EXHIBIT B

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GROUNDWATER SUB-BASINS IN THE ANTELOPE VALLEY

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SUMMARY

Multiple lines of evidence (seismic crustal surveys, gravity anomaly surveys and well log data) support the conclusion that the southern Antelope Valley is divided into two substantially independent major groundwater sub-basins. These sub-basins are physically separated by a partially buried ridge of bedrock extending NE from the Antelope Buttes toward Willow Springs. This bedrock ridge provides a substantial restriction to groundwater flow between the two sub-basins.

There is also clear evidence that groundwater development in the East Antelope Basin has not influenced the West Antelope Basin in that (a) major declines of groundwater levels in the East Antelope Basin/Sub-Basin have had no significant effect on the groundwater levels in the West Sub-Basin, and (b) the land subsidence resulting from pumping in the Eastern Sub-Basin is not manifest in the Western Sub-Basin. Support for the existence of two other minor sub-basins, one north of the Willow Springs fault and the other west of the Randsburg Mojave Fault, also appears to be evident in the groundwater and geophysical data, such that the groundwater in the area north of the Willow Springs Fault appears to be essentially isolated from the rest of the Antelope Valley.

PHYSICAL SETTING

The Antelope Valley is a closed basin with no net surface drainage to the ocean. It was formed by intermittent tectonic motions over the last 20+ million years (Stanley et al, 2000). The defining features of the valley are the Garlock Fault to the north and San Andreas Fault to the south (see **Figure 1**) and the faulted valley floor has been filled in by major flood events and lacustrine deposits over a period of several million years.

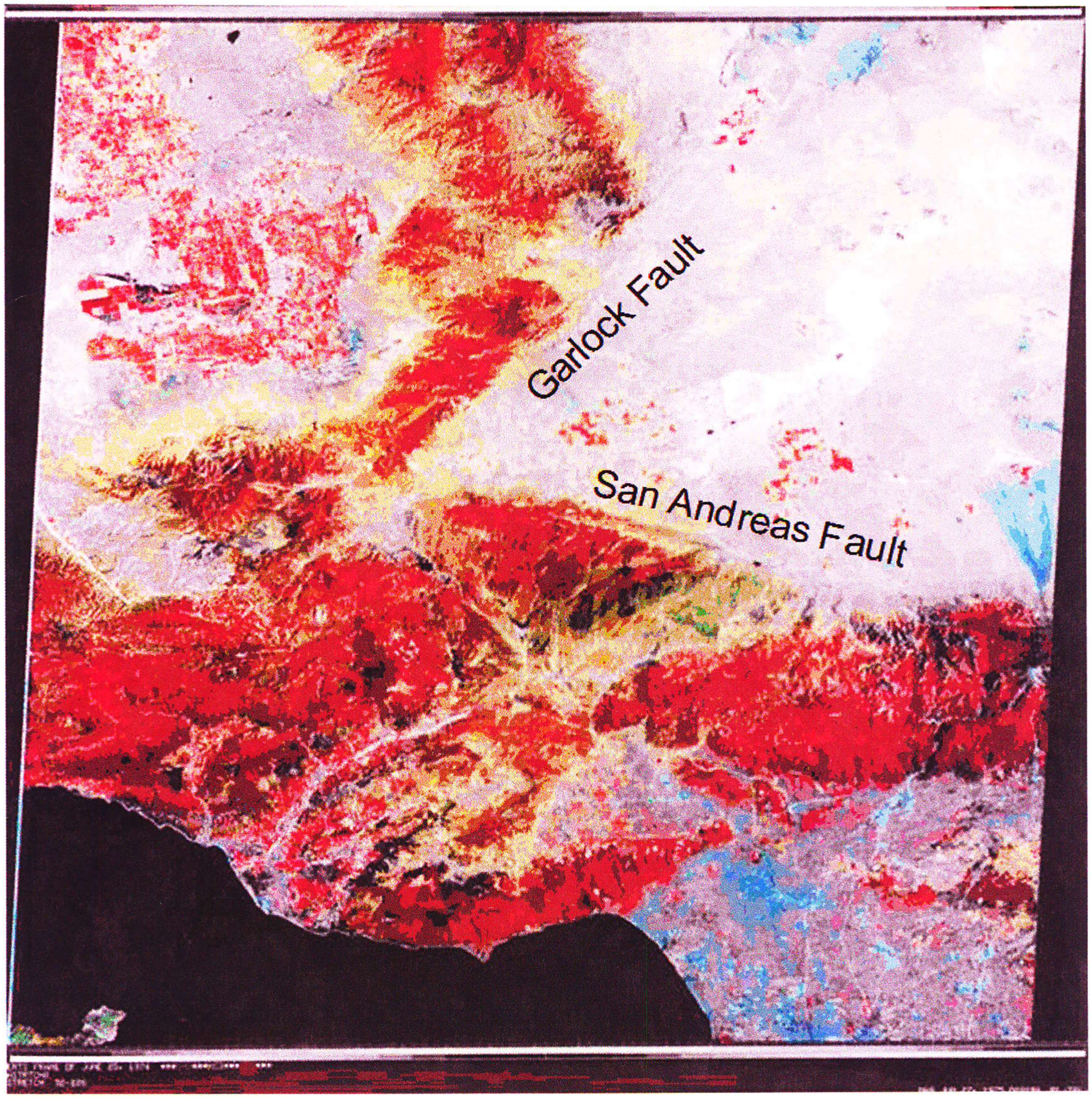
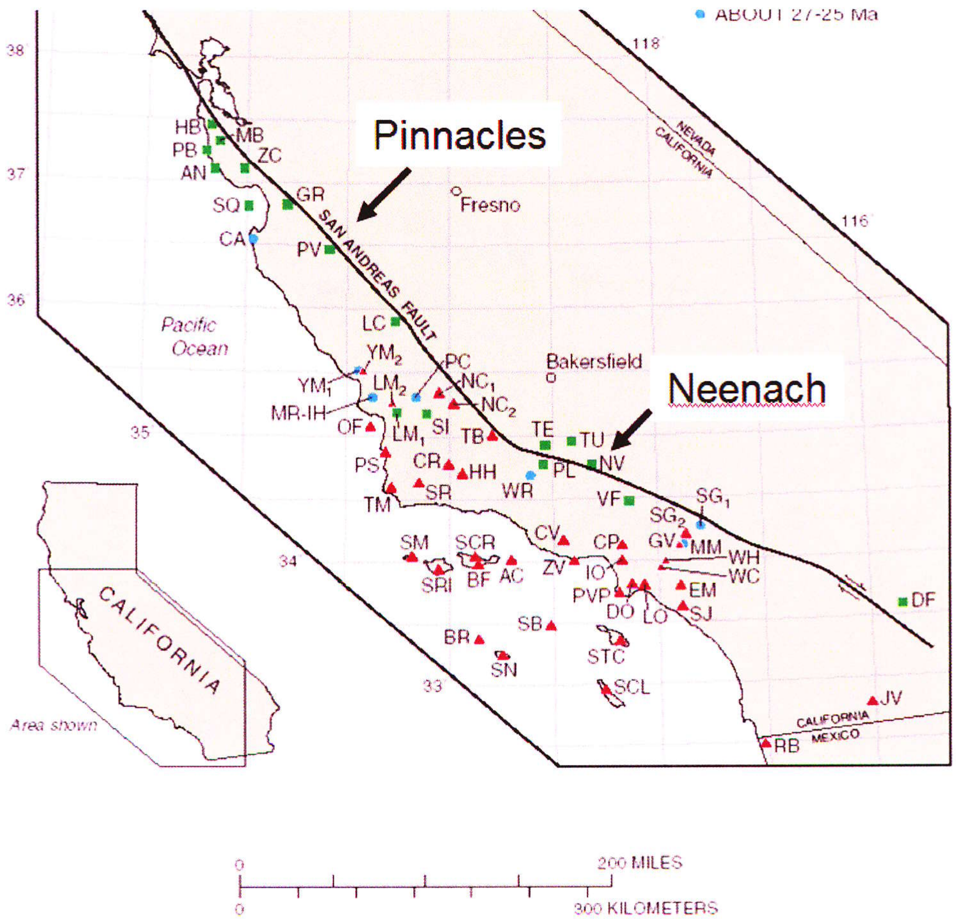


Figure 1 – Infra-red satellite view of the Antelope Valley (Source: NASA , ca. 1970).

The San Andreas Fault is still very active and has moved 195 miles in 23 million years. The evidence for this is the unique Neenach volcanic zone that has been split in two by the San Andreas Fault, so that the eastern section of this zone remains within the Antelope Valley while the western section is now located at the Pinnacles in San Benito County (**Figure 2).**

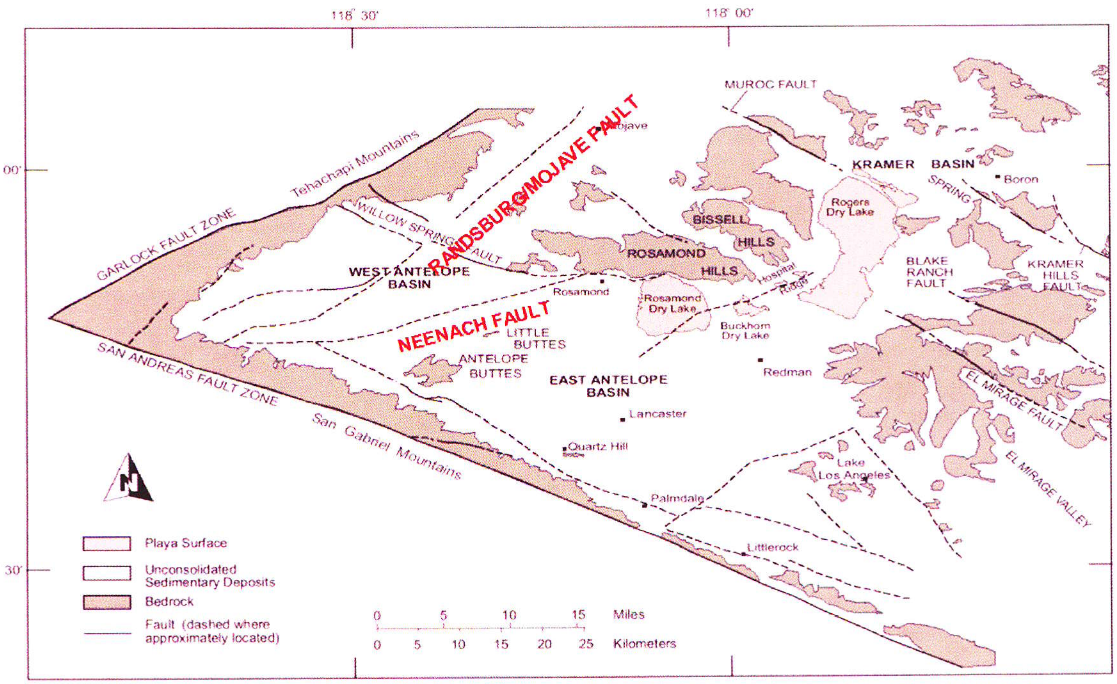


Source: Stanley et al., USGS Open-File Report 00-154

Figure 2 – Map illustrating movement of the San Andreas Fault.

In addition to the two main bounding faults there are a number of minor faults (some of which have no surface traces) within the valley. This faulting is result of the structural distortion caused by the movement of the Pacific Tectonic Plate on the west of the San Andreas Fault.

The presumed intra-valley fault locations are shown in **Figure 3**. Some of these faults are well defined, e.g., the Willow Springs Fault. Others, such as the Neenach Fault, have no surface manifestation, but their presence deep within the sediments of the valley can be inferred from the results of crustal seismic (Lutter et al, 2004) and gravity surveys (Mabey, 1960)

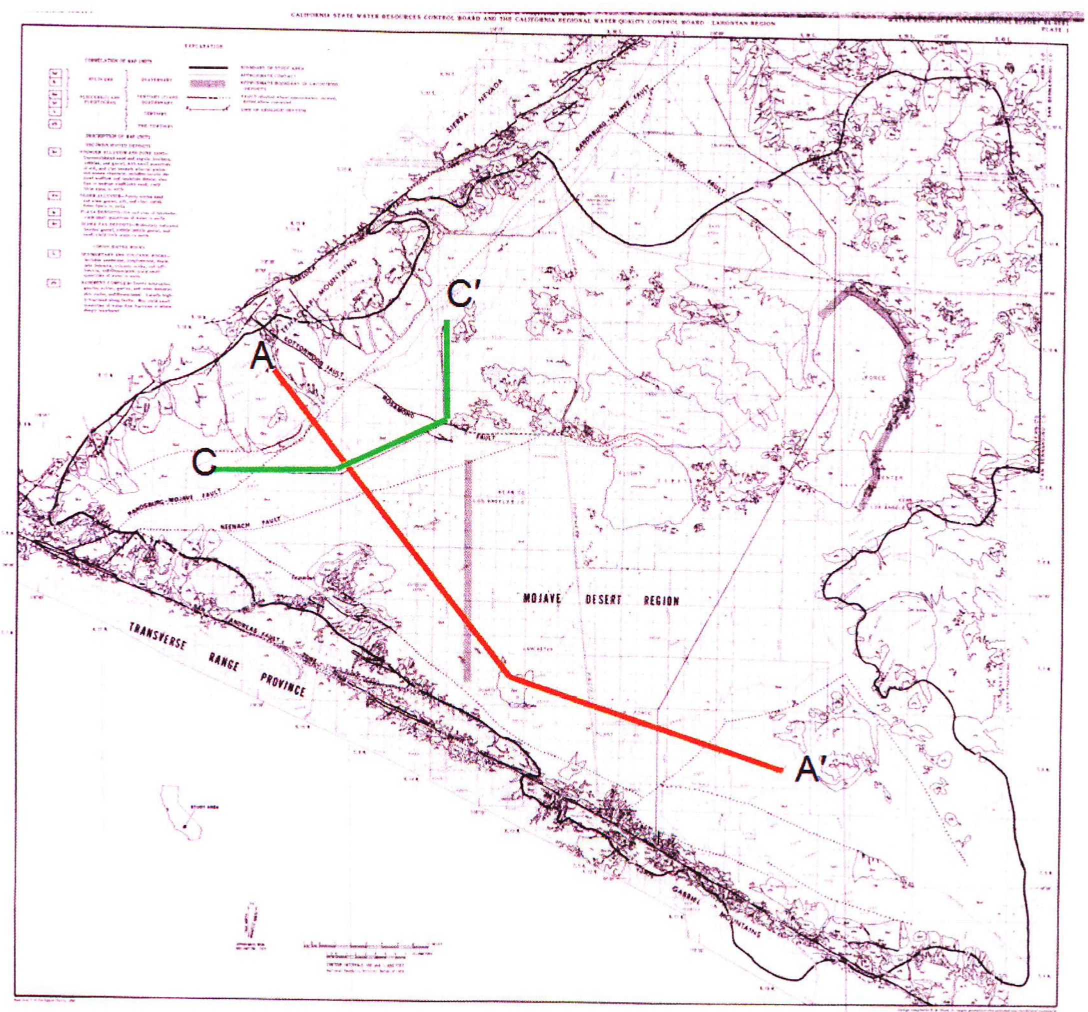


Source: Figure 2-5 at http://www.lacsd.org/Draft%20PWRP%202025%20Plan/Figures.htm

Figure 3 – Location of presumed intra-valley faults in the Antelope Valley.

An examination of well drilling records compiled by California Department of Water Resources enables the subsurface basement rock structure of the Antelope Valley to be determined and mapped. Although well log data is sometimes difficult to interpret there is enough information to enable the basic geological structure to be understood.

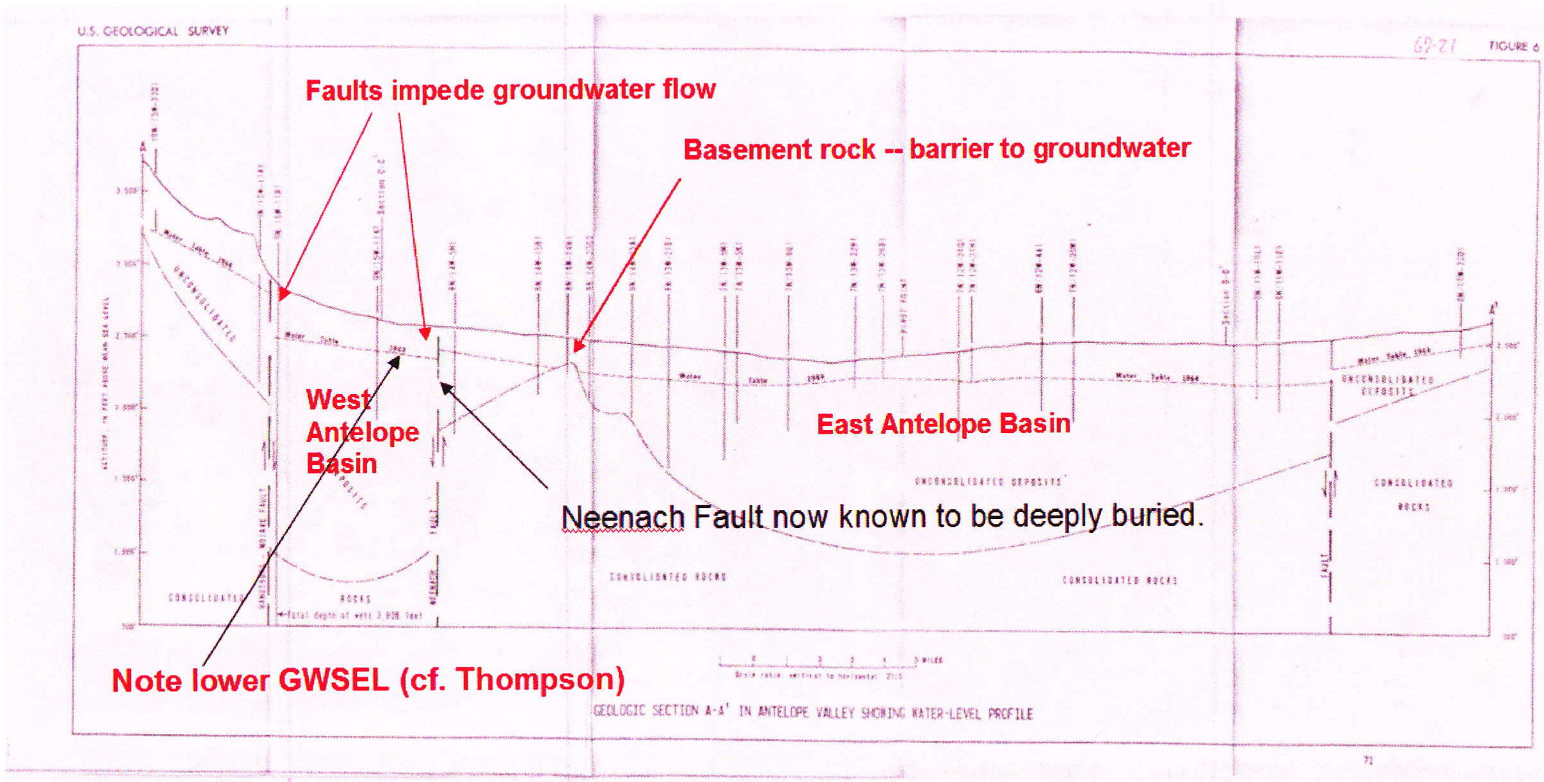
Figure 4 shows the location of two cross-sections that were developed by the US Geological Survey in 1967. **Figure 5** has Section AA′ and **Figure 6** has Section CC′. From these two sections it is clear that the southern portion of the Antelope Valley is divided into two major sub-basins and that additional smaller sub-basins are north of the Willow Springs Fault and west of the Randsburg Mojave Fault, where groundwater flow is impeded by the faults. It is noted that in 1967 the USGS also believed that the Neenach Fault impeded groundwater flow. However, more recent detailed analysis of groundwater elevations in the area between 1965 and 2005 (discussed below) show this not to be the case. In addition, seismic surveys (Lutter et al, 2004) show that although the Neenach Fault exists in the basement rock it probably does not extend into the sedimentary aquifer.



MAP SHOWING GENERALIZED GEOLOGY AND LINES OF GEOLOGIC SECTIONS IN ANTELOPE VALLEY, CALIFORNIA

Figure 4 – Plan of the two cross-sections presented below in Figures 5 and 6. (Source: Bloyd, USGS Open File Report 67-21)

Section AA' Across West and East Antelope Basins



Source: USGS Open-File Report 67-21 Plate 6

Figure 5 – Annotated Section AA′ across the West and East Antelope Basins.

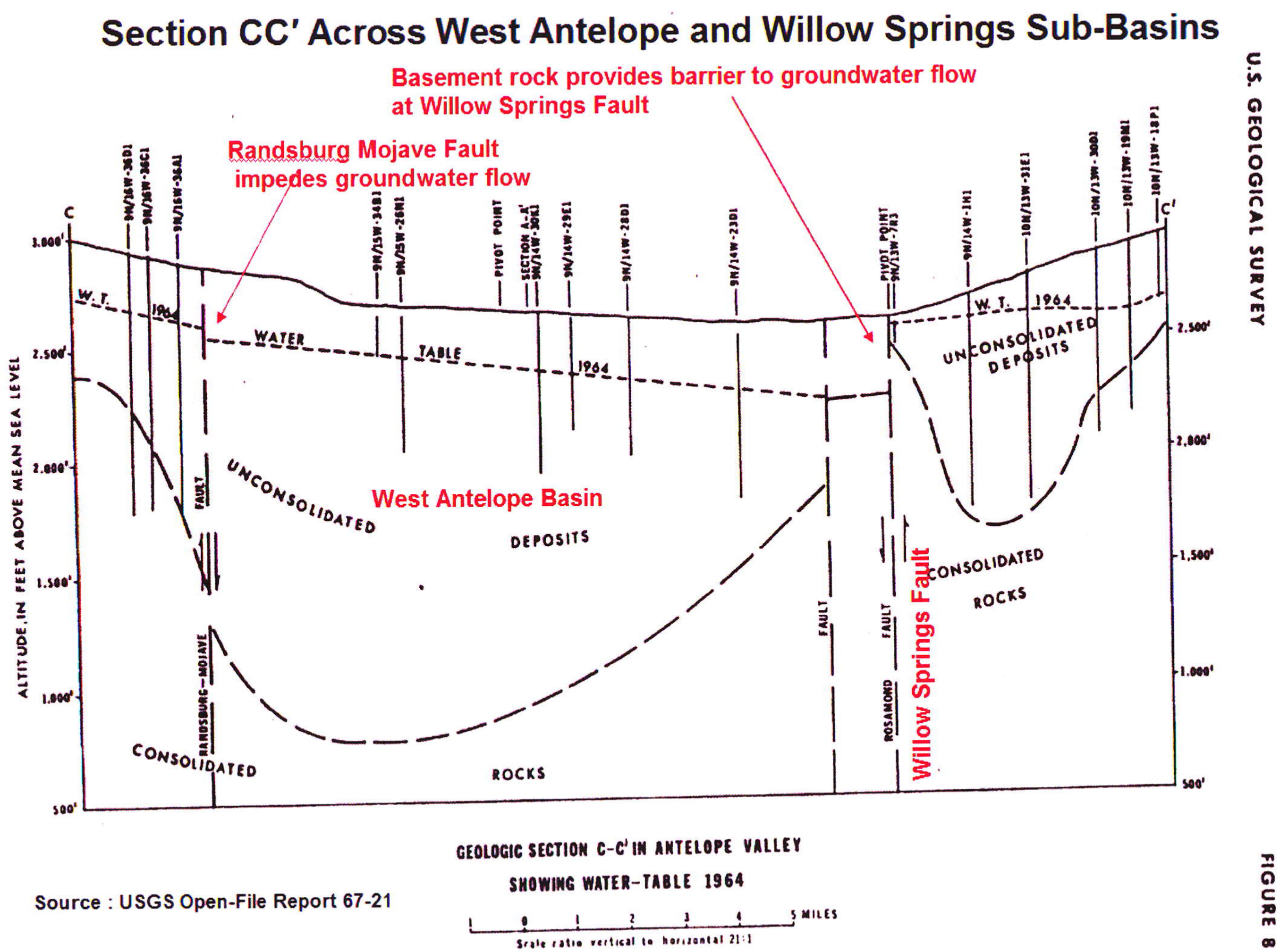


Figure 6 – Annotated Section CC′ across West Antelope Valley and Willow Springs Fault

Figure 7 shows the depth to basement rock contours developed from of a more recent analysis of DWR well log data and the relationship of the basins to the mountains ranges that define the Antelope Valley.

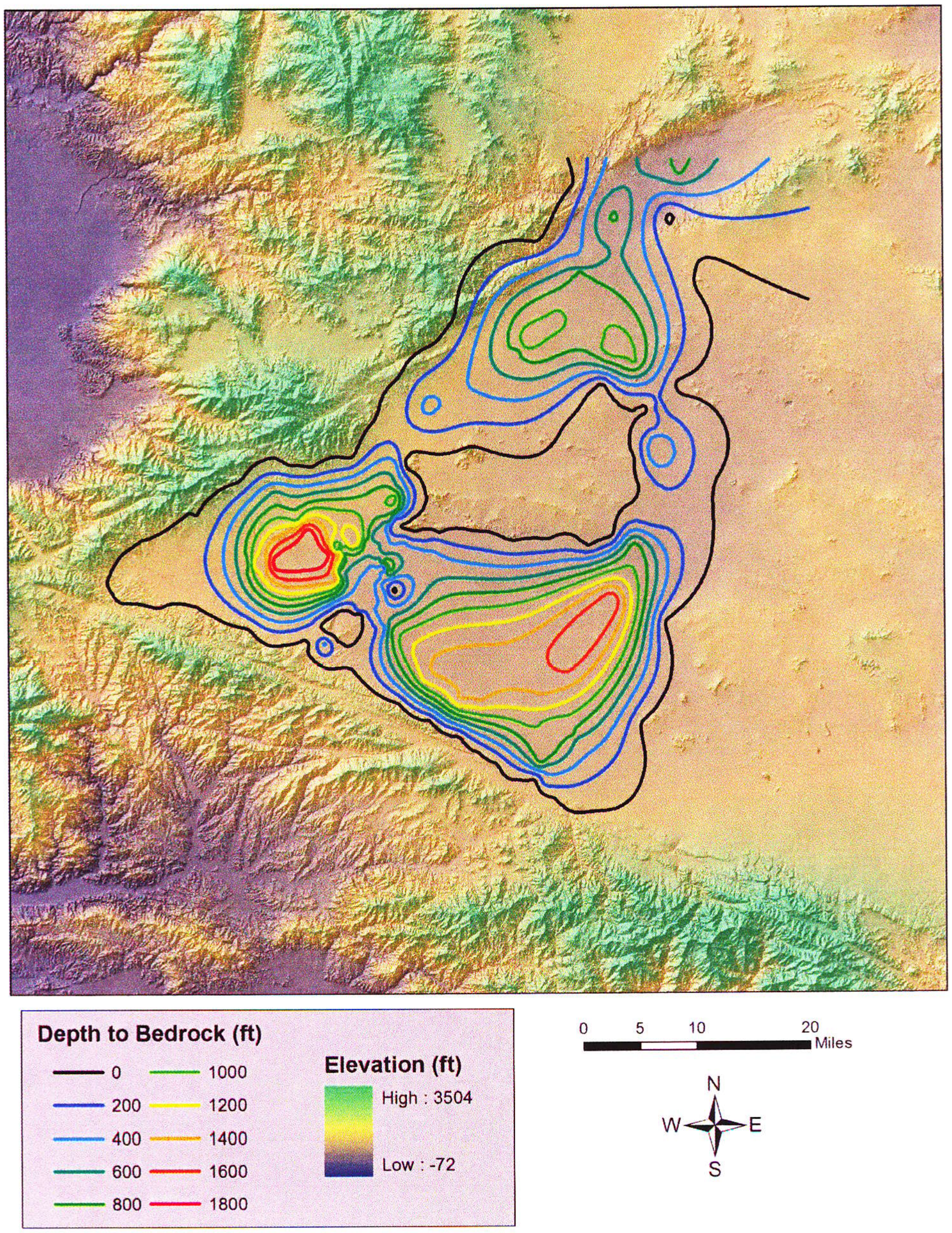


Figure 7 –Depth to basement rock contours developed from DWR well log data.

An oblique view of this data is shown in **Figure 8**. It is very evident that the Antelope Valley clearly has two major sub-basins, and two smaller sub-basins, each delineated by buried basement rock ridges. Each of these four basins is currently filled with sediment now comprise the groundwater aquifers of the Antelope Valley. The two major (southern) basins are more than 1500 feet deep.

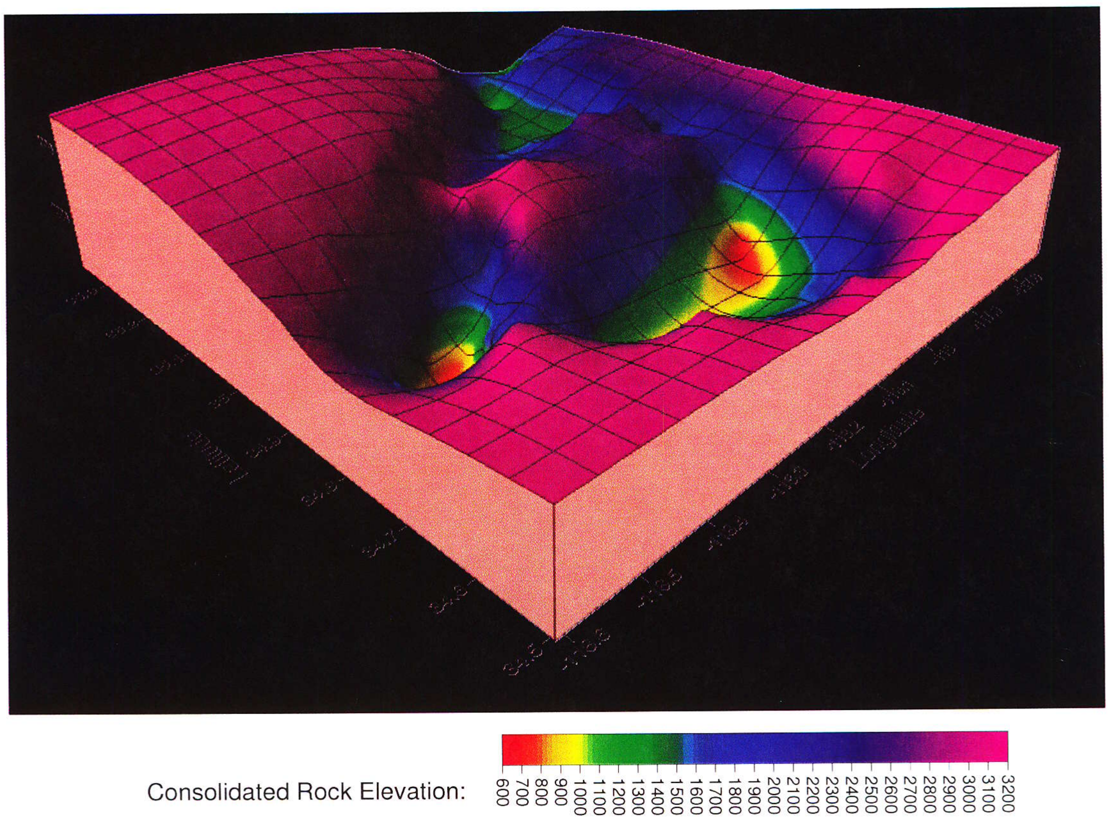


Figure 8 – An oblique view of bed rock contours as seen from the South West.

This basic result is confirmed by other sub-surface investigative techniques that allow the structure of the basement rock to be inferred. The technique known as Bouguer gravity anomaly surveying also suggests existence of buried basement rock that separates the southern Antelope Valley aquifer into two major basins. **Figure 9a** provides the result of one such gravity anomaly survey in the Valley (Mabey, 1960) and in **Figure 9b** the bedrock contours are superimposed on the results of the gravity survey.

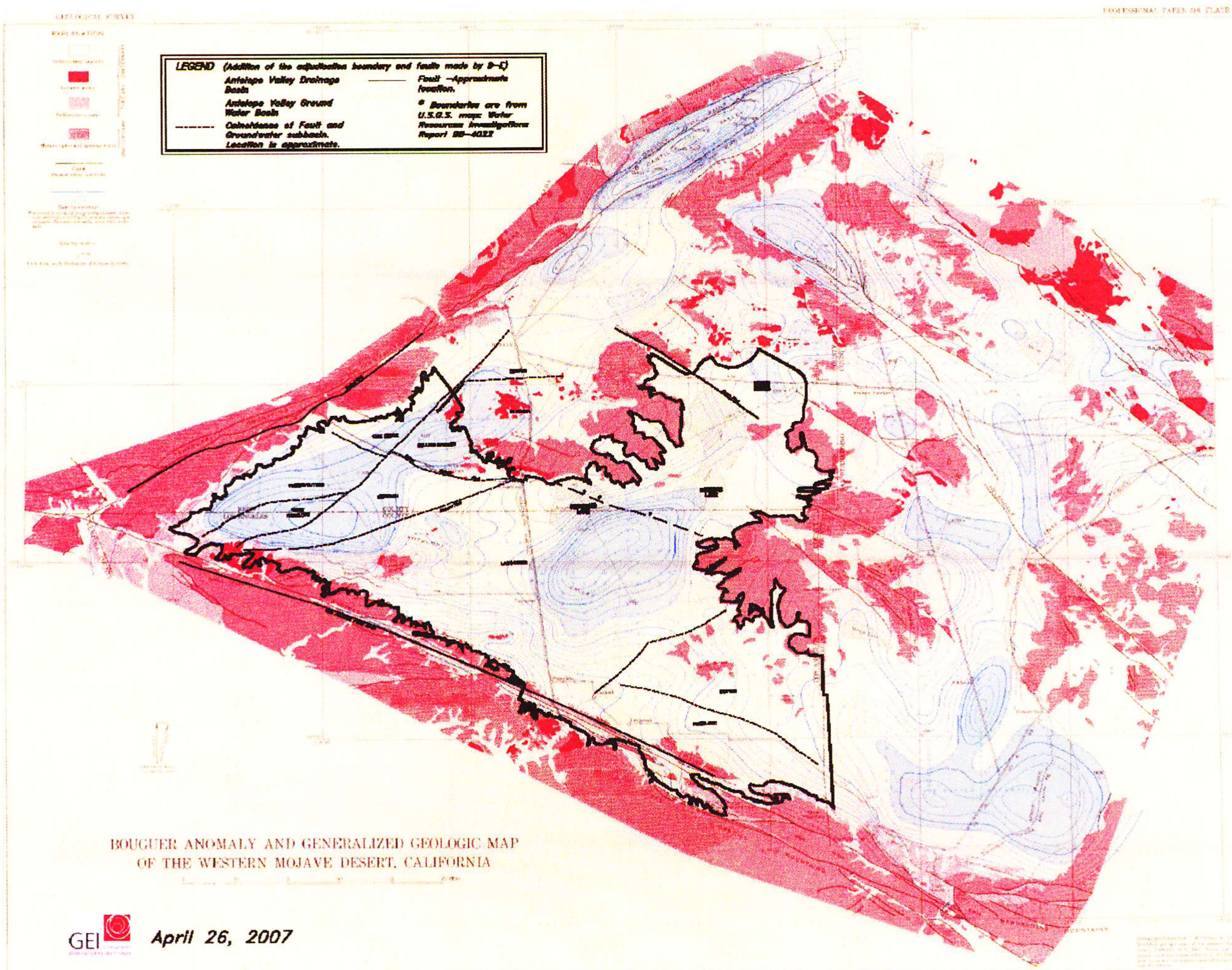


Figure 9a – Bouguer Gravity anomaly map for the Antelope Valley (Mabey, 1960). Faults and adjudication boundary superimposed by GEI.

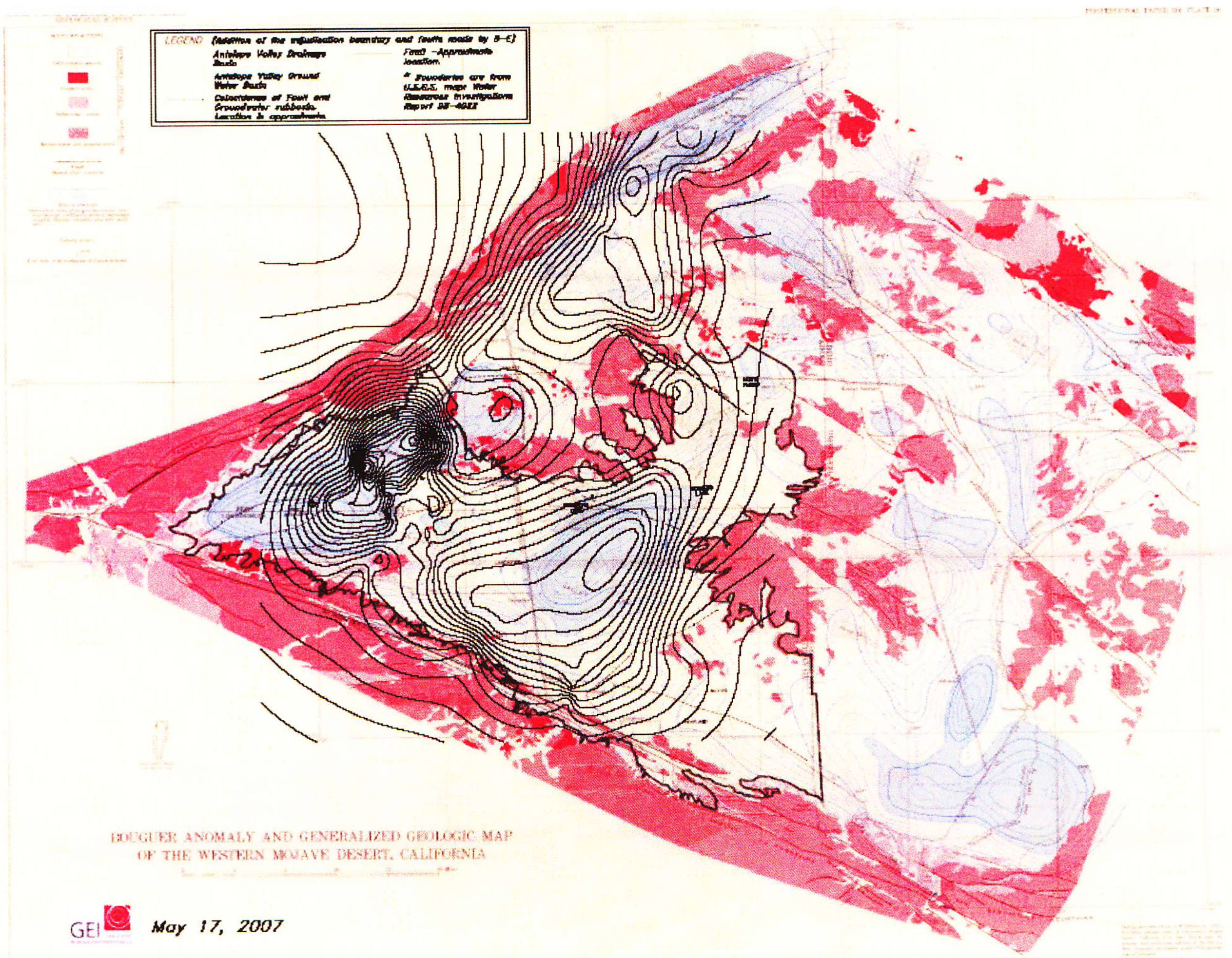


Figure 9b – Bed rock contour map super-imposed on gravity anomaly map.

It can be clearly seen that the anomaly map suggests very strongly the existence of raised sections of bed rock separating the groundwater basin in the southern Antelope Valley into two major sub-basins. The coincidence of the gravity anomaly map and the bedrock contour map derived from DWR well logs is quite remarkable (**Figure 9b**).

Another remote sensing technique that helps identify sub-surface structure is aero-magnetic surveying. An aero-magnetic survey of the Antelope Valley also suggesting a buried basement rock ridge is shown in **Figure 10** (USGS Geophysical Investigations Map GP-695)

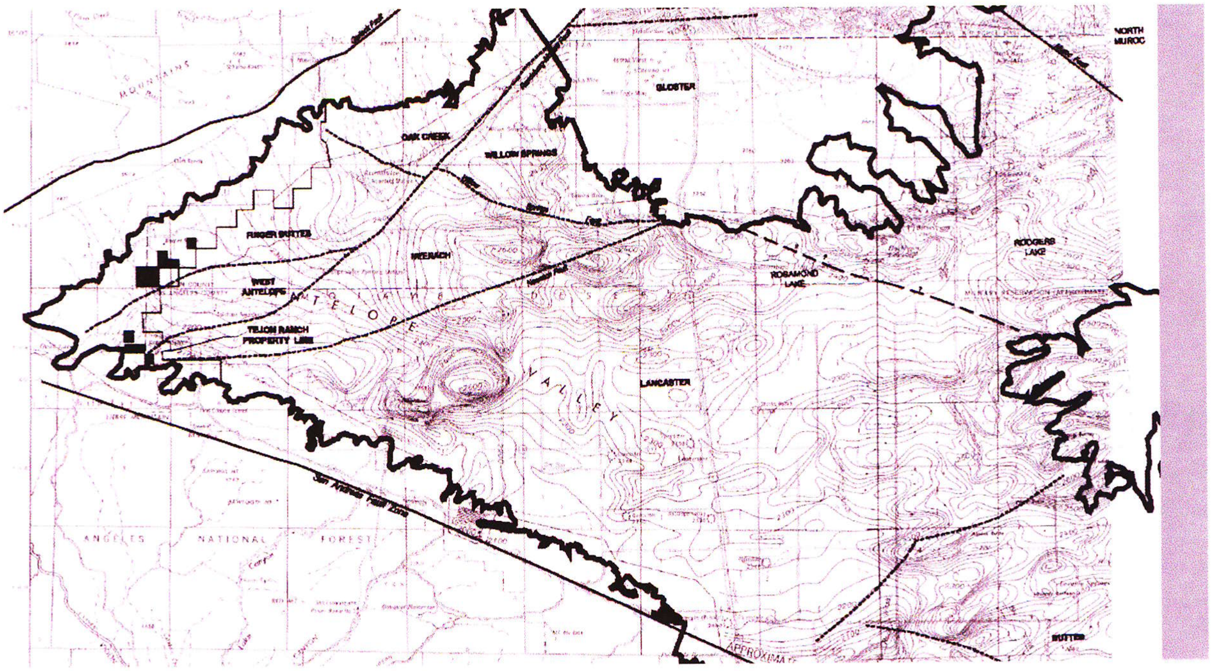


Figure 10 – Part of an aero-magnetic survey of the Antelope Valley (USGS Map GP-65); adjudication boundary superimposed by GEI.

The geophysical evidence therefore strongly suggests that the southern Antelope Valley is divided by basement consolidated rock into two distinct and separate major basins or sub-basins. Sections drawn across the basement rock ridge dividing the two southern basins are shown in **Figures 11 through 15**. **Figure 11** shows the locations of the wells whose logs were used to develop the basement rock elevations and illustrates the planform of the four sections plotted in **Figures 12 through 15**. The small green diamonds in these figures also mark the ground water surface elevation at the indicated date. In general, the water surface elevation at the bedrock ridge is at about 2200-2250 ft. Note that in **Figure 13** the high water table elevation above 2500 ft shown on the left of the figure is located north of the Willow Springs Fault.

Antelope Valley, CA
Depth to Bedrock Contours and Cross-Section Locations

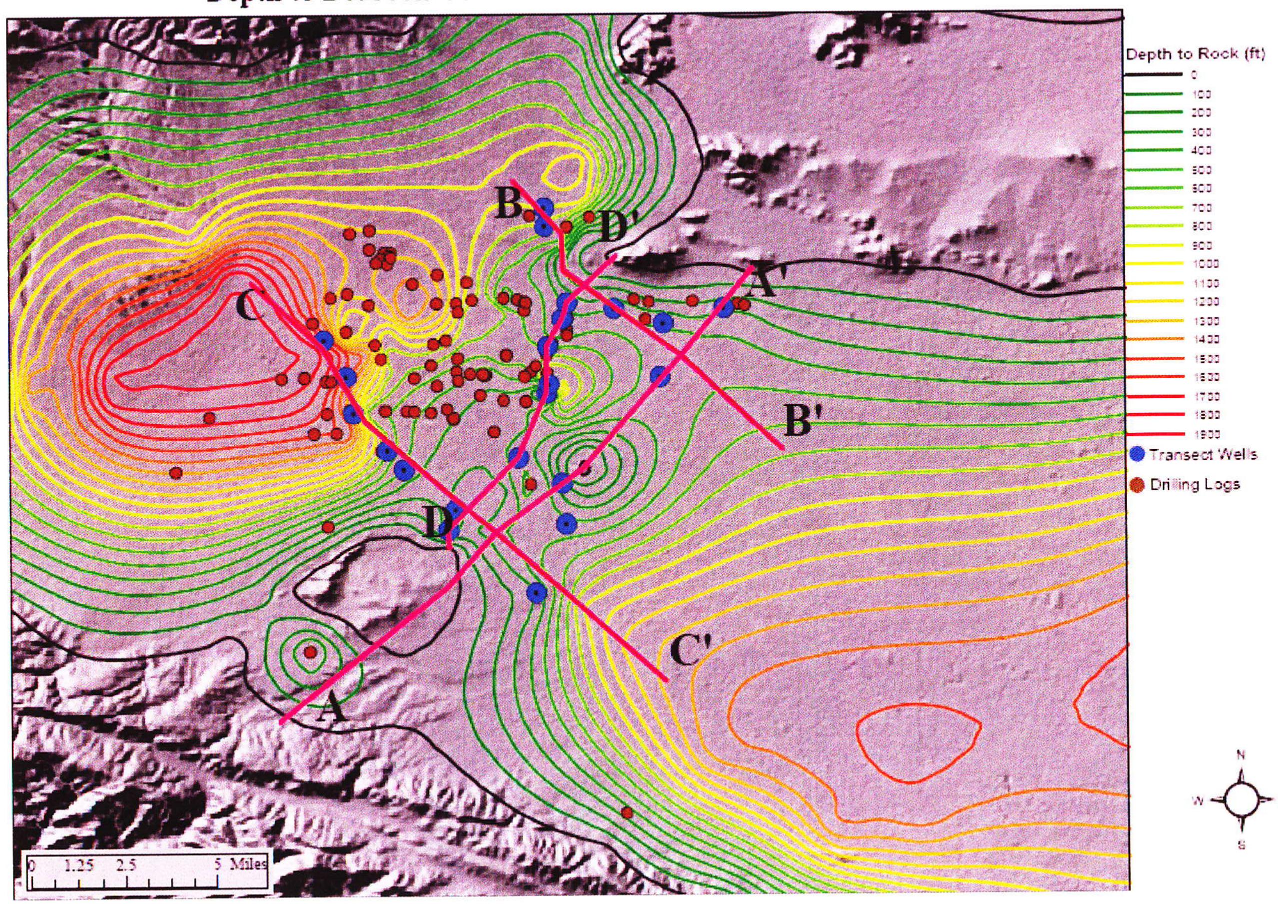


Figure 11 – Planform for sections shown in Figures 12 through 15 showing DWR well data used to develop transects.

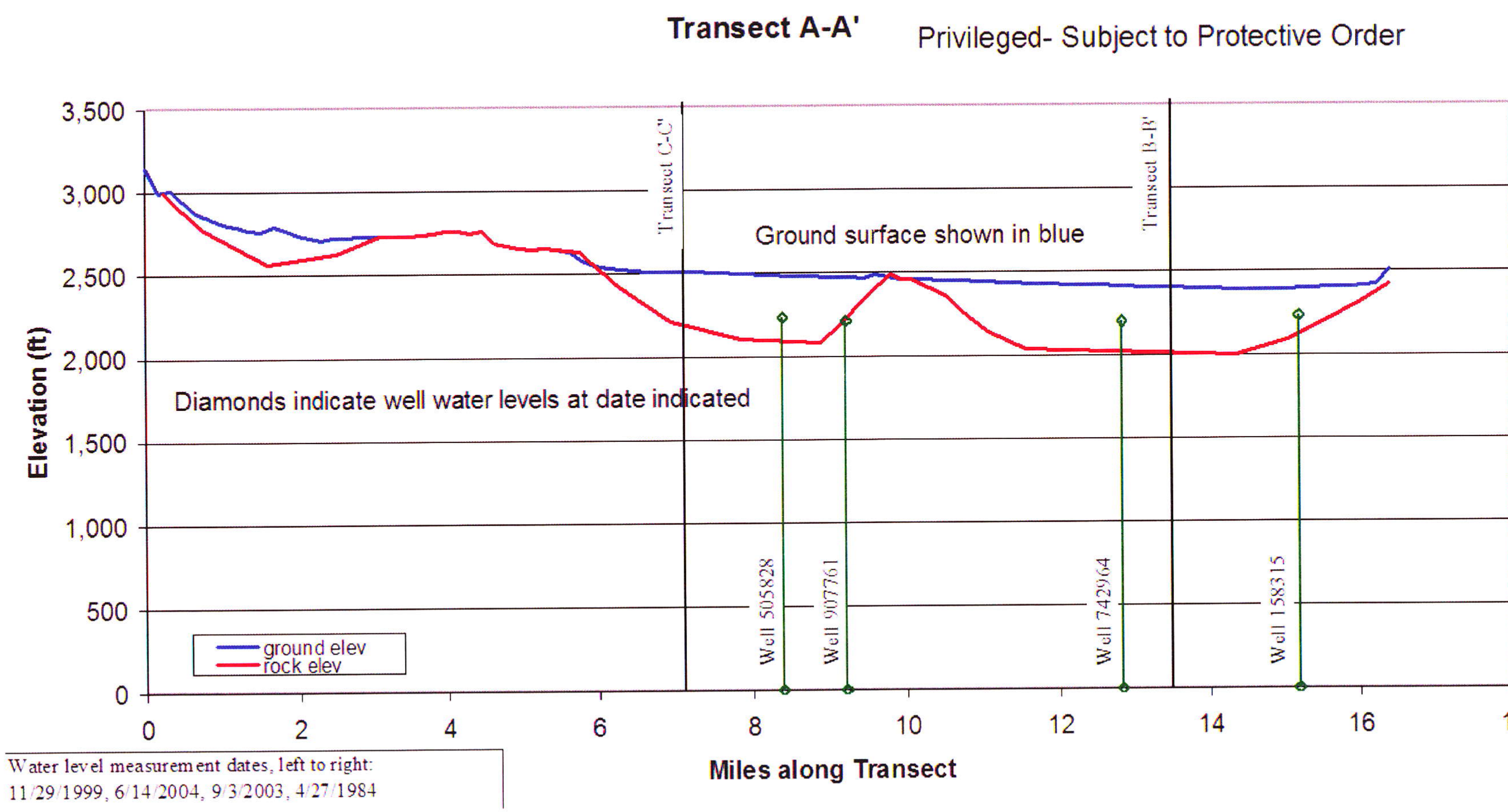
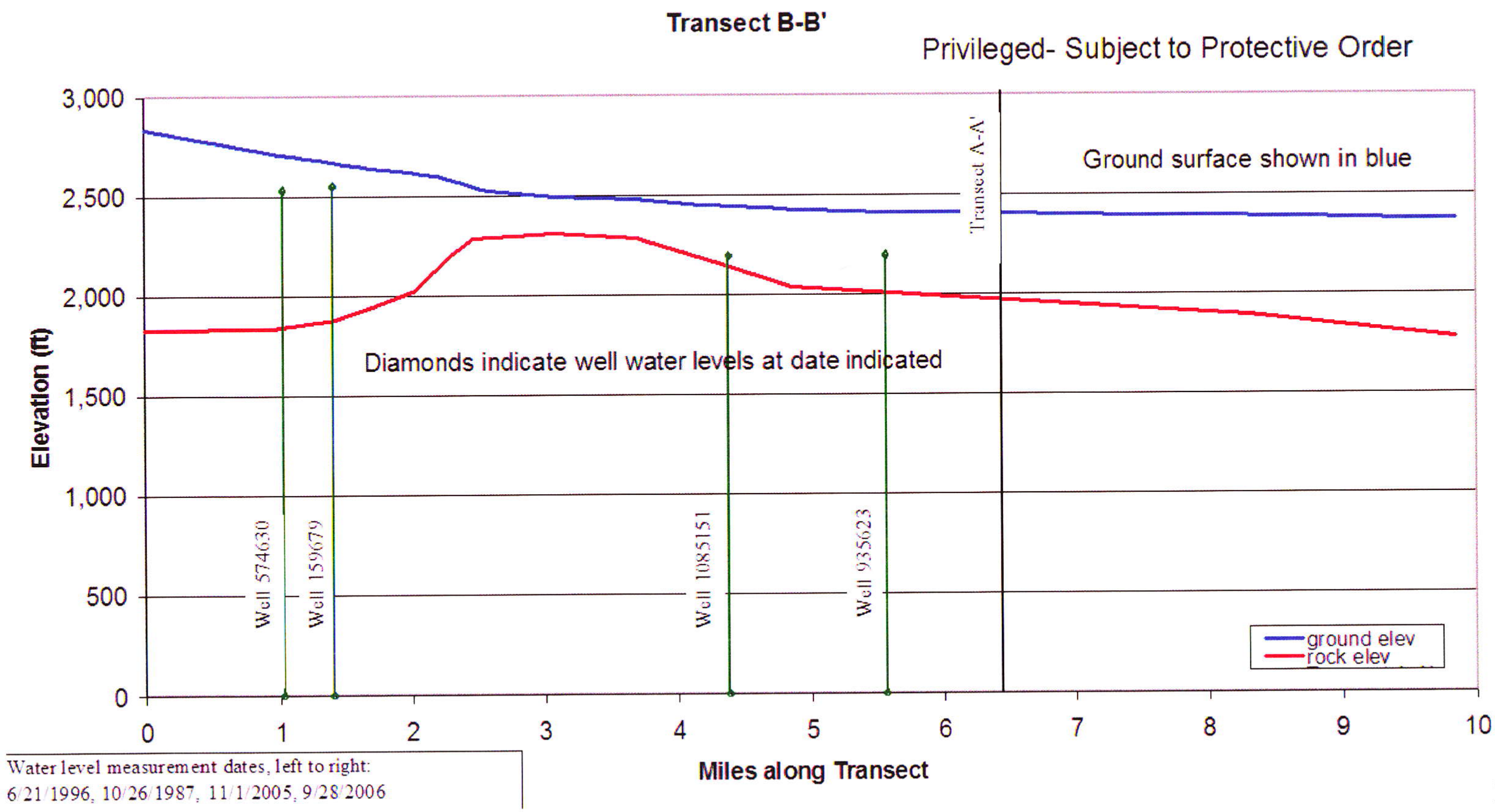


Figure 12 – Transect A-A' shown in Figure 11



Figure

Figure 13 – Transect B-B' shown in Figure 11.

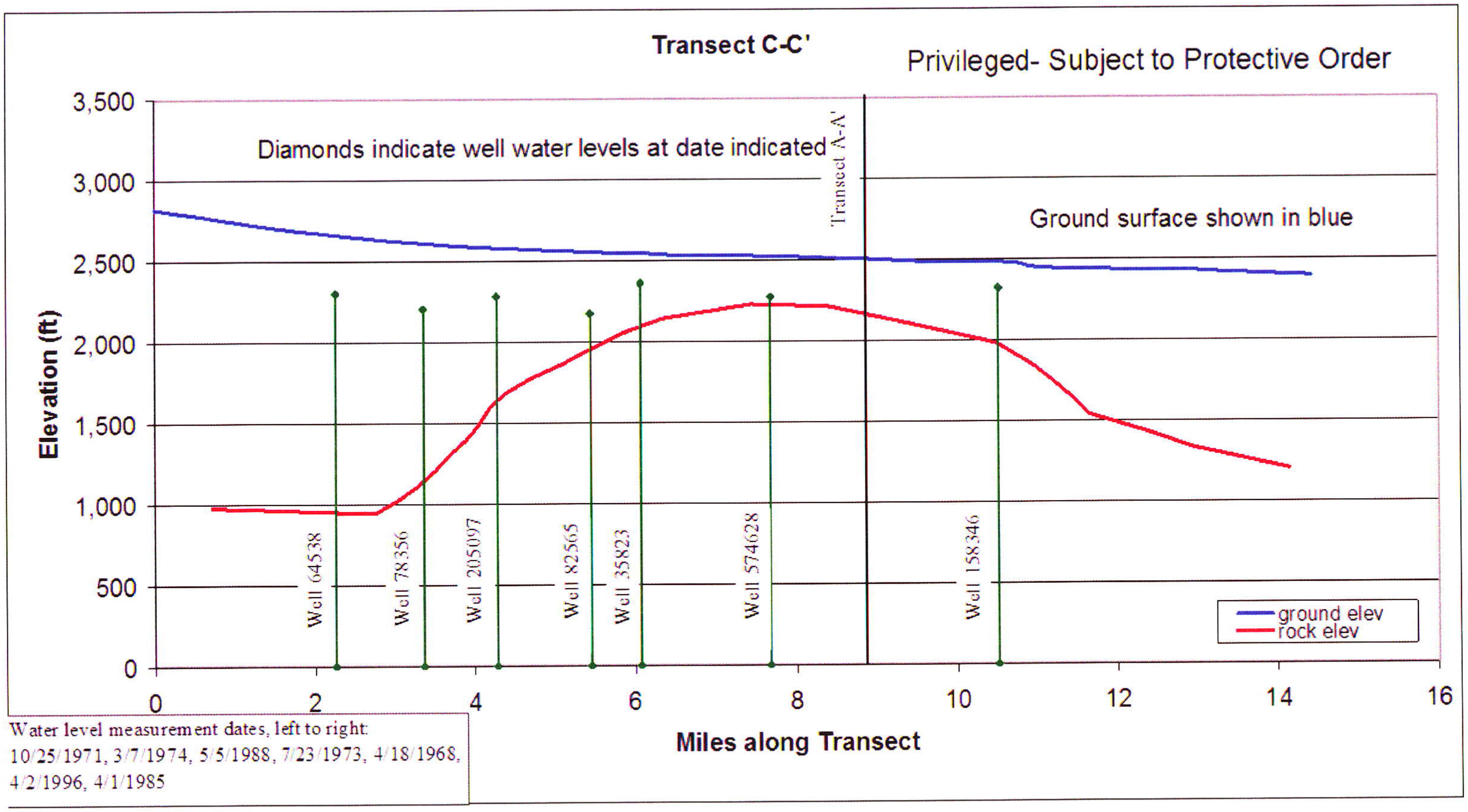


Figure 14 – Transect C-C' shown in Figure 11.

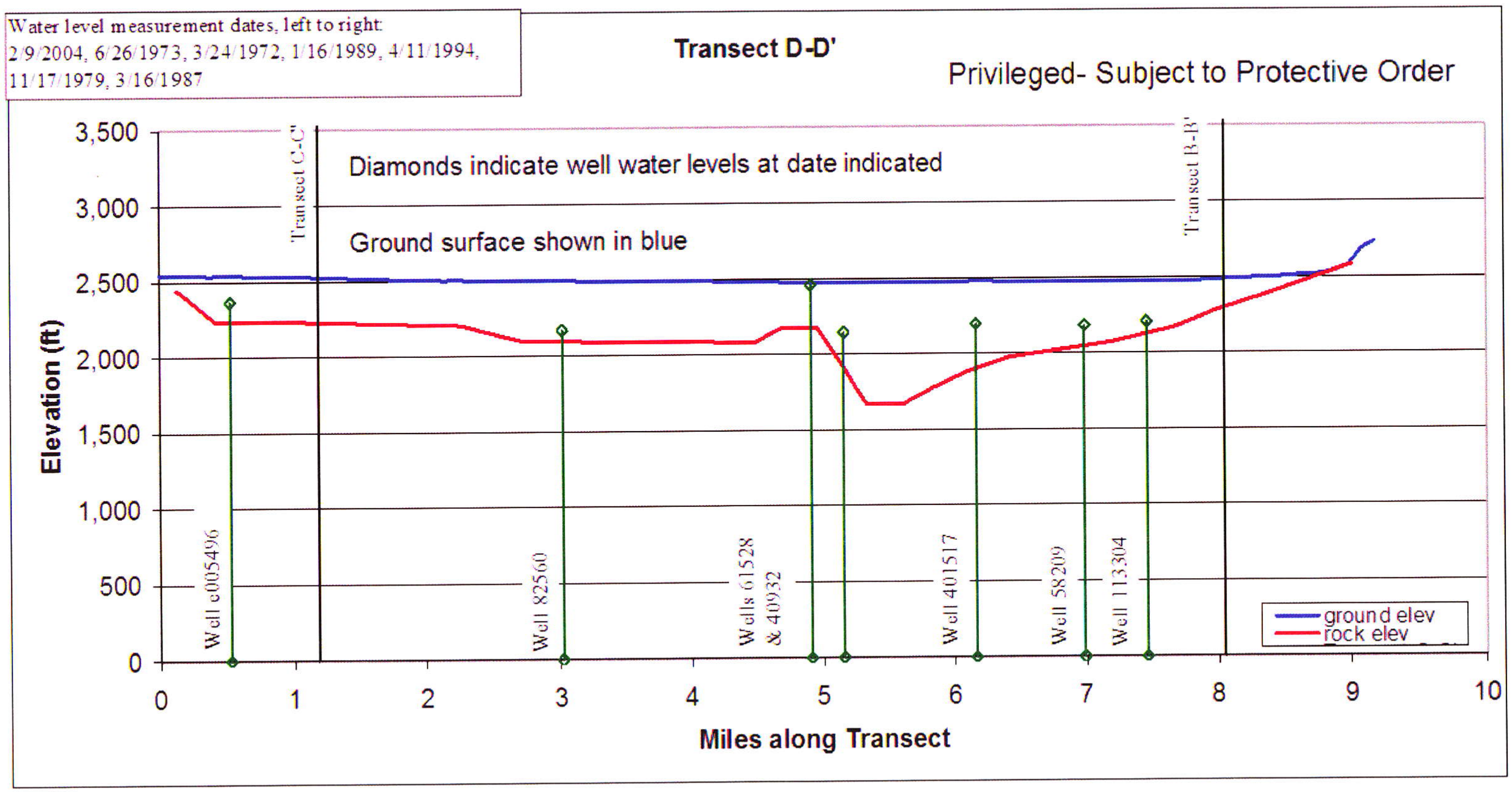


Figure 15 – Transect D-D' shown in Figure 11.

WATER FLOW ACROSS THE BEDROCK RIDGE

The basic inference from these sections in **Figures 12-15**, and the measured water levels shown on them, is that the bedrock ridge forms a fairly effective barrier between the two southern basins in the area between the Antelope Buttes and Little Buttes. North of Little Buttes there is a saddle in the bedrock ridge that provides a narrow passage for possible groundwater flow, with a saturated aquifer approximately 200 feet thick in the region between the Little Buttes and the Willow Springs Fault. However, groundwater level contour maps, such as shown in **Figures 16, 17 and 18** show that the area above the bedrock saddle has a relatively flat groundwater table, implying little or no flow across this ridge. **Figure 16** has the groundwater surface elevation contours for 1965, for which a large number of wells were surveyed by the USGS; it shows a flat water table over the saddle in the bedrock ridge. This flat water table is maintained through 1985 and 2005, as shown in **Figures 17 and 18**.

Furthermore, the groundwater "valley" in the very western end of the Antelope Valley, shown in the groundwater surface elevation contours, suggests that this part of the Antelope Valley is a convergence zone for groundwater flow from both the Tehachapi and San Gabriel mountains. It is therefore unlikely to show significant changes in water surface elevation in response to groundwater demands to the east, because the capture zone for wells located in this area will be particularly narrow.

This conclusion is supported by the land subsidence data, which indicate that all measured land subsidence in the Antelope Valley occurs east of the bedrock ridge. This observation implies that the effects of groundwater overdraft in the Lancaster area have not propagated west of the bedrock ridge. Surface surveys and interferometric satellite observations (see **Figures 19, 20 and 21**) all show significant land subsidence east of the bedrock ridge and no subsidence evident west of this ridge (see Galloway et al, 1998).

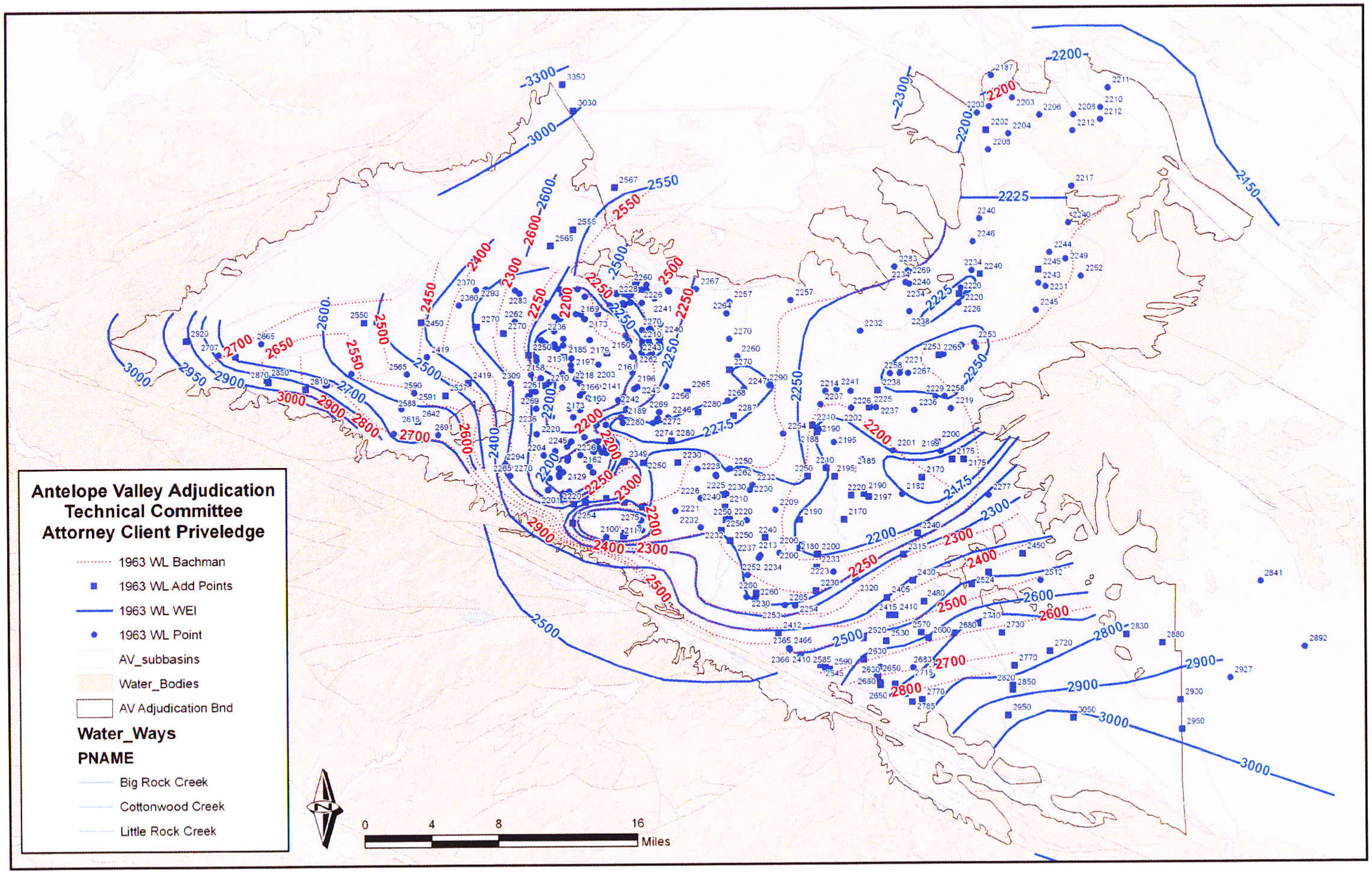


Figure 16 – Groundwater surface contours in 1963 (developed from USGS well log data by WEI).

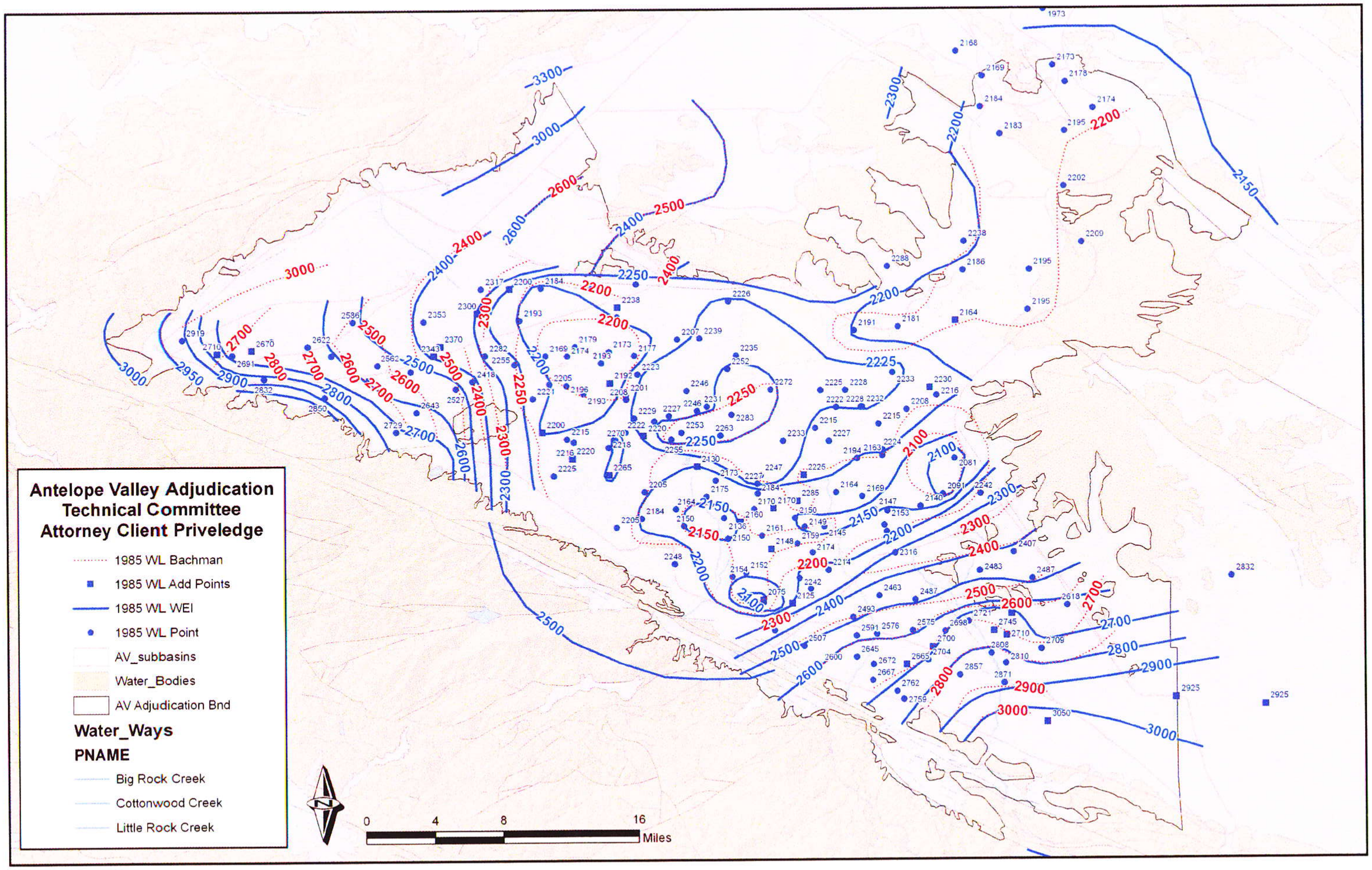


Figure 17 – Groundwater surface contours in 1985 (developed from USGS well log data by WEI).

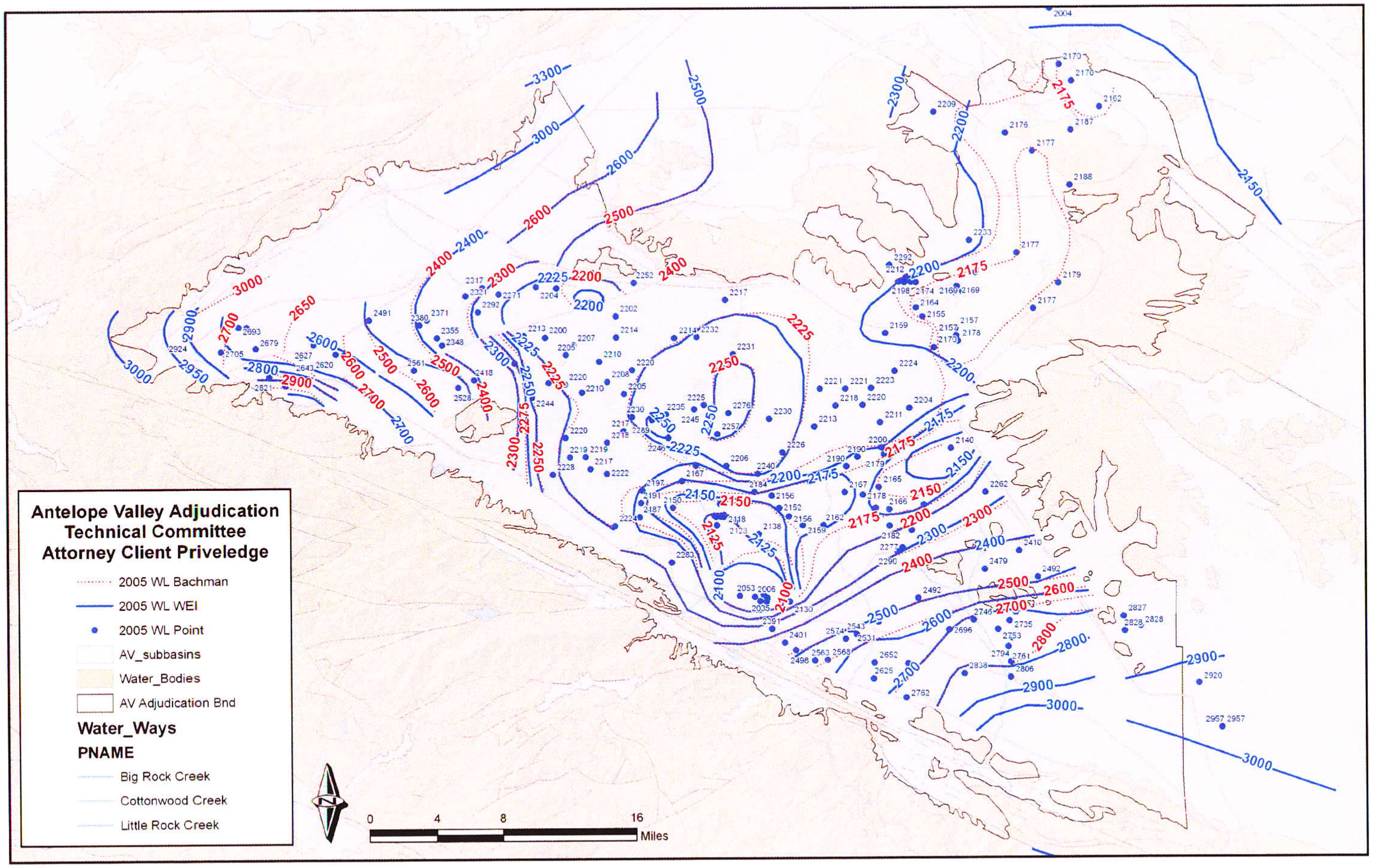


Figure 18 – Groundwater surface contours in 2005 (developed from USGS well log data by WEI).

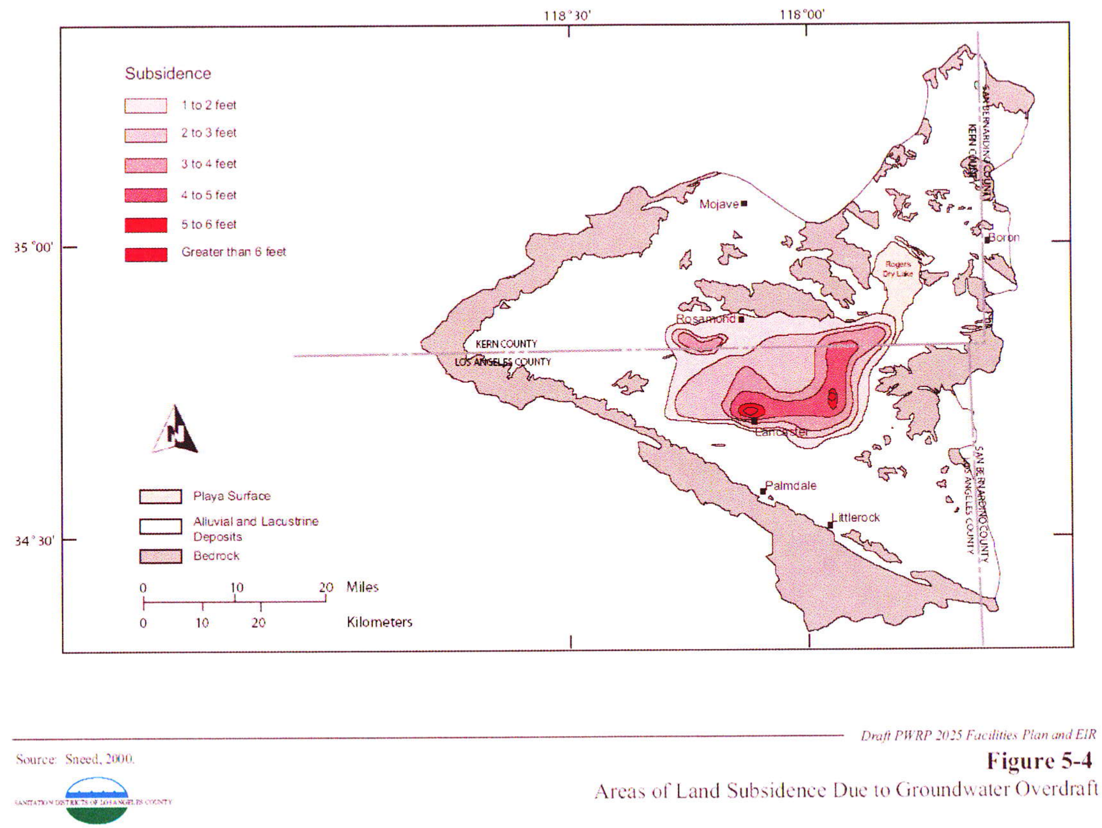


Figure 19 – Subsidence in the Antelope Valley.

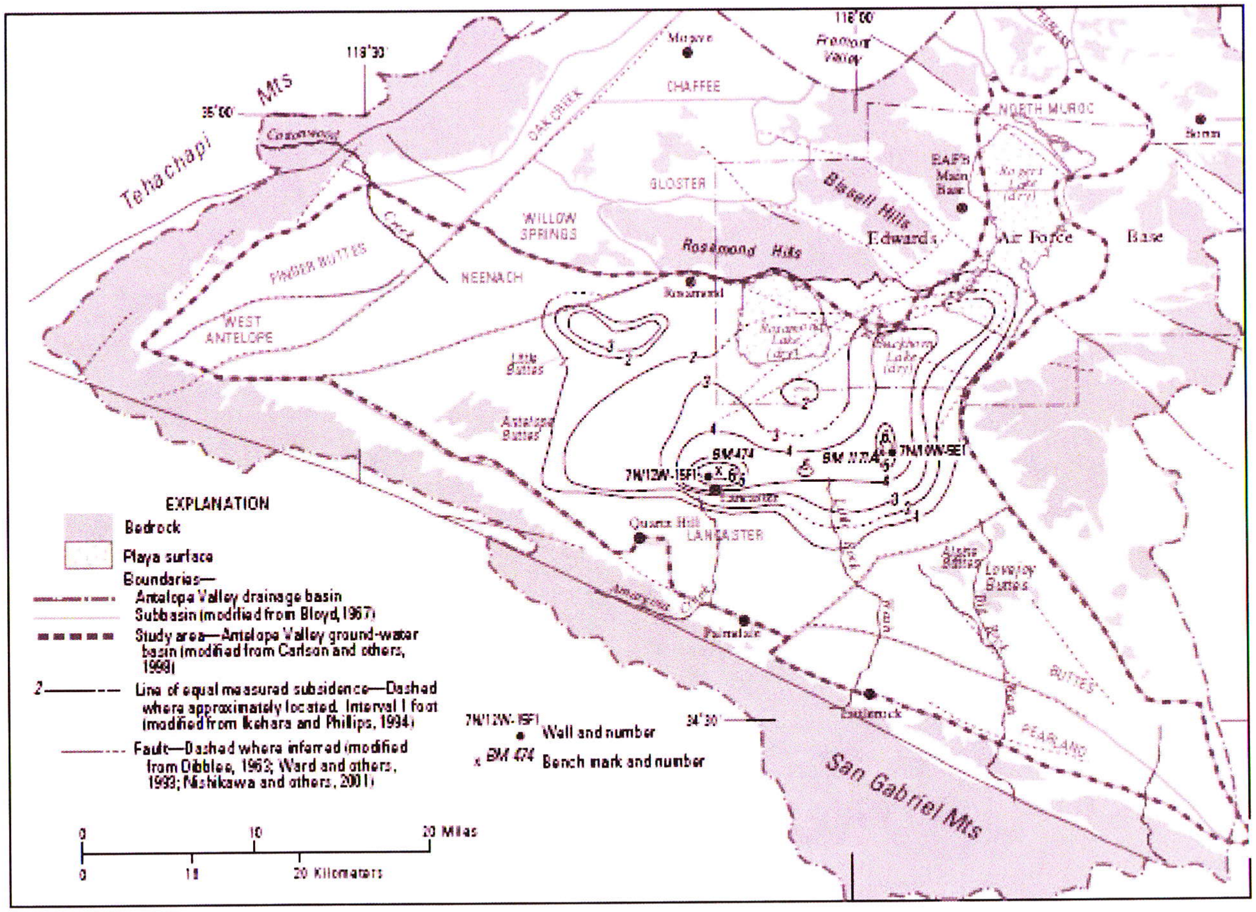
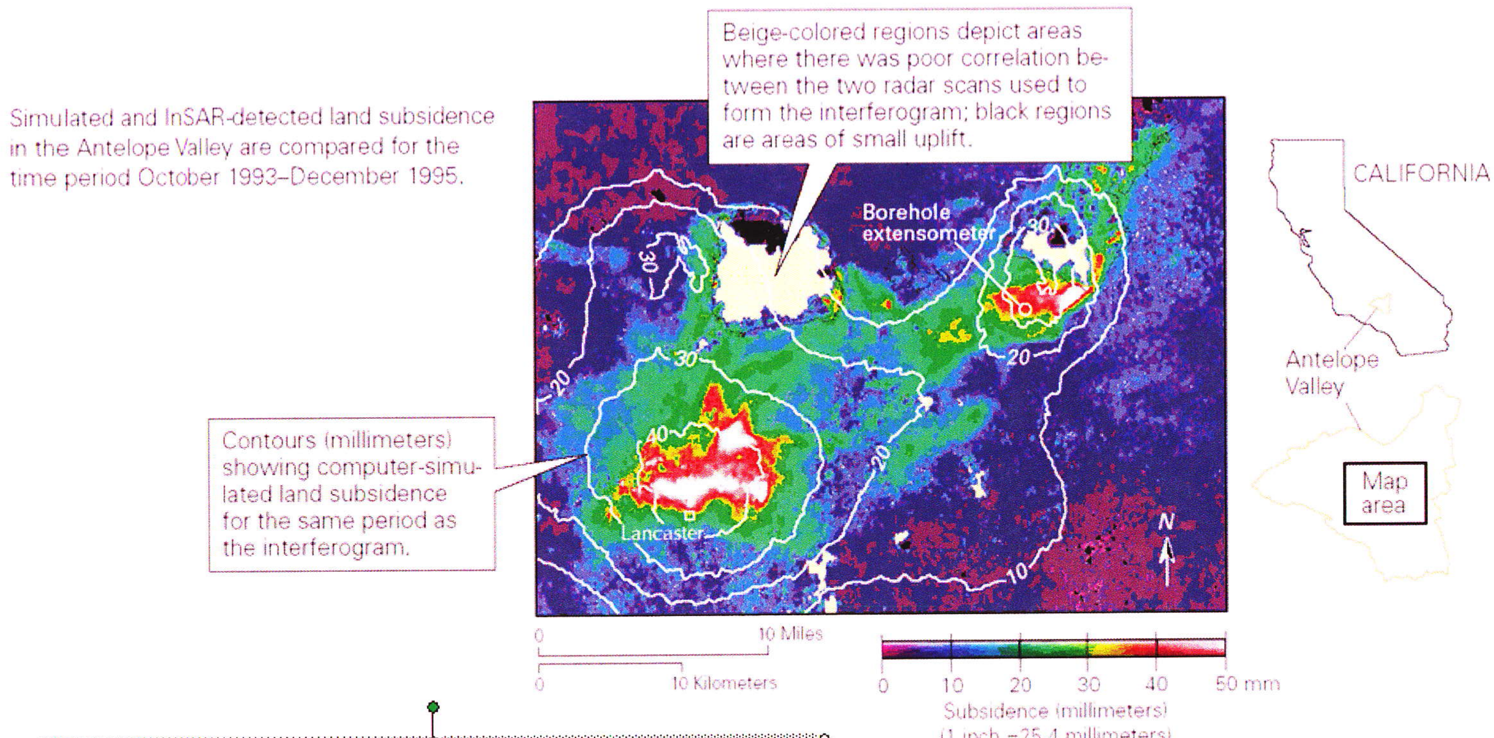


Figure 8. Measured subsidence in the Antelope Valley ground-water basin, California, 1930–92.

Figure 20 – Measured subsidence in Antelope Valley 1930-1982.



Source: Galloway et al at http://pubs.usgs.gov/fs/fs-051-00/

Figure 21 – Synthetic aperture radar measurement of subsidence between October 1993 and December 1995.

CONCLUSIONS

Multiple lines of evidence support the conclusion that the southern Antelope Valley is divided into two substantially independent major groundwater sub-basins. They are physically separated by a partially buried ridge of bedrock extending NE from the Antelope Buttes that provides a substantial restriction to groundwater flow between the basins. There is clear evidence that groundwater development in the East Antelope Basin has not influenced the West Antelope Basin in that (a) major declines of groundwater levels in the East Antelope Basin/Sub-Basin have had no perceptible effect on the groundwater levels in the West Antelope Basin/Sub-Basin, and (b) the land subsidence resulting from pumping in the Eastern Basin/Sub-Basin is not manifest in the Western Basin/Sub-Basin. Support for the existence of two other minor sub-basins, one north of the Willow Springs fault and the other west of the Randsburg Mojave Fault, also appears to be evident in the ground water and geophysical data. The groundwater in the area north of the Willow Springs Fault appears to be essentially isolated from the rest of the Antelope Valley.

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