DEEP GROUNDWATER CONDITIONS REPORT

DECEMBER 2001

Westlands Water District
Report Date: February 2002

INTRODUCTION

Agricultural production in the Westlands Water District (District) area was originally developed and sustained through the use of groundwater for irrigation. Surface water deliveries from the San Luis Unit of the Central Valley Project (CVP) began in 1968 with the goal to reduce historical groundwater pumping. However, the District's contractual entitlements for CVP water were and are not sufficient to irrigate the entire District thus some groundwater pumping is still required. Since 1990, CVP water supplies have been severely reduced due to drought and/or regulatory actions resulting from the Central Valley Project Improvement Act (CVPIA), the Endangered Species Act (ESA), and Bay/Delta water quality requirements. As a result, groundwater pumping has increased together with other conjunctive use programs to increase water users' flexibility in efficiently managing their groundwater and surface water supplies to meet crop water demands.

This increased reliance on groundwater resources to supplement surface water resulted in the development of the District's Groundwater Management Plan in 1996 which includes continuation of this groundwater monitoring and reporting program.

WESTSIDE GROUNDWATER BASIN

The groundwater basin underlying the District is comprised generally of two water-bearing zones: (1) an upper zone above a nearly impervious Corcoran Clay layer containing the Coastal and Sierran aquifers and (2) a lower zone below the Corcoran Clay containing the Sub-Corcoran aquifer. These water-bearing zones are recharged by subsurface inflow from the west, east, and northeast, and by percolation of applied surface water. A generalized cross section of the District showing the Corcoran Clay and these water-bearing zones is shown in Figure 1.

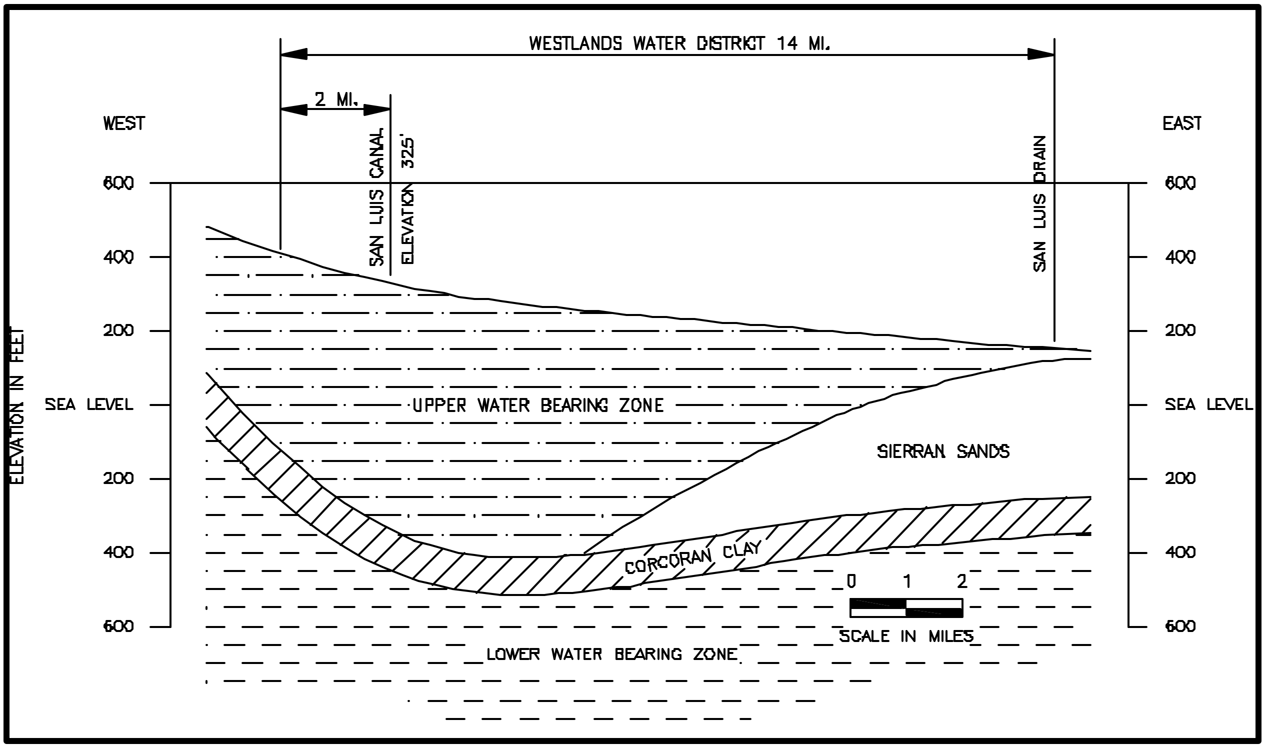

Figure 1. Generalized Hydrogeological Cross Section of the District

The Corcoran Clay separates the upper and lower water-bearing zones in the majority of the District, however, it is not continuous west of Huron. The United States Geological Survey (USGS) elevation of the base of the Corcoran Clay is shown in Figure 2.

Groundwater quality, measured as electrical conductivity, in the lower water bearing zone varies throughout the District and is shown in Figure 3. Typically, water quality varies with depth with poorer quality existing at the upper and lower limits of the aquifer and with the optimum quality somewhere between. The upper limit of the aquifer is the base of the Corcoran Clay with the USGS identifying the lower limit as the base of the fresh groundwater. The quality of the groundwater below the base of fresh water exceeds 2,000 parts per million total dissolved solids (TDS) which is too high for irrigating crops. The elevation of the base of the fresh groundwater is shown in Figure 4.

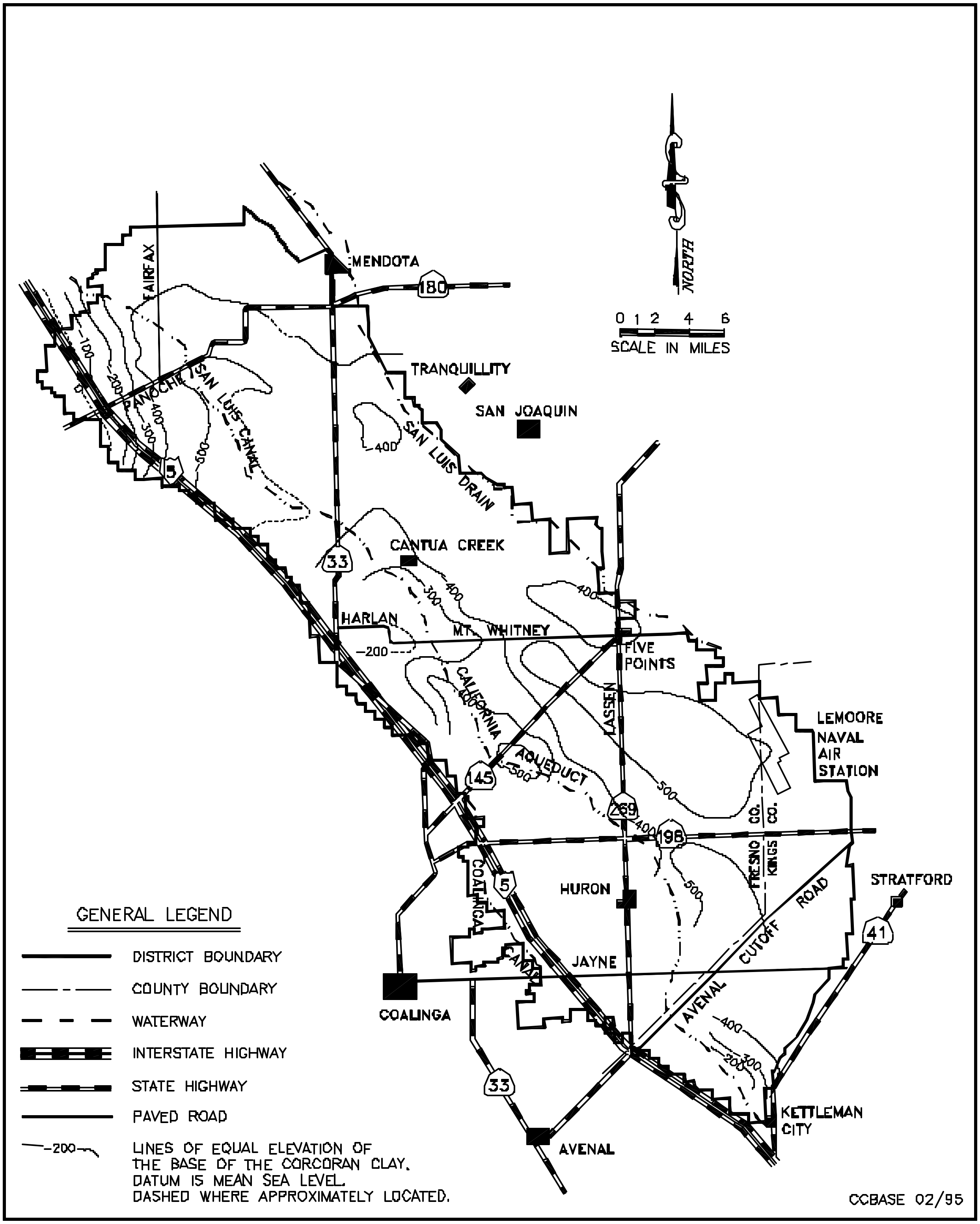

Figure 2. Elevation of the Base of the Corcoran Clay (USGS Lines of Equal Elevation)

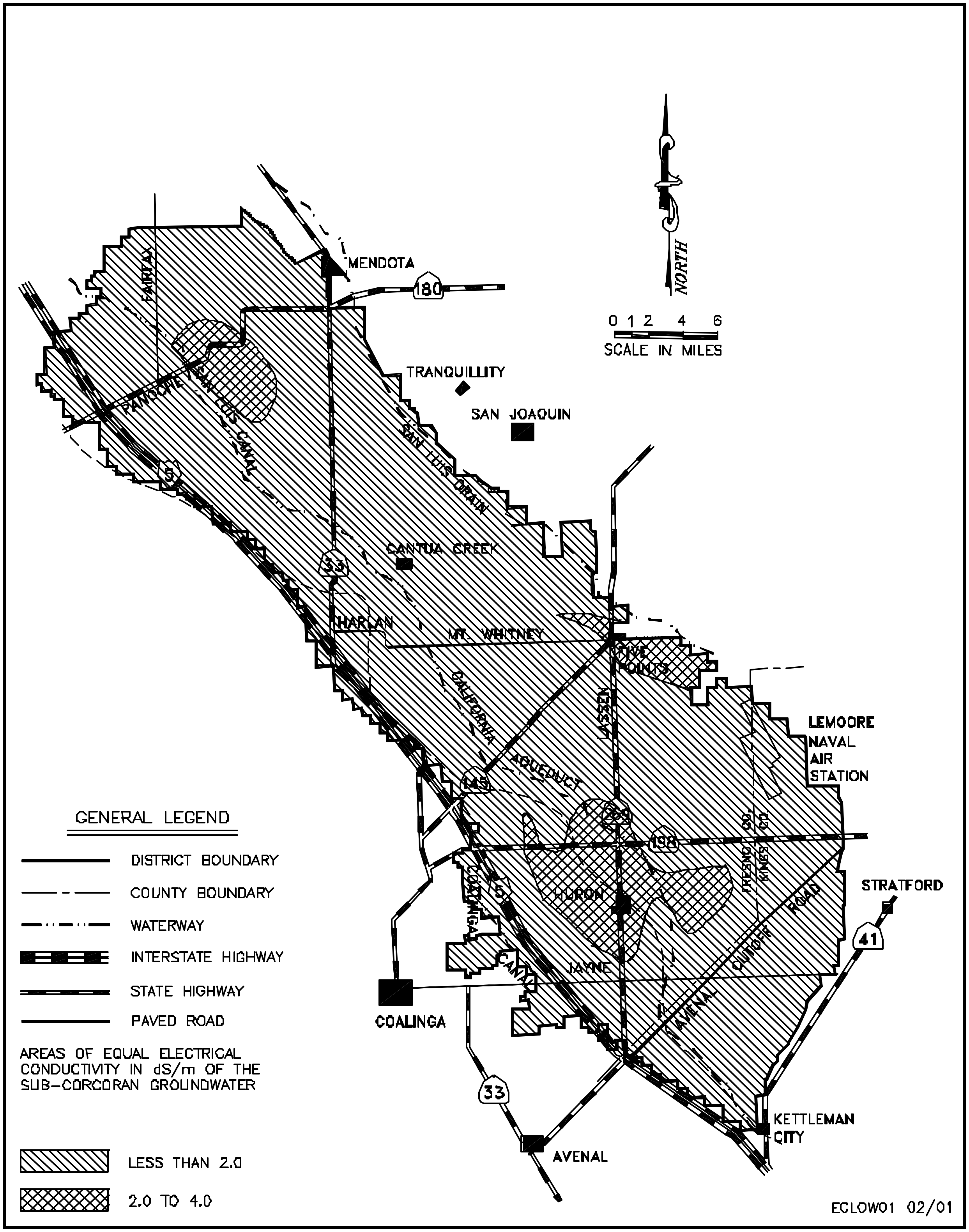

Figure 3. Electrical Conductivity (dS/m) of Sub-Corcoran Groundwater, December 2001

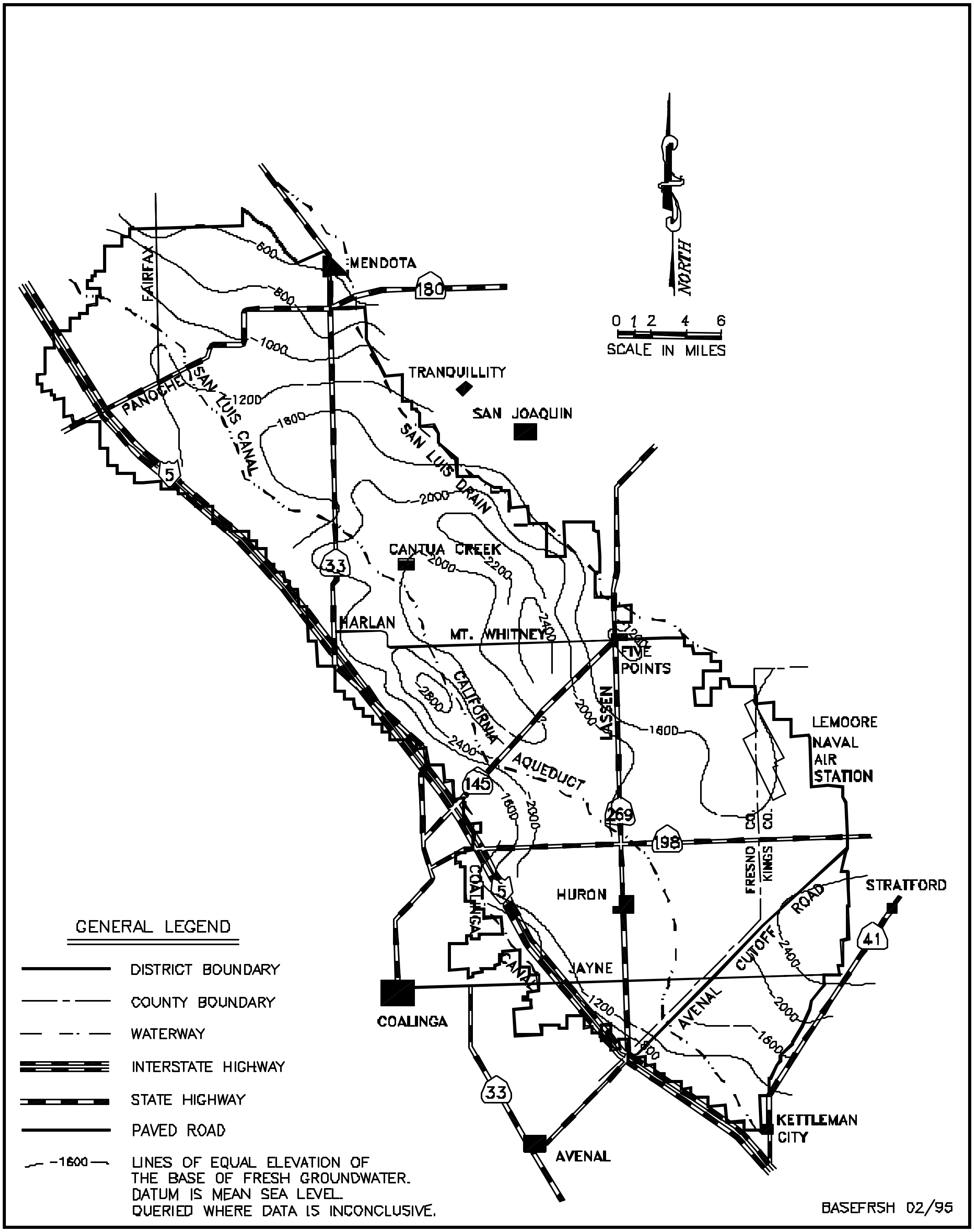

Figure 4: Elevation of the Base of Fresh Groundwater (USGS Lines of Equal Elevation)

GROUNDWATER MONITORING PROGRAM

CVP Project water and other surface water supplies are carefully allocated and all deliveries are metered resulting in accurate water use data to manage the supplies and determine water delivery costs. Surface water quality is monitored by state and federal agencies.

Groundwater measurement and quality testing have proved useful to water users to help them manage water supplies, facilitate more accurate irrigation scheduling, monitor pump efficiency, and participate in District groundwater programs. It also enables the District to better monitor groundwater supplies, calculate drought impacts, and determine long term water needs.

Since 1990, the shortage of CVP Project water and other surface water supplies resulted in the construction of many new wells so that groundwater could be used to supplement surface supplies and meet crop demands. More than 200 wells were constructed during the 1990-2001 period, bringing the total number of operational wells within the District to approximately 970, with 60 percent being metered in 1998. Many water users participated in the District Groundwater Integration Program during the 1990-94 period which allowed groundwater to be pumped into the San Luis Canal (SLC) and into the District's distribution system. The water users received surface water credits for the volume of groundwater pumped into the system which then could be used to meet their crop demand schedule. However, the discharge of groundwater into the SLC has been suspended due to concerns that groundwater could degrade the water quality in the SLC.

Groundwater monitoring is an essential part of managing any conjunctive use program. This information is vital to determine the affect of groundwater pumping on overdraft of the aquifer, aquifer water quality, pumping costs, and subsidence. Without effective monitoring, the short and long term impacts of conjunctive use cannot be determined.

The wells in the District are monitored annually for water level and quality by sounding each well while in a static condition for depth and measuring the electrical conductivity of the water while the pump is operating. The results are included in a District database which is used to formulate District reports and maps. This information enables the District to monitor groundwater trends, provide reports to water users, estimate District-wide pumped groundwater quantities, and calculate seasonal application efficiency more accurately.

GENERAL GROUNDWATER CONDITIONS

Prior to the delivery of CVP water into the District, the annual groundwater pumping ranged from 800,000 to 1,000,000 acre-feet (AF) during the period of 1950-1968. The majority of this pumping was from the aquifer below the Corcoran Clay causing the sub-Corcoran piezometric groundwater surface to reach the lowest recorded average elevation of more than 150 feet below mean sea level in 1967. The USGS calculated that the large quantity of groundwater pumped prior to delivery of CVP water compacted water bearing sediments and caused land subsidence ranging from 1 to 24 feet between 1926 and 1970.

After CVP water deliveries began in 1968, the groundwater surface rose steadily until reaching 89 feet above mean sea level in 1987, the highest average elevation of record dating back to the early 1940's. The only exception during this period was in 1977 when a drought and drastic reduction of CVP deliveries resulted in groundwater pumping of approximately 472,000 AF and accompanying drop in the groundwater surface elevation of approximately 97 feet.

During the early 1990's, groundwater pumping increased because of reduced CVP water supplies caused by drought and regulatory actions related to the Central Valley Project Improvement Act, the Endangered Species Act, and Bay/Delta water quality requirements. Groundwater pumping reached an estimated 600,000 AF annually during 1991 and 1992 when the District received only 25 percent of its contractual entitlement of CVP water. This increased pumping caused the groundwater surface to decline to 62 feet below mean sea level, the lowest elevation since 1977. As a result of the groundwater pumping, increased subsidence occurred in the District and other areas in the western Central Valley. The Department of Water Resources estimated the amount of subsidence since 1983 to be almost two feet in some areas of the District with the most of that subsidence occurring since 1989.

CURRENT GROUNDWATER CONDITIONS

From 1995 to 1999, CVP deliveries into the District averaged 91% (1,046,500 acre feet) which reduced groundwater pumping and allowed the groundwater surface elevation to increase from –51 feet to 65 feet, an increase of 116 feet. However in 2000 and 2001, CVP deliveries only averaged 57% (655,500 acre-feet) which has resulted in the groundwater surface falling 40 feet to an average elevation of 25 feet above mean sea level. Groundwater pumping in 2000 and 2001 totaled 440,000 acre-feet and would have been greater if the District and water users had not transferred in other surface water supplies.

The estimated amount of groundwater pumping from 1976 through 2001 is shown in Table 1. Table 1 also shows the average elevation of the groundwater in the lower water bearing zone and the average change in elevation from the prior year.

Crop Year[1/]	Pumping AF	Elevation FT	Elevation Change FT	Crop Year[1/]	Pumping AF	Elevation FT	Elevation Change FT
1976	97,000	-2	9	1989	175,000	63	-1
1977	472,000	-99	-97	1990	300,000	9	-54
1978	159,000	-4	95	1991	600,000	-32	-41
1979	140,000	-13	-9	1992	600,000	-62	-30
1980	106,000	4	17	1993	225,000	1	63
1981	99,000	11	7	1994	325,000	-51	-52
1982	105,000	32	21	1995	150,000	27	78
1983	31,000	56	24	1996	50,000	49	22
1984	73,000	61	5	1997	30,000	63	14
1985	228,000	63	2	1998	15,000	63	0
1986	145,000	71	8	1999	20,000	65	2
1987	159,000	89	18	2000	225,000	43	-22
1988	160,000	64	-25	2001	215,000	25	-18

[1/] October 1 to September 30

[2/] District Estimate

Table 1. Groundwater Pumping

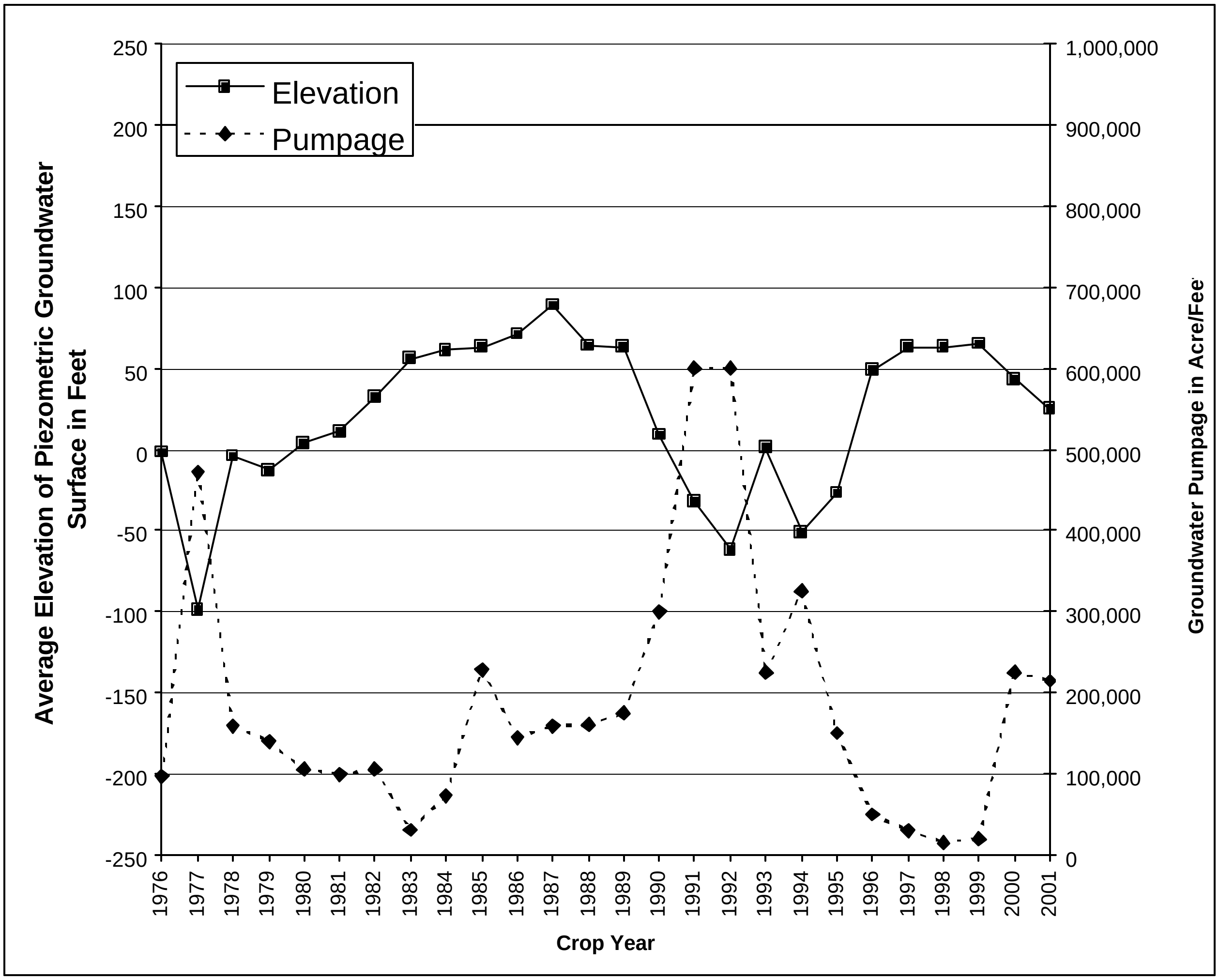

Figure 5. Historical Average Elevation of Sub-Corcoran Piezometric Groundwater Surface and Groundwater Pumping

The historical average elevation of the Sub-Corcoran piezometric groundwater surface and the estimated amount of groundwater pumped in the District is shown in graphical format in Figure 5.

The depth to the piezometric groundwater surface in the lower water-bearing zone during December 1994 and December 2001 is shown in Figures 6 and 7, respectively. The change in depth to the piezometric groundwater surface from December 1994 to December 2001 is shown in Figure 8.

In addition to monitoring the water levels of wells pumping from the lower aquifer, the wells pumping from the upper aquifer are also monitored. The majority of the wells pumping from the upper aquifer had groundwater surface levels 100 to 200 feet below ground surface during December 2001 as shown in Figure 9.

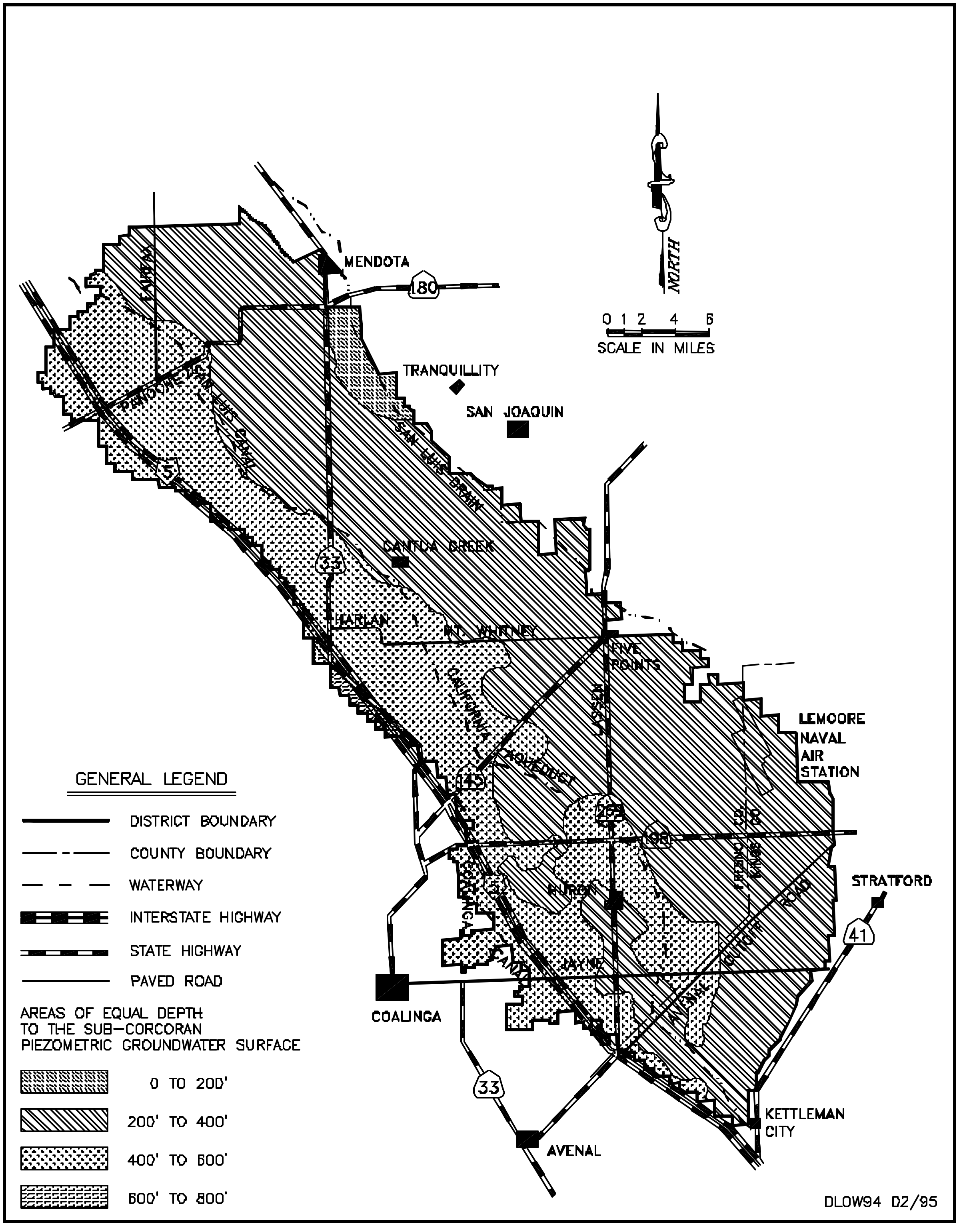

Figure 6. Depth to Sub-Corcoran Piezometric Groundwater Surface, December 1994

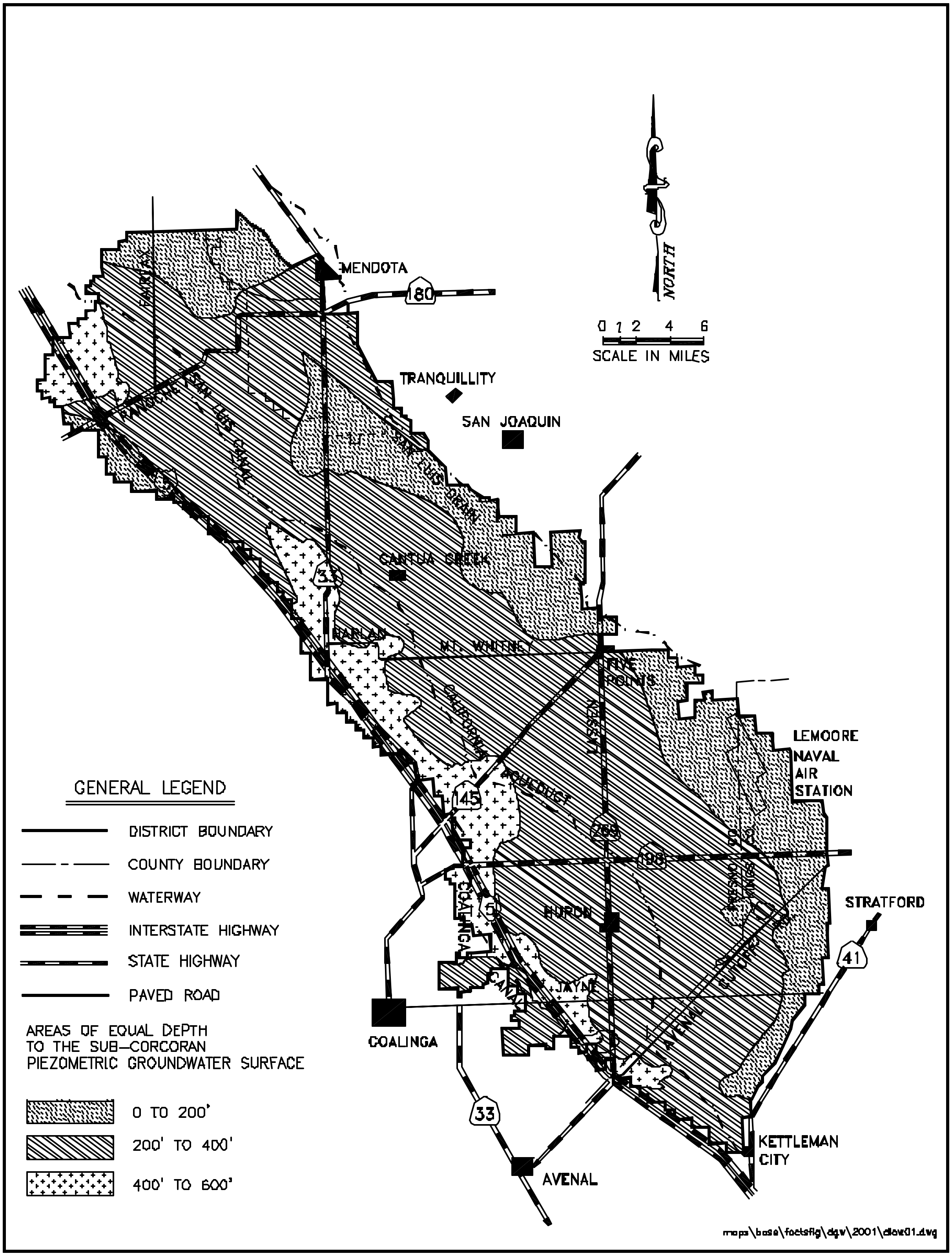

Figure 7. Depth to Sub-Corcoran Piezometric Groundwater Surface December 2001

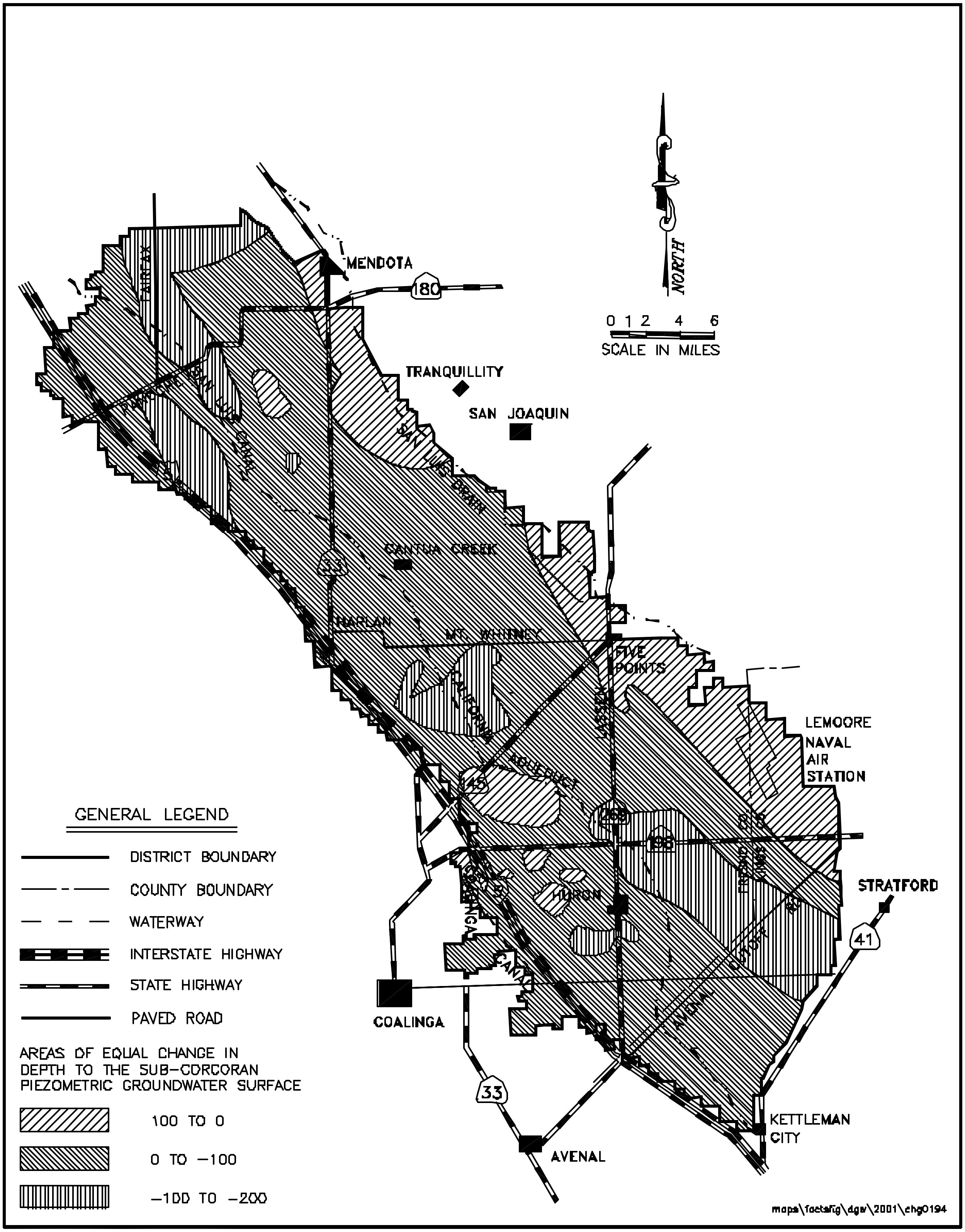

Figure 8. Change in Depth to the Sub-Corcoran Piezometric Groundwater Surface. 1994 - 2001

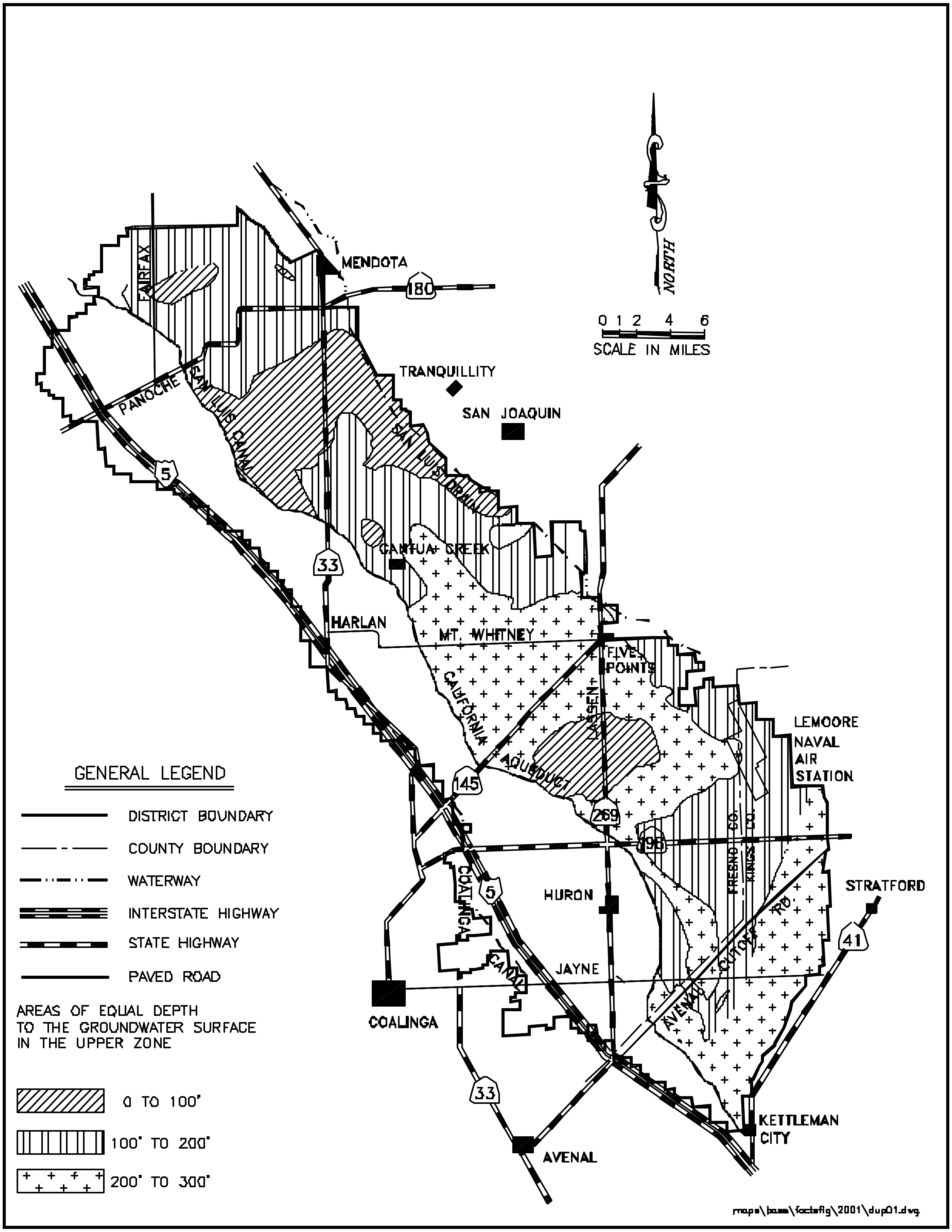

Figure 9. Depth to Groundwater in the Upper Zone, December 2001

SAFE YIELD

Safe yield or current perennial yield is the amount of groundwater that can be extracted without lowering groundwater levels over the long term. Current perennial yield can be determined by plotting the amount of groundwater pumped in one year versus the average change in groundwater level in the basin for that year. Data for 1976 to present were plotted and a "best fit" was drawn. The intersection of the best fit with the line showing zero groundwater level change as shown in Figure 10 indicates the current perennial yield of groundwater to be approximately 200,000 AF.

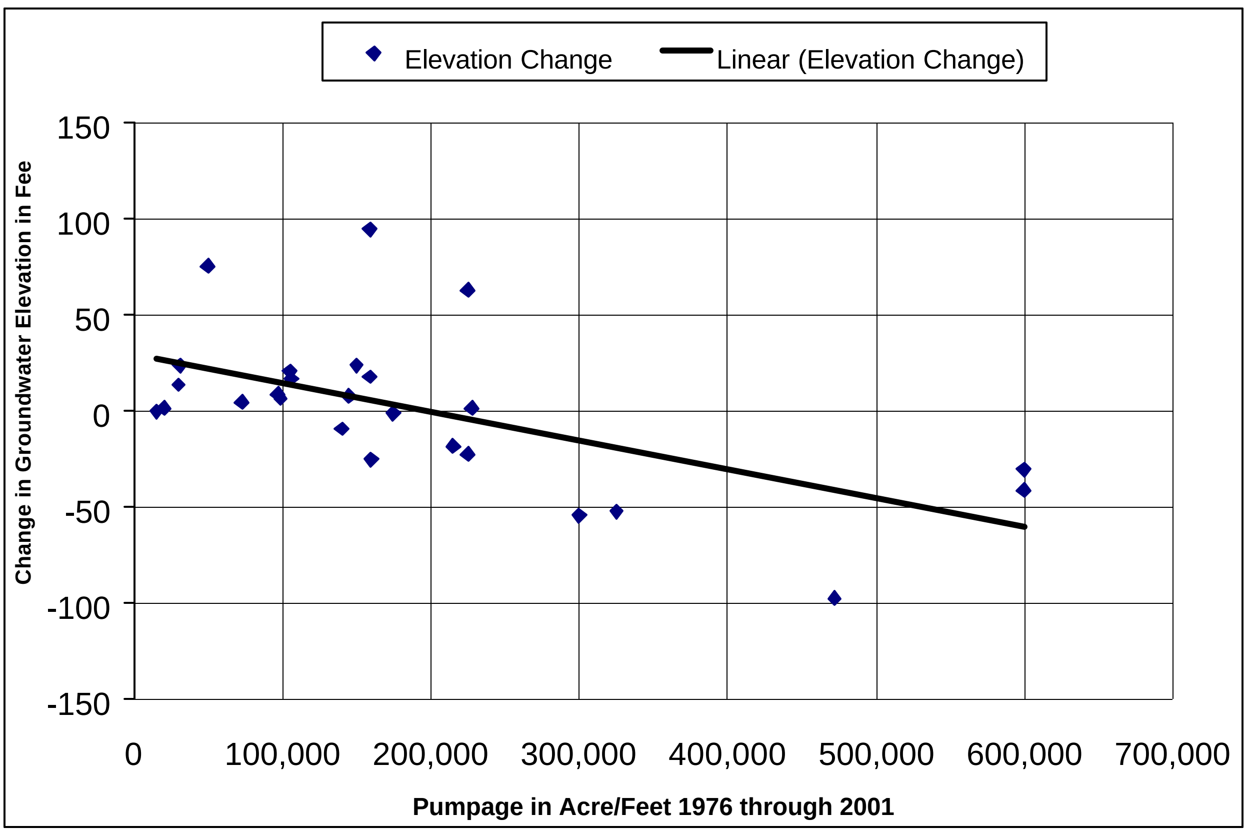

Figure 10. Change in Groundwater Elevation Versus Pumping