aquifer). The simulated and observed groundwater levels match very well from 1975 through the middle of 1987. During the 1987-90 and 1992-93 periods the simulated levels were about 30 feet higher than the observed groundwater levels, although at the end of 1991, the match is again very good. From the end of 1993 to the end of the simulation period the match remains very good. Although there are about six years out of 20 when the match is weaker than at the other wells shown, the overall calibration at this location appears acceptable.

These hydrographs indicate generally good agreement between simulated and observed groundwater levels. The hydrographs presented represent the Main Basin area of the model. For calibrations in the fringe basin area, see the CH2M Hill June 1998 technical memorandum that presents the complete calibration results (Reference A).

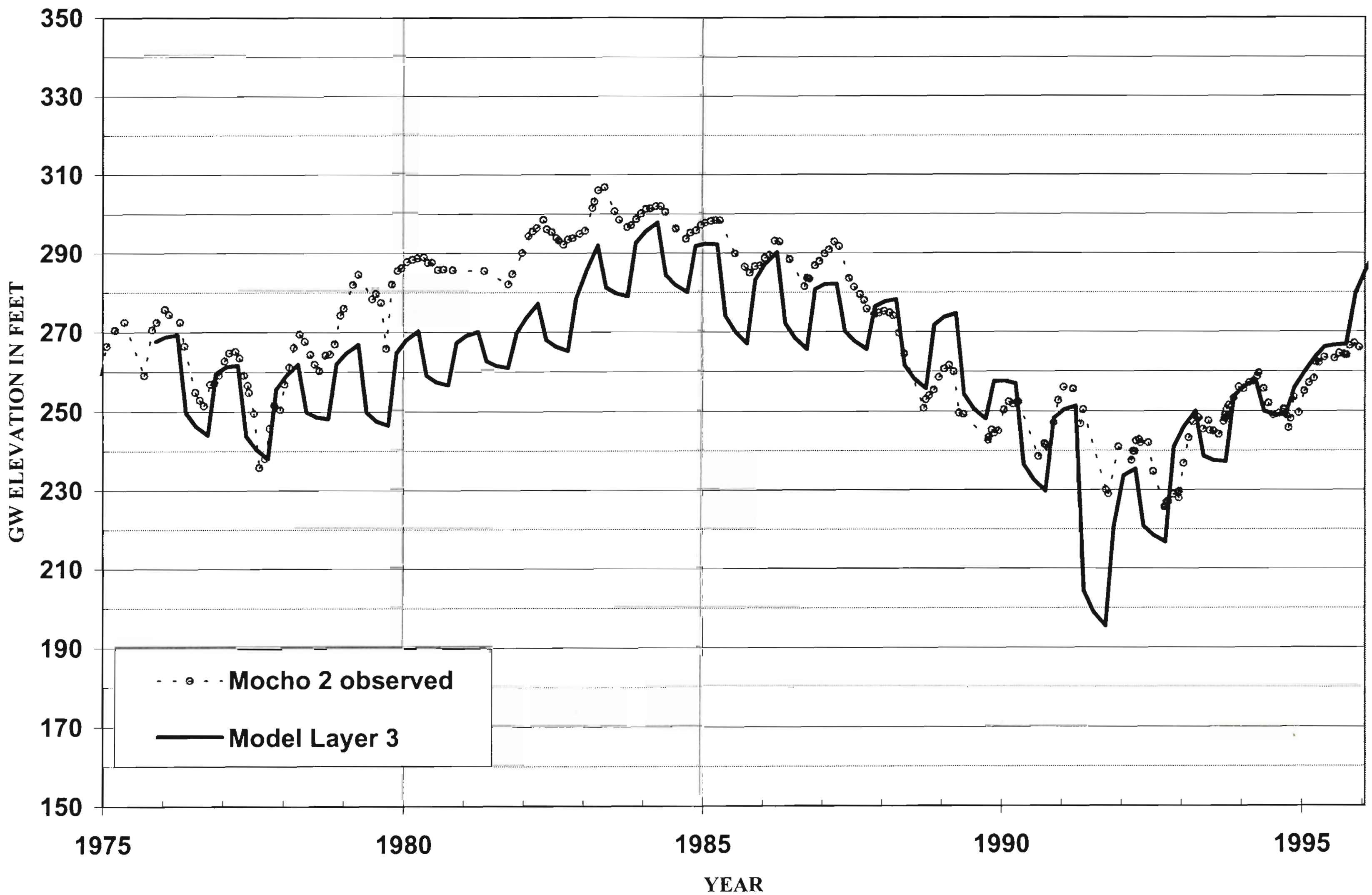
Groundwater Level Maps - Simulated groundwater level maps also show good agreement with observed groundwater level maps. Figure 3.26 is the groundwater level map prepared from the Zone 7 spring 1994 measured groundwater levels. The solid line contours represent groundwater levels in the upper aquifer and the dashed line contours (drawn only in applicable portions of the basin) represent the deep aquifer. Deep aquifer groundwater level data is limited to parts of the Main Basin.

Figure 3.27 presents the model simulated groundwater levels in the upper aquifer for spring 1994. The simulated and observed contour elevations and contour shapes match well. The elevation difference in the key high yielding basin areas is about +/- 20 feet and the contour pattern is very similar. Figure 3.28 presents the model simulated groundwater levels in the deep aquifer for spring 1994. Although there are only a few deep aquifer observed groundwater level contours drawn on Figure 3.26, the pattern and the elevations match very well with the simulated contours.

3.7.5 *Solute Transport Calibration (Non-Reactive)*

Solute transport calibration involves adjusting the solute transport model parameters and the recharge concentrations. Since most of the assigned recharge concentrations for the model were determined from actual monitored data, only model parameters were adjusted during calibration. In non-reactive (TDS) solute transport, advection is the primary mechanism responsible for TDS migration in aquifers. Advection involves transport by bulk movement where it is assumed that the dissolved solute travels in the same direction and with the same velocity as the groundwater itself. Since the model was already calibrated for flow, an acceptable level of non-reactive transport calibration was readily achievable. The calibration was checked by comparing the simulated and observed groundwater TDS hydrochemographs and groundwater TDS maps. Figures 3.29 through 3.32

Mocho-2 Well Hydrograph: Layer 3



6/16/00

FIGURE - 3.24

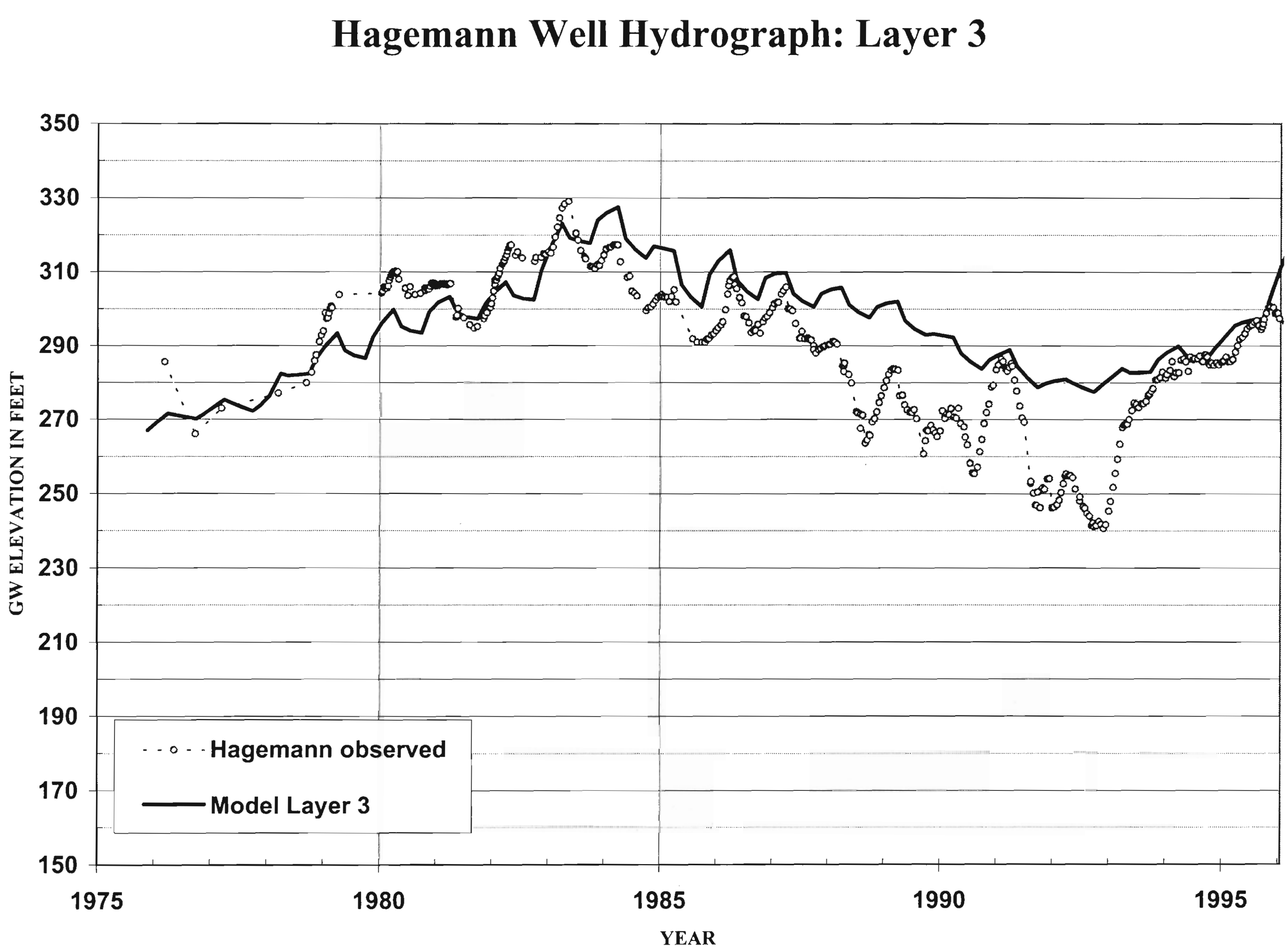


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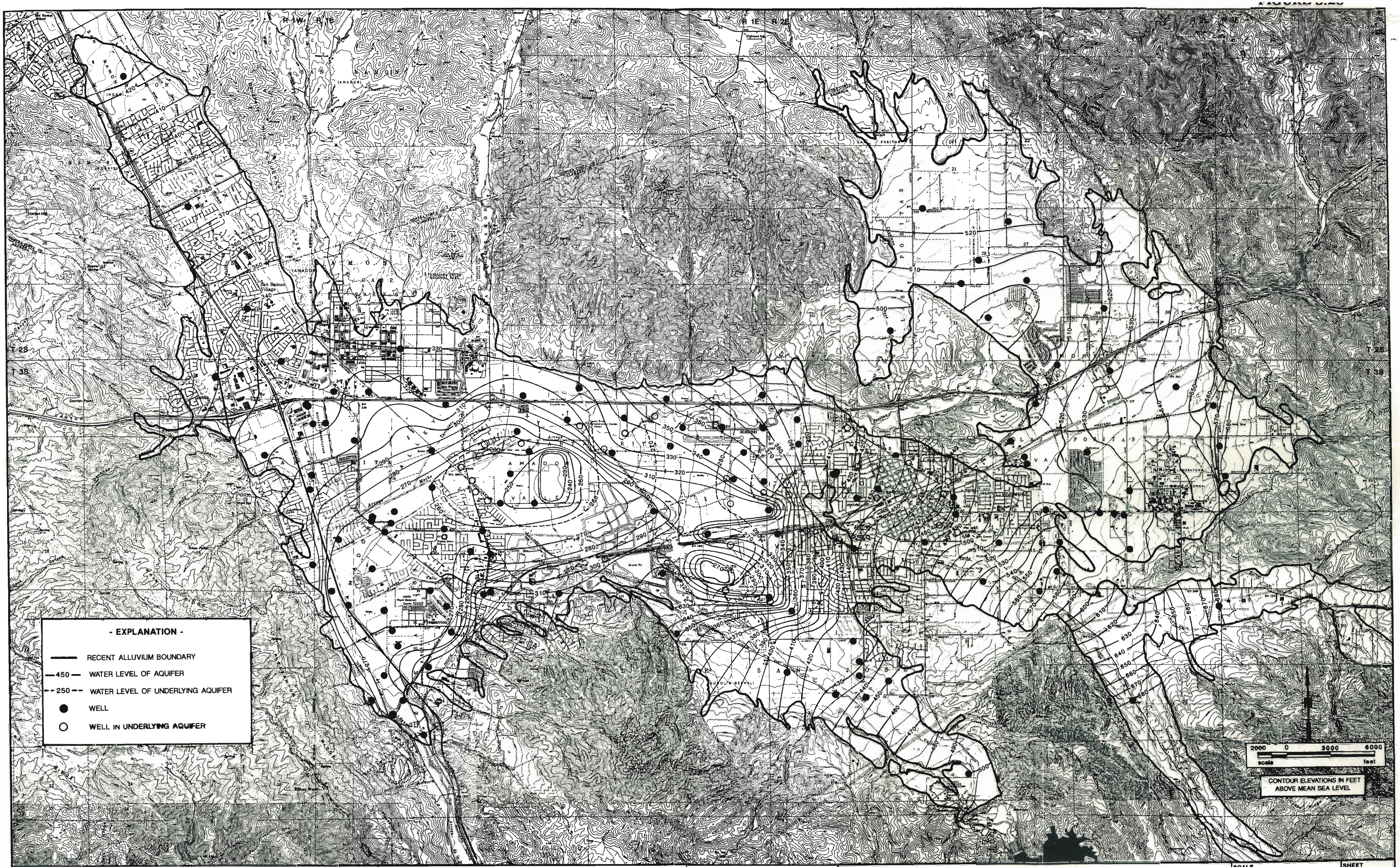
FIGURE - 3.25



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NUMBER	DESCRIPTION	BY	DATE	APVD

ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN G GATES
DESIGNED Steven J. Ellis
CHECKED Steven J. Ellis
APPROVED

WATER RESOURCES ENGINEERING

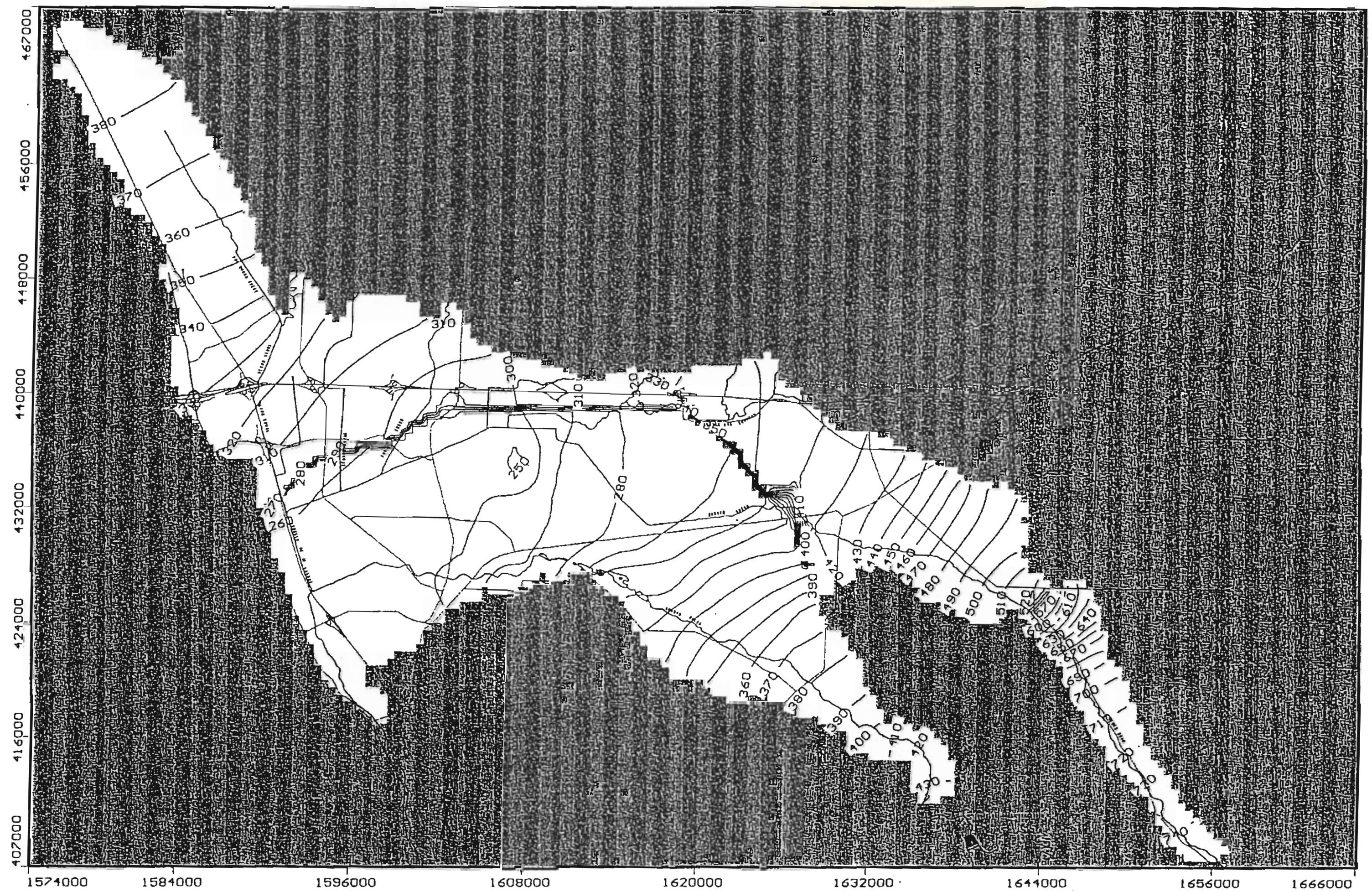
SPRING 1994

GROUNDWATER LEVEL CONTOURS

SCALE 1"=6000'
DATE 28 MAY 1994
FILE NO. B-334
SHEET OF SHEETS

Zone 7 Water Agency – Pleasanton, CA Project: LVGWB Model V 2.0.55 Description: L1 GWL Spring 1994 (SP37) Modeller: CH2M hILL & Zone 7 12 Jun 00	Visual MODFLOW v.2.61, (C) 1995–1997 Waterloo Hydrogeologic, Inc. NC: 184 NR: 120 NL: 4 Current Layer: 1

FIGURE 3.27



Zone 7 Water Agency – Pleasanton, CA Project: LVGWB Model V 2.0.55 Description: L3 GWL Spring 1994 (SP37) Modeller: CH2M HILL & Zone 7 12 Jun 00	Visual MODFLOW v.2.61, (C) 1995–1997 Waterloo Hydrogeologic, Inc. NC: 184 NR: 120 NL: 4 Current Layer: 3

FIGURE 3.28

present the observed and simulated TDS at some selected well locations. Figures 3.33 through 3.36 present the observed and simulated groundwater TDS maps.

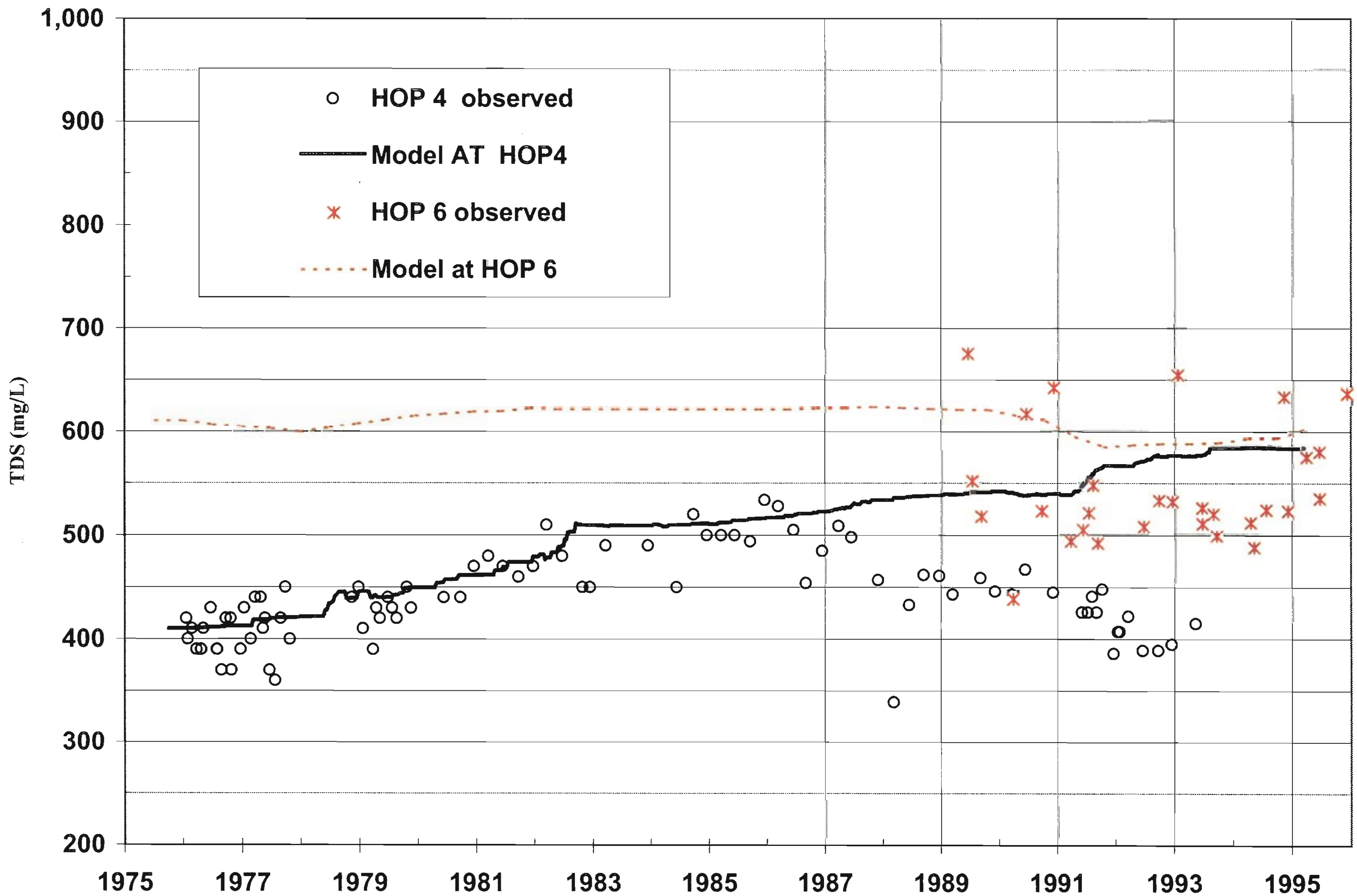
TDS Graphs (Chemographs) - The chemograph for the Hop 4 (Figure 3.29) location shows a good correlation between observed and simulated TDS for the 1975-1987 period. Both the data sets show a rising groundwater TDS trend during this period. Beginning in 1988, the observed and simulated TDS lines start diverging from each other. The simulated TDS data continue to show a rising groundwater TDS trend and the observed TDS data show a declining TDS trend for 1988-95. Based upon the data for the Hop 4 location, it can be concluded that the model tracks the observed data acceptably for the 1975-87 period but not for 1988-95.

To analyze this 1988-95 period further, the observed and simulated TDS results for the Hop 6 location were also plotted on the Hop 4 figure. The Hop 6 well is about 1,500 feet upgradient from the Hop 4 well. The simulated TDS for the Hop 6 well was a good match with the observed TDS at the Hop 6 well. This could be caused by different boundary conditions or model property assumptions along the 500-foot grids in the relatively close 1,500 feet between Hop 4 and 6. Although the model could not precisely match the observed and simulated TDS for the exact Hop 4 location for the 1988-95 period, the predicted TDS and calibration for the Hopyard well field as a whole appears adequate.

The simulated TDS line for the Mocho 2 well (Fig 3.30) appears potentially more representative of actual conditions than the observed data. The simulated data indicates a gradual increase in groundwater TDS at Mocho 2 while the observed groundwater TDS shows large fluctuations ranging from 350 mg/L to 950 mg/L over short periods of time. Groundwater quality generally does not change as rapidly as shown by the observed data. The observed data for Mocho 2 therefore seem suspect. It is possible there were problems with the sampling protocol (e.g., inadequate well purging before sampling). The primary conclusion that can be drawn at this time is that additional data need to be collected to verify the accuracy of the historic data before meaningful simulation comparisons can be made.

The chemograph for the Mohr Avenue key well (3s/1e 9p5, Fig 3.31) shows similar trends for the simulated and observed TDS lines. The simulated TDS is generally about 50 to 75 mg/L higher than the observed TDS. This difference increases to about 250 mg/L during 1983-86. However, the simulated and observed TDS lines converge again in 1987 (the end of the observed dataset). The simulated and observed TDS trend match is impressive during the most part except for 1983-86. One reason why the simulated TDS line is always above the observed line could be that due to the limited observed dataset, the initial TDS concentration used for this location was not truly representative of actual conditions. The model would have interpolated the initial TDS concentration data based upon available data points from the nearest adjacent grids that contained higher TDS actual data.

Hopyard-4 & 6 Well Chemograph: Layer 3



6/16/00

FIGURE 3.29

Mocho-2 Well Chemograph: Layer 3

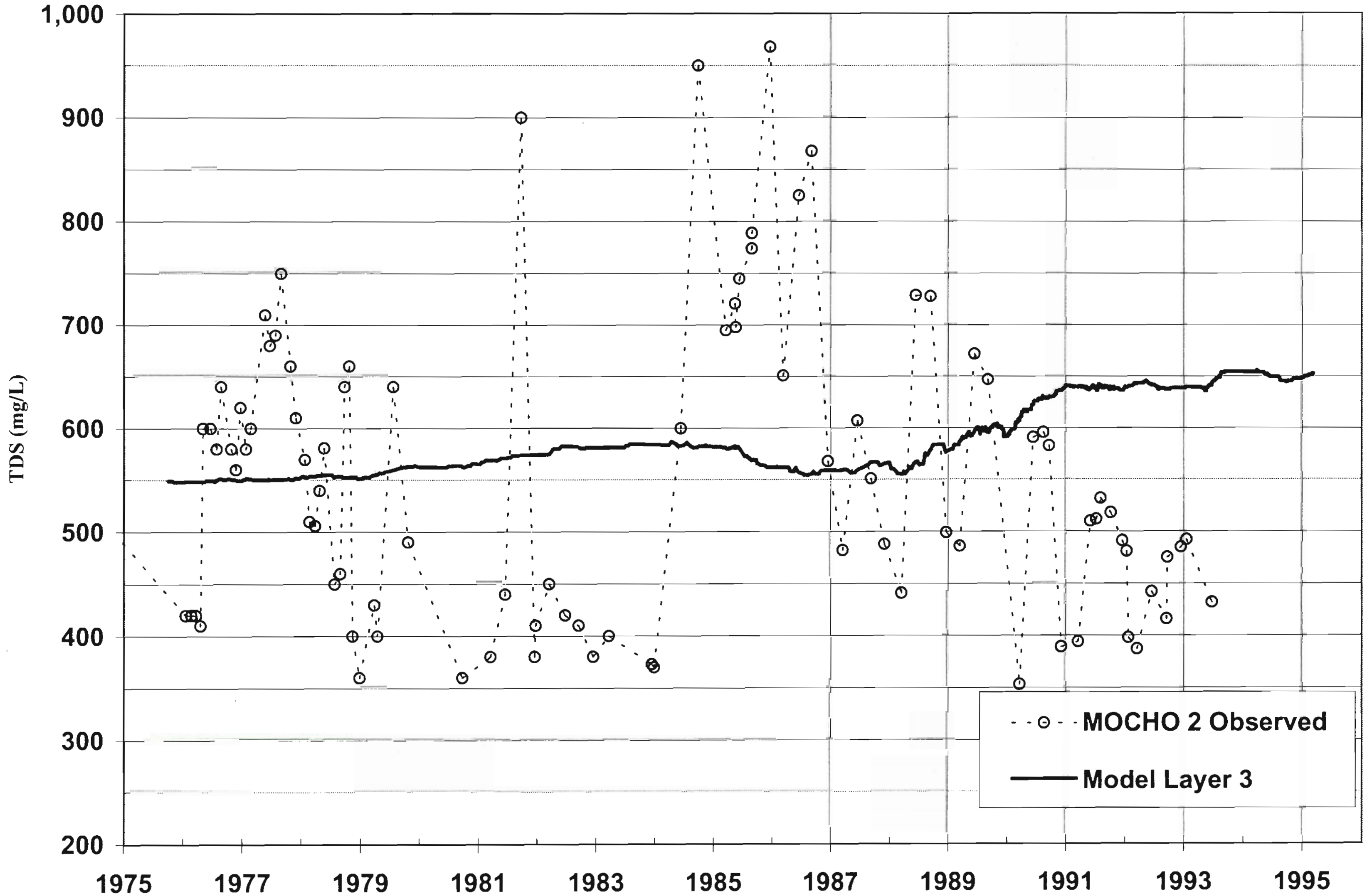


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FIGURE 3.30

The simulated and observed TDS lines for the Hagemann key well (Figure 3.32) appear to show a good correlation. This well had the same initial concentration issues as the Mohr Avenue well since the observed data does not begin until 1979. Although the model initial TDS concentration does not seem to reflect the actual TDS for this location, the simulated TDS line matches very well during the latter part of the calibration period.

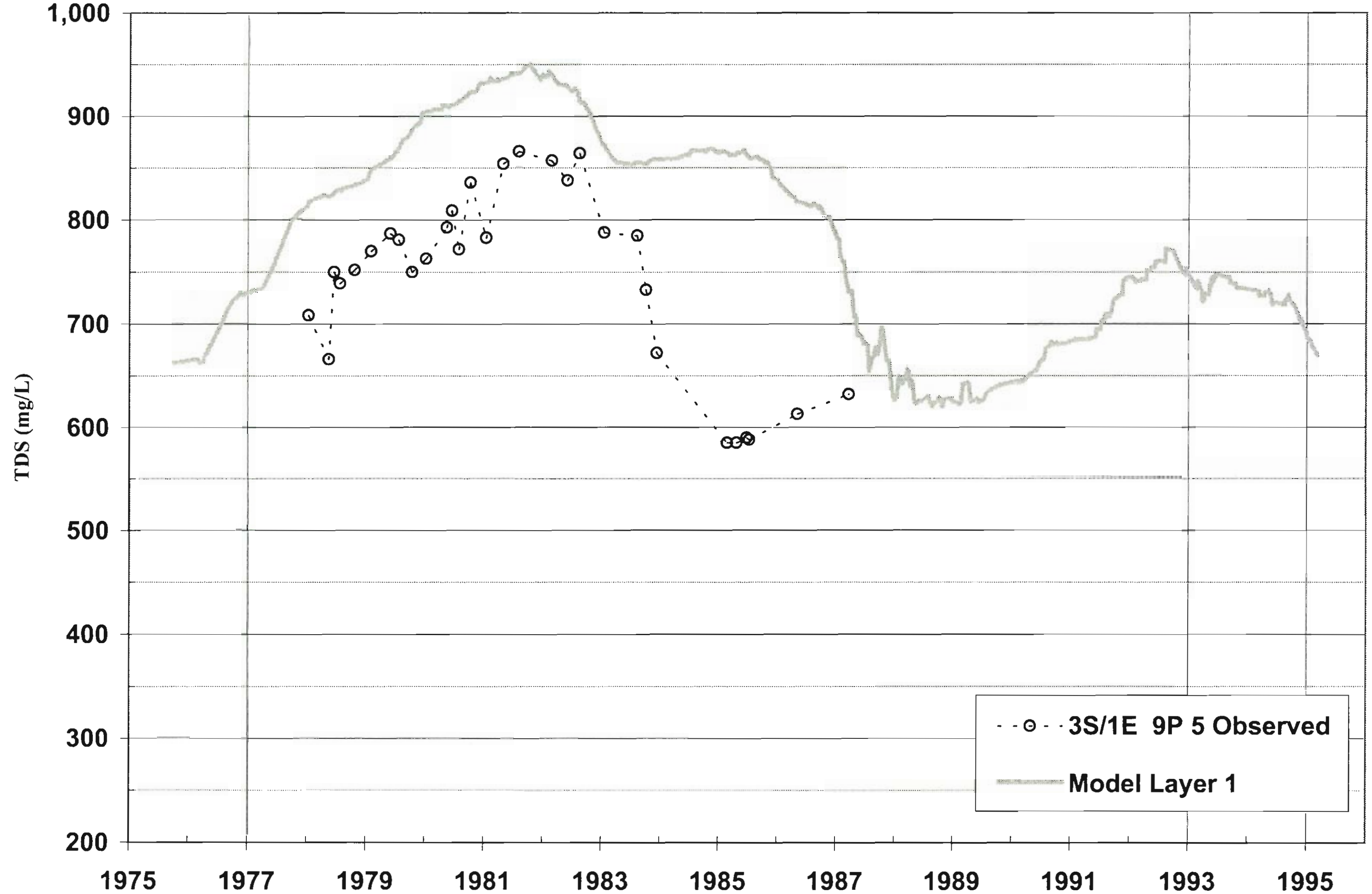
Groundwater TDS Maps - The TDS chemographs are useful in comparing the changes over time in simulated and observed TDS at a particular location. The groundwater TDS maps are useful in comparing the areal variations in simulated and observed concentrations at any time for any model layer.

Figures 3.33 and 3.34 present the observed and simulated groundwater TDS maps for the upper aquifer at approximately 1994 conditions. For the most part the two maps match reasonably well. For example, the Dublin Sub-basin has a low TDS of 400-500 mg/L in the north portion and a high TDS in the south portion in both the simulated and observed maps. Lower groundwater TDS exists along both the Arroyo Valle and Arroyo Mocho recharge zone areas on both maps.

Figure 3.35 and 3.36 present the observed and simulated groundwater TDS maps for the deep aquifer. Due to the general lack of deep aquifers in the fringe basins, the observed TDS maps present the TDS only for the Main Basin. The deep aquifer TDS maps match even better than in the upper aquifer. The blue shade on both maps represents groundwater TDS below 500 mg/L. The pink shade on the observed TDS map (Figure 3.35) represents groundwater of 500 mg/L to 700 mg/L. This same 500-700 mg/L TDS range is shown in green on the simulated TDS map (Figure 3.36). Comparing both maps, it can be concluded that there is a good overall match with the exception of one small high TDS (800-1000 mg/L) area on the simulated map in the Bernal Sub-basin near the Fairgrounds.

The technical memorandum from CH2M Hill "Livermore Valley Groundwater Basin Model v2.0, June 29, 1998" describes the model calibration in more detail (Reference E).

Well 3S/1E 9P 5 Chemograph: Layer 1



6/16/00

FIGURE 3.31

Hagemann Well Chemograph: Layer 3

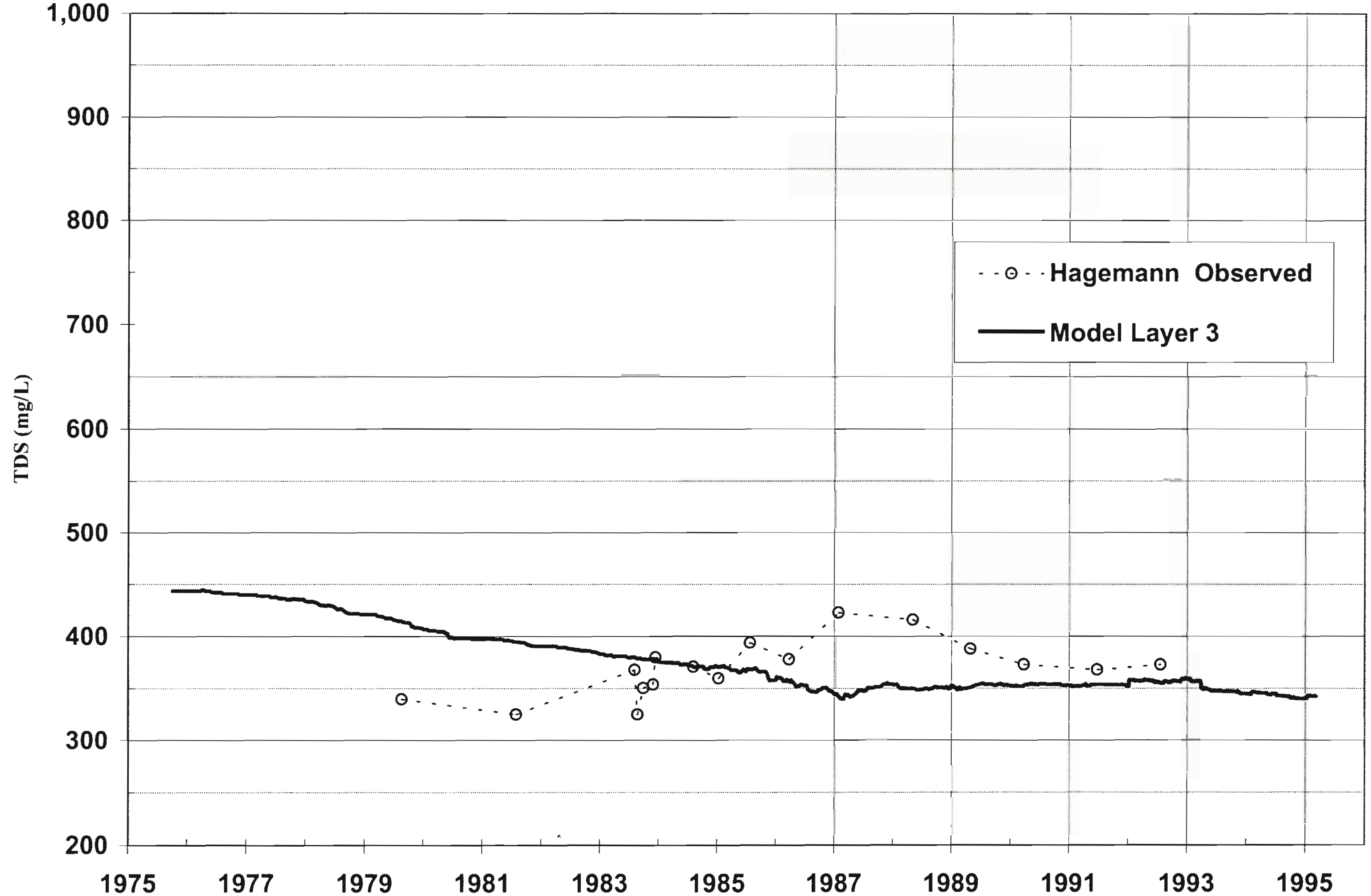


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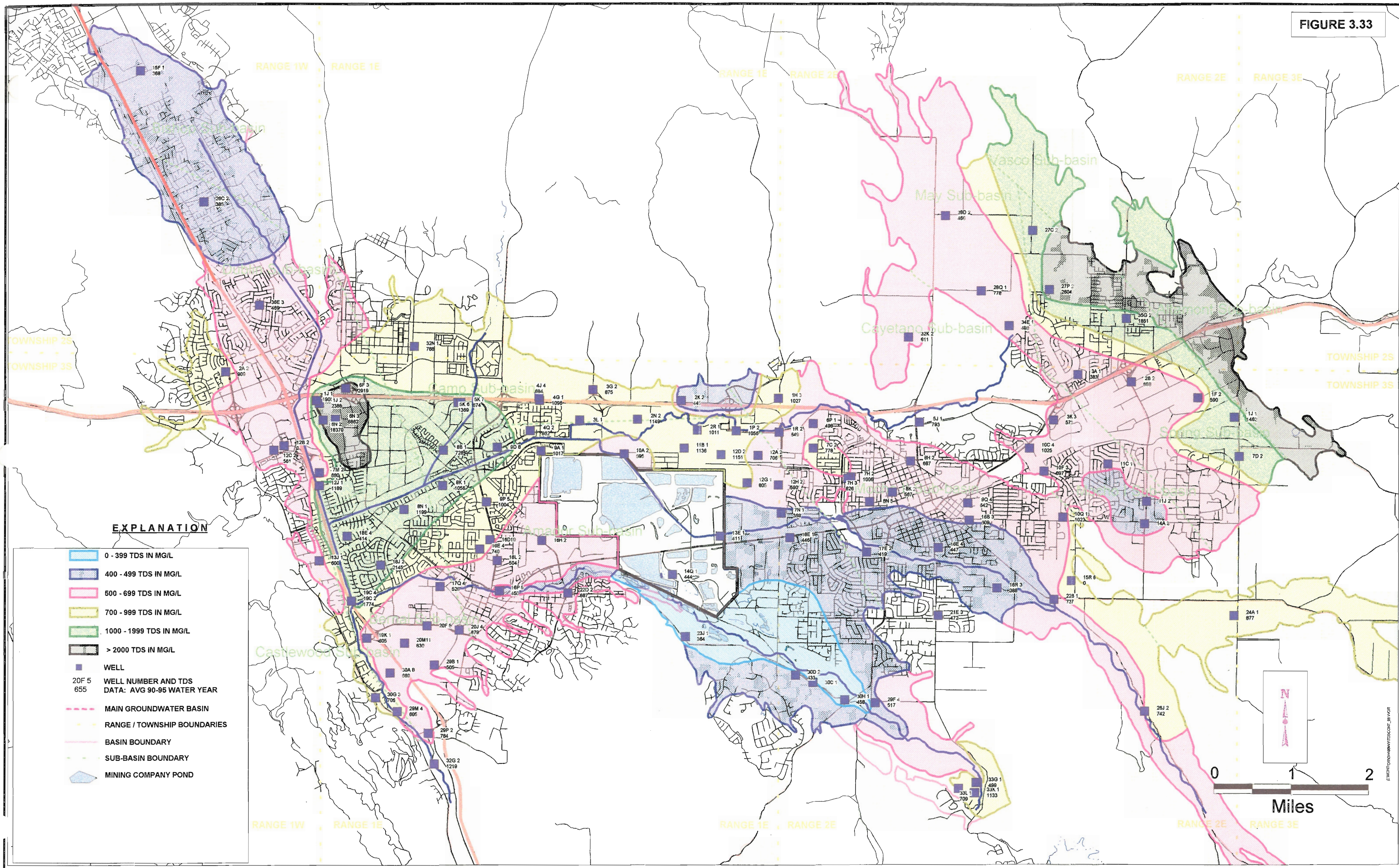
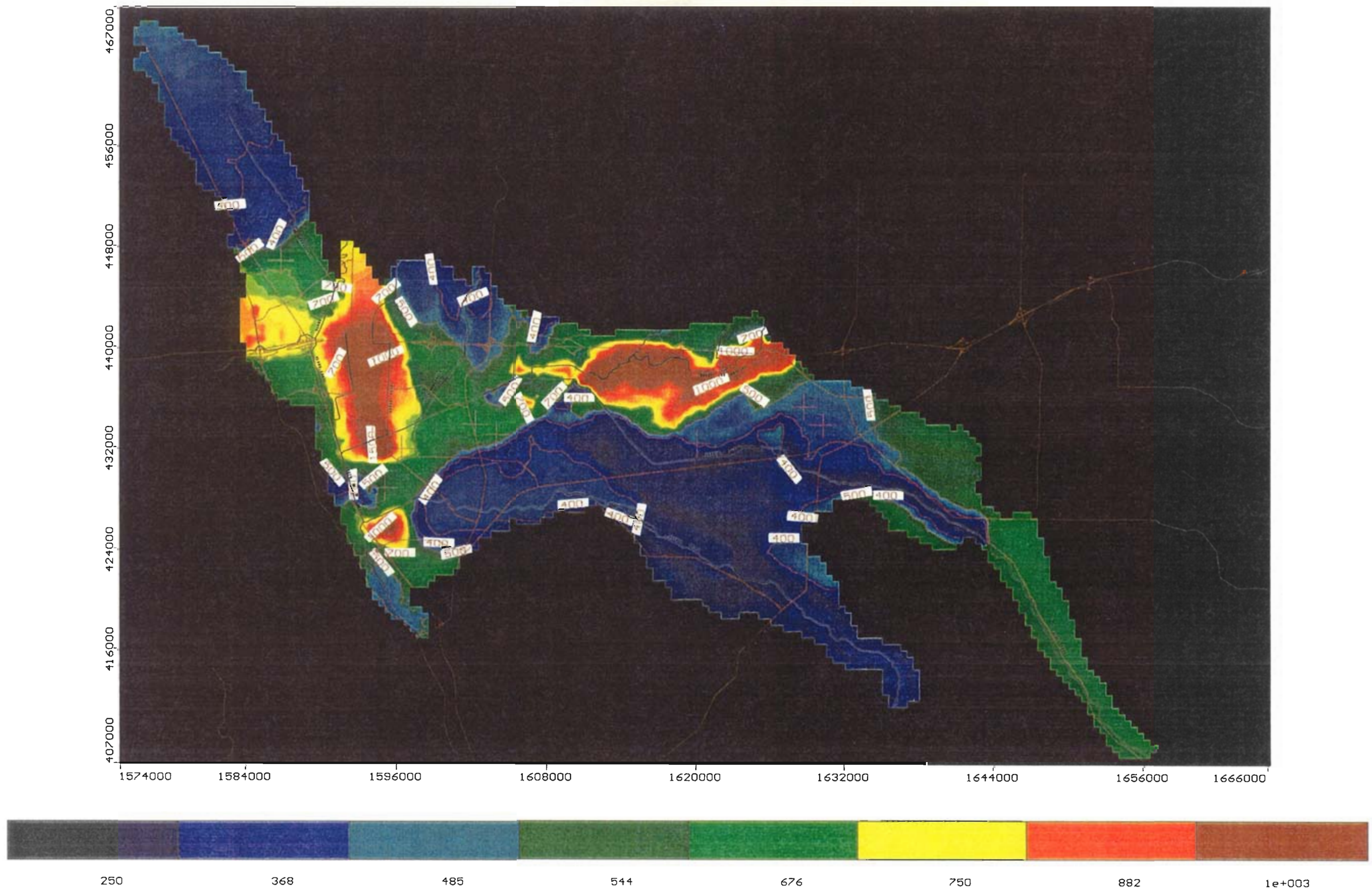
FIGURE 3.32

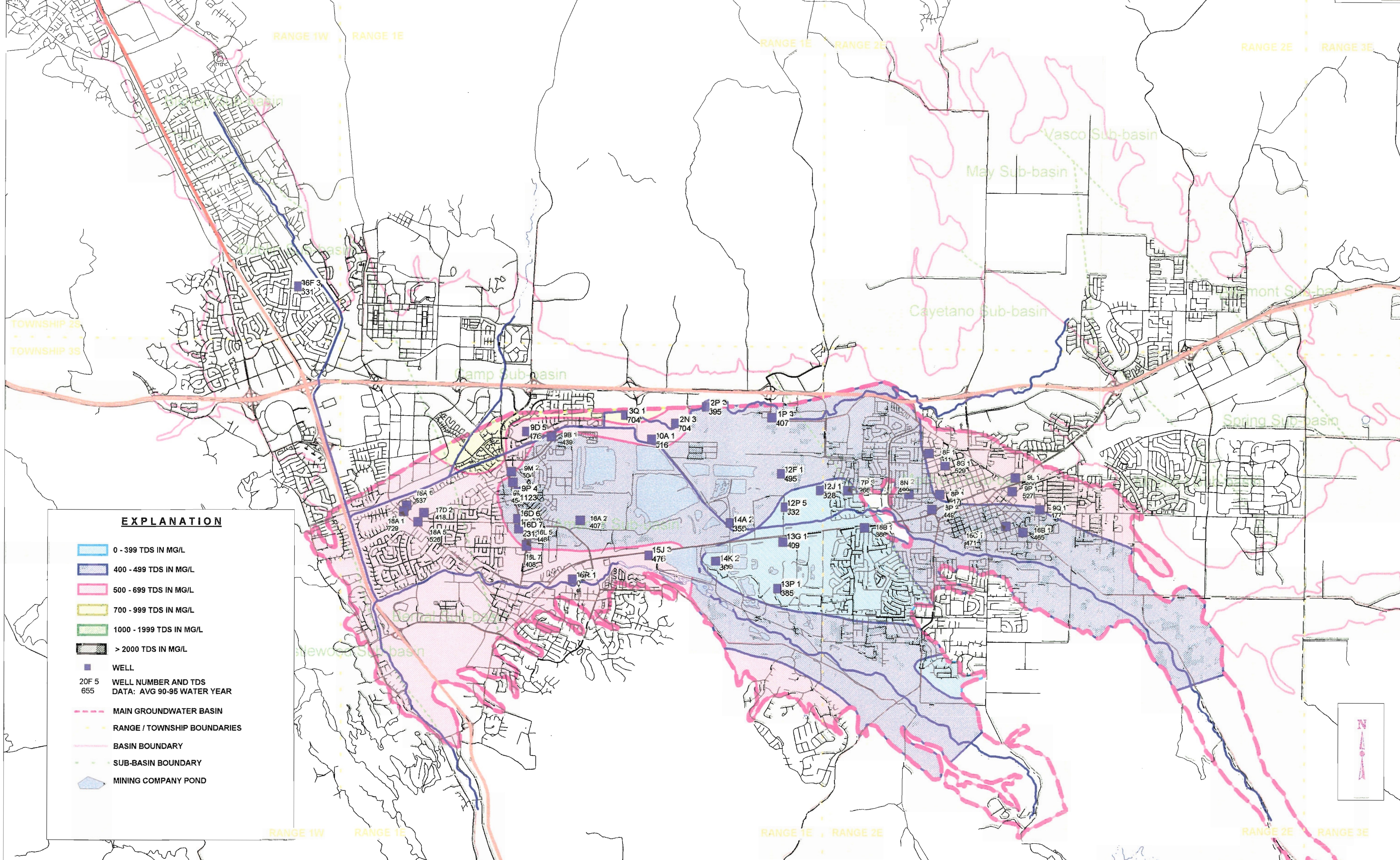


ZONE 7 WATER AGENCY	DRAWN BY: GERALD GATES	WATER RESOURCES ENGINEERING	SCALE: 1" = 6000' (ON ORIGINAL)
5997 PARKSIDE DRIVE PLEASANTON CA 94588	DESIGNED BY: D. LUNN	UPPER AQUIFER TDS CONTOUR MAP	DATE: 7 JULY 1997
	CHECKED BY:	AVERAGE 1990-1995 TOTAL DISOLVED SOLIDS	FILE NO.: H:\SMP\FIG4-6.WOR
	APPROVED BY:		

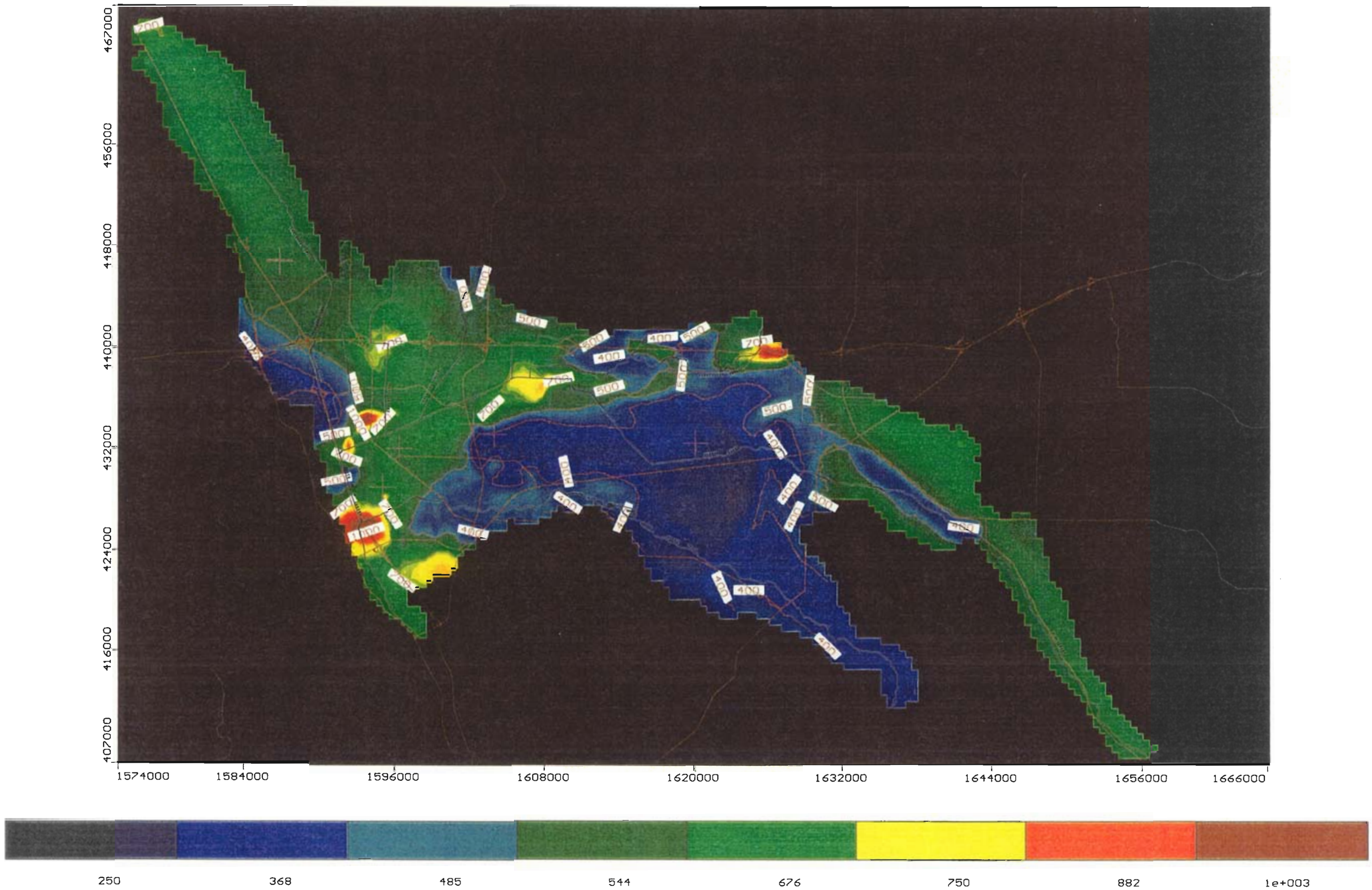


Zone 7 Water Agency – Pleasanton, CA Project: LVGWB Model V 2.0.55 Description: L1 TDS Fall 1995 (SP40) Modeller: CH2M HILL & Zone 7 5 Oct 00	Visual MODFLOW v.2.61, (C) 1995–1997 Waterloo Hydrogeologic, Inc. NC: 184 NR: 120 NL: 4 Current Layer: 1 FIGURE 3.34

FIGURE 3.35



ZONE 7 WATER AGENCY	DRAWN BY: GERALD GATES	WATER RESOURCES ENGINEERING	SCALE: 1" = 6000' (ON ORIGINAL)
5997 PARKSIDE DRIVE PLEASANTON CA 94588	DESIGNED BY: D. LUNN, G. GATES	MAIN BASIN LOWER AQUIFER TDS CONTOURS	DATE: 7 JULY 1997
	CHECKED BY:	AVERAGE 1990-1995 TOTAL DISOLVED SOLIDS	FILE NO.: H:\SMP\FIG4-7.WOR
	APPROVED BY:		



Zone 7 Water Agency – Pleasanton, CA
Project: LVGWB Model V 2.0.55
Description: L3 TDS Fall 1995 (SP40)
Modeller: CH2M HILL & Zone 7
5 Oct 00

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Waterloo Hydrogeologic, Inc.
NC: 184 NR: 120 NL: 4
Current Layer: 3

FIGURE 3.36