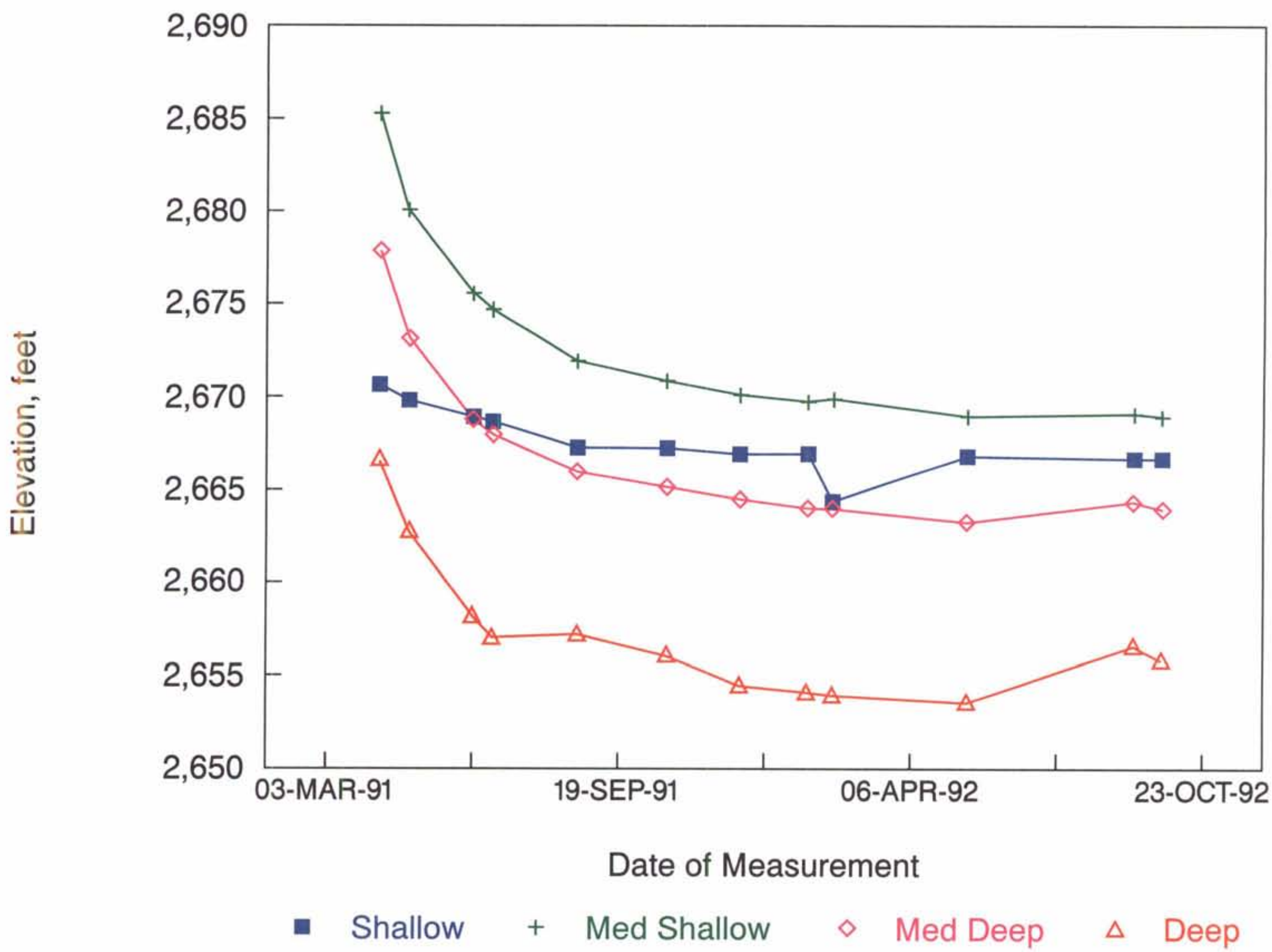
REFERENCES:
EPA = "Methods for Chemical Analysis of Water and Wastes", EPA-600, 14-79-020.
SW = "Test Methods for Evaluating Solid Wastes Physical/Chemical Methods", EPA-SW-846, September, 1986.

Department Supervisor

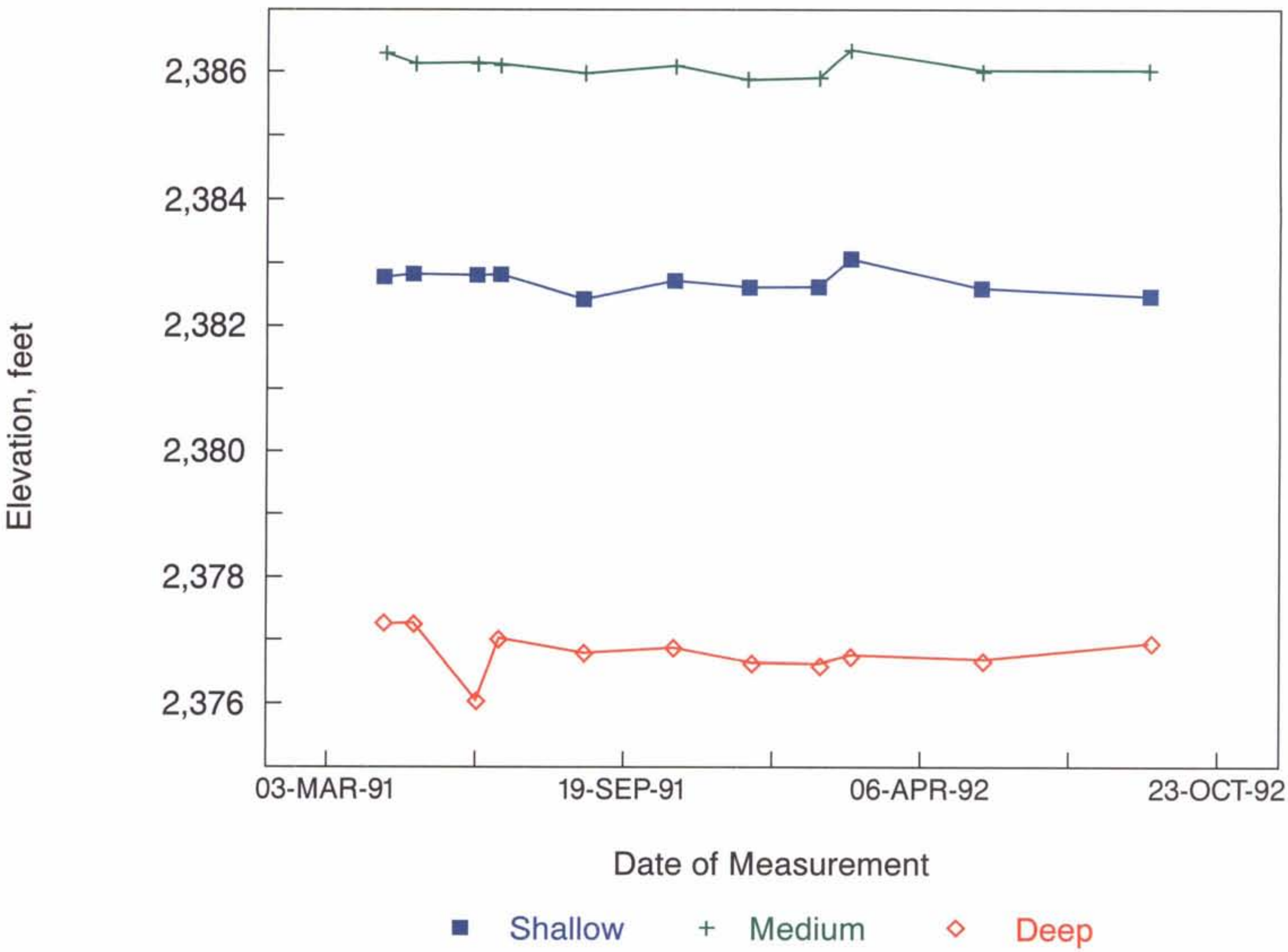
APPENDIX IX

Water Elevation Hydrographs

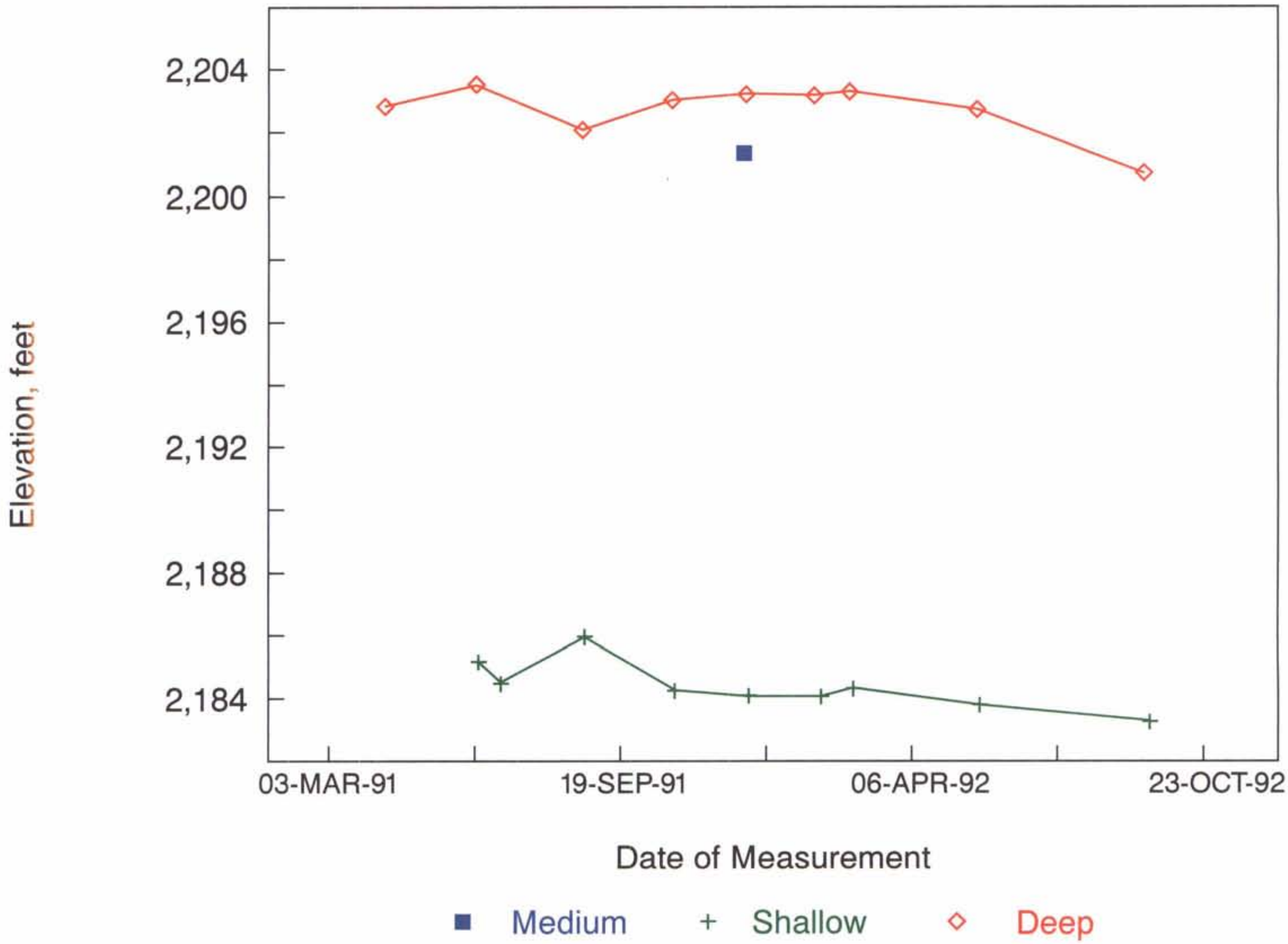
Well BR-1. Water elevation hydrograph.



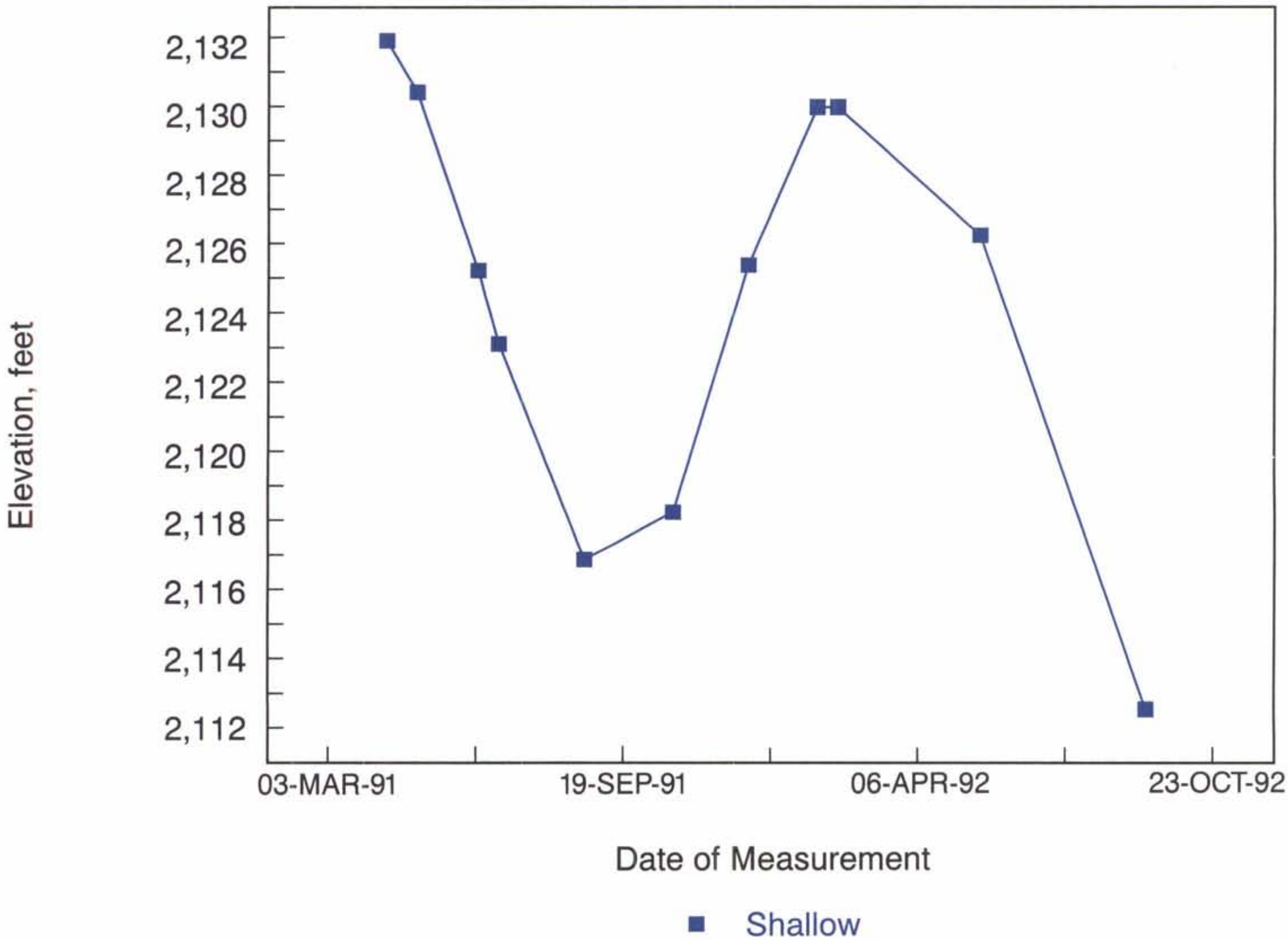
Well BR-2. Water elevation hydrograph.



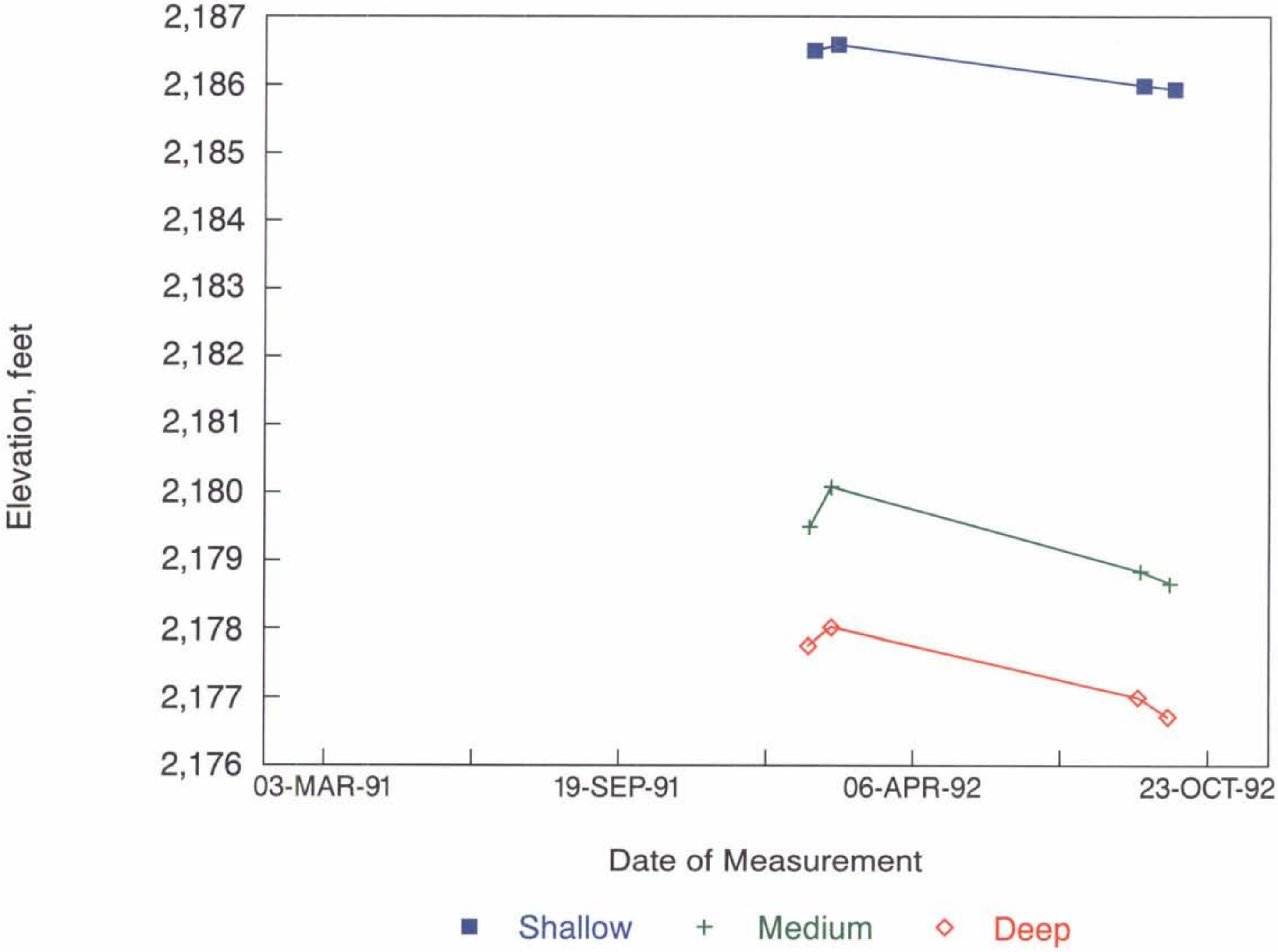
Well BR-3. Water elevation hydrograph.



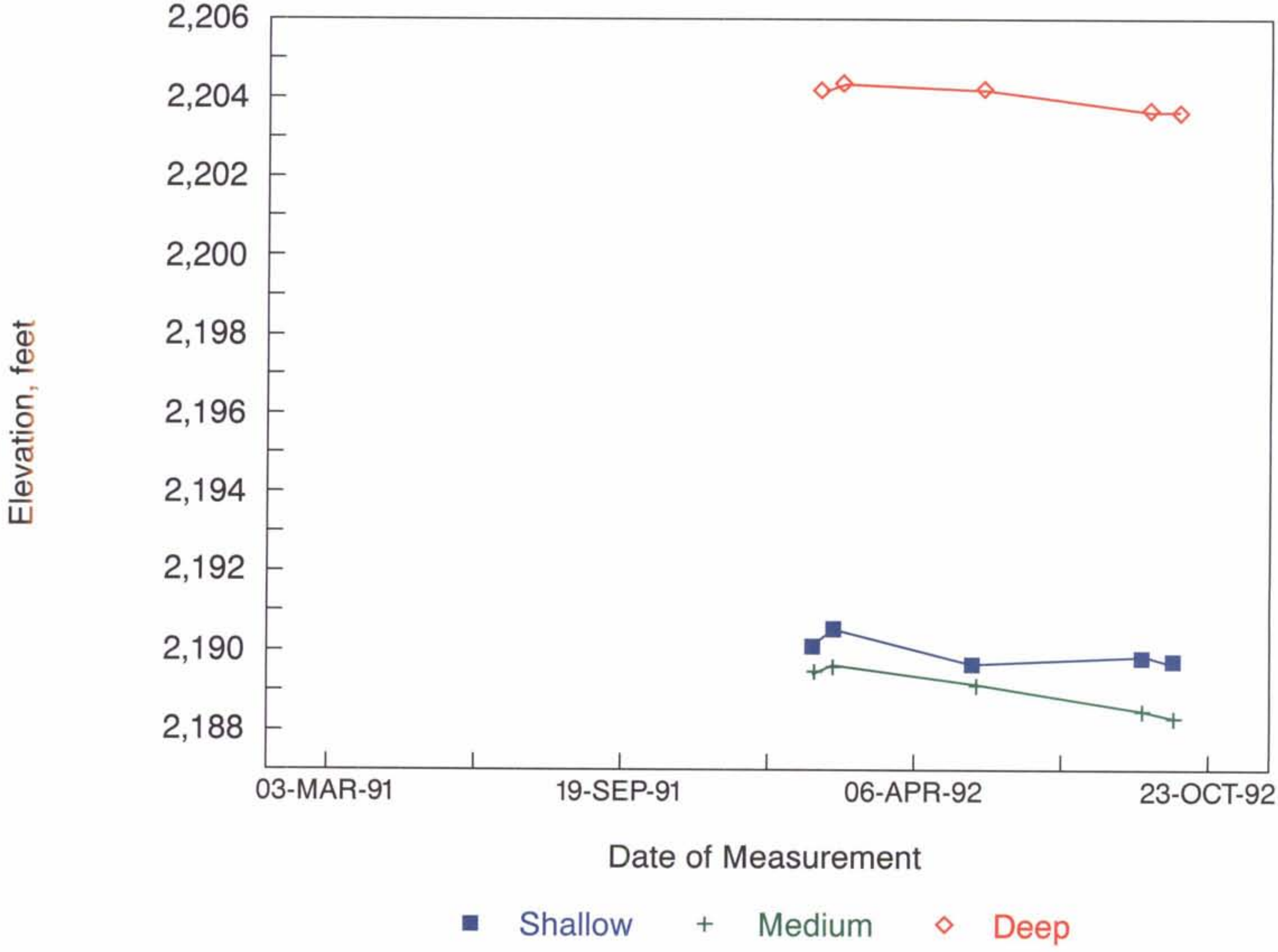
Well BR-4. Water elevation hydrograph.



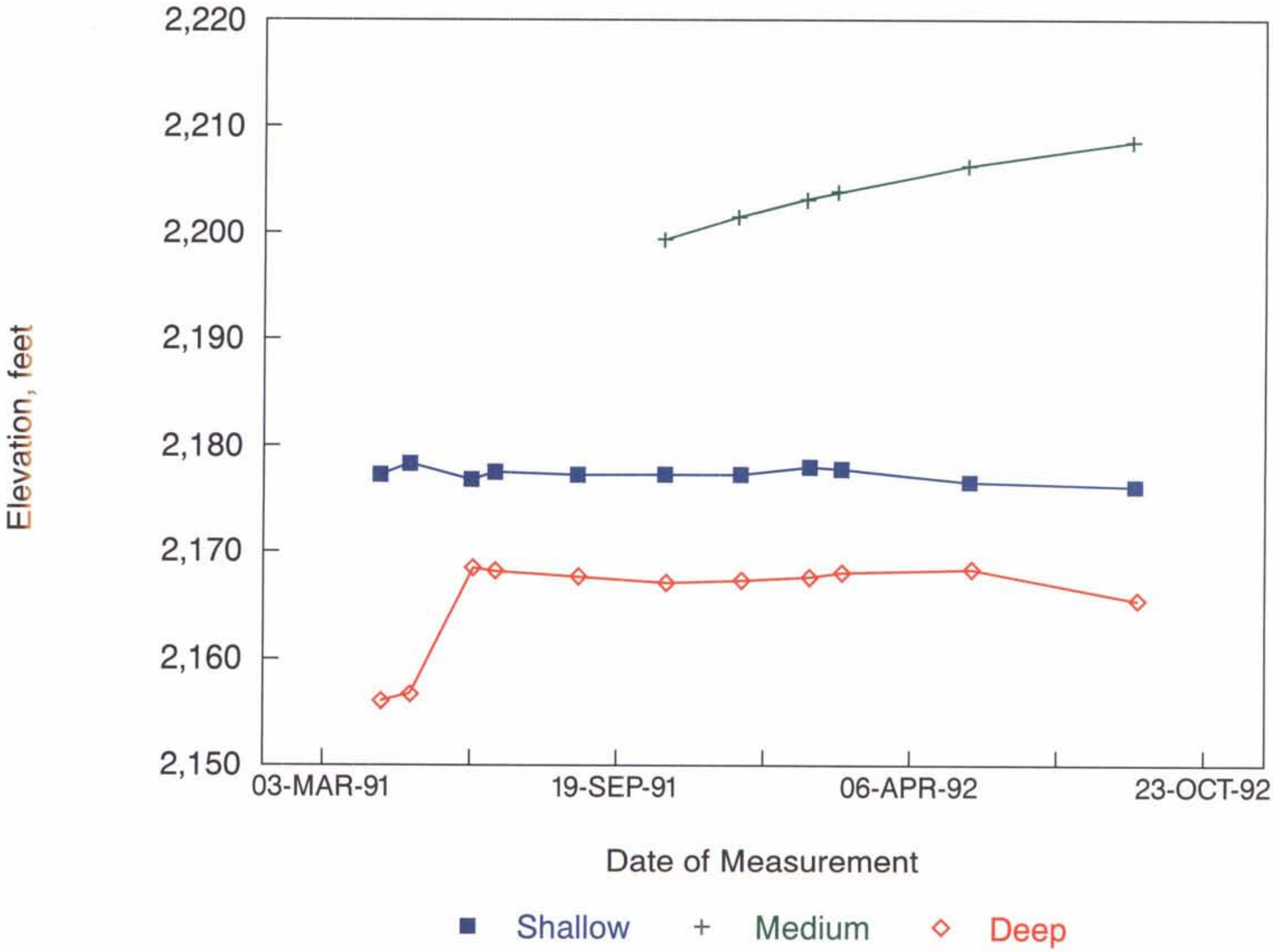
Well BR-5. Water elevation hydrograph.



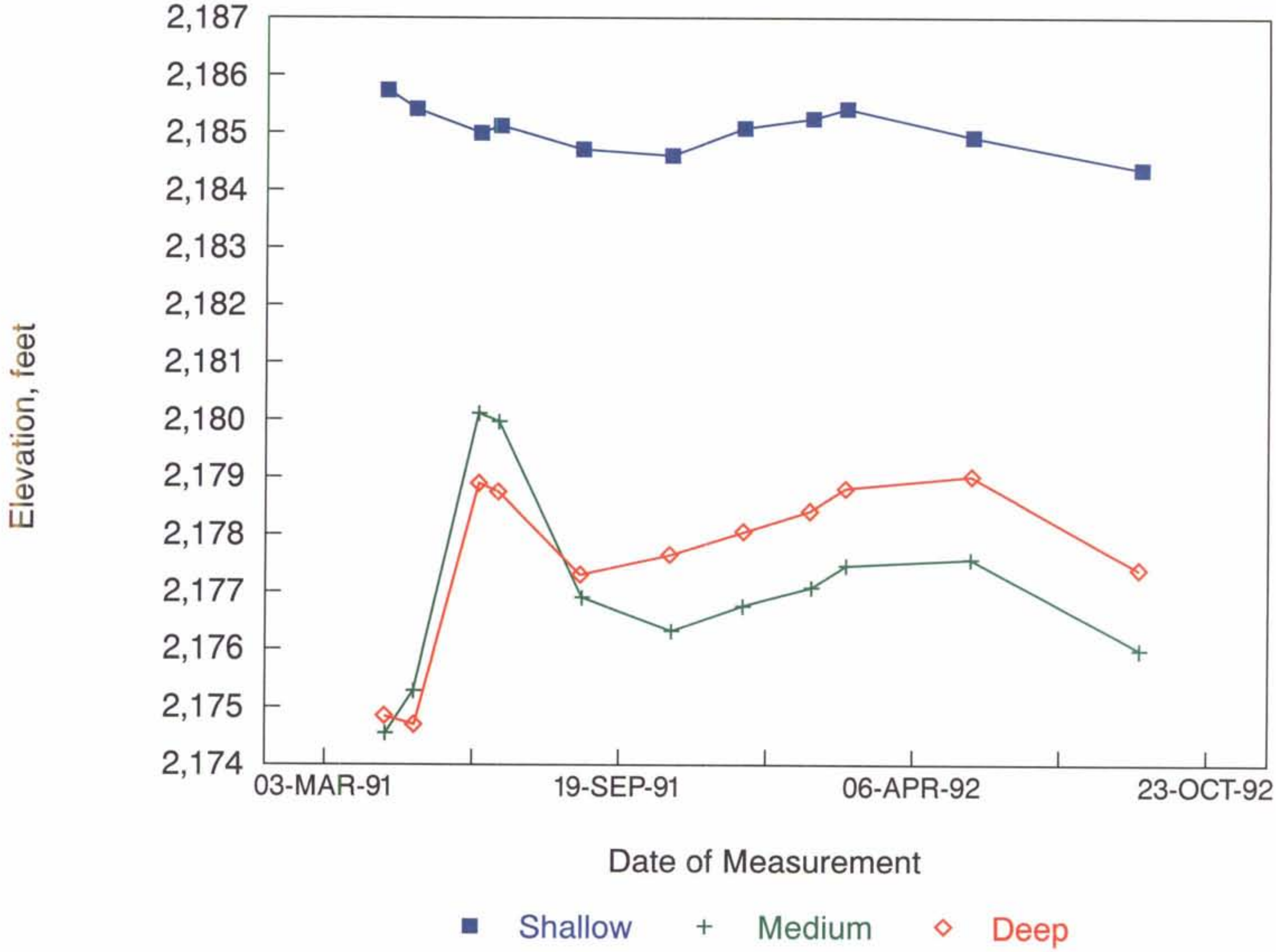
Well BR-6. Water elevation hydrograph.



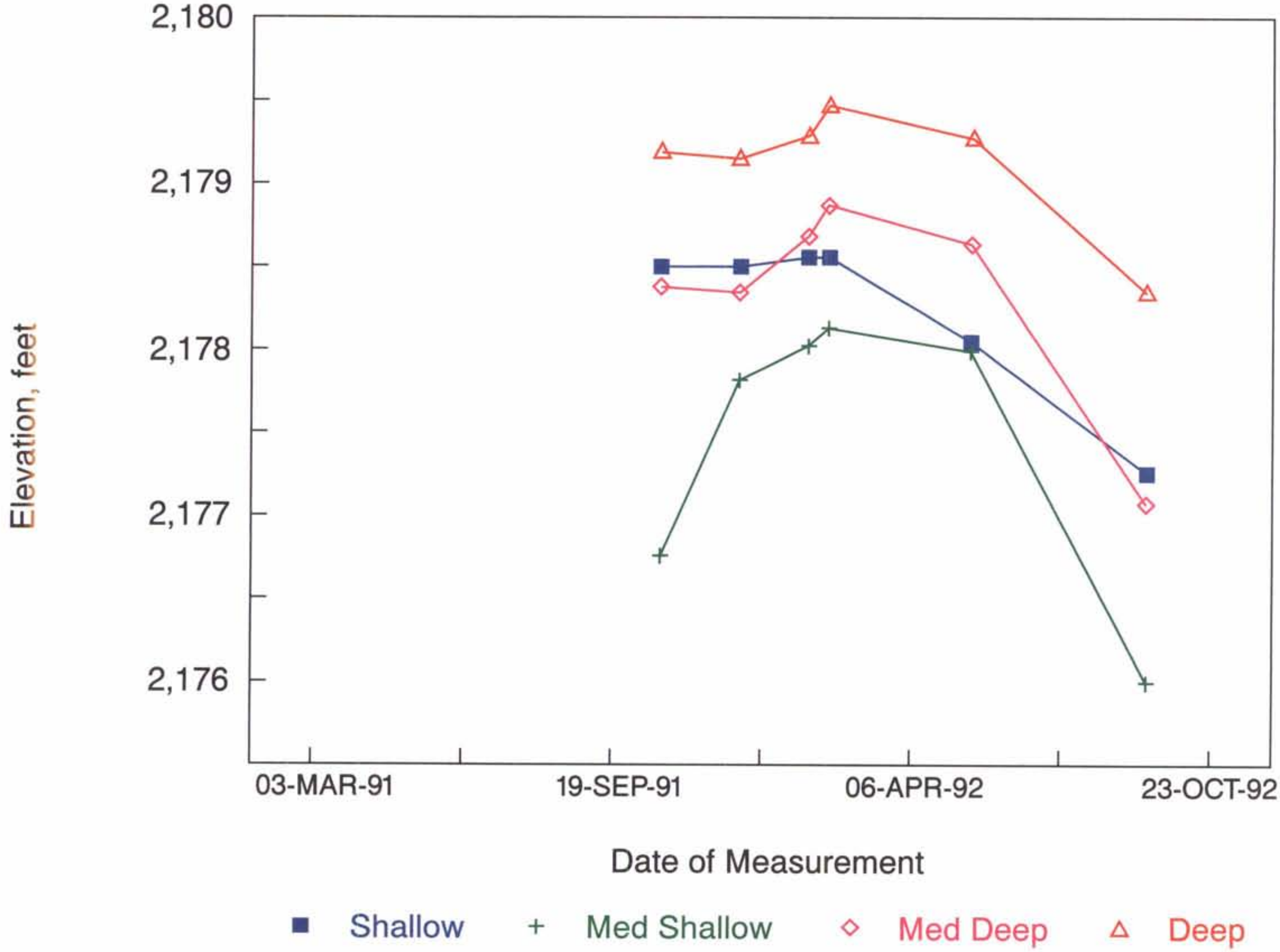
Well NR-1. Water elevation hydrograph.



Well NR-2. Water elevation hydrograph.



Well MW-32. Water elevation hydrograph.



APPENDIX X

Depth to Water Measurements

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on April 9, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	Comments	
BR-3	medium	(shal)	?		
	tall	(med)	?		
	short	(deep)	308.44		

Black oily coating on inside of pipe. Due to "skin friction" could only get sounder down to about 150-170 feet.

Well	Piezometer		Depth to Water	Comments	
BR-1	tall	(shal)	181.30	TOC to TOP -------->	.12
	next tall	(sh/med)	166.62	(Top of Casing to)	.25
	next short	(dp/med)	173.84	(Top of 2" pipe)	.36
	short	(deep)	184.96		.39
BR-2	tall(blue)	(shal)	275.9		.20
	(yellow)	(med)	272.13		.40
	(red)	(deep)	281.19		.42
NR-1	(red)	(shal)	94.14		.91
	(yellow)	(med)	4.0 psi (GAGE)		
	(white)	(deep)	111.51		.93
NR-2	tall	(shal)	131.72		.32
	medium	(med)	142.51		.59
	short	(deep)	141.98		.79
BR-4	10:20am		245.19		
	5:25pm		245.05		

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on April 29, 1991, by Dennis Watt and Bill Green using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	?		Could not get sounder down. Heavy black "oil" in pipes.
	tall	(med)	?		
	short	(deep)	?		
BR-1	tall	(shal)	182.18	.12	
	next tall	(sh/med)	171.80	.25	
	next short	(dp/med)	178.65	.36	
	short	(deep)	188.88	.39	
BR-2	tall (blue)	(shal)	275.84	.20	
	(yellow)	(med)	272.27	.40	
	(red)	(deep)	281.21	.42	
NR-1	(red)	(shal)	93.25	.91	
	(yellow)	(med)	4.5 psi (GAGE)		
	(white)	(deep)	110.84	.93	
NR-2	tall	(shal)	132.04	.32	
	medium	(med)	141.77	.59	
	short	(deep)	142.14	.79	
BR-4			246.67		

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on June 11, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	326.2		
	tall	(med)	?		Can't get sounder down
	short	(deep)	307.66		
BR-1	tall	(shal)	183.09	.12	
	next tall	(sh/med)	176.30	.25	
	next short	(dp/med)	183.00	.36	
	short	(deep)	193.37	.39	
BR-2	tall(blue)	(shal)	275.85	.20	
	(yellow)	(med)	272.30	.40	
	(red)	(deep)	282.41	.42	
NR-1	(red)	(shal)	94.58	.91	
	(yellow)	(med)	5.5 psi (GAGE)		
	(white)	(deep)	98.98	.93	
NR-2	tall	(shal)	132.48	.32	
	medium	(med)	136.92	.59	
	short	(deep)	137.95	.79	
BR-4			251.83		

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on June 24, 25, and 26, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	326.90		6-26
	tall	(med)	?		
	short	(deep)	?		
BR-1	tall	(shal)	183.38	.12	6-24
	next tall	(sh/med)	177.15	.25	
	next short	(dp/med)	183.83	.36	
	short	(deep)	194.51	.39	
BR-2	tall(blue)	(shal)	275.86	.20	6-26
	(yellow)	(med)	272.30	.40	
	(red)	(deep)	281.46	.42	
NR-1	(red)	(shal)	93.85	.91	6-26
	(yellow)	(med)	ZERO ? psi (GAGE)		
	(white)	(deep)	99.20	.93	
NR-2	tall	(shal)	132.33	.32	6-25
	medium	(med)	137.07	.59	
	short	(deep)	138.13	.79	
BR-4			253.98		6-25

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on August 22, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	325.4	Measure	Try chalk
	tall	(med)	?	next	next time
	short	(deep)	309.15	time!!	
BR-1	tall	(shal)	184.7	.12	
	next tall	(sh/med)	179.91	.25	
	next short	(dp/med)	185.53	.36	
	short	(deep)	194.49	.39	
BR-2	tall (blue)	(shal)	276.22	.20	
	(yellow)	(med)	272.45	.40	
	(red)	(deep)	281.66	.42	
NR-1	(red)	(shal)	94.11	.91	
	(yellow)	(med)	0 psi (GAGE)		
	(white)	(deep)	99.75	.93	
NR-2	tall	(shal)	132.72	.32	
	medium	(med)	140.12	.59	
	short	(deep)	139.52	.79	
BR-4			260.34		

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on October 22, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	327.07	.43	
	tall	(med)	?	.39	
	short	(deep)	308.18	.64	
BR-1	tall	(shal)	184.78	.12	
	next tall	(sh/med)	181.07	.25	
	next short	(dp/med)	186.42	.36	
	short	(deep)	195.68	.39	
BR-2	tall (blue)	(shal)	275.92	.20	
	(yellow)	(med)	272.32	.40	
	(red)	(deep)	281.57	.42	
NR-1	(red)	(shal)	94.15	.91	
	(yellow)	(med)	78.55?	Measure	
	(white)	(deep)	100.35	.93	
NR-2	tall	(shal)	132.82	.32	
	medium	(med)	140.70	.59	
	short	(deep)	139.18	.79	
MW-32	tall	(shal)	?	Measure!	
	next tall	(sh/med)	242.32	.42	
	next short	(dp/med)	240.63	.50	
	short	(deep)	239.65	.64	
BR-4			258.88		

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on December 12, 1991, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	327.20	.43	
	tall	(med)	310.	.39	
	short	(deep)	307.95	.64	
BR-1	tall	(shal)	184.97	.12	
	next tall	(sh/med)	181.81	.25	
	next short	(dp/med)	187.07	.36	
	short	(deep)	196.94	.39	
BR-2	tall(blue)	(shal)	276.02	.20	
	(red)	(med)	272.52	.40	
	(yellow)	(deep)	281.79	.42	
NR-1	(red)	(shal)	93.95	.91	
	(yellow)	(med)	76.51	.33	Valve top = TOP
	(white)	(deep)	100.11	.93	
NR-2	tall	(shal)	132.35	.32	
	medium	(med)	140.27	.59	
	short	(deep)	138.77	.79	
MW-32	tall	(shal)	240.7	.31	
	next tall	(sh/med)	241.25	.42	
	next short	(dp/med)	240.65	.50	
	short	(deep)	239.71	.64	
BR-4			251.70		

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on January 28, 1992, by Dennis Watt (USBR) and Mike Hasting (NWC Geothermal Office) using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	327.25	.43	Re-sound bottoms
	tall	(med)	?	.39	(Done 1-93)
	short	(deep)	308.04	.64	(tall = med piezo)
BR-1	tall	(shal)	185.04	.12	
	next tall	(sh/med)	182.23	.25	
	next short	(dp/med)	187.55	.36	
	short	(deep)	197.38	.39	
BR-2	tall(blue)	(shal)	276.02	.20	
	(yellow)	(med)	272.52	.40	Re-sound bottom
	(red)	(deep)	281.84	.42	
BR-5	tall	(shal)	334.75	.19	-Pressure equalization
	medium	(med)	341.51	.41	-(hiss) while unscrew-
	short	(deep)	343.05	.64	ing the cap!!
BR-6	tall	(shal)	163.56	.38	
	medium	(med)	163.88	.70	
	short	(deep)	148.81	1.08	
NR-2	tall	(shal)	132.20	.32	
	medium	(med)	139.96	.59	
	short	(deep)	138.42	.79	
NR-1	(red)	(shal)	93.41	.91	
	(yellow)	(med)	74.88	.33	Valve top = TOP
	(white)	(deep)	99.73	.93	
MW-32	tall	(shal)	240.64	.31	
	next tall	(sh/med)	241.06	.42	
	next short	(dp/med)	240.32	.50	
	short	(deep)	239.58	.64	
BR-4			247.11	Measure	

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements in mid-February 1992 by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	326.95	.43	Feb. 20
	tall	(med)	310+/-	.39	
	short	(deep)	307.92	.64	
BR-1	tall	(shal)	187.54	.12	Feb. 20
	next tall	(sh/med)	182.10	.25	
	next short	(dp/med)	187.56	.36	
	short	(deep)	197.64	.39	
BR-2	tall(blue)	(shal)	275.57	.20	Feb. 19
	(yellow)	(med)	272.07	.40	
	(red)	(deep)	281.68	.42	
BR-5	tall	(shal)	334.68	.19	Feb. 12
	medium	(med)	340.93	.41	
	short	(deep)	342.78	.64	
BR-6	tall	(shal)	163.13	.38	Feb. 11
	medium	(med)	163.71	.70	
	short	(deep)	148.63	1.08	
NR-2	tall	(shal)	132.02	.32	Feb. 20
	medium	(med)	139.57	.59	
	short	(deep)	138.02	.79	
NR-1	(red)	(shal)	93.65	.91	Feb. 20
	(yellow)	(med)	74.09	.33	
	(white)	(deep)	99.21	.93	
MW-32	tall	(shal)	240.64	.31	Feb. 11
	next tall	(sh/med)	240.94	.42	
	next short	(dp/med)	240.13	.50	
	short	(deep)	239.37	.64	
BR-4			247.11		

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on May 18 and 19, 1992, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)	327.52	.43	Re-sound bottoms
	tall	(med)	?	.39	(Done 1-93)
	short	(deep)	308.50	.64	(tall = med piezo)
BR-1	tall	(shal)	185.20	.12	
	next tall	(sh/med)	182.96	.25	
	next short	(dp/med)	188.38	.36	
	short	(deep)	198.08	.39	
BR-2	tall(blue)	(shal)	276.03	.20	
	(yellow)	(med)	272.40	.40	Re-sound bottoms
	(red)	(deep)	281.74	.42	
BR-5	tall	(shal)	______	.19	Different lock.
	medium	(med)	______	.41	Will cut next time.
	short	(deep)	______	.64	
BR-6	tall	(shal)	163.97	.38	
	medium	(med)	164.15	.70	
	short	(deep)	148.74	1.08	
NR-2	tall	(shal)	132.49	.32	
	medium	(med)	139.46	.59	
	short	(deep)	137.82	.79	
NR-1	(red)	(shal)	94.62	.91	
	(yellow)	(med)	71.65	.33	Valve top = TOP
	(white)	(deep)	98.95	.93	
MW-32	tall	(shal)	241.15	.31	
	next tall	(sh/med)	241.09	.42	
	next short	(dp/med)	240.40	.50	
	short	(deep)	239.58	.64	
BR-4			250.82	Measure	

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on September 10, 1992, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Elev TOP	Comments Water Elev
BR-3	medium	(shal)	328.03	.43	2511.43	2183.40
	tall	(med)	(310?)	.39	2511.48	2201.48
	short	(deep)	310.51	.64	2511.22	2200.71
BR-1	tall	(shal)	185.33	.12	2852.05	2666.72
	next tall	(sh/med)	182.88	.25	2851.91	2669.03
	next short	(dp/med)	187.38	.36	2851.80	2664.42
	short	(deep)	195.00	.39	2851.77	2656.77
BR-2	tall(blue)	(shal)	276.14	.20	2658.64	2382.50
	(yellow)	(med)	272.38	.40	2658.44	2386.06
	(red)	(deep)	281.48	.42	2658.42	2376.94
BR-5	tall	(shal)	335.26	.19	2521.28	2186.02
	medium	(med)	342.21	.41	2521.07	2178.86
	short	(deep)	343.80	.64	2520.84	2177.04
BR-10	tall	(shal)	307.63	.25	2561.14	2253.51
	next tall	(sh/med)	321.59	.42	2560.97	2239.38
	next short	(dp/med)	362.35	.54	2560.85	2198.50
	short	(deep)	364.62	.68	2560.71	2196.09
BR-6	tall	(shal)	163.85	.38	2353.75	2189.90
	medium	(med)	164.88	.70	2353.43	2188.55
	short	(deep)	149.30	1.08	2353.05	2203.75
NR-2	tall	(shal)	133.07	.32	2317.38	2184.31
	medium	(med)	141.08	.59	2317.11	2176.08
	short	(deep)	139.46	.79	2316.91	2177.45
NR-1	(red)	(shal)	95.18	.91	2271.67	2176.49
	(yellow)	(med)	69.48	.33	2278.26	2208.78
	(white)	(deep)	101.78	.93	2267.65	2165.87
MW-32	tall	(shal)	241.93	.31	~2418.69	2176.76
	next tall	(sh/med)	243.08	.42	~2418.58	2175.50
	next short	(dp/med)	241.92	.50	~2418.50	2176.58
	short	(deep)	240.51	.64	~2418.36	2177.85
BR-4			264.51	.27	2377.20	2112.69
SW Wells (SE Mon Well)			396.75		2582.82	2186.07

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on Sept 30 and Oct 1, 1992, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)		.43	Confirmed short s/u
	tall	(med)		.39	is deep piezo w/NACC
	short	(deep)		.64	thief sampler. Deep EC=11,450
BR-1	tall	(shal)	185.39	.12	Sept 30
	next tall	(sh/med)	183.04	.25	
	next short	(dp/med)	187.79	.36	
	short	(deep)	195.73	.39	
BR-2	tall(blue)	(shal)		.20	
	(yellow)	(med)		.40	Re-sound bottoms
	(red)	(deep)		.42	
BR-5	tall	(shal)	335.30	.19	Oct 1
	medium	(med)	342.39	.41	
	short	(deep)	344.08	.64	
BR-10	tall	(shal)	308.43	.25	
	next tall	(sh/med)	321.76	.42	
	next short	(dp/med)	362.14	.54	
	short	(deep)	363.95	.68	
BR-6	tall	(shal)	163.95	.38	
	medium	(med)	165.00	.70	
	short	(deep)	149.35	1.08	
NR-2	tall	(shal)		.32	
	medium	(med)		.59	
	short	(deep)		.79	
NR-1	(red)	(shal)		.91	
	(yellow)	(med)		.33	Valve top = TOP
	(white)	(deep)		.93	
MW-32	tall	(shal)		.31	
	next tall	(sh/med)		.42	
	next short	(dp/med)		.50	
	short	(deep)		.64	
BR-4				.27	

Sept 30, 1992

SW Wells	Mon #1 [E]	Wood? at ~ 341′	Muted thud sound
	Mon #2 [SE]	396.93	
	Prod Well	373.85	TOP (2" pipe)
	Mon #3 [S]	201.82	

April 7, 1989
(from Tom Field, Krieger and Stewart)

SW Wells	Mon #1	365.9	TOC
	Mon #2	392.4	"
	Mon #3	196.2	"

Indian Wells Valley Groundwater Project
Depth to Water Measurements

All measurements on January 5, 1993, by Dennis Watt using (the old) 1000 foot "twin-lead" electric sounder. All measurements are in feet from the top of each 2 inch piezometer pipe.

Well	Piezometer		Depth to Water	TOC to TOP	Comments
BR-3	medium	(shal)		.43	
	tall	(med)		.39	NACC test w/thief
	short	(deep)	319.2?	.64	tall = med piezo
BR-1	tall	(shal)	185.38	.12	
	next tall	(sh/med)	183.38	.25	
	next short	(dp/med)	188.18	.36	
	short	(deep)	196.27	.39	
BR-2	tall (blue)	(shal)	276.14	.20	
	(red)	(med)	272.48	.40	
	(yellow)	(deep)	281.68	.42	
BR-5	tall	(shal)	335.43	.19	
	medium	(med)	342.15	.41	
	short	(deep)	343.73	.64	
BR-10	tall	(shal)	307.70	.25	
	next tall	(sh/med)	322.80	.42	
	next short	(dp/med)	362.15	.54	
	short	(deep)	363.87	.68	
BR-6	tall	(shal)	163.08	.38	
	medium	(med)	164.85	.70	
	short	(deep)	149.63	1.08	
NR-2	tall	(shal)	132.68	.32	
	medium	(med)	140.81	.59	
	short	(deep)	139.22	.79	
NR-1	(red)	(shal)	95.21	.91	
	(yellow)	(med)	68.61	.33	Valve top = TOP
	(white)	(deep)	101.44	.93	
MW-32	tall	(shal)	241.77	.31	
	next tall	(sh/med)	241.98	.42	
	next short	(dp/med)	241.44	.50	
	short	(deep)	240.55	.64	
BR-4			250.00	.27	

SW Wells	Mon #1 [E]	Wood block at ~ 341′
	Mon #2 [SE]	397.20
	Prod Well	
	Mon #3 [S]	201.96

APPENDIX XI

Slug Test Data

BR-1 Shallow

SE2000
Environmental Logger
06/24 18:37

Unit# WATER:AD Test 7

Setups:	INPUT 1
Type	Level (F)
mode	TOC
I.D.	BR:1SHAL
Reference	183.380
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 06/24 18:20:23

	Elapsed Time	INPUT 1	
	0.0000	183.897	
	0.0083	183.897	
	0.0166	183.897	
	0.0250	193.217	
0	0.0333	202.565	17.073
	0.0416	200.638	[illegible]
.0167	0.0500	200.422	15.76
	0.0583	200.120	15.[illegible]
.0333	0.0666	198.796	14.234
	0.0750	198.193	13.[illegible]
.05003	0.0833	197.392	12.83
	0.1000	195.693	[illegible]
.0833	0.1166	194.227	[illegible]
	0.1333	193.106	[illegible]
.1167	0.1500	192.164	7.632
	0.1666	191.418	[illegible]
.15	0.1833	190.802	[illegible]
	0.2000	190.334	5.772
.1833	0.2166	189.872	[illegible]
	0.2333	189.466	4.904
.2167	0.2500	189.115	4.553
	0.2666	188.733	4.171
.25	0.2833	188.486	3.924
	0.3000	188.148	[illegible]
.2833	0.3166	187.901	3.339
	0.3333	187.624	3.062
.3833	0.4166	186.620	2.058
	0.5000	185.887	[illegible]
.55	0.5833	185.382	.82
	0.6666	185.031	[illegible]
.7167	0.7500	184.803	.241
	0.8333	184.723	.161
.8833	0.9166	184.741	[illegible]
	1.0000	184.735	.173
1.05	1.0833	184.667	.105
	1.1666	184.679	.117
1.2167	1.2500	184.661	[illegible]
	1.3333	184.618	.056
1.1133	1.4166	184.636	.074
	1.5000	184.636	.074
1.55	1.5833	184.630	[illegible]
	1.6666	184.630	[illegible]
1.7167	1.7500	184.624	.062
	1.8333	184.618	.056
1.8833	1.9166	184.605	.043
	2.0000	184.587	.025
	2.5000	184.593	
2.9667	3.0000	184.605	.043
	3.5000	184.575	
	4.0000	184.569	
4.4667	4.5000	184.569	.007
	5.0000	184.562	
	5.5000	184.569	
	6.0000	184.550	
6.4667	6.5000	184.562	0
	7.0000	184.544	
	7.5000	184.556	
	8.0000	184.562	
	8.5000	184.550	
	9.0000	184.556	
	9.5000	184.544	
	10.0000	184.544	
	12.0000	184.538	
	14.0000	184.532	
	16.0000	184.544	

END

BR-1 Shal/Med

SE2000
Environmental Logger
06/24 17:42

Unit# WATER:AD Test 6

Setups:	INPUT 1
Type	Level (F)
mode	TOC
I.D.	BR:1SMED
Reference	177.150
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 06/24 17:22:21

	Elapsed Time	INPUT 1	
	0.0000	177.150	
	0.0083	177.150	
	0.0166	177.150	
	0.0250	190.209	
0	0.0333	195.130	17.882
	0.0416	194.354	17.[illegible]
.0167	0.0500	193.498	16.25
	0.0583	193.670	16.42
.0333	0.0666	192.931	15.[illegible]
	0.0750	192.161	14.[illegible]
.05003	0.0833	191.767	[illegible]
	0.1000	190.166	12.[illegible]
.0833	0.1166	188.860	[illegible]
	0.1333	187.370	[illegible]
.1167	0.1500	186.082	[illegible]
	0.1666	184.807	7.559
.15	0.1833	183.711	[illegible]
	0.2000	182.688	[illegible]
.1833	0.2166	181.813	[illegible]
	0.2333	181.062	[illegible]
.2167	0.2500	180.396	3.148
	0.2666	179.867	2.[illegible]
.25	0.2833	179.398	[illegible]
	0.3000	179.053	1.805
.2833	0.3166	178.745	1.497
	0.3333	178.530	[illegible]
.3833	0.4166	178.006	.758
	0.5000	177.987	[illegible]
.55	0.5833	178.000	.752
	0.6666	177.944	[illegible]
.7167	0.7500	177.852	.604
	0.8333	177.772	.524
.8833	0.9166	177.673	.425
	1.0000	177.630	.382
1.05	1.0833	177.599	.351
	1.1666	177.568	.32
1.2167	1.2500	177.544	.296
	1.3333	177.519	.271
1.1133	1.4166	177.501	.253
	1.5000	177.482	.234
1.55	1.5833	177.464	.216
	1.6666	177.445	.197
1.7167	1.7500	177.433	.185
	1.8333	177.414	.166
1.8833	1.9166	177.414	.166
	2.0000	177.402	.154
	2.5000	177.347	
2.9667	3.0000	177.322	.074
	3.5000	177.297	
3. "	4.0000	177.279	.031
	4.5000	177.273	
4. "	5.0000	177.267	.019
	5.5000	177.260	
5.9667	6.0000	177.248	0
	6.5000	177.248	
	7.0000	177.254	
	7.5000	177.236	
	8.0000	177.242	
	8.5000	177.242	
	9.0000	177.236	
	9.5000	177.236	
	10.0000	177.230	
	12.0000	177.230	
	14.0000	177.217	
	16.0000	177.230	
	18.0000	177.211	

END

06/24 16:44

BR-1 Deep/Med

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR1DMED

Reference	183.830
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 06/24 16:18:43

	Elapsed Time	INPUT 1	
	0.0000	183.614	
	0.0083	183.614	
	0.0166	183.614	
	0.0250	183.626	
	0.0333	199.870	
	0.0416	198.020	
	0.0500	200.000	
	0.0583	199.236	
	0.0666	198.959	
0	0.0750	199.193	15.491
	0.0833	198.780	
.025	0.1000	198.602	14.89
	0.1166	198.263	
.0583	0.1333	198.029	14.317
	0.1500	197.819	
.0916	0.1666	197.585	13.872
	0.1833	197.376	
.125	0.2000	197.142	13.43
	0.2166	196.945	
.1583	0.2333	196.735	13.023
	0.2500	196.544	
.1916	0.2666	196.341	12.629
	0.2833	196.163	
.225	0.3000	195.978	12.206
	0.3166	195.799	
.2583	0.3333	195.608	11.896
	0.4166	194.783	
.425	0.5000	194.038	10.326
	0.5833	193.335	
.5916	0.6666	192.726	9.014
	0.7500	192.171	
.7583	0.8333	191.672	7.96
	0.9166	191.186	
.925	1.0000	190.754	7.042
	1.0833	190.360	
1.0916	1.1666	189.990	6.178
	1.2500	189.639	
1.2583	1.3333	189.362	5.65
	1.4166	189.054	
1.425	1.5000	188.789	5.077
	1.5833	188.530	
1.5916	1.6666	188.303	4.591
	1.7500	188.081	
1.7582	1.8333	187.896	4.184
	1.9166	187.711	
1.925	2.0000	187.532	3.82
	2.5000	186.695	
2.925	3.0000	186.140	2.428
	3.5000	185.758	
3.925	4.0000	185.468	1.756
	4.5000	185.247	
4.	5.0000	185.080	1.368
	5.5000	184.932	
5.	6.0000	184.809	1.097
	6.5000	184.704	
6.	7.0000	184.624	.912
	7.5000	184.532	
7.	8.0000	184.476	.764
	8.5000	184.396	
8.	9.0000	184.347	.635
	9.5000	184.279	
9.	10.0000	184.230	.518
	12.0000	184.070	
13.925	14.0000	183.959	.247
	16.0000	183.873	
17.	18.0000	183.811	.099
	20.0000	183.768	
19.925	22.0000	183.743	.031
23. "	24.0000	183.712	0

END

06/24 14:59

BR-1 Deep

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR1DEEP

Reference	210.000
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 06/24 14:23:36

	Elapsed Time	INPUT 1	
	0.0000	210.147	
	0.0083	210.147	
	0.0166	210.147	
	0.0250	218.651	
	0.0333	226.599	
	0.0416	224.936	
	0.0500	225.207	
	0.0583	225.207	
	0.0666	224.843	
0	0.0750	225.090	14.596
	0.0833	224.831	
.025	0.1000	224.825	14.771
	0.1166	224.665	
.0583	0.1333	224.640	14.686
	0.1500	224.609	
.0916	0.1666	224.566	14.012
	0.1833	224.486	
.125	0.2000	224.387	13.873
	0.2166	224.336	
.1583	0.2333	224.264	13.7
	0.2500	224.215	
.1916	0.2666	224.153	13.605
	0.2833	224.098	
.225	0.3000	224.042	13.438
	0.3166	223.981	
.2583	0.3333	223.919	13.365
	0.4166	223.642	
.425	0.5000	223.365	12.811
	0.5833	223.112	
.5916	0.6666	222.860	12.306
	0.7500	222.625	
.7583	0.8333	222.385	11.831
	0.9166	222.163	
.925	1.0000	221.948	11.394
	1.0833	221.738	
1.0916	1.1666	221.535	10.951
	1.2500	221.338	
1.2583	1.3333	221.147	10.593
	1.4166	220.950	
1.425	1.5000	220.777	10.223
	1.5833	220.598	
1.5916	1.6666	220.426	9.572
	1.7500	220.253	
1.7583	1.8333	220.106	9.[illegible]
	1.9166	219.952	
1.925	2.0000	219.791	9.277
	2.5000	218.935	
2.925	3.0000	218.159	7.605
	3.5000	217.462	
3.925	4.0000	216.871	6.317
	4.5000	216.347	
4.925	5.0000	215.854	5.3
	5.5000	215.423	
5.925	6.0000	215.022	4.468
	6.5000	214.659	
6.925	7.0000	214.332	3.778
	7.5000	214.018	
7.925	8.0000	213.740	3.186
	8.5000	213.475	
8.925	9.0000	213.241	2.687
	9.5000	213.019	
9.925	10.0000	212.828	2.274
	12.0000	212.144	
13.925	14.0000	211.688	1.134
	16.0000	211.362	
17.925	18.0000	211.115	.561
	20.0000	210.949	
21.925	22.0000	210.832	.278
	24.0000	210.739	
25.925	26.0000	210.665	.111
	28.0000	210.622	
29.925	30.0000	210.585	.031
31.925	32.0000	210.554	0

END

BR-2 Shallow

SE2000
Environmental Logger
05/31 09:34

Unit# SE2000	Test 5
Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR2BLUE
Reference	275.000
SG	1.000
Linearity	0.000
Scale factor	10.041
Offset	-0.023
Delay mSEC	50.000

Step 0 05/31 09:27:35

	Elapsed Time	INPUT 1	
	0.0000	276.773	
	0.0083	276.065	
	0.0166	275.590	
	0.0250	275.409	
	0.0333	275.342	
	0.0416	275.320	
	0.0500	275.234	
	0.0583	275.180	
	0.0666	275.069	
	0.0750	274.923	
	0.0833	274.930	
	0.1000	274.828	
	0.1166	274.730	
	0.1333	274.603	
	0.1500	274.457	
	0.1666	274.295	
	0.1833	274.225	
	0.2000	274.137	
	0.2166	273.918	
	0.2333	273.981	
	0.2500	274.003	
	0.2666	273.940	
	0.2833	274.000	
	0.3000	274.003	
	0.3166	274.143	
	0.3333	274.162	
0	0.4166	274.324	3.309
	0.5000	274.533	3.100
.1667	0.5833	274.765	2.869
	0.6666	274.911	2.722
.3334	0.7500	275.057	2.576
	0.8333	275.158	2.475
.5	0.9166	275.266	2.367
	1.0000	275.250	2.383
.6667	1.0833	275.342	2.291
	1.1666	275.440	2.193
.8334	1.2500	275.494	2.139
	1.3333	275.507	2.126
1.0	1.4166	275.320	2.313
	1.5000	275.450	2.183
1.1667	1.5833	275.536	2.097
	1.6666	275.599	2.034
1.3394	1.7500	275.675	1.958
	1.8333	275.640	1.993
1.5	1.9166	275.723	1.910
	2.0000	275.793	1.840
2.0834	2.5000	276.395	1.238
	3.0000	276.798	.835
3.0834	3.5000	277.090	.543
	4.0000	277.382	.251
4.0834	4.5000	277.633	0

END

BR-2 Medium

SE2000
Environmental Logger
05/29 17:22

Unit# SE2000	Test 6
Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR2YELLO
Reference	100.000
SG	1.000
Linearity	0.000
Scale factor	10.041
Offset	-0.023
Delay mSEC	50.000

Step 0 05/29 16:50:13

	Elapsed Time	INPUT 1		
	0.0000	99.384		
	0.0083	110.276		
	0.0166	116.113		
0	0.0250	116.814	[illegible]	6.326
	0.0333	115.809	[illegible]	
.0166	0.0416	116.224	[illegible]	15.736
	0.0500	115.495		
.0333	0.0583	115.409	[illegible]	14.921
	0.0666	114.930	[illegible]	
.05	0.0750	114.508		14.02
	0.0833	114.149		
.075	0.1000	113.178		12.69
	0.1166	112.090		
.1083	0.1333	111.015		10.527
	0.1500	109.939		
.1416	0.1666	108.873		[illegible]
	0.1833	107.890		
.175	0.2000	106.954	[illegible]	6.466
	0.2166	106.275	[illegible]	
.2083	0.2333	105.295	94.91	[illegible]
	0.2500	104.559	95.44	
.2416	0.2666	103.918	[illegible]	[illegible]
	0.2833	103.353	96.65	
.275	0.3000	102.845	97.16	2.357
	0.3166	102.395	97.61	
.3083	0.3333	102.030	97.97	1.542
	0.4166	100.926	99.07	
.475	0.5000	100.501	99.5	[illegible]
.5523	0.5833	100.488		0
	0.6666	100.567		
	0.7500	100.618		
	0.8333	100.571		
	0.9166	100.488		
	1.0000	100.396		
	1.0833	100.317		
	1.1666	100.234		
	1.2500	100.187		
	1.3333	100.152		
	1.4166	100.111		
	1.5000	100.098		
	1.5833	100.069		
	1.6666	100.050		
	1.7500	100.031		
	1.8333	100.003		
	1.9166	99.993		
	2.0000	99.965		
	2.5000	100.019		
	3.0000	100.003		
	3.5000	99.987		
	4.0000	99.968		
	4.5000	99.949		
	5.0000	100.000		
	5.5000	99.895		
	6.0000	99.873		
	6.5000	99.854		
	7.0000	99.838		

END

BR-2 Deep

SE2000
Environmental Logger
05/31 10:14

Unit# SE2000   Test 7

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR2RED
Reference	272.000
SG	1.000
Linearity	0.000
Scale factor	10.041
Offset	-0.023
Delay mSEC	50.000

Step 0 05/31 10:05:50

	Elapsed Time	INPUT 1	
	0.0000	272.117	
	0.0083	271.178	
	0.0166	270.553	
	0.0250	270.185	
	0.0333	269.966	
	0.0416	269.848	
	0.0500	269.722	
	0.0583	269.620	
	0.0666	269.595	
	0.0750	269.506	
	0.0833	269.407	
	0.1000	269.312	
	0.1166	269.214	
	0.1333	269.122	
	0.1500	269.046	
	0.1666	268.989	
	0.1833	268.884	
	0.2000	268.786	
	0.2166	268.735	
	0.2333	268.729	
	0.2500	268.640	
	0.2666	268.570	
	0.2833	268.586	
	0.3000	268.545	
	0.3166	268.529	
	0.3333	268.513	
	0.4166	268.827	
0	0.5000	269.081	2.919
	0.5833	269.274	2.726
.1666	0.6666	269.401	[illegible]
	0.7500	269.480	[illegible]
.3333	0.8333	269.598	[illegible]
	0.9166	269.687	[illegible]
.5	1.0000	269.826	[illegible]
	1.0833	269.890	[illegible]
.6666	1.1666	269.934	2.066
	1.2500	269.985	2.015
.8333	1.3333	270.086	1.914
	1.4166	270.102	1.898
1.0	1.5000	270.125	1.875
	1.5833	270.156	1.844
1.1666	1.6666	270.191	1.809
	1.7500	270.191	1.809
1.3333	1.8333	270.220	1.78
	1.9166	270.210	1.79
1.5	2.0000	270.293	1.707
	2.5000	270.832	1.168
2.5	3.0000	271.124	.876
	3.5000	271.371	.629
3.5	4.0000	271.533	.467
	4.5000	271.695	.305
4.5	5.0000	271.803	.197
	5.5000	271.882	.118
5.5	6.0000	272.000	0
	6.5000	272.079	
	7.0000	272.161	
	7.5000	271.838	
	8.0000	271.698	

END

BR-3 Shallow

SE2000
Environmental Logger
06/26 09:22

Unit# WATER:AD Test 2

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR:3~~DEE~~ SHAL
Reference	326.200
SG	1.000
Linearity	0.000
Scale factor	10.003
Offset	-0.020
Delay mSEC	50.000

Step 0 06/26 09:15:08

	Elapsed Time	INPUT 1	
	0.0000	326.200	
	0.0083	326.200	
	0.0166	326.200	
	0.0250	327.965	
	0.0333	335.868	
0	0.0416	338.590	12.39
	0.0500	337.951	
.0167	0.0583	336.851	10.651
	0.0666	336.721	
.0334	0.0750	335.523	9.323
	0.0833	335.014	
.0584	0.1000	333.656	7.456
	0.1166	332.922	
.0917	0.1333	332.410	6.21
	0.1500	332.009	
.125	0.1666	331.677	5.477
	0.1833	331.392	
.1584	0.2000	331.121	4.921
	0.2166	330.849	
.1917	0.2333	330.583	4.383
	0.2500	330.330	
.225	0.2666	330.097	3.897
	0.2833	329.869	
.2584	0.3000	329.654	3.454
	0.3166	329.445	
.2917	0.3333	329.253	3.053
	0.4166	328.393	
.4584	0.5000	327.654	[illegible]
	0.5833	327.141	
.625	0.6666	326.702	.502
	0.7500	326.354	
.7917	0.8333	326.200	0
	0.9166	326.200	
	1.0000	326.200	
	1.0833	326.200	
	1.1666	326.200	
	1.2500	326.200	
	1.3333	326.200	
	1.4166	326.200	
	1.5000	326.200	
	1.5833	326.200	
	1.6666	326.200	
	1.7500	326.200	
	1.8333	326.200	
	1.9166	326.200	
	2.0000	326.200	
	2.5000	326.200	
	3.0000	326.200	
	3.5000	326.200	
	4.0000	326.200	
	4.5000	326.200	
	5.0000	326.200	
	5.5000	326.200	
	6.0000	326.200	
	6.5000	326.200	

END

BR-3 Medium

Elapsed Time	INPUT 1
0.0000	325.745
0.0083	325.749
0.0166	336.201
0.0250	341.122
0.0333	341.204
0.0416	340.534
0.0500	341.251
0.0583	340.698
0.0666	340.573
0.0750	340.945
0.0833	340.799
0.1000	340.825
0.1166	340.900
0.1333	340.916
0.1500	340.894
0.1666	340.872
0.1833	340.869
0.2000	340.872
0.2166	340.872
0.2333	340.869
0.2500	340.866
0.2666	340.859
0.2833	340.859
0.3000	340.859
0.3166	340.859
0.3333	340.856
0.4166	340.850
0.5000	340.847
0.5833	340.843
0.6666	340.840
0.7500	340.837
0.8333	340.837
0.9166	340.834
1.0000	340.834
1.0833	340.831
1.1666	340.828
1.2500	340.828
1.3333	340.825
1.4166	340.825
1.5000	340.821
1.5833	340.821
1.6666	340.818
1.7500	340.818
1.8333	340.815
1.9166	340.815
2.0000	340.815
2.5000	340.809
3.0000	340.802
3.5000	340.799
4.0000	340.796
4.5000	340.793
5.0000	340.793
5.5000	340.790
6.0000	340.787
6.5000	340.787
7.0000	340.783
7.5000	340.780
8.0000	340.777
8.5000	340.777
9.0000	340.774
9.5000	340.774
10.0000	340.771
12.0000	340.771
14.0000	340.771
16.0000	340.768
18.0000	340.768
20.0000	340.768
22.0000	340.761
24.0000	340.761
26.0000	340.764
28.0000	340.758
30.0000	340.758
32.0000	340.755
34.0000	340.755
36.0000	340.758
38.0000	340.755
40.0000	340.752
42.0000	340.752
44.0000	340.749
46.0000	340.755
48.0000	340.745
50.0000	340.749
52.0000	340.745
54.0000	340.745
56.0000	340.745
58.0000	340.745
60.0000	340.739
62.0000	340.742
64.0000	340.742

END

BR-3 Deep

SE2000
Environmental Logger
06/26 11:57

Unit# WATER:AD Test 4

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR:3DEEP
Reference	307.000
SG	1.000
Linearity	0.000
Scale factor	0.003
Offset	-0.020
Delay mSEC	50.000

Step 0 06/26 11:22:05

	Elapsed Time	INPUT 1	
	0.0000	304.999	
	0.0083	305.002	
	0.0166	305.002	
	0.0250	314.452	
	0.0333	320.552	
	0.0416	321.785	
	0.0500	320.682	
	0.0583	321.235	
	0.0666	320.969	
	0.0750	320.795	
0	0.0833	321.023	12.456
	0.1000	320.865	
.0333	0.1166	320.723	12.356
	0.1333	320.694	
.0667	0.1500	320.704	12.[illegible]37
	0.1666	320.675	
.1	0.1833	320.616	12.051
	0.2000	320.571	
.1333	0.2166	320.533	[illegible]
	0.2333	320.499	
.1667	0.2500	320.464	11.977
	0.2666	320.426	
.2	0.2833	320.388	[illegible]
	0.3000	320.353	
.2333	0.3166	320.315	11.712
	0.3333	320.280	
.3333	0.4166	320.103	11.576
	0.5000	319.933	
.5	0.5833	319.768	11.221
	0.6666	319.604	
.6667	0.7500	319.443	10.376
	0.8333	319.288	
.8333	0.9166	319.133	10.566
	1.0000	318.981	
1.0	1.0833	318.833	10.266
	1.1666	318.684	
1.1667	1.2500	318.539	9.972
	1.3333	318.397	
1.3333	1.4166	318.254	9.687
	1.5000	318.115	
1.5	1.5833	317.976	9.407
	1.6666	317.840	
1.6667	1.7500	317.708	9.141
	1.8333	317.572	
1.8333	1.9166	317.442	8.875
	2.0000	317.312	
2.4167	2.5000	316.532	7.965
	3.0000	315.830	
3.4167	3.5000	315.182	6.615
	4.0000	314.588	
4.	4.5000	314.044	5.477
	5.0000	313.551	
5.	5.5000	313.103	4.536
	6.0000	312.692	
6.	6.5000	312.319	3.752
	7.0000	311.974	
7.	7.5000	311.658	3.091
	8.0000	311.367	
8.	8.5000	311.102	2.535
	9.0000	310.862	
9.	9.5000	310.640	2.073
	10.0000	310.441	
12.	12.0000	309.771	1.204
	14.0000	309.323	
16.	16.0000	309.035	.468
	18.0000	308.848	
20.	20.0000	308.728	.161
	22.0000	308.652	
24.	24.0000	308.615	.048
	26.0000	308.596	
28.	28.0000	308.589	.022
	30.0000	308.580	
32.	32.0000	308.577	.01
34.4167	34.0000	308.567	0

END

BR-4

SE2000
Environmental Logger
06/25 11:36

Unit# WATER:HD Test 3

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	BR:4ORIG
Reference	253.960
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 06/25 11:18:48

Elapsed Time	INPUT 1	
0.0000	254.029	
0.0083	254.029	
0.0166	254.029	
0.0250	266.500	
0.0333	272.146	
0.0416	270.551	H
0.0500	271.080	17.52
0.0583	270.015	
0.0666	269.668	16.124
0.0750	268.851	
0.0833	268.376	14.716
0.1000	266.837	
0.1166	265.106	11.546
0.1333	263.671	
0.1500	262.285	8.725
0.1666	260.868	
0.1833	259.759	6.199
0.2000	258.736	
0.2166	257.793	4.233
0.2333	257.029	
0.2500	256.358	2.79
0.2666	255.760	
0.2833	255.260	1.72
0.3000	254.867	
0.3166	254.516	[illegible]
0.3333	254.244	
0.4166	253.560	—
0.5000	253.551	
0.5833	253.869	
0.6666	254.103	
0.7500	254.189	
0.8333	254.152	
0.9166	254.066	
1.0000	253.998	
1.0833	253.967	
1.1666	253.980	
1.2500	253.998	
1.3333	254.016	
1.4166	254.023	
1.5000	254.016	
1.5833	254.010	
1.6666	254.004	
1.7500	253.998	
1.8333	254.004	
1.9166	254.004	
2.0000	254.004	
2.5000	253.998	
3.0000	254.004	
3.5000	253.998	
4.0000	253.998	
4.5000	254.004	
5.0000	254.004	
5.5000	254.004	
6.0000	254.004	
6.5000	254.004	
7.0000	254.004	
7.5000	254.004	
8.0000	254.004	
8.5000	254.004	
9.0000	254.004	
9.5000	254.004	
10.0000	254.004	
12.0000	254.004	
14.0000	254.004	
16.0000	254.004	

END

BR-5 Shallow

SE2000
Environmental Logger
02/12 12:07

Unit# SE-2000 Test 9

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	
Reference	334.000
SG	1.000
Linearity	0.013
Scale factor	10.308
Offset	0.020
Delay mSEC	50.000

Step 0 02/12 11:55:23

	Elapsed Time	INPUT 1	
	0.0000	333.967	
	0.0083	333.967	
	0.0166	333.967	
	0.0250	344.498	
	0.0333	349.169	
0	0.0416	349.935	15.83
	0.0500	348.530	
.0167	0.0583	348.256	14.43
	0.0666	347.728	
.0334	0.0750	346.936	12.53
	0.0833	346.167	
.0584	0.1000	344.575	10.47
	0.1166	343.258	
.0917	0.1333	342.349	8.25
	0.1500	341.466	
.125	0.1666	340.900	6.69
	0.1833	340.281	
.1584	0.2000	339.808	5.70
	0.2166	339.391	
.1917	0.2333	338.966	4.96
	0.2500	338.589	
.225	0.2666	338.216	4.11
	0.2833	337.870	
.2584	0.3000	337.547	3.44
	0.3166	337.253	
.2917	0.3333	336.979	2.88
	0.4166	335.964	
.4584	0.5000	335.246	1.14
	0.5833	334.780	
.625	0.6666	334.505	.40
	0.7500	334.259	
.7917	0.8333	334.287	.18
	0.9166	334.257	
.9584	1.0000	334.251	.15
	1.0833	334.244	
1.1244	1.1666	334.244	.14
	1.2500	334.241	
	1.3333	334.238	
	1.4166	334.238	
1.4584	1.5000	334.235	.13
	1.5833	334.231	
	1.6666	334.228	
	1.7500	334.225	
	1.8333	334.225	
	1.9166	334.221	
1.9584	2.0000	334.218	.11
	2.5000	334.199	
	3.0000	334.179	
	3.5000	334.169	
3.9584	4.0000	334.159	.06
	4.5000	334.153	
	5.0000	334.150	
	5.5000	334.130	
5.9584	6.0000	334.120	.02
	6.5000	334.117	
	7.0000	334.114	
	7.5000	334.114	
7.9584	8.0000	334.110	0
	8.5000	334.110	
	9.0000	334.110	
	9.5000	334.110	
	10.0000	334.107	
	11.0000	334.104	

END

BR-5 Medium

SE2000
Environmental Logger
02/12 10:56

Unit# SE-2000 Test 9

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	
Reference	334.000
SG	1.000
Linearity	0.013
Scale factor	10.308
Offset	0.020
Delay mSEC	50.000

Step 0 02/12 10:40:49

	Elapsed Time	INPUT 1	
	0.0000	334.254	
	0.0083	334.254	
	0.0166	340.834	
	0.0250	346.755	
0	0.0333	349.101 —	14.55
	0.0416	348.521	
.0167	0.0500	347.925 —	13.37
	0.0583	348.238	
.0333	0.0666	347.589 —	13.04
	0.0750	347.270	
.05	0.0833	347.058 —	12.57
	0.1000	346.171	
.0833	0.1166	345.311 —	10.76
	0.1333	344.577	
.1167	0.1500	343.837 —	9.27
	0.1666	343.176	
.15	0.1833	342.536 —	7.99
	0.2000	341.956	
.1833	0.2166	341.415 —	6.86
	0.2333	340.908	
.2167	0.2500	340.430 —	5.88
	0.2666	340.009	
.25	0.2833	339.601 —	5.05
	0.3000	339.217	
.2833	0.3166	338.954 —	4.30
	0.3333	338.512	
.3833	0.4166	337.223 —	2.67
	0.5000	336.160	
.55	0.5833	335.419 —	.27
	0.6666	334.943	
.7167	0.7500	334.669 —	.12
	0.8333	334.541	
.8833	0.9166	334.512 —	-.04
	1.0000	334.531	
	1.0833	334.567 —	+.02
	1.1666	334.600	
	1.2500	334.613 —	+.06
	1.3333	334.613	
	1.4166	334.603 —	+.05
	1.5000	334.587	
	1.5833	334.590 —	.03
	1.6666	334.574	
	1.7500	334.574 —	.02
	1.8333	334.577	
	1.9166	334.577	
	2.0000	334.577 —	.02
	2.5000	334.571	
	3.0000	334.567	
	3.5000	334.567	
	4.0000	334.564 —	
	4.5000	334.561	
	5.0000	334.561	
	5.5000	334.558	
	6.0000	334.554 —	
	6.5000	334.554	
	7.0000	334.554	
	7.5000	334.554	
	8.0000	334.554 —	
	8.5000	334.554	
	9.0000	334.554	
	9.5000	334.554	
	10.0000	334.554 —	
	11.0000	334.551	
	12.0000	334.551 —	
	13.0000	334.551	
	14.0000	334.551	
	15.0000	334.551	

END

BR-5 Deep

SE2000
Environmental Logger
02/12 11:36

Unit# SE-2000 Test 9

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	
Reference	340.000
SG	1.000
Linearity	0.013
Scale factor	10.306
Offset	0.020
Delay mSEC	50.000

Step 0 02/12 11:24:42

	Elapsed Time	INPUT 1	
	0.0000	340.319	
	0.0083	340.319	
	0.0166	340.326	
	0.0250	348.968	
	0.0333	354.655	
0	0.0416	356.467	18.17
.0084	0.0500	355.629	17.33
.0167	0.0583	355.317	17.02
.025	0.0666	355.463	17.16 ?
.0334	0.0750	354.782	16.48
.0417	0.0833	354.532	16.23
.0584	0.1000	353.609	15.31
.075	0.1166	352.749	14.45
.0917	0.1333	351.684	13.39
.1084	0.1500	350.478	12.18
.125	0.1666	349.347	11.05
.1417	0.1833	348.212	9.93
.1584	0.2000	347.066	8.77
.175	0.2166	345.982	7.68
.1917	0.2333	344.955	6.66
.2084	0.2500	344.019	5.72
.225	0.2666	343.125	4.83
.2417	0.2833	342.332	4.03
.2584	0.3000	341.611	3.31
.275	0.3166	340.956	2.66
.2917	0.3333	340.394	2.10
.375	0.4166	338.717	.42
.4584	0.5000	338.299	0
	0.5833	338.893	
	0.6666	339.921	
	0.7500	340.838	
	0.8333	341.311	
	0.9166	341.321	
	1.0000	341.044	
	1.0833	340.661	
	1.1666	340.321	
	1.2500	340.212	
	1.3333	340.176	
	1.4166	340.239	
	1.5000	340.339	
	1.5833	340.427	
	1.6666	340.473	
	1.7500	340.476	
	1.8333	340.450	
	1.9166	340.417	
	2.0000	340.385	
	2.5000	340.379	
	3.0000	340.365	
	3.5000	340.362	
	4.0000	340.355	
	4.5000	340.352	
	5.0000	340.349	
	5.5000	340.349	
	6.0000	340.345	
	6.5000	340.342	
	7.0000	340.342	
	7.5000	340.338	
	8.0000	340.339	
	8.5000	340.339	
	9.0000	340.336	
	9.5000	340.336	
	10.0000	340.332	
	11.0000	340.329	

END

BR-6 Shallow

SE2000
Environmental Logger
02/11 14:14

Unit# SE-2000 Test 3

Elapsed Time	INPUT 1
0.0000	148.557
0.0083	148.557
0.0166	148.564
0.0250	148.557
0.0333	162.770
0.0416	162.199
0.0500	162.470
0.0583	161.577
0.0666	160.154
0.0750	159.304
0.0833	158.601
0.1000	157.332
0.1166	156.605
0.1333	156.211
0.1500	155.946
0.1666	155.718
0.1833	155.502
0.2000	155.244
0.2166	154.991
0.2333	154.781
0.2500	154.603
0.2666	154.430
0.2833	154.298
0.3000	154.171
0.3166	154.036
0.3333	153.919
0.4166	153.475
0.5000	153.105
0.5833	152.803
0.6666	152.551
0.7500	152.335
0.8333	152.132
0.9166	151.941
1.0000	151.750
1.0833	151.577
1.1666	151.423
1.2500	151.275
1.3333	151.133
1.4166	151.004
1.5000	150.893
1.5833	150.770
1.6666	150.647
1.7500	150.529
1.8333	150.425
1.9166	150.338
2.0000	150.265
2.5000	149.815
3.0000	149.525
3.5000	149.346
4.0000	149.241
4.5000	149.161
5.0000	149.118
5.5000	149.106
6.0000	149.081
6.5000	149.087
7.0000	149.087
7.5000	149.081
8.0000	149.100
8.5000	149.087
9.0000	149.094
9.5000	149.106
10.0000	149.118
11.0000	149.106
12.0000	149.118
13.0000	149.124
14.0000	149.124
15.0000	149.106
16.0000	149.112
17.0000	149.124
18.0000	149.131
19.0000	149.137
20.0000	149.118
21.0000	149.118
22.0000	149.131
23.0000	149.131
24.0000	149.137
25.0000	149.124
26.0000	149.131
27.0000	149.124
28.0000	149.137
29.0000	149.137
30.0000	149.137

END

BR-6 Medium

[illegible]
Type Level (F)
Mode TOC
I.D.

Reference	150.002
SG	1.000
Linearity	0.014
Scale factor	19.496
Offset	0.026
Delay mSEC	50.000

Step 0 02/11 12:56:41

Elapsed Time	INPUT 1
0.0000	150.086
0.0083	150.086
0.0166	150.073
0.0250	163.709
0.0333	167.252
0.0416	167.514
0.0500	166.517
0.0583	165.760
0.0666	165.735
0.0750	165.150
0.0833	164.386
0.1000	163.203
0.1166	161.502
0.1333	160.166
0.1500	158.866
0.1666	157.634
0.1833	156.451
0.2000	155.354
0.2166	154.430
0.2333	153.566
0.2500	152.910
0.2666	152.107
0.2833	151.491
0.3000	150.992
0.3166	150.566
0.3333	150.166
0.4166	149.217
0.5000	149.166
0.5833	149.716
0.6666	150.263
0.7500	150.591
0.8333	150.573
0.9166	150.369
1.0000	150.154
1.0833	150.030
1.1666	150.030
1.2500	150.098
1.3333	150.166
1.4166	150.203
1.5000	150.197
1.5833	150.172
1.6666	150.141
1.7500	150.123
1.8333	150.123
1.9166	150.129
2.0000	150.135
2.5000	150.117
3.0000	150.098
3.5000	150.117
4.0000	150.092
4.5000	150.110
5.0000	150.086
5.5000	150.098
6.0000	150.098
6.5000	150.086
7.0000	150.098
7.5000	150.092
8.0000	150.086
8.5000	150.092
9.0000	150.086
9.5000	150.086
10.0000	150.092
11.0000	150.092

END

BR-6 Deep

SE2000
Environmental Logger
02/11 12:36

Unit# SE-2000 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	
Reference	150.000
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 02/11 12:27:20

	Elapsed Time	INPUT 1	
	0.0000	150.055	
	0.0083	150.049	
	0.0166	150.043	
	0.0250	150.036	
	0.0333	164.996	
	0.0416	166.210	
0	0.0500	167.331	18.07
.0033	0.0583	167.115	17.85
.0166	0.0666	166.302	17.04
.025	0.0750	165.791	16.53
.0333	0.0833	165.471	16.21
.05	0.1000	164.645	15.38
.0666	0.1166	163.493	14.23
.0833	0.1333	162.384	13.12
.10	0.1500	161.115	11.85
.1166	0.1666	160.093	11.23
.1333	0.1833	158.891	9.63
.15	0.2000	157.955	8.61
.1666	0.2166	156.883	7.62
.1833	0.2333	156.106	6.94
.20	0.2500	155.164	5.70
.2166	0.2666	154.547	5.07
.2333	0.2833	153.759	4.49
.25	0.3000	153.204	3.94
.2666	0.3166	152.582	3.32
.2833	0.3333	152.107	2.84
.3666	0.4166	150.412	1.15
.450	0.5000	149.469	.20
.5333	0.5833	149.266	0
	0.6666	149.494	
	0.7500	149.907	
	0.8333	150.265	Undamped
	0.9166	150.431	✓
	1.0000	150.394	
	1.0833	150.221	
	1.1666	150.024	
	1.2500	149.876	
	1.3333	149.833	
	1.4166	149.870	
	1.5000	149.963	
	1.5833	150.049	
	1.6666	150.092	
	1.7500	150.092	
	1.8333	150.061	
	1.9166	150.018	
	2.0000	149.981	
	2.5000	150.012	
	3.0000	150.006	
	3.5000	149.987	
	4.0000	150.000	
	4.5000	149.987	
	5.0000	150.000	
	5.5000	149.987	
	6.0000	149.993	
	6.5000	150.006	

END

BR-10 Shallow

SE1000C
Environmental Logger
09/14 08:51

Unit# 00506 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00000
Reference	321.000
Linearity	0.010
Scale factor	10.020
Offset	0.020
Delay mSEC	50.000

Step 0 09/11 08:48:03

	Elapsed Time	INPUT 1	
	0.0000	322.852	
	0.0033	322.852	
	0.0066	322.852	
	0.0100	322.852	
	0.0133	322.855	
	0.0166	322.855	
	0.0200	322.855	
	0.0233	322.855	
	0.0266	323.483	
	0.0300	327.246	
	0.0333	329.536	
0	0.0500	336.458	12.30
	0.0666	334.303	
.0333	0.0833	333.003	9.91
	0.1000	331.256	
.0666	0.1166	329.828	5.64
	0.1333	328.693	
.10	0.1500	327.820	3.63
	0.1666	327.175	
.1333	0.1833	326.760	2.57
	0.2000	326.505	
.1666	0.2166	326.353	2.16
	0.2333	328.265	
.200	0.2500	326.195	2.01
	0.2666	326.142	
.2333	0.2833	326.076	1.89
	0.3000	326.000	
.2666	0.3166	325.912	.72
	0.3333	325.814	
.3666	0.4166	325.322	.13
	0.5000	325.000	
.5333	0.5833	324.778	.58
	0.6666	324.612	
.700	0.7500	324.498	.31
	0.8333	324.417	
.8666	0.9166	324.357	.16
	1.0000	324.316	
1.0333	1.0833	324.284	.09
	1.1666	324.259	
1.20	1.2500	324.243	.05
	1.3333	324.231	
1.3666	1.4166	324.221	.07
	1.5000	324.215	
1.5333	1.5833	324.208	.02
	1.6666	324.205	
1.70	1.7500	324.202	.01
	1.8333	324.199	
1.866	1.9166	324.196	.003
	2.0000	324.196	
2.45	2.5000	324.193	0
	3.0000	324.193	
	3.5000	324.193	
	4.0000	324.196	
	4.5000	324.199	
	5.0000	324.202	
	5.5000	324.205	
	6.0000	324.208	
	6.5000	324.212	
	7.0000	324.215	
	7.5000	324.218	
	8.0000	324.218	
	8.5000	324.221	
	9.0000	324.224	
	9.5000	324.224	
	10.0000	324.227	

END

BR-10 Shal/Med

SE1000C
Environmental Logger
09/14 08:55

Unit# 00508 Test 2

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00000
Reference	321.000
Linearity	0.010
Scale factor	10.020
Offset	0.020
Delay mSEC	50.000

Step 0 09/11 09:40:31

	Elapsed Time	INPUT 1	
	0.0000	320.656	
	0.0033	320.656	
	0.0066	320.659	
	0.0100	320.662	
	0.0133	320.665	
	0.0166	320.669	
	0.0200	320.669	
	0.0233	320.672	
	0.0266	323.171	
	0.0300	328.542	
	0.0333	331.237	
0	0.0500	336.485	14.89
	0.0666	335.634	
.0333	0.0833	334.547	12.90
	0.1000	333.857	
.0666	0.1166	333.359	11.71
	0.1333	332.902	
.10	0.1500	332.549	11.00
	0.1666	332.276	
.1333	0.1833	332.079	10.49
	0.2000	331.899	
.1666	0.2166	331.651	10.04
	0.2333	331.471	
.200	0.2500	331.240	9.60
	0.2666	331.204	
.2333	0.2833	330.771	9.12
	0.3000	330.544	
.2666	0.3166	330.326	8.68
	0.3333	330.121	
.3666	0.4166	329.194	7.54
	0.5000	328.366	
.5333	0.5833	327.637	5.99
	0.6666	326.990	
.70	0.7500	326.410	4.76
	0.8333	325.893	
.8666	0.9166	325.432	3.78
	1.0000	325.025	
1.0333	1.0833	324.659	3.01
	1.1666	324.335	
1.20	1.2500	324.044	2.39
	1.3333	323.789	
1.3666	1.4166	323.559	1.91
	1.5000	323.353	
1.5333	1.5833	323.174	1.52
	1.6666	323.013	
1.70	1.7500	322.868	1.22
	1.8333	322.742	
1.866	1.9166	322.626	.98
	2.0000	322.527	
2.45	2.5000	322.107	.46
	3.0000	321.906	
3.45	3.5000	321.808	.16
	4.0000	321.754	
4.45	4.5000	321.723	.07
	5.0000	321.707	
5.45	5.5000	321.697	.05
	6.0000	321.688	
6.45	6.5000	321.675	.03
	7.0000	321.666	
7.45	7.5000	321.656	.01
	8.0000	321.650	

END

BR-10 Deep/Med

SE1000C
Environmental Logger
09/14 08:55

Unit# 00508 Test 3

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00000
Reference	362.000
Linearity	0.010
Scale factor	10.020
Offset	0.020
Delay mSEC	50.000

Step 0 09/11 10:17:06

	Elapsed Time	INPUT 1	
	0.0000	362.035	
	0.0033	362.035	
	0.0066	362.035	
	0.0100	362.035	
	0.0133	362.035	
	0.0166	362.035	
	0.0200	362.035	
	0.0233	362.047	
	0.0266	366.857	
	0.0300	369.251	
	0.0333	371.502	
0	0.0500	376.144	13.64
	0.0666	375.180	
.0333	0.0833	374.455	11.95
	0.1000	374.042	
.0666	0.1166	373.308	10.81
	0.1333	372.554	
.10	0.1500	371.966	9.47
	0.1666	371.357	
.1333	0.1833	370.758	9.26
	0.2000	370.226	
[illegible]	0.2166	369.724	[illegible]
	0.2333	369.241	
.200	0.2500	368.797	6.30
	0.2666	368.380	
.2333	0.2833	367.986	5.47
	0.3000	367.617	
.2166	0.3166	367.274	4.77
	0.3333	366.952	
.3666	0.4166	365.587	3.45
	0.5000	364.628	
[illegible]	0.5833	363.965	[illegible]
	0.6666	363.511	
.7000	0.7500	363.205	.70
	0.8333	363.006	
.8666	0.9166	362.874	.37
	1.0000	362.792	
1.0333	1.0833	362.732	.23
	1.1666	362.694	
1.20	1.2500	362.663	.16
	1.3333	362.644	
1.3666	1.4166	362.625	.12
	1.5000	362.609	
1.5333	1.5833	362.600	.10
	1.6666	362.590	
1.70	1.7500	362.581	.08
	1.8333	362.574	
1.866	1.9166	362.568	.07
	2.0000	362.562	
2.45	2.5000	362.536	.03
	3.0000	362.521	
3.45	3.5000	362.514	.01
	4.0000	362.505	
4.45	4.5000	362.502	0
	5.0000	362.502	
	5.5000	362.499	
	6.0000	362.499	
	6.5000	362.499	
	7.0000	362.502	
	7.5000	362.502	
	8.0000	362.505	
	8.5000	362.506	

END

BR-10 Deep

SE1000C
Environmental Logger
09/14 09:56

Unit# 00506 Test 4

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	00000

Reference	364.500
Linearity	0.010
Scale factor	10.020
Offset	0.020
Delay mSEC	50.000

Step 0 09/11 10:43:29

	Elapsed Time	INPUT 1	
	0.0000	363.664	
	0.0033	363.664	
	0.0066	363.667	
	0.0100	363.667	
	0.0133	363.667	
	0.0166	363.670	
	0.0200	363.670	
	0.0233	363.674	
	0.0266	363.680	
	0.0300	365.112	
	0.0333	370.230	
0	0.0500	378.435	12.92
.0166	0.0666	377.401	
.0333	0.0833	377.300	12.79
.05	0.1000	376.306	
.0666	0.1166	376.223	11.61
.0833	0.1333	375.772	
.10	0.1500	375.350	10.74
.1166	0.1666	374.849	
.1333	0.1833	374.442	9.73
.150	0.2000	374.045	
.1666	0.2166	373.670	9.06
.1833	0.2333	373.252	
.200	0.2500	372.560	[illegible]
.2166	0.2666	372.828	
.2333	0.2833	372.308	[illegible].70
.250	0.3000	372.005	
.2666	0.3166	371.715	[illegible]
.2833	0.3333	371.435	
.3666	0.4166	370.174	[illegible]
.450	0.5000	369.146	
.5333	0.5833	368.313	3.70
.6166	0.6666	367.645	
.7000	0.7500	367.105	2.49
	0.8333	366.673	
.8666	0.9166	366.330	1.72
	1.0000	366.049	
1.0333	1.0833	365.825	1.21
	1.1666	365.642	
1.20	1.2500	365.491	.88
	1.3333	365.371	
1.3666	1.4166	365.270	.66
	1.5000	365.186	
1.5333	1.5833	365.118	.58
	1.6666	365.062	
1.70	1.7500	365.014	.40
	1.8333	364.970	
1.866	1.9166	364.935	.32
	2.0000	364.907	
2.45	2.5000	364.781	.17
	3.0000	364.718	
3.45	3.5000	364.660	.07
	4.0000	364.658	
4.45	4.5000	364.642	.03
	5.0000	364.633	
5.45	5.5000	364.623	.01
	6.0000	364.617	
6.45	6.5000	364.611	0

END

NR-1 Shallow

SE2000
Environmental Logger
05/30 11:47

Unit# SE2000 Test 1

Setups:	INPUT 2
Type	Level (F)
Mode	TOC
I.D.	NRIRED

Reference	0.000
SG	1.000
Linearity	0.000
Scale factor	16.000
Offset	4.000
Delay mSEC	50.000

Step 0 05/30 11:26:39

	Elapsed Time	INPUT 2	
	0.0000	-0.171	
	0.0083	-0.192	
	0.0166	-0.166	
	0.0250	-0.192	
	0.0333	-0.131	
	0.0416	-0.237	
	0.0500	-0.247	
	0.0583	-0.080	
	0.0666	-0.065	
	0.0750	-0.075	
	0.0833	0.035	
	0.1000	-0.060	
	0.1166	0.010	
	0.1333	-0.010	
	0.1500	0.030	
	0.1666	0.060	
	0.1833	-0.045	
	0.2000	-0.121	
	0.2166	-1.744	
	0.2333	-3.412	
	0.2500	-5.414	
	0.2666	-5.075	
	0.2833	-9.767	
	0.3000	-8.275	
	0.3166	-13.417	
	0.3333	-13.765	
	0.4166	-21.819	
	0.5000	-25.337	
	0.5833	-25.580	
	0.6666	-25.721	
	0.7500	-25.605	
	0.8333	-25.555	
	0.9166	-25.393	
	1.0000	-25.130	
	1.0833	-24.877	
	1.1666	-24.442	
	1.2500	-25.732	
	1.3333	-25.807	
	1.4166	-25.782	
0	1.5000	-25.838	[illegible]
	1.5833	-25.767	[illegible]
.1666	1.6666	-25.681	[illegible]
	1.7500	-25.534	[illegible]
.3333	1.8333	-25.373	[illegible]
	1.9166	-25.256	[illegible]
.5	2.0000	-25.145	10.749
	2.5000	-24.225	9.829
1.5	3.0000	-24.700	[illegible]
	3.5000	-24.033	9.636
2.5	4.0000	-23.477	9.080
	4.5000	-23.163	8.766
3.5	5.0000	-22.309	7.912
	5.5000	-21.809	7.412
4.5	6.0000	-21.308	6.911
	6.5000	-20.818	6.421
5.5	7.0000	-20.236	5.839
	7.5000	-19.741	5.344
6.5	8.0000	-19.311	4.914
	8.5000	-18.932	4.535
7.5	9.0000	-18.517	4.120
	9.5000	-18.138	3.741
8.5	10.0000	-17.800	3.403
10.5	12.0000	-17.056	2.659
12.5	14.0000	-15.661	1.264
14.5	16.0000	-14.397	0

END

NR-1 Deep

SE2000
Environmental Logger
05/29 10:19

Unit# SE2000   Test 2

Setups:	INPUT 1	INPUT 2
Type	Level (F)	Level (F)
Mode	TOC	TOC
I.D.	NR1WHITE	NR1RED
Reference	100.000	100.000
SG	1.000	1.000
Linearity	0.000	0.000
Scale factor	10.003	10.041
Offset	-0.020	-0.023
Delay mSEC	50.000	50.000

Step 0 05/29 10:10:19

	Elapsed Time	INPUT 1	INPUT 2	
	0.0000	91.494	100.000	
	0.0083	91.494	100.000	
	0.0166	97.474	100.000	
	0.0250	107.364	100.000	
	0.0333	107.325	100.000	
	0.0416	107.345	100.000	
0	0.0500	107.332	100.000	8.017
	0.0583	107.310	100.000	8.075
.0166	0.0666	107.272	100.000	8.037
	0.0750	107.225	100.000	7.990
.0333	0.0833	107.168	100.000	7.933
	0.1000	107.044	100.000	7.809
.0666	0.1166	106.905	100.000	7.670
	0.1333	106.754	100.000	7.519
.1	0.1500	106.596	100.000	7.361
	0.1666	106.431	100.000	7.196
.1333	0.1833	106.264	100.000	7.029
	0.2000	106.096	100.000	6.861
.1666	0.2166	105.922	100.000	6.687
	0.2333	105.755	100.000	6.520
.2	0.2500	105.584	100.000	6.349
	0.2666	105.414	100.000	6.179
.2333	0.2833	105.246	100.000	6.011
	0.3000	105.082	100.000	5.847
.2666	0.3166	104.921	100.000	5.686
	0.3333	104.763	100.000	5.528
.3666	0.4166	104.001	100.000	4.766
	0.5000	103.305	100.000	4.070
.5333	0.5833	102.667	100.000	3.432
	0.6666	102.073	100.000	2.838
.7	0.7500	101.536	100.000	2.301
	0.8333	101.061	100.000	1.826
.8666	0.9166	100.651	100.000	1.416
	1.0000	100.303	100.000	1.068
1.033	1.0833	100.012	100.000	.777
	1.1666	99.775	100.000	.540
1.2	1.2500	99.589	100.000	.354
	1.3333	99.446	100.000	.21
1.3666	1.4166	99.342	100.000	[illegible]
	1.5000	99.273	100.000	[illegible]
1.5333	1.5833	99.241	100.000	.006
1.6166	1.6666	99.225	100.000	0
	1.7500	99.235	100.000	
	1.8333	99.238	100.000	
	1.9166	99.238	100.000	
	2.0000	99.238	100.000	
	2.5000	99.244	100.000	
	3.0000	99.250	100.000	
	3.5000	99.254	100.000	
	4.0000	99.254	100.000	
	4.5000	99.257	100.000	
	5.0000	99.257	100.000	
	5.5000	99.260	100.000	
	6.0000	99.263	100.000	
	6.5000	99.260	100.000	
	7.0000	99.260	100.000	

END

NR-2 Shallow

SE2000
Environmental Logger
06/25 13:59

Unit# WATER:HO Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	NR:2SHAL
Reference	132.330
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.025
Delay mSEC	50.000

Step 0 06/25 13:29:29

	Elapsed Time	INPUT 1	
	0.0000	132.336	
	0.0083	132.336	
0	0.0166	147.785	18.629
.0084	0.0250	146.781	17.625
.0167	0.0333	145.967	16.811
.025	0.0416	144.934	15.778
.0334	0.0500	143.565	14.429
.0417	0.0583	141.762	12.606
.05	0.0666	139.938	10.792
.0584	0.0750	138.183	9.027
.0667	0.0833	136.458	7.302
.0834	0.1000	133.630	4.474
.1	0.1166	131.535	2.379
.1167	0.1333	130.111	.955
.1334	0.1500	129.353	.197
.15	0.1666	129.156	0
	0.1833	129.409	
.1834	0.2000	129.994	
	0.2166	130.814	
.217	0.2333	131.726	
	0.2500	132.576	
.25	0.2666	133.266	
	0.2833	133.728	
.283	0.3000	133.944	
	0.3166	133.913	
.317	0.3333	133.691	
.4	0.4166	131.707	
.483	0.5000	131.692	
.567	0.5833	132.859	
.65	0.6666	132.422	
.73	0.7500	132.052	
.817	0.8333	132.416	
.9	0.9166	132.490	
.98	1.0000	132.262	
	1.0833	132.305	
	1.1666	132.410	
	1.2500	132.348	
	1.3333	132.311	
	1.4166	132.354	
	1.5000	132.360	
	1.5833	132.336	
	1.6666	132.342	
	1.7500	132.354	
	1.8333	132.342	
	1.9166	132.336	
	2.0000	132.342	
	2.5000	132.336	
	3.0000	132.336	
	3.5000	132.336	
	4.0000	132.336	
	4.5000	132.336	
	5.0000	132.336	
	5.5000	132.336	
	6.0000	132.336	
	6.5000	132.336	
	7.0000	132.336	
	7.5000	132.336	
	8.0000	132.336	
	8.5000	132.336	
	9.0000	132.336	
	9.5000	132.336	
	10.0000	132.336	
	12.0000	132.336	
	14.0000	132.330	
	16.0000	132.330	
	18.0000	132.330	
	20.0000	132.323	
	22.0000	132.330	
	24.0000	132.323	
	26.0000	132.323	
	28.0000	132.323	

END

NR-1 Deep

SE2000
Environmental Logger
05/29 10:19

Unit# SE2000 Test 2

Setups:	INPUT 1	INPUT 2
Type	Level (F)	Level (F)
Mode	TOC	TOC
I.D.	NR1WHITE	NR1RED
Reference	100.000	100.000
SG	1.000	1.000
Linearity	0.000	0.000
Scale factor	10.003	10.041
Offset	-0.020	-0.023
Delay mSEC	50.000	50.000

Step 0 05/29 10:10:19

	Elapsed Time	INPUT 1	INPUT 2	
	0.0000	91.494	100.000	
	0.0083	91.494	100.000	
	0.0166	97.474	100.000	
	0.0250	107.364	100.000	
	0.0333	107.326	100.000	
	0.0416	107.345	100.000	
0	0.0500	107.332	100.000	8.097
	0.0583	107.310	100.000	8.075
.0166	0.0666	107.272	100.000	8.037
	0.0750	107.225	100.000	7.990
.0333	0.0833	107.168	100.000	7.933
	0.1000	107.044	100.000	7.809
.0666	0.1166	106.905	100.000	7.670
	0.1333	106.754	100.000	7.519
.1	0.1500	106.596	100.000	7.361
	0.1666	106.431	100.000	7.196
.1333	0.1833	106.264	100.000	7.029
	0.2000	106.096	100.000	6.861
.1666	0.2166	105.922	100.000	6.687
	0.2333	105.755	100.000	6.520
.2	0.2500	105.584	100.000	6.349
	0.2666	105.414	100.000	6.179
.2333	0.2833	105.246	100.000	6.011
	0.3000	105.082	100.000	5.847
.2666	0.3166	104.921	100.000	5.686
	0.3333	104.763	100.000	5.528
.3666	0.4166	104.001	100.000	4.766
	0.5000	103.305	100.000	4.070
.5333	0.5833	102.667	100.000	3.432
	0.6666	102.073	100.000	2.838
.7	0.7500	101.536	100.000	2.301
	0.8333	101.061	100.000	1.826
.8666	0.9166	100.651	100.000	1.416
	1.0000	100.303	100.000	1.068
1.033	1.0833	100.012	100.000	.777
	1.1666	99.775	100.000	.540
1.2	1.2500	99.589	100.000	.354
	1.3333	99.446	100.000	.21
1.3666	1.4166	99.342	100.000	.085
	1.5000	99.273	100.000	.040
1.5333	1.5833	99.241	100.000	.006
1.6166	1.6666	99.235	100.000	0
	1.7500	99.235	100.000	
	1.8333	99.238	100.000	
	1.9166	99.238	100.000	
	2.0000	99.238	100.000	
	2.5000	99.244	100.000	
	3.0000	99.250	100.000	
	3.5000	99.254	100.000	
	4.0000	99.254	100.000	
	4.5000	99.257	100.000	
	5.0000	99.257	100.000	
	5.5000	99.260	100.000	
	6.0000	99.263	100.000	
	6.5000	99.260	100.000	
	7.0000	99.260	100.000	

END

NR-2 Shallow

SE2000
Environmental Logger
06/25 13:59

Unit# WATER:AD Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	NR:2SHAL
Reference	132.330
SG	1.000
Linearity	0.014
Scale factor	19.466
Offset	0.026
Delay mSEC	50.000

Step 0 06/25 13:29:29

	Elapsed Time	INPUT 1	
	0.0000	132.336	
	0.0083	132.336	
0	0.0166	147.785	18.629
.0084	0.0250	146.781	17.625
.0167	0.0333	145.987	16.831
.025	0.0416	144.934	15.778
.0334	0.0500	143.585	14.429
.0417	0.0583	141.762	12.606
.05	0.0666	139.938	10.782
.0584	0.0750	138.183	9.027
.0667	0.0833	136.458	7.302
.0834	0.1000	133.630	4.474
.1	0.1166	131.535	2.379
.1167	0.1333	130.111	.955
.1334	0.1500	129.353	.197
.15	0.1666	129.156	0
	0.1833	129.409	
.1834	0.2000	129.994	
	0.2166	130.814	
.217	0.2333	131.725	
	0.2500	132.575	
.25	0.2666	133.256	
	0.2833	133.728	
.283	0.3000	133.944	
	0.3166	133.913	
.317	0.3333	133.691	
.4	0.4166	131.707	
.483	0.5000	131.892	
.567	0.5833	132.859	
.65	0.6666	132.422	
.73	0.7500	132.052	
.817	0.8333	132.416	
.9	0.9166	132.490	
.98	1.0000	132.262	
	1.0833	132.305	
	1.1666	132.410	
	1.2500	132.348	
	1.3333	132.311	
	1.4166	132.354	
	1.5000	132.360	
	1.5833	132.336	
	1.6666	132.342	
	1.7500	132.354	
	1.8333	132.342	
	1.9166	132.336	
	2.0000	132.342	
	2.5000	132.336	
	3.0000	132.336	
	3.5000	132.336	
	4.0000	132.336	
	4.5000	132.336	
	5.0000	132.336	
	5.5000	132.336	
	6.0000	132.336	
	6.5000	132.336	
	7.0000	132.336	
	7.5000	132.336	
	8.0000	132.336	
	8.5000	132.336	
	9.0000	132.336	
	9.5000	132.336	
	10.0000	132.336	
	12.0000	132.336	
	14.0000	132.330	
	16.0000	132.330	
	18.0000	132.330	
	20.0000	132.323	
	22.0000	132.330	
	24.0000	132.323	
	26.0000	132.323	
	28.0000	132.323	

END

NR-2 Medium

SE2000
Environmental Logger
06/25 15:35

Unit# WATER:AD Test 1

Setups:	INPUT 1
Type	Level (F)
mode	TOC
I.D.	NR:2MED

Step 0 06/25 14:58:30

	Elapsed Time	INPUT 1	
	0.0000	136.174	
	0.0083	136.180	
0	0.0166	151.332	14.074
	0.0250	149.700	11.742
.0167	0.0333	149.017	11.759
	0.0416	149.152	11.894
.0334	0.0500	149.195	11.937
	0.0583	149.072	11.814
.05	0.0666	148.770	11.512
	0.0750	148.573	11.315
.0667	0.0833	148.197	10.939
	0.1000	147.483	10.227
.1	0.1166	147.058	9.8
	0.1333	146.344	9.086
.1334	0.1500	145.863	8.605
	0.1666	145.272	8.014
.1667	0.1833	144.767	7.509
	0.2000	144.256	6.998
.2	0.2166	143.775	6.517
	0.2333	143.326	6.068
.2334	0.2500	142.895	5.637
	0.2666	142.494	5.236
.2667	0.2833	142.100	4.842
	0.3000	141.749	4.491
.3	0.3166	141.404	4.146
	0.3333	141.090	3.832
.4	0.4166	139.741	2.483
	0.5000	138.755	1.497
.5667	0.5833	138.078	.82
	0.6666	137.640	.382
.7334	0.7500	137.388	.13
	0.8333	137.271	.013
.9	0.9166	137.258	0
	1.0000	137.295	
	1.0833	137.369	
	1.1666	137.425	
	1.2500	137.455	
	1.3333	137.462	
	1.4166	137.449	
	1.5000	137.431	
	1.5833	137.412	
	1.6666	137.394	
	1.7500	137.369	
	1.8333	137.357	
	1.9166	137.344	
	2.0000	137.344	
	2.5000	137.344	
	3.0000	137.344	
	3.5000	137.338	
	4.0000	137.332	
	4.5000	137.332	
	5.0000	137.332	
	5.5000	137.332	
	6.0000	137.320	
	6.5000	137.320	
	7.0000	137.308	
	7.5000	137.301	
	8.0000	137.289	
	8.5000	137.277	
	9.0000	137.271	
	9.5000	137.264	
	10.0000	137.252	
	12.0000	137.221	
	14.0000	137.197	
	16.0000	137.178	
	18.0000	137.166	
	20.0000	137.154	
	22.0000	137.129	
	24.0000	137.135	
	26.0000	137.129	
	28.0000	137.123	
	30.0000	137.117	
	32.0000	137.117	
	34.0000	137.117	
	36.0000	137.104	

END

NR-2 Deep

SE2000
Environmental Logger
05/29 14:14

Unit# SE2000 Test 4

Setups:	INPUT 3
Type	Level (F)
Mode	TOC
I.D.	NR2SHORT
Reference	100.000
SG	1.000
Linearity	0.000
Scale factor	13.688
Offset	0.212
Delay mSEC	50.000

Step 0 05/29 14:10:33

	Elapsed Time	INPUT 3	
	0.0000	96.665	
	0.0083	96.665	
	0.0166	97.045	
	0.0250	97.598	
	0.0333	100.410	
0	0.0416	116.435	17.356
	0.0500	115.402	16.323
.0167	0.0583	115.414	16.335
	0.0666	115.315	16.236
.0334	0.0750	114.985	15.906
	~~0.0833~~	~~115.813~~	
.0584	0.1000	114.568	15.489
	0.1166	114.575	15.4[illegible]
.0917	0.1333	114.276	15.197
	0.1500	113.561	14.482
.125	0.1666	112.242	[illegible]
	0.1833	111.477	12.3[illegible]
.1584	0.2000	110.674	11.595
	0.2166	109.729	10.650
.1917	0.2333	108.485	9.406
	0.2500	107.589	[illegible]
.225	0.2666	106.811	7.73[illegible]
	0.2833	105.990	[illegible]
.2584	0.3000	105.044	5.965
	0.3166	104.273	5.194
.2917	0.3333	103.651	4.572
	0.4166	100.964	1.885
.4584	0.5000	99.533	.454
.5417	0.5833	99.079	0
	0.6666	99.290	
	0.7500	99.825	
	0.8333	100.385	
	0.9166	100.758	
	1.0000	100.908	
	1.0833	100.852	
	1.1666	100.690	
	1.2500	100.516	
	1.3333	100.404	
	1.4166	100.335	
	1.5000	100.317	
	1.5833	100.329	
	1.6666	100.354	
	1.7500	100.385	
	1.8333	100.404	
	1.9166	100.391	
	2.0000	100.391	
	2.5000	100.335	
	3.0000	100.323	
	3.5000	100.304	

END

MW-32 Shallow

SE2000
Environmental Logger
02/11 19:16

Unit# SE-2000 Test 7

Reference	240.000
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 02/11 18:52:14

	Elapsed Time	INPUT 1	
	0.0000	239.414	
	0.0083	239.414	
	0.0166	249.229	
0	0.0250	254.151 –	13.78
	0.0333	252.722	
.0166	0.0416	253.172 –	12.80
	0.0500	251.977	
.0333	0.0583	251.687 –	11.32
	0.0666	250.739	
.05	0.0750	250.751 –	10.32
	0.0833	250.400	
.075	0.1000	250.092 –	9.72
	0.1166	249.759	
.1083	0.1333	249.463 –	9.09
	0.1500	249.192	
.1416	0.1666	248.940 –	8.57
	0.1833	248.706	
.175	0.2000	248.494 –	8.12
	0.2166	248.274	
.2083	0.2333	248.077 –	7.71
	0.2500	247.892	
.2416	0.2666	247.708 –	7.34
	0.2833	247.547	
.275	0.3000	247.381 –	7.01
	0.3166	247.233	
.3083	0.3333	247.085 –	6.72
	0.4166	246.494	
.475	0.5000	245.952 –	5.58
	0.5833	245.490	
.6416	0.6666	245.089 –	4.72
	0.7500	244.744	
.8083	0.8333	244.436 –	4.07
	0.9166	244.153	
.975	1.0000	243.906 –	3.54
	1.0833	243.578	
	1.1666	243.475	
	1.2500	243.284	
	1.3333	243.111	
	1.4166	242.951	
1.475	1.5000	242.803 –	2.43
	1.5833	242.668	
	1.6666	242.538	
	1.7500	242.421	
	1.8333	242.310	
	1.9166	242.206	
1.975	2.0000	242.107 –	1.74
	2.5000	241.632	
	3.0000	241.300	
	3.5000	241.059	
3.975	4.0000	240.893 –	.52
	4.5000	240.776	
	5.0000	240.684	
	5.5000	240.616	
5.975	6.0000	240.565 –	.20
	6.5000	240.523	
	7.0000	240.492	
	7.5000	240.468	
7.775	8.0000	240.443 –	.07
	8.5000	240.431	
	9.0000	240.419	
	9.5000	240.406	
	10.0000	240.400	
	11.0000	240.382	
11.775	12.0000	240.369 –	0
	13.0000	240.369	
	14.0000	240.363	
	15.0000	240.363	
	16.0000	240.357	
	17.0000	240.363	
	18.0000	240.363	
	19.0000	240.369	
	20.0000	240.375	
	21.0000	240.382	
	22.0000	240.388	
	23.0000	240.394	

END

MW-32 Shal/Med

SE2000
Environmental Logger
02/11 19:18

Unit# SE-2000 Test 5

Setup:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	

Reference	240.000
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 02/11 18:02:34

	Elapsed Time	INPUT 1	
	0.0000	240.018	
	0.0083	240.019	
	0.0166	251.207	
0	0.0250	258.089	19.76
.0083	0.0333	257.047	18.72
.0166	0.0416	256.905	18.58
.025	0.0500	255.870	17.54
.0333	0.0583	255.433	17.10
.0416	0.0666	254.257	15.93
.05	0.0750	253.252	14.92
.058	0.0833	251.891	13.56
.075	0.1000	249.685	11.36
.0916	0.1166	247.197	8.87
.1083	0.1333	245.077	6.75
.125	0.1500	242.970	4.64
.1416	0.1666	241.201	2.87
.1583	0.1833	239.651	1.33
.175	0.2000	238.329	0
	0.2166	237.319	
	0.2333	236.493	
	0.2500	235.981	
	0.2666	235.648	
	0.2833	235.581	
	0.3000	235.698	
	0.3166	235.994	
	0.3333	236.462	
	0.4166	239.624	
	0.5000	242.347	
	0.5833	242.206	
	0.6666	240.240	
	0.7500	238.668	
	0.8333	238.736	
	0.9166	239.932	
	1.0000	240.924	
	1.0833	240.930	
	1.1666	240.191	
	1.2500	239.537	
	1.3333	239.506	
	1.4166	239.944	
	1.5000	240.359	
	1.5833	240.412	
	1.6666	240.147	
	1.7500	239.870	
	1.8333	239.827	
	1.9166	239.981	
	2.0000	240.160	
	2.5000	240.092	
	3.0000	240.061	
	3.5000	240.049	
	4.0000	240.043	
	4.5000	240.043	
	5.0000	240.036	
	5.5000	240.036	
	6.0000	240.036	
	6.5000	240.036	
	7.0000	240.036	
	7.5000	240.036	
	8.0000	240.036	
	8.5000	240.036	
	9.0000	240.036	
	9.5000	240.030	
	10.0000	240.036	
	11.0000	240.030	
	12.0000	240.024	
	13.0000	240.030	
	14.0000	240.024	
	15.0000	240.024	

END

MW-32 Deep/Med

SE2000
Environmental Logger
02/11 17:42

Unit# SE-2000 Test 5

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	
Reference	240.000
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

Step 0 02/11 17:30:05

	Elapsed Time	INPUT 1	
	0.0000	240.000	
	0.0083	240.000	
	0.0166	248.793	
0	0.0250	256.952	20.3
.0083	0.0333	256.542	19.86
.0166	0.0416	256.487	19.80
.025	0.0500	255.983	19.30
.0333	0.0583	255.495	18.81
.0416	0.0666	254.516	17.83
.05	0.0750	254.146	17.46
.058	0.0833	253.358	16.67
.075	0.1000	251.765	15.08
.0916	0.1166	250.074	13.39
.1083	0.1333	248.213	11.53
.125	0.1500	246.595	9.92
.1416	0.1666	245.071	8.39
.1583	0.1833	243.666	6.98
.175	0.2000	242.354	5.67
.1916	0.2166	241.072	4.39
.2083	0.2333	240.061	3.38
.225	0.2500	239.174	2.49
.2416	0.2666	238.440	1.76
.2583	0.2833	237.818	1.13
.275	0.3000	237.282	.59
.2916	0.3166	236.918	.23
.3083	0.3333	236.684	0
	0.4166	236.912	
	0.5000	236.822	
	0.5833	240.930	
	0.6666	241.947	Disregard
	0.7500	241.569	
	0.8333	240.456	
	0.9166	239.383	
	1.0000	238.964	
	1.0833	239.254	
	1.1666	239.926	
	1.2500	240.466	
	1.3333	240.653	
	1.4166	240.431	
	1.5000	240.049	
	1.5833	239.753	
	1.6666	239.585	
	1.7500	239.833	
	1.8333	240.055	
	1.9166	240.203	
	2.0000	240.221	
	2.5000	240.061	
	3.0000	240.000	
	3.5000	240.012	
	4.0000	240.018	
	4.5000	240.018	
	5.0000	240.024	
	5.5000	240.018	
	6.0000	240.018	
	6.5000	240.018	
	7.0000	240.024	
	7.5000	240.024	
	8.0000	240.018	
	8.5000	240.018	
	9.0000	240.012	
	9.5000	240.018	
	10.0000	240.024	
	11.0000	240.018	

END

MW-32 Deep

SE2000
Environmental Logger
02/11 17:08

Unit# SE-2000 Test 4

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	
Reference	240.000
SG	1.000
Linearity	0.014
Scale factor	19.486
Offset	0.026
Delay mSEC	50.000

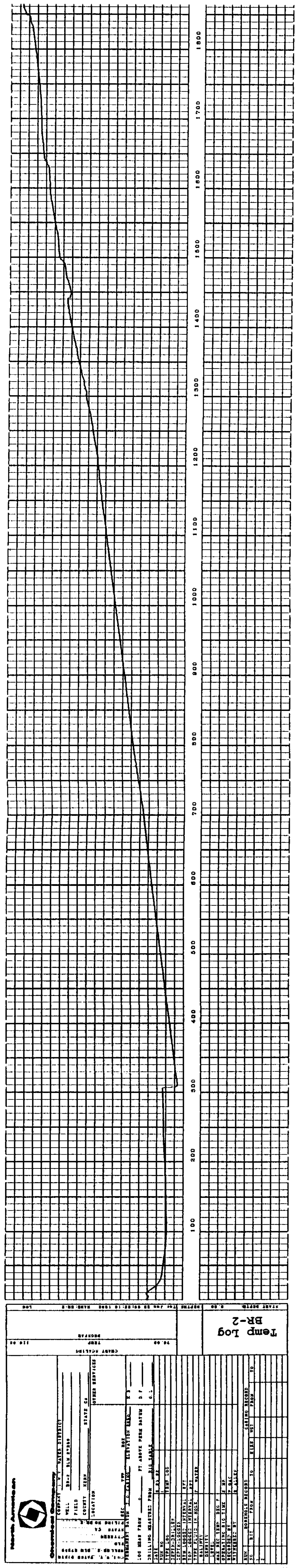
Step 0 02/11 16:54:54

	Elapsed Time	INPUT 1	
	0.0000	240.018	
	0.0083	240.018	
	0.0166	240.030	
	0.0250	252.083	
	0.0333	257.442	
	0.0416	256.660	
0	0.0500	257.343	17.3
	0.0583	256.044	
.0166	0.0666	256.709	16.68
	0.0750	255.394	
.0333	0.0833	255.674	15.64
	0.1000	255.144	
.0666	0.1166	254.294	14.26
	0.1333	253.302	
.10	0.1500	252.562	12.53
	0.1666	251.762	
.1333	0.1833	250.949	10.92
	0.2000	250.315	
.1666	0.2166	249.661	[illegible]
	0.2333	249.033	
.20	0.2500	248.534	[illegible]
	0.2666	248.028	
.2333	0.2833	247.554	7.52
	0.3000	247.166	
.2666	0.3166	246.772	6.74
	0.3333	246.414	
.3666	0.4166	245.151	5.12
	0.5000	244.122	
.5333	0.5833	243.340	3.3
	0.6666	242.742	
.70	0.7500	242.280	2.25
	0.8333	241.910	
.8666	0.9166	241.626	1.60
	1.0000	241.392	
	1.0833	241.207	
	1.1666	241.053	
	1.2500	240.924	
	1.3333	240.825	
	1.4166	240.733	
1.45	1.5000	240.659	.63
	1.5833	240.597	
	1.6666	240.548	
	1.7500	240.499	
	1.8333	240.462	
	1.9166	240.425	
1.95	2.0000	240.394	.35
	2.5000	240.277	
	3.0000	240.203	
	3.5000	240.160	
3.95	4.0000	240.129	.10
	4.5000	240.110	
	5.0000	240.098	
	5.5000	240.086	
	6.0000	240.073	
	6.5000	240.067	
	7.0000	240.061	
	7.5000	240.061	
7.95	8.0000	240.055	.03
	8.5000	240.049	
	9.0000	240.049	
	9.5000	240.049	
	10.0000	240.049	
	11.0000	240.036	
11.95	12.0000	240.030	0
	13.0000	240.036	

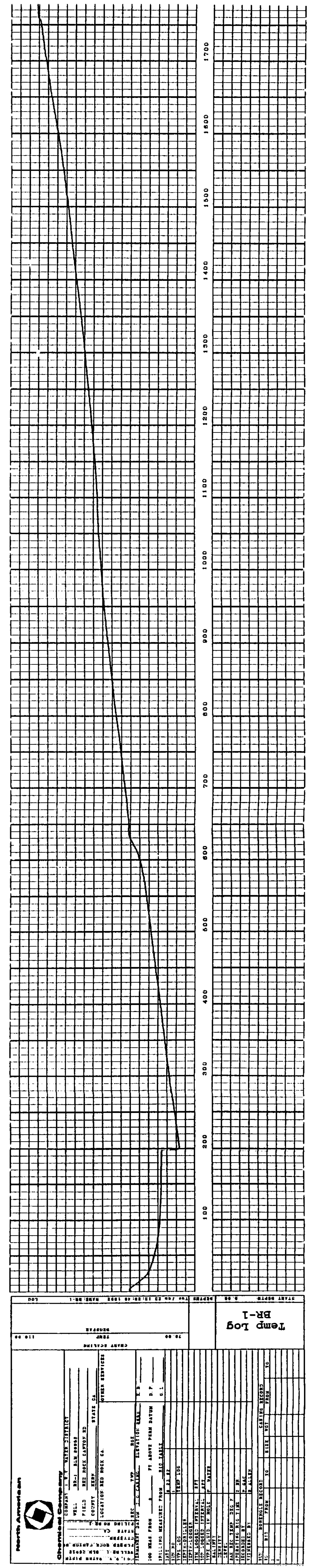
END

APPENDIX XII

Down-Hole Temperature Logs



Temp Log
BR-2
North American
Chemical Company



Temp Log
BR-1
North American
Chemical Company

North American Chemical Company

COMPANY	I W V WATER DISTRICT
WELL	BR-4
FIELD	1.4MI SOUTH INYOKERN-BROWN RD
COUNTY	KERN
STATE	CA
LOCATION	DESERT
OTHER SERVICES	
SEC / TWP / RGE	
PERMANENT DATUM	T.C CASING
ELEVATION	
LOG MEAS FROM	0 FT. ABOVE PERM DATUM
DRILLING MEASURED FROM	RIG TABLE
K.B. / D.F. / G.L.	
DATE	6 23 92
RUN NO	1
TYPE LOG	TEMP LOG
DEPTH-DRILLER	
DEPTH-LOGGER	
BTM LOGGED INTERVAL	2FT
TOP LOGGED INTERVAL	2FT
TYPE FLUID IN HOLE	F WATER
SALINITY	
DENSITY	
LEVEL	
MAX REC TEMP DEG F	
OPERATING RIG TIME	2 HR
RECORDED BY	P GAC
WITNESSED BY	B ALLEN

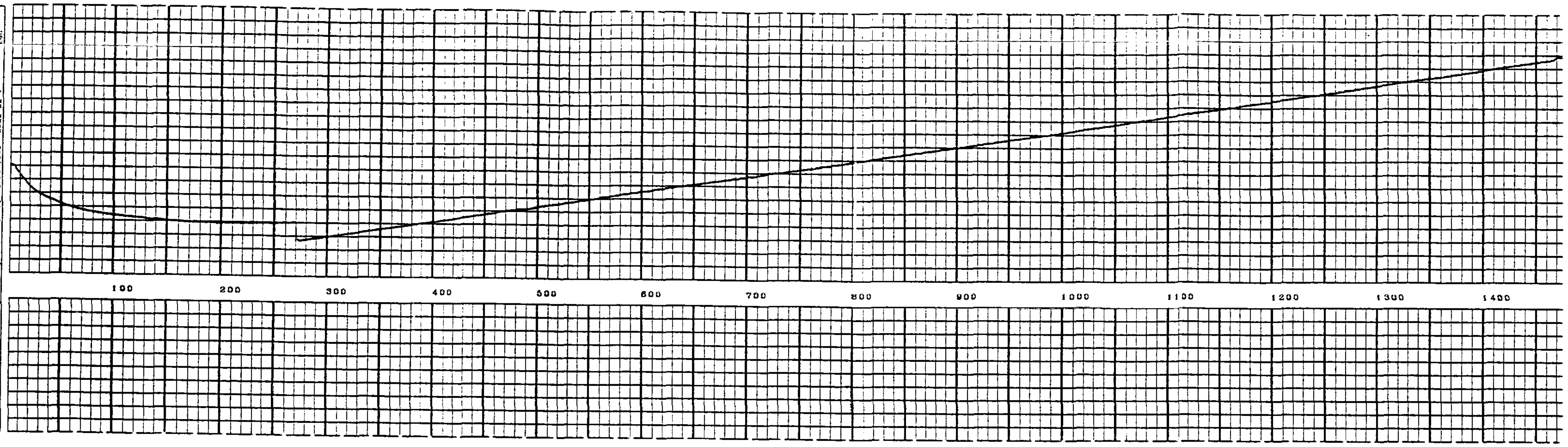
RUN NO	BOREHOLE RECORD BIT	FROM	TO	CASING RECORD SIZE	WGT	FROM	TO
1							
2							

CHART SCALING: TEMP DEGF/IN — 70.00 to 110.00

Temp Log BR-4

START DEPTH 0.00 — DEPTHS

Tue Jun 23 12:52:03 1992 NAME BR-4 LOG



North American Chemical Company

COMPANY	I W V WATER DISTRICT
WELL	BR-3 BLM-27380
FIELD	BOWMAN RD
COUNTY	KERN
STATE	CA
LOCATION	BOWMAN RD.
OTHER SERVICES	
SEC / TWP / RGE	
PERMANENT DATUM	T.C CASING
ELEVATION	2810
LOG MEAS. FROM	0 FT. ABOVE PERM DATUM
DRILLING MEASURED FROM	LAKE LEVEL
K.B. / D.F. / G.L.	
DATE	6 23 92
RUN NO	1
TYPE LOG	TEMP LOG
DEPTH-DRILLER	
DEPTH-LOGGER	
BTM LOGGED INTERVAL	2FT
TOP LOGGED INTERVAL	2FT
TYPE FLUID IN HOLE	F WATER
SALINITY	
DENSITY	
LEVEL	307
MAX REC TEMP DEG F	115
OPERATING RIG TIME	2 HR
RECORDED BY	P. GAC
WITNESSED BY	B ALLEN

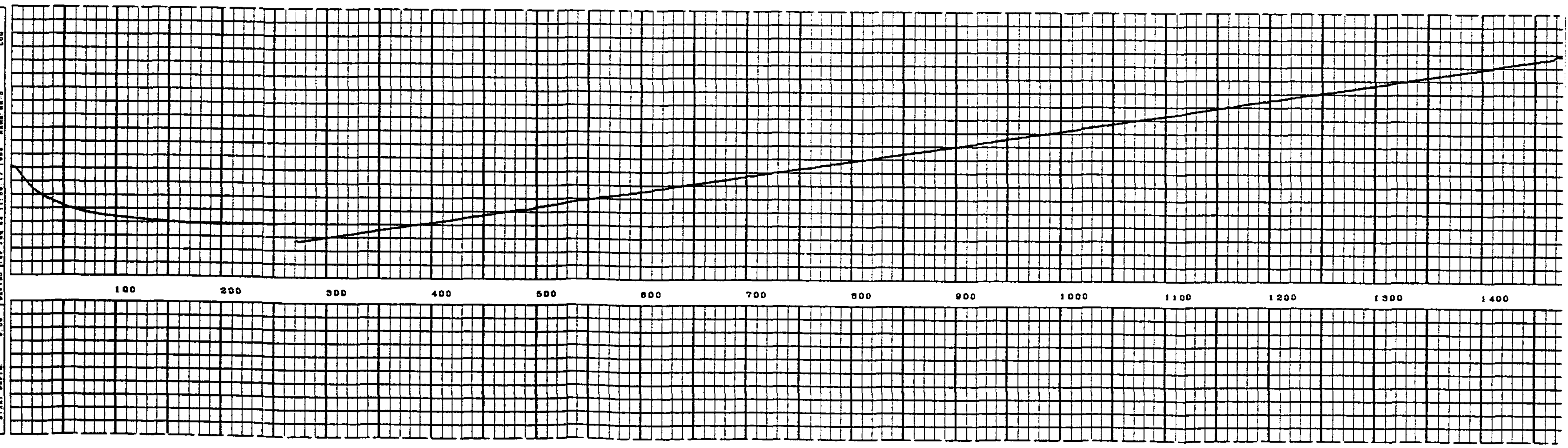
RUN NO	BOREHOLE RECORD BIT	FROM	TO	CASING RECORD SIZE	WGT	FROM	TO
1							
2							

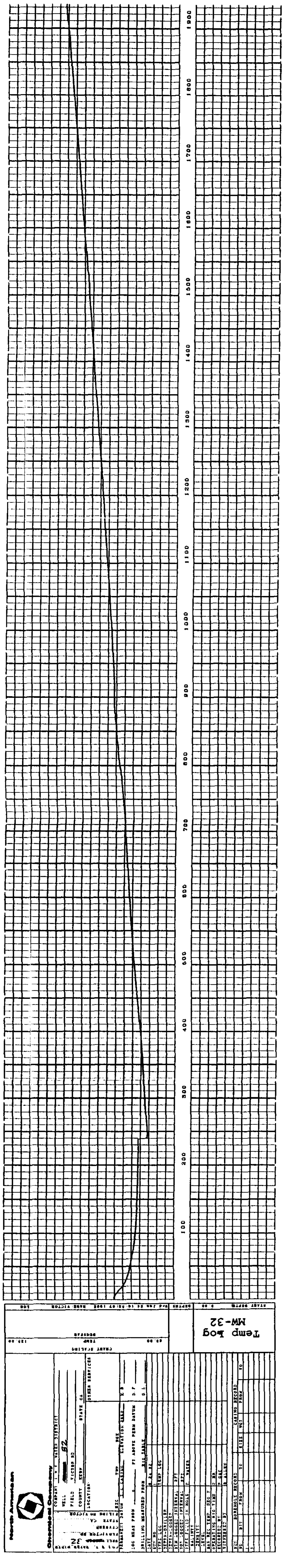
CHART SCALING: TEMP DEGF/IN — 70.00 to 110.00

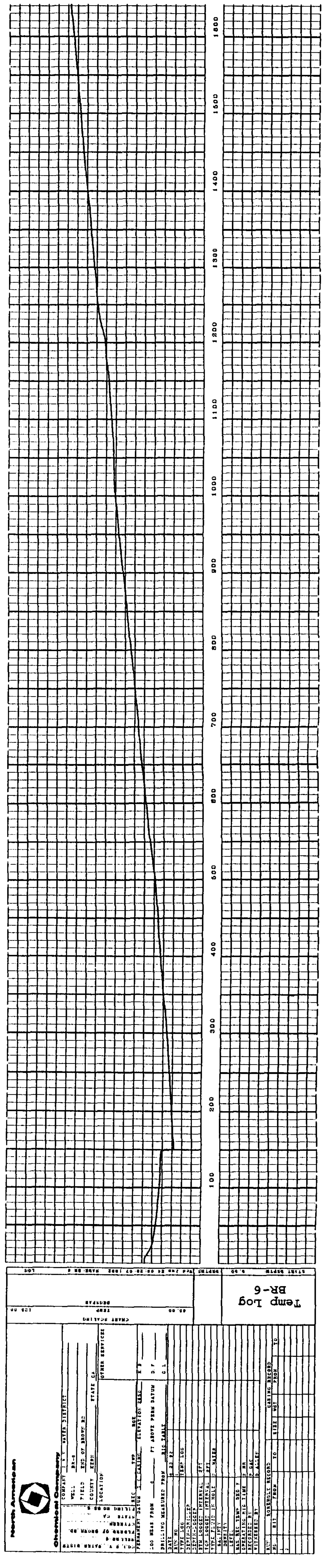
Temp Log BR-3

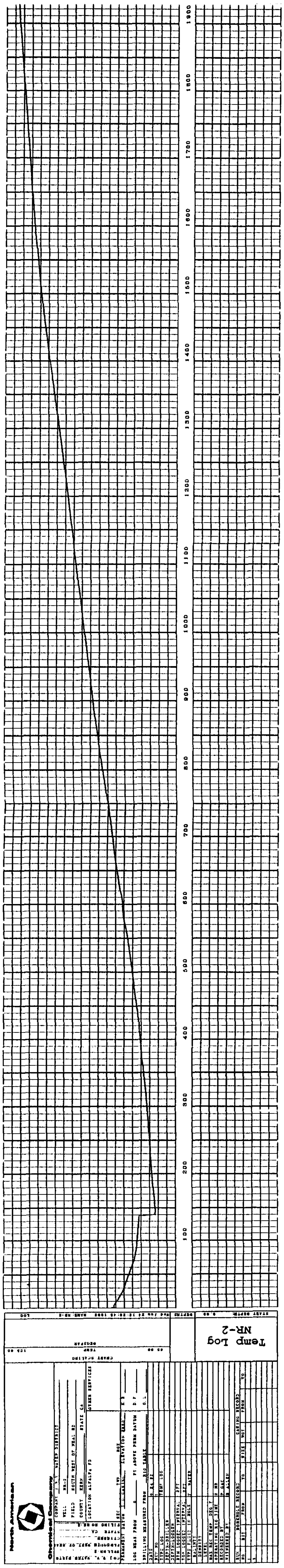
START DEPTH 0.00 — DEPTHS

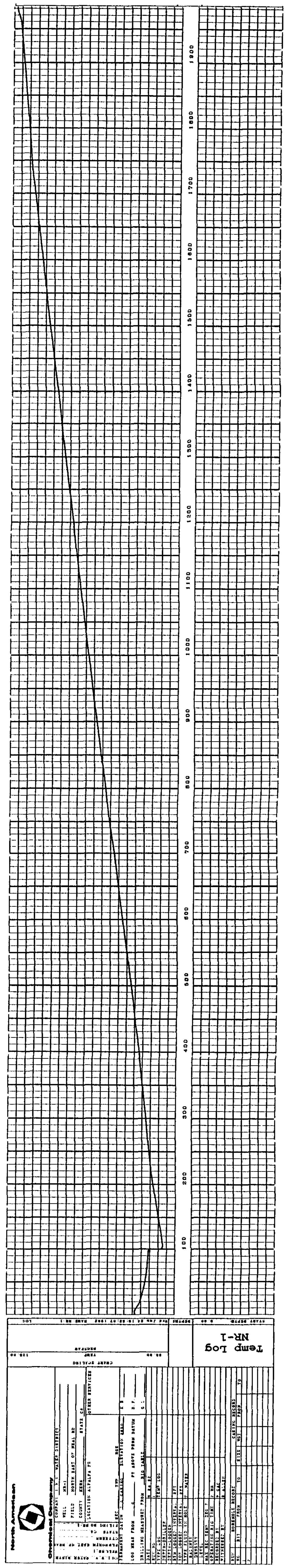
Tue Jun 23 11:50:17 1992 NAME BR-3 LOG




Temp Log
MW-32
North American
Chemical Company


Temp Log
BR-6
North American
Chemical Company


North American Chemical Company
Temp Log
NR-2
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900

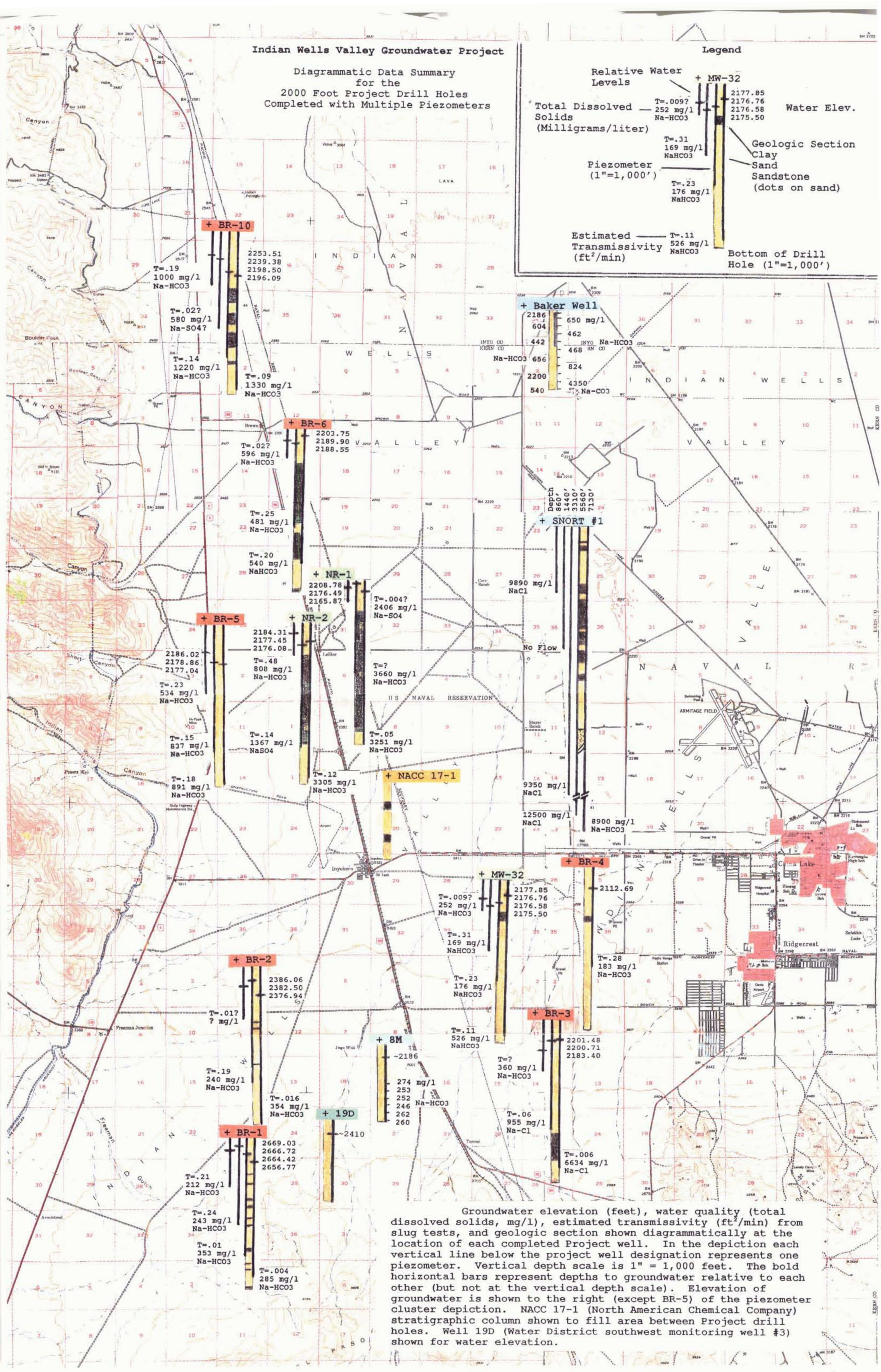

North American Chemical Company
Temp Log
NR-1
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900

APPENDIX XIII

Project Well Location Map

Indian Wells Valley Groundwater Project

Diagrammatic Data Summary
for the
2000 Foot Project Drill Holes
Completed with Multiple Piezometers



Groundwater elevation (feet), water quality (total dissolved solids, mg/l), estimated transmissivity (ft²/min) from slug tests, and geologic section shown diagrammatically at the location of each completed Project well. In the depiction each vertical line below the project well designation represents one piezometer. Vertical depth scale is 1" = 1,000 feet. The bold horizontal bars represent depths to groundwater relative to each other (but not at the vertical depth scale). Elevation of groundwater is shown to the right (except BR-5) of the piezometer cluster depiction. NACC 17-1 (North American Chemical Company) stratigraphic column shown to fill area between Project drill holes. Well 19D (Water District southwest monitoring well #3) shown for water elevation.

APPENDIX XIV

Project Well Site Elevations

INDIAN WELLS VALLEY GROUND WATER PROJECT
Elevation @ wells in Group I

Well	Elevation	2" Pipe Elev.	Description
BR-1	2852.17		X stamped on rim of casing
		2851.91	Shallow Med.
		2851.80	Deep Med.
		2852.05	Shallow
		2851.77	Deep
	2849.2		Concrete Pad
	2848.3		Ground
BR-2	2658.84		X stamped on rim of casing
		2658.64	Shallow
		2658.45	Deep
		2658.42	Medium
	2656.5		Concrete Pad
	2655.9		Ground
BR-3	2511.86		X stamped on rim of casing
		2511.23	2" Pipe
		2511.44	2" Pipe
		2511.48	2" Pipe
	2509.0		Concrete Pad
	2508.6		Ground
BR-4	2377.48		X stamped on rim of casing
		2377.19	2" Pipe
	2375.7		Concrete Pad
	2375.2		Ground
BR-5	2521.48		X stamped on rim of casing
		2521.27	2" Pipe
		2521.06	2" Pipe
		2520.83	2" Pipe
	2519.2		Concrete Pad
	2518.6		Ground
BR-6	2354.13		X stamped on rim of casing
		2353.06	2" Pipe
		2353.43	2" Pipe
		2353.75	2" Pipe
	2352.6		Concrete Pad
	2352.2		Ground

INDIAN WELLS VALLEY GROUND WATER PROJECT
Elevation @ wells in Group I

Well	Elevation	2" Pipe Elev.	Description
BR-10	2558.77		5/8" rebar 100' East of proposed well BR-10
	2560.3		Ground @ proposed site
NR-1	2278.58		X stamped on rim of casing
		2277.67	Deep
		2277.69	Shallow
		2278.26	Medium with valve cap
	2276.3		Concrete Pad
	2275.7		Ground
NR-2	2317.69		X stamped on rim of casing
		2316.91	Deep
		2317.11	Medium
		2317.38	Shallow
	2315.3		Concrete Pad
	2314.7		Ground
MW-32	2418.06		X stamped top of welded cover between two 2" pipes
		2418.69	East 2" pipe
		2418.69	West 2" pipe

Note: All "X" stamped above latch area opposite the hinge of the cover unless noted otherwise.

INDIAN WELLS VALLEY GROUND WATER PROJECT

Elevations @ wells in Group II

Well	Elevation	Description
NAWS-13	2295.03	X stamped on rim of casing
(13J)	2291.3	Ground
NAWS-31	2263.40	Top of 4" pvc pipe
(31R)	2264.38	Top of rim 30 gal drum
	2261.1	Concrete Pad
	2261.1	Ground
NACC-17	2355.79	NW corner of cover plate
(17-F01)	2357.15	Top NW corner of cover box
	2354.3	Ground
CSD # 1	2441.34	NE corner bottom of pump casing
	2441.21	NE corner concrete pad
	2440.8	Ground
CSD # 2	2443.19	NE corner bottom of pump casing
	2442.71	NE corner concrete pad
	2441.4	Ground
OW-8	2532.97	Chisled square SW corner of concrete pad
	2534.33	Top west corner of welded cover plate over 8" well
	2532.5	Ground
INYO WELL	2566.21	X stamped E. side rim casing
	2565.24	Top of 1/2" cap inside casing
	2562.8	Concrete Pad
	2562.6	Ground
INVWD-8	2582.82	X stamped on rim of 6" casing
	2579.7	Ground
		Extra well is near S 1/4 corner of Section 8 T27S R39E

INDIAN WELLS VALLEY GROUND WATER PROJECT
Distance and error of level loops to wells

Well	Distance in miles	Error of closure
BR-1	3.5	-0.027
BR-2	1.5	+0.045
BR-3	2.5	+0.042
BR-4	0.3	+0.009
BR-5	2.0	-0.014
BR-6	0.5	+0.016
BR-10	0.2	-0.016
NR-1	0.3	-0.008
NR-2	0.7	-0.009
MW-32	0.2	-0.006
NAWS-13	1.3	-0.010
NAWS-31	1.0	+0.042
NACC-17-1	0.5	-0.002
CSD-1&2	0.2	+0.013
OW-8	0.2	-0.010
INYO WELL	0.8	+0.007
INVWD-8	0.5	-0.012

APPENDIX XV

Engineering Cost Calculations

APPENDIX XV

CALCULATION OF ESTIMATED TRANSMISSION LINE COST

An estimate of the cost of building a 34.5kV electric transmission line from a substation in Inyokern to a pumping field in the southwest area of Indian Wells Valley was derived by indexing a 1978 engineers estimate of a similar transmission line. The engineer's estimate of the contract cost of a 7.86-mile 34.5kV woodpole transmission line on flat desert terrain south of Yuma, Arizona was $135,082 in 1978. This is $17;186 a mile.

Using a cost index of 2 to account for the difference in cost between 1978 and 1992, the unit contract cost becomes

$17,186 X 2 = $34,372 a mile in 1992 costs.

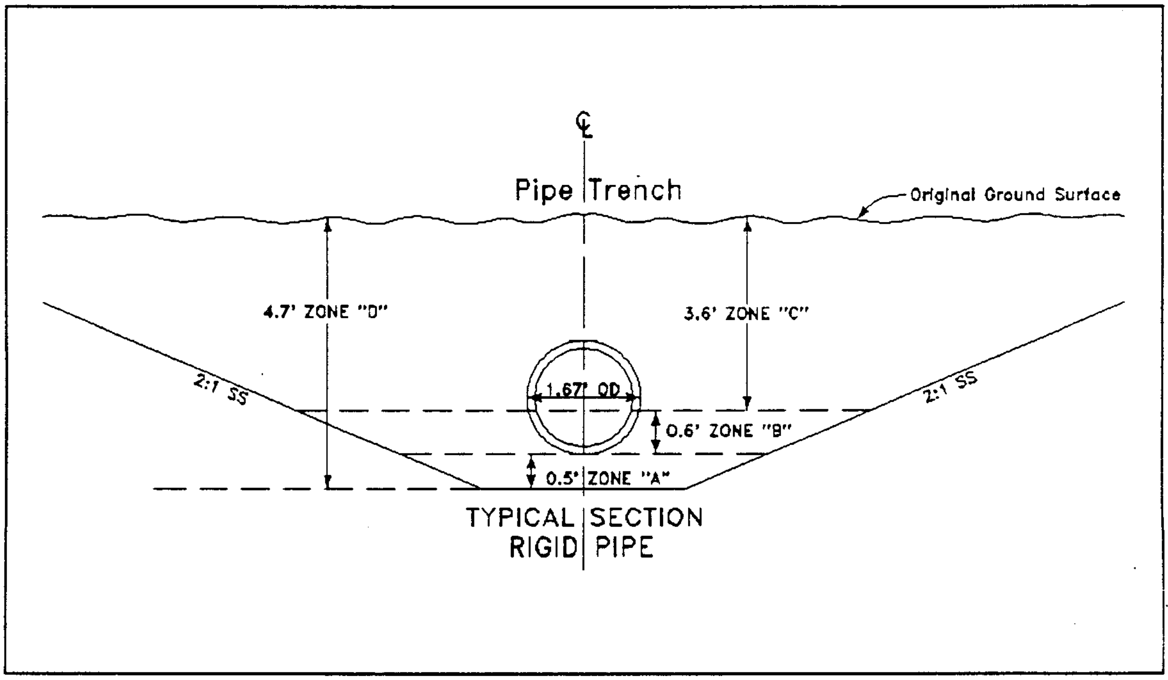
Adding 34 percent to account for engineering, inspection, contract administration, etc., the total unit cost is

$34,372 X 1.34 = $46,000 a mile.

For the 5 miles between Inyokern and the southwest area a transmission line is estimated to cost

$46,000 X 5 = $230,000.

CALCULATION OF ESTIMATED 20" AND 30" PIPELINE COST



Estimated Cost for 20" Pipeline

Construction in Alluvial Fill

Minimum cover = 30 in.
Excavation depth = 4.7 ft.
Trench bottom width = 2.7 ft.
Trench top width = 21.5 ft.
Side Slope is 2:1

Excavation

Zone D

$$\{\{4.7'\{2.7'+21.5'\}/2\}5{,}280/27\} \text{ x } \$3.50/\text{yd.}^3 = \$38{,}900/\text{mi.}$$

Compacted Backfill
(selected material)
Zone A + Zone B

$$\{\{0.5'\{2.7'+4.7'\}/2\}+\{0.6'\{4.7'+7.1'\}/2\}-(0.37'(\pi\ 0.83^2))\}/27 \text{ x } 5{,}280'$$

@ $5.00/yd.^{3}
= $4,500/mi.

Backfill
(common material)
Zone C

$$\{\{3.6'((7.1'+21.5')/2)-(0.63(\pi\ 0.83^2))\}/27 \text{ x } 5{,}280' \text{@ } \$2.50/\text{yd.}^3$$

= $24,500/mi.

Pipe
(installed)

5,280/ft. x $26/lin. ft. = $137,300/mi.

Right of Way

50' wide x 5,280 = 6 acres x $200/acre = $1,200/mi.

Subtotal

Subtotal = $206,400/mi.

Road Crossings

Jacking
2 @ $5,000 ea. = $10,000

Subtotal

Subtotal =	$216,400
+ unlisted items (15%) =	$248,860
+ contingencies (25%) =	$311,075
+ indirect costs (25%) =	$388,844

Total construction cost ≈ $388,800/mi.

14 mi. x $388,800/mi. = $5,400,000
7 mi. x $388,800/mi. = $2,700,000

Estimated Cost for 30" Pipeline

Construction in Alluvial Fill

Minimum cover = 30 in.
Excavation depth = 5.3 ft.
Trench bottom width = 3.3 ft.
Trench top width = 24.5 ft.
Side Slope is 2:1

Excavation

Zone D

$$\left\{\left\{5.3'\left\{3.3'+24.5'\right\}/2\right\}5{,}280/27\right\} \text{ x } \$3.50/\text{yd.}^3 = \$50{,}400/\text{mi.}$$

Compacted Backfill

(selected material)
Zone A + Zone B

$$\left\{\left\{0.5'\left\{3.3'+5.3'\right\}/2\right\}+\left\{0.9'\left\{5.3'+8.9'\right\}/2\right\}-\left(0.37(\pi\ 1.12^2)\right)\right\}/27 \text{ x } 5{,}280'$$

@ $5.00/yd.^{3}
= $6,900/mi.

Backfill
(common material)
Zone C

$$\left\{\left(3.9'\left((8.9'+24.5')/2\right)-\left(0.63(\pi\ 1.12^2)\right)\right)\right\}/27 \times 5{,}280' @ \$2.50/yd.^3$$
$$= \$30{,}600/mi.$$

Pipe
(installed)

5,280/ft. x $55.00/lin. ft. = $290,400/mi.

Right of Way

50' wide x 5,280 = 6 acres x $200/acre = $1,200/mi.

Subtotal

Subtotal = $379,500/mi.

Road Crossings

Jacking
2 @ $5,000 ea. = $10,000

Subtotal

Subtotal =	$389,500
+ unlisted items (15%) =	$447,925
+ contingencies (25%) =	$559,906
+ indirect costs (25%) =	$699,883

Total construction cost ≈ $700,000/mi.

10 mi. x $700,000/mi. = $7,000,000