Chapter 4

Mineral Water Quality

Chapter 4

Mineral Water Quality

4.1 Introduction

Zone 7 operates several water quality monitoring programs which collect and evaluate an extensive amount of water quality data. The focus of this effort historically has been on collecting the relevant data necessary to accurately track trends in spatial variations in groundwater quality. Water quality monitoring has primarily been concerned with general dissolved mineral (ion) composition. In general, laboratory analyses for most samples include Calcium (Ca), magnesium (Mg), Sodium (Na), Potassium (K), Bicarbonate (HCO_3), Sulfate (SO_4), Chloride (Cl), Nitrite (NO_3), Silica (SiO_2), alkalinity, boron (B), electrical conductivity (EC), pH, total dissolved solids (TDS), and hardness. In the late 1990's arsenic (As) and manganese (Mn) were added to the list of analytes. Sampling frequencies typically are monthly or quarterly for new sites, and are usually reduced to quarterly, biennially or annually for well characterized sites. Dissolved mineral data are used to track sources of water and water quality trends, as well as to calculate annual and long-term salt loading to the Main Basin.

The purpose of this chapter is to summarize historic water quality data as they relate to groundwater salt impacts, to provide a synopsis of the most significant water quality trends, and to explain how the water that Zone 7 delivers to its customers is affected by changes in local and imported water quality. Zone 7 delivered water is a combination of groundwater, imported surface water, and local surface water. The water quality of each of those components varies geographically, seasonally, and annually. Section 4.6 describes delivered water quality and the historic variability of that delivered water quality.

Section 4.7 briefly describes tertiary recycled water quality and RO recycled water quality produced by the Livermore and DSRSD treatment plants and membrane filtration/reverse osmosis (RO) facilities. Comparisons are shown between raw (untreated) and treated water and the RO recycled water.

Reference F contains extensive monitoring data prepared by Zone 7 in the form of a groundwater annual report. Data from these monitoring programs are used not only to describe historic and current water quality and quantity, as described in this chapter, but are also used to calculate current and predict future salt loading to the Main Basin. Salt loading to the Main Basin directly impacts groundwater quality, which in turn impacts Zone 7 delivered water quality. Salt loading calculations are discussed in detail in Chapter 5. Chapter 6 presents recommended extensions to current monitoring programs aimed at tracking changes in future water quality and quantity associated with increased urban and agricultural irrigation.

4.2 Imported Water

Zone 7 currently has a maximum entitlement from the State Water Project of 80.619 TAF per year. State Water Project (SWP) water is imported from the Sacramento-San Joaquin Delta at the Banks Pumping Plant and delivered through the South Bay Aqueduct (SBA) along which Zone 7 has several turnouts. This imported surface water is then: 1) treated and delivered to M&I retailers; 2) used to artificially recharge the Main Basin aquifers; or 3) delivered as untreated water for agricultural irrigation.

The actual volume of SWP water, which Zone 7 has access to, varies annually with climatic conditions. Historically during wet years it was likely that Zone 7's full entitlement would be delivered. However, during periods of drought, deliveries may be restricted by the State to as low as 10% of entitlement. Other restrictions can, and have been imposed for environmental protection purposes. Based upon the State Department of Water Resources Simulation Model for State Water Project deliveries studies, the long-term average SWP deliveries are expected to be about 75% of maximum entitlements. When Zone 7 supply exceeds the 75% average, Zone 7 stores the excess in the groundwater basin. When Zone 7 demand exceeds the available State Project supply, Zone 7 makes up the difference by using Lake del Valle water, pumping stored groundwater, and/or requesting pumpback from Zone 7 storage in the Semitropic Groundwater Basin.

In addition to quantity, imported water quality from the State Water Project also varies. Figure 4.1 presents historic monthly average TDS and percent sodium values for South Bay Aqueduct water above and below Lake del Valle. Figure 4.1 shows that between 1962 and 1999 the historic monthly average TDS ranged from less than 100 mg/L to over 700 mg/L, that the TDS varied significantly between years, and that the TDS also commonly varied significantly between months in the same year. The percent sodium shows similar variations as did TDS between months and years. Hardness increases with the increase in TDS and decreases with the increase in the percentage of sodium.

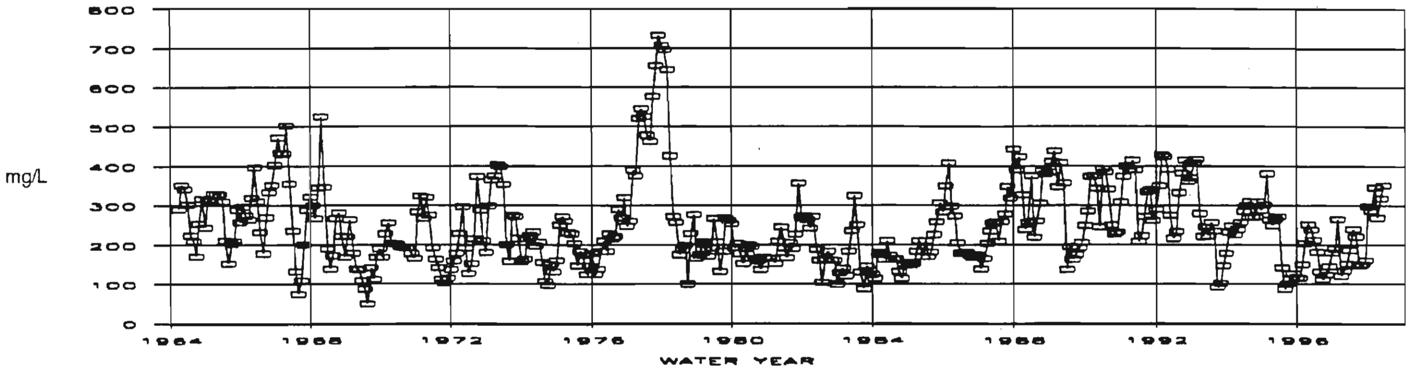
Figure 4.2 illustrates in greater detail the variability that can be expected from SBA water. Monthly average TDS values for SBA water delivered to the Patterson Pass Water Treatment Plant and the Del Valle Water Treatment Plant for the 1993-1998 water years ranged from less than 100 mg/L to over 410 mg/L. The time period shown in Figures 4.1 and 4.2 covers typical climatic conditions ranging from very wet years to drought conditions.

Figure 4.1

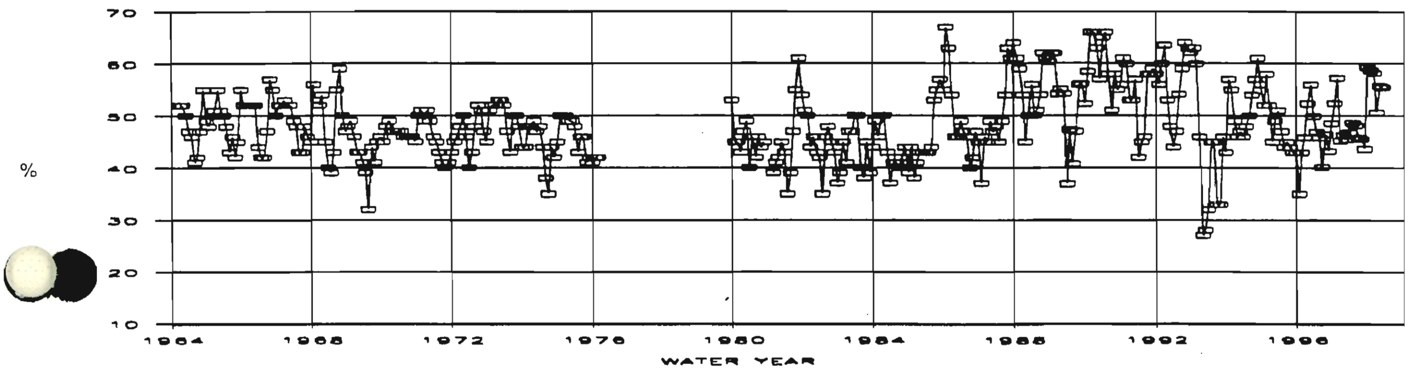
ZONE 7
WATER RESOURCES ENGINEERING
ARTIFICIAL GROUNDWATER RECHARGE WATER QUALITY
HISTORIC RECORD

SOUTH BAY AQUEDUCT TURNOUT ABOVE LAKE DEL VALLE (PPWTP)

TOTAL DISSOLVED SOLIDS

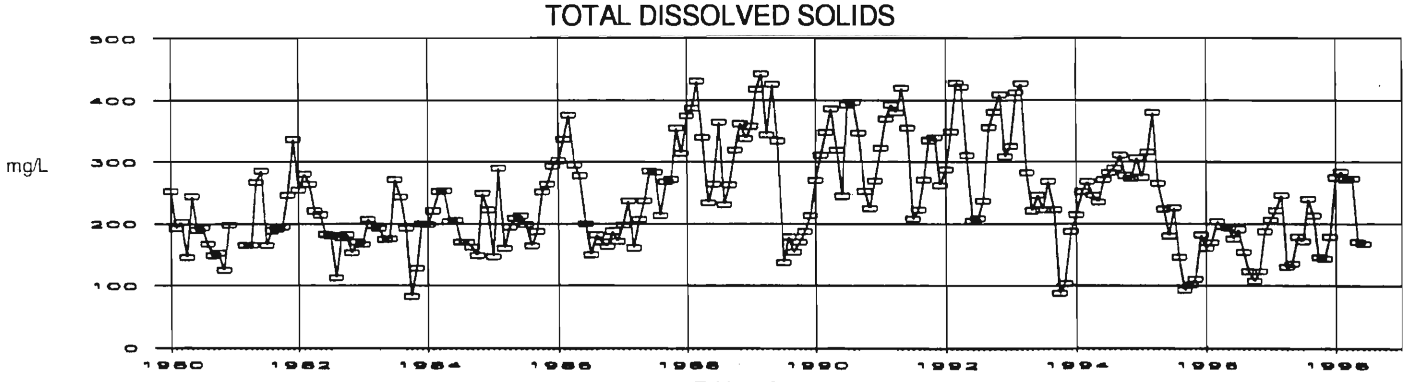


PERCENT SODIUM



SOUTH BAY AQUEDUCT TURNOUT BELOW LAKE DEL VALLE (DVWTP) 1980 - 1995

TOTAL DISSOLVED SOLIDS



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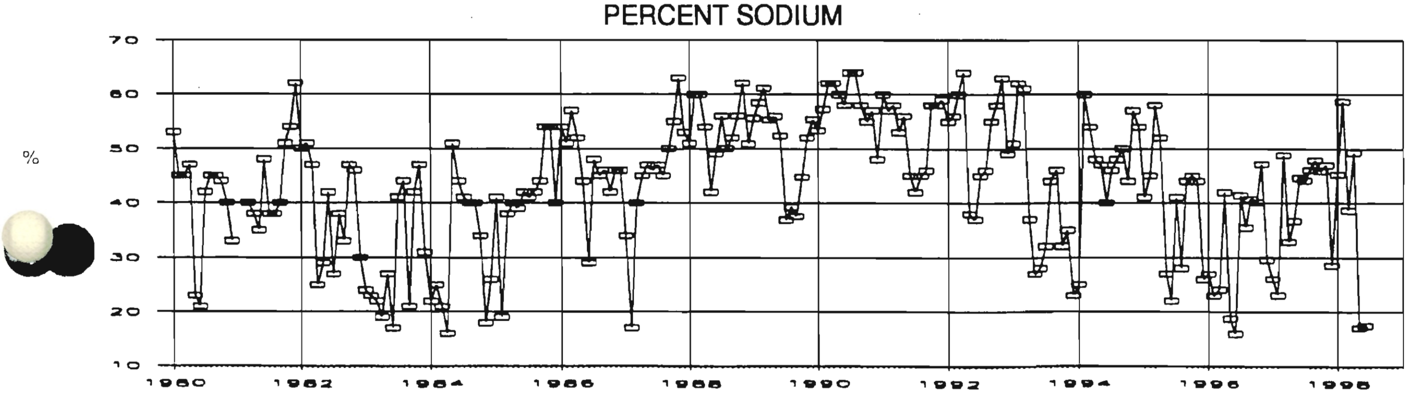
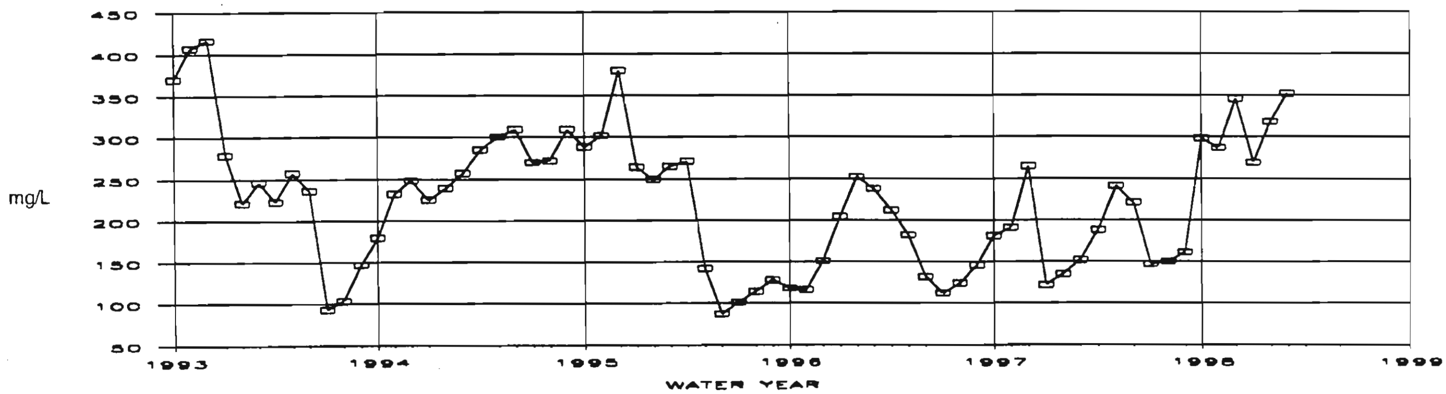


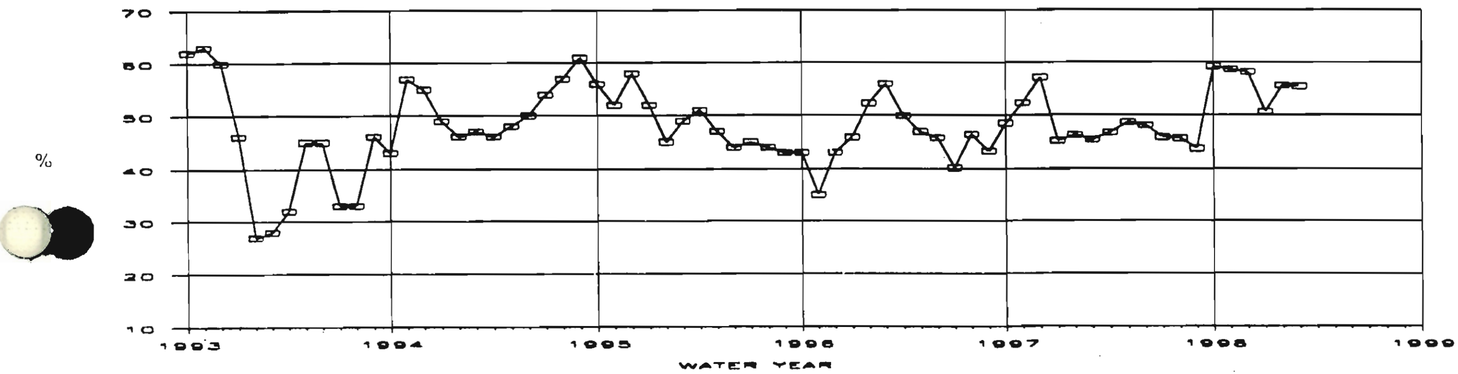
ZONE 7
WATER RESOURCES ENGINEERING
ARTIFICIAL GROUNDWATER RECHARGE WATER QUALITY
1993-1998 WATER YEARS

SOUTH BAY AQUEDUCT TURNOUT ABOVE LAKE DEL VALLE (PPWTP)

TOTAL DISSOLVED SOLIDS

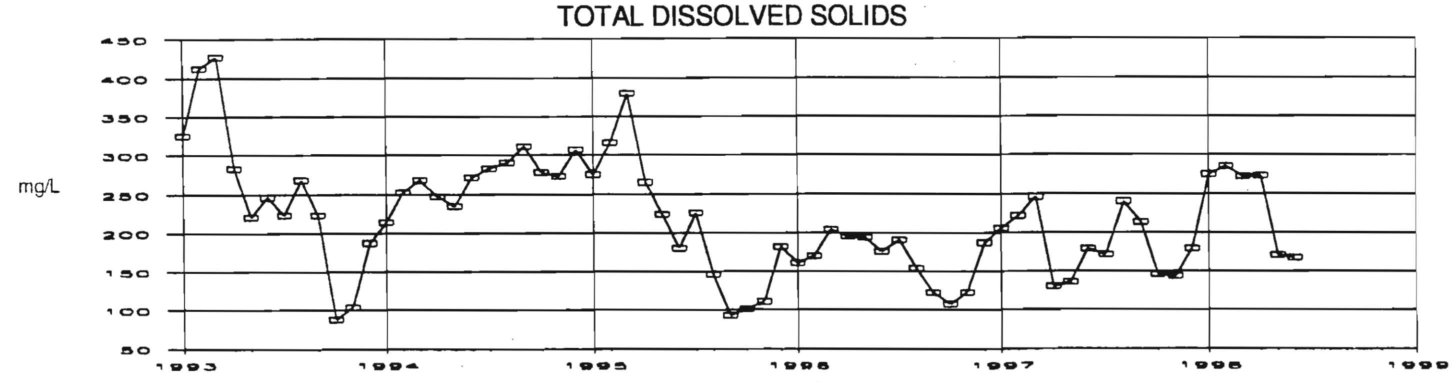


PERCENT SODIUM

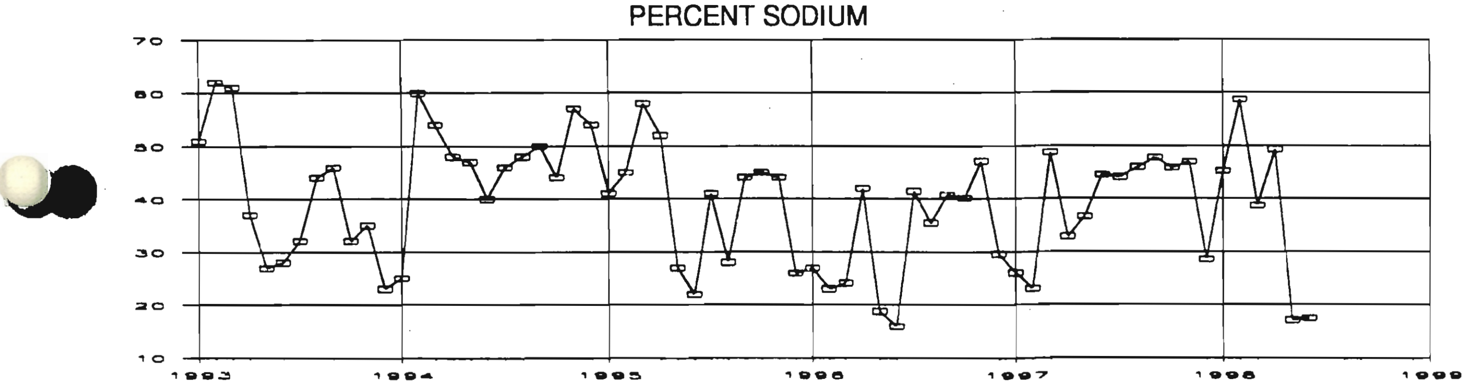


SOUTH BAY AQUEDUCT TURNOUT BELOW LAKE DEL VALLE (DVWTP)

TOTAL DISSOLVED SOLIDS



PERCENT SODIUM



4.3 Local Surface Water

Zone 7 local surface water consists of upper Del Valle watershed runoff into Lake Del Valle, local natural runoff into four major streams (Arroyo del Valle, Arroyo Mocho, Arroyo las Positas, and Arroyo de la Laguna), water from several quarry ponds, rainfall and urban runoff, and applied irrigation water seepage and runoff. Zone 7 monitors (and in a few cases estimates) the quantity and quality of each component and uses the information to calculate the annual hydrologic inventory (groundwater recharge and pumpage), and salt accumulation in the groundwater basin. Water quality data results are the focus of this section. Additional information on specific monitoring programs is discussed in Chapter 6.

Lake del Valle

Lake del Valle is used to capture stream outflow and rainfall runoff from the upper Del Valle watershed. In addition, State Water Project (SWP) water is diverted into the reservoir by the California Department of Water Resources (DWR) for recreational use and for storage to meet seasonal peak demands on the South Bay Aqueduct (SBA). On occasion, particularly as the reservoir approaches full levels, the DWR makes flood control releases from the reservoir to the SBA and to the Arroyo Valle. Zone 7 and ACWD share the "water rights" for the natural inflow to the reservoir and can take it either through the various SBA turnouts or by direct release to the Arroyo Valle for "artificial" recharge of the groundwater basin.

The water quality in Lake del Valle is a combination of rainfall runoff and SWP water quality. The quality of flood releases is measured at the Zone 7 Del Valle Water Treatment Plant inlet or at the Arroyo Valle near Livermore (AVNL) gaging station. Average TDS concentrations of the flood releases have ranged from 130 mg/L to 240 mg/L between 1993 and 1998. The quality of the Arroyo Valle recharge releases (release from upper turnouts over 10 cfs) and the natural seepage from the lake is measured at the Arroyo Valle near Livermore gaging station. The TDS concentrations measured at this station during base flow conditions (flow less than 2 cfs) between 1992 and 1998 represent the seepage component, and have ranged from 340 mg/L to 710 mg/L.

Local Streams

Water quality in the local streams varies by reach and by season. The streams can contain one or more of the following components: 1) natural inflow, including groundwater seepage (i.e., rising groundwater); 2) imported water from SBA releases; 3) urban runoff; 4) groundwater discharges from aggregate mining operations; and occasionally 5) flood control releases from Lake del Valle. The quantity and quality of each component is monitored by Zone 7. Electrical conductivity, pH and temperature are measured monthly at stream gaging stations throughout the basin and daily at various SBA turnouts to the

Table 4.1

Zone 7 SURFACE WATER MONITORING

1997 WATER YEAR

MONTHLY CONDUCTIVITY SAMPLING
(EC in Micromhos/cm.Flow in CFS)

	ARROYO VALLE Below LANG CANYON		ARROYO VALLE Near LIVERMORE		ARROYO VALLE At PLEASANTON		ARROYO MOCHO Near LIVERMORE		ARROYO MOCHO At LIVERMORE		ARROYO MOCHO Near PLEASANTON		ARROYO LAS POSITAS At LIVERMORE		ARROYO LAS POSITAS At EL CHARRO		ARROYO DE LA LAGUNA Near PLEASANTON		DATE OF SAMPLING
	EC	FLOW	EC	FLOW	EC	FLOW	EC	FLOW	EC	FLOW	EC	FLOW	EC	FLOW	EC	FLOW	EC	FLOW	
OCT	DRY	0	680	3.5	910	12	1240	1.1	DRY	0	1020	7.1	1570	2.6	1460	1.3	1110	25.7	15-Oct-96
NOV	520	19	760	1.3	800	11.3	880	1.0	640	9.0	1100	28.7	1570	12.0	1160	18.5	630	146.0	19-Nov-96
DEC	470	41	890	2.4	780	7.5	790	2.4	DRY	0	940	27.0	2040	3.7	1890	4.2	1230	52.0	17-Dec-96
JAN	500	116	520	55	490	96.6	610	17.0	535	13.7	690	291	1140	33.7	755	68.3	650	307.0	15-Jan-97
FEB	525	64	610	3.5	650	14.8	740	9.5	785	0.4	1230	30.4	2110	8.0	1860	11.5	1140	80.0	14-Feb-97
MAR	590	29.0	740	3.9	800	9.3	860	6.4	DRY	0	1380	11.6	1870	4.2	1850	6.0	1150	54.0	19-Mar-97
APR	690	15.0	780	1.2	890	2.9	740	4.2	DRY	0	1100	12.1	1800	3.3	1750	3.3	1210	42.0	14-Apr-97
MAY	710	4.5	850	1.0	900	5.6	1010	1.2	DRY	0	1910	16.2	1620	2.3	1590	0.6	1120	37.0	19-May-97
JUN	740	1.9	870	1.0	DRY	0	1100	0.5	DRY	0	1010	16.0	1470	2.3	1570	0.3	1140	38.0	17-Jun-97
JUL	DRY	0	820	1.0	DRY	0	1180	0.2	DRY	0	990	14.0	1260	2.1	1250	0.5	1100	30.0	17-Jul-97
AUG	DRY	0	770	0.6	860	5.9	1250	0.1	DRY	0	870	18.0	1240	2.1	1420	0.4	1140	46.0	18-Aug-97
SEP	DRY	0	410	20	540	11.3	1190	0.1	DRY	0	1050	14.5	1430	2.1	1320	0.5	1230	44.0	12-Sep-97

Table 4.2
Surface Water Quality Monitoring
1997 Water Year

Station Name	DATE	Flow (cfs)	TEMP	EC	pH	Ca	Mg	Na	K	HCO3	S04	Cl	NO3	SIO2	Hardness	B	Fl	TDS
ALAMO CANAL NEAR PLEASANTON	5/19/97	5.6	28.8	1250	7.9	93	34	145	2	390	137	136	1	22	373	0.6	0.40	769
ALAMO CANAL ABOVE SOUTH SAN RAMON	5/20/97		22.5	1160	7.9													
ARROYO DE LA LAGUNA NEAR PLEASANTO	3/19/97	54.0	18.7	1150	8.0	71	44	113	3	343	112	134	5	15	358	1.1	0.30	673
ARROYO VALLE AT PLEASANTON	3/19/97	9.2	19.4	800	8.2	50	38	65	2	253	65	95	2	13	284	0.6	0.20	463
ARROYO LAS POSITAS AT LIVERMORE	3/19/97	4.2	17.1	1870	8.0	81	51	260	3	466	110	306	23	16	414	4.6	0.70	1089
ARROYO LAS POSITAS AT EL CHARRO	3/19/97	6.0	17.5	1850	8.1	72	47	262	4	434	110	284	20	19	374	4.3	0.70	1042
ARROYO MOCHO NEAR LIVERMORE	3/19/97	6.4	17.1	860	8.4	44	77	34	2	430	73	31	0	16	426	0.3	0.20	515
ARROYO MOCHO NEAR PLEASANTON	3/19/97	11.6	22.5	1380	8.4	61	48	164	3	349	95	204	11	18	351	2.4	0.40	777
DRY CREEK AT ARROYO MOCHO	5/21/97	1.0	23.2	1050	7.8													
ARROYO VALLE BELOW LANG CANYON	3/19/97	29.0	17.8	590	8.1	63	31	23	2	283	69	18	0	11	285	0.2	0.20	366
ARROYO VALLE NEAR LIVERMORE	3/19/97	3.9	16.1	740	7.4	60	32	50	2	239	121	42	0	15	280	0.6	0.20	441
CAYETANO CREEK ABOVE POSITAS	5/20/97	0.1	26.6	1850	7.9	88	34	296	8	464	335	172	0	31	359	1.3	0.80	1203
DSRSD (LINE G-1-1)	5/19/97	0.3	29.4	7700	7.5	156	143	683	4	397	1202	596	0	14	977	3.7	0.80	2999
DUBLIN CREEK AT DUBLIN RD	5/19/97	0.5	18.2	1525	7.4	196	41	112	3	372	440	79	1	34	658	0.3	0.30	1097
SOUTHBAY TRIBUTARY	5/21/97		18.1	621	8.8	34	19	64	2	152	63	78	0	5	162	0.3	0.30	349
SOUTH SAN RAMON CREEK ABOVE SOUTH	5/20/97		23.9	1060	7.9													
TASSAJARA CREEK ABOVE ARROYO MOCHO	5/28/97		25.0	1098	8.2	41	30	165	3	300	124	121	0	4	227	0.7	0.60	641
TASSAJAR CREEK AT EB Park	5/28/97	0.6	22.2	1360	8.2	52	42	197	4	450	134	141	0	8	302	0.9	0.50	808

Zone 7 treatment plants. The electrical conductivity (EC) measurements are used to estimate TDS content using the formula TDS $\approx$0.56 x EC. Table 4.1 shows the monthly EC data for the 1997 water year for the major streams monitored by Zone 7. Additionally, surface water samples are collected periodically and analyzed for major and total ion content (Table 4.2). See Section 6.2, Existing Monitoring Programs, for additional information regarding the specific surface water monitoring stations.

Natural inflow and groundwater seepage are measured (gaged) by Zone 7 at various gaging stations along the streams. Water quality of the natural inflow/seepage into the upper reach of Arroyo Valle is monitored at the Arroyo Valle near Livermore (AVNL) gaging station, as discussed above. Inflow into the lower reach is essentially a mixture of urban runoff and mining discharges (see below). Water quality of the natural inflow into the Arroyo Mocho is monitored at the Arroyo Mocho near Livermore (AMNL) gaging station. The annual average TDS concentrations measured at AMNL have ranged from 350 mg/L to 580 mg/L between 1992 and 1998.

At various times during average and wet years, surplus SWP water is released into the Arroyo Mocho and Arroyo Valle to supplement the natural recharge of the groundwater basins. This "artificial stream recharge" began in 1962 with the importation of State Water Project water into the valley. Since water quality of the imported water at the stream channel turnouts is essentially the same as the water entering the Zone 7 water treatment plants, the water quality data collected at the treatment plant intakes are used for the artificial recharge component (See Section 4.2 - Imported Water for additional detail). The volume of SBA releases is metered at the respective SBA turnouts.

Natural inflow into the Arroyo las Positas is from the Seco, Upland Positas and the Positas drainage basins (see Reference G) plus seepage or outflow from the Spring and May subbasins. Water quality of the natural inflow into the Arroyo las Positas is monitored at the Arroyo las Positas near Livermore (ALPL) gaging station. The annual average TDS concentrations measured at ALPL have ranged from 1,080 mg/L to 1,590 mg/L between 1992 and 1998. The elevated TDS concentrations in the Arroyo las Positas are mainly due to the contributing subbasin groundwater components, but also due to runoff from the undifferentiated marine formations of the Altamont Hills. The poor quality groundwater flowing into the Arroyo las Positas is believed to get its salts from the particles and clasts of undifferentiated marine formations which help to makeup the alluvial aquifers in the Spring and May sub-basins. Evaporative concentration of these marine salts through the evaporation of shallow groundwater is also a cause of the high TDS in this area.

The Arroyo de la Laguna conveys the outflow from the Livermore-Amador basin. It contains a mixture of outflow from Alamo Canal, Arroyo Mocho, Arroyo las Positas and Arroyo Valle, and groundwater from the Bernal subbasin. Water quality of the various stream outflow components are monitored at the respective gaging stations by Zone 7. The subsurface groundwater outflow water quality is determined by averaging the TDS concentrations of several shallow monitoring wells located in the vicinity of the rising groundwater (near the Arroyo Valle and Arroyo de la Laguna confluence). Between 1995 and 1998 the subsurface groundwater outflow TDS values ranged from 830 mg/L and 980 mg/L. Groundwater seepage into the Arroyo de la Laguna did not occur in significant quantities from 1992 through 1995 (see Section 3.3 discussion). Alameda County Water District monitors the quantity and quality of the Arroyo de la Laguna near Pleasanton.

Natural Stream Recharge—Figure 3.3 has shown the relative recharge capacity associated with each of the major streams in the watershed and the associated water quality in terms of TDS. Note that the dashed lines represent areas of rising groundwater rather than areas of stream recharge. Table 4.1 and Figure 3.3 show that the TDS in the local surface water varies significantly throughout the watershed from approximately 350 mg/L to over 1,000 mg/L TDS. The highest quality surface water recharging the basin occurs through Arroyo Mocho and Arroyo Valle where the TDS is generally less than 500 mg/L. The poorest quality surface water recharging the basin has a TDS of approximately 1,000 mg/L and occurs in Arroyo Las Positas. On average, given 1997 land use conditions, approximately 2,700 AF of natural recharge occurs through Arroyo Mocho, 1,200 AF through Arroyo Las Positas, and 2,700 AF through Arroyo Valle annually.

The volume of flow through each of the major streams varies significantly on a seasonal basis. Further, the EC/TDS values at times of peak flow are often well below those during other times of the year (Table 4.1). For example, base-flow conditions for Arroyo de la Laguna (ADLLP) occurred during the months of April through October when flow was approximately 40 cfs and EC about 1,100 µmhos/cm. During high flow conditions at ADLLP in January (300 cfs), the EC was 650 µmhos/cm.

Rainfall and Urban Runoff

The quantity of local rainfall is monitored by Zone 7 at several rain gage stations located strategically around the basin. For the purpose of salt loading estimates, all of the rainfall is assumed to have a TDS concentration of 0 mg/L.

The quantity and quality of the urban runoff component is empirically determined. Previous studies found a correlation between rainfall and urban runoff. Now simple factors are used to determine the runoff components of several stream reaches. These estimated values are then checked against stream gaging data and adjusted if necessary. The water quality of this runoff component was also monitored in the past, and was found to average about 250 mg/L TDS. This average value is used in the Zone 7 salt loading calculation for the lower reach of Arroyo Valle.

Mining Ponds and Discharges

Zone 7 monitors the water level, electrical conductivity and TDS content of over 25 mining ponds located along the Arroyo Mocho and Arroyo Valle. In addition, Zone 7 monitors the water discharges made to the two Arroyos by the mining companies. Based on the monitoring results, the flow-weighted average TDS content of the mining export has ranged from 490 mg/L to 550 mg/L between 1992 and 1998.

Applied Irrigation

Urban and agricultural irrigation are monitored separately. The quality of the urban irrigation water is determined by flow-weighting the average of SWP water quality, groundwater quality, and recycled water quality on an annual basis. Agricultural irrigation water quality is determined by flow-weighting the average qualities of the SWP and groundwater components.

4.4 Groundwater

Zone 7 operates a groundwater monitoring program that collects groundwater level and quality data from approximately 200 "program" wells annually. The data is stored in a computerized database for ready retrieval and reporting. A map showing the location of the program wells in the groundwater monitoring program is presented in Figure 4.3. The current Zone 7 groundwater monitoring program and future monitoring plans with respect to the Salt Management Plan are discussed in Chapter 6, Watershed Salt Management Monitoring Program.

In addition to data from the program wells, Zone 7 has compiled a computerized database of historic water level and mineral quality data from other wells within the local watershed. In general, laboratory analyses for most well samples include Ca, Mg, Na, K, HCO_3, SO_4, Cl, NO_3, SiO_2, alkalinity, boron (B), electrical conductivity (EC), pH, TDS, and hardness. In the late 1990's arsenic (As) and manganese (Mn) were added to the list of analytes.

Table 4.3 contains representative summaries of the groundwater quality data collected in each of the main subbasins during 1997. Figure 4.3 shows the locations of the wells with their numbers as listed in Table 4.3. A copy of the 1996 water year groundwater monitoring program annual report is included as Reference F.

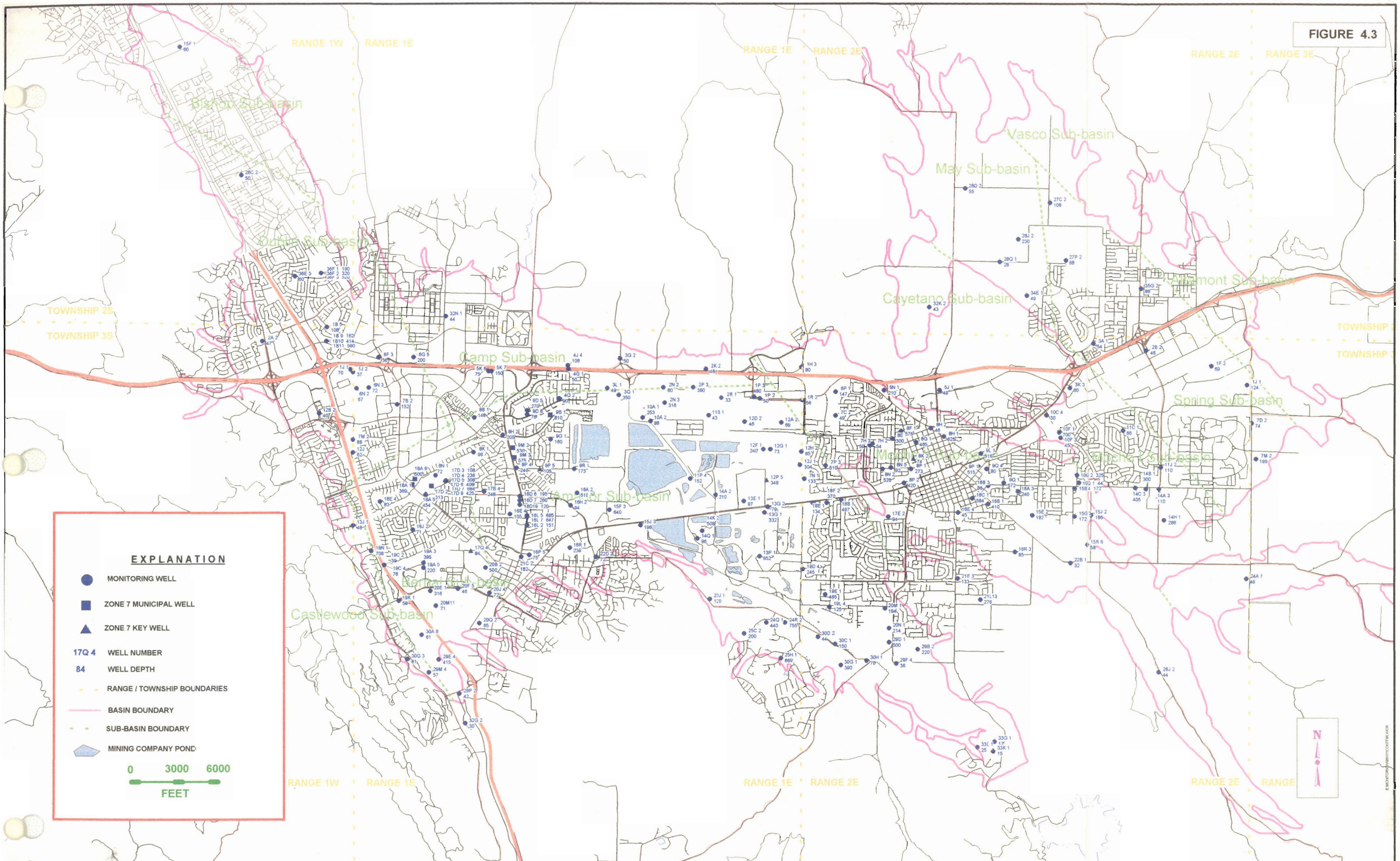
Figures 4.4 and 4.5 show the contours of average TDS concentrations in the upper and lower aquifers of the main and fringe basins from the 1990 through 1995 water years. The upper aquifer contour map was created primarily using data from wells having a total depth of 150 feet or less, whereas the lower aquifer contour map uses water quality data from deeper aquifer monitoring wells and the municipal supply wells.

Graphical map-based summaries of the TDS, chloride, hardness, and nitrate concentrations measured in 1997 in the program wells are provided in Figures 4.6, 4.6A, 4.7 and 4.8, respectively. On this series of figures, the size (area) of each symbol (circle or square) is proportional to the concentration of the respective constituent. Larger symbols

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER QUALITY BY BASIN
MAJOR MINERAL SUMMARY
1997 WATER YEAR

SUB-BASIN	WELL	DATE	DTW	TEMP.	EC	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3	SiO2	HARD	B	F	As	Mn	TDS	%Na	LAB
AMADOR EAST SUB-BASIN: LOWER	3S/1E 14A 2	08/12/97	102	22.2	608	7.8	63	30	32	1	234	16	82	7	20	281	0.3	0.1	0	0	368	20	ZONE 7
AMADOR EAST SUB-BASIN: UPPER	3S/1E 11B 1	09/01/97			1630		58	55	200	1	448	120	255	31	33	374	4.6				1110	54	LWRP
AMADOR WEST SUB-BASIN: LOWER	3S/1E 9M 3	06/04/97			650	7.9	49	37	30	2	270	32	41	11	21	274	0.3	0.1	0	0	357	19	ZONE 7
AMADOR WEST SUB-BASIN: UPPER	3S/1E 16P 5	05/29/97	38	17.3	620		37	28	43	2	197	58	52	7	12	206	0.3	0.1			336	31	ZONE 7
BERNAL SUB-BASIN: LOWER	3S/1E 18A 6	06/04/97			1005	7.8	76	43	79	2	381	90	80	9	26	364	0.5	0.1	0	0	594	32	ZONE 7
BERNAL SUB-BASIN: UPPER	3S/1E 19C 4	07/01/97	34.1	17.4	1130	7.1	137	40	47	2	428	126	90	16	20	507	0.3	0.2			690	17	ZONE 7
CAMP SUB-BASIN	2S/1E 32N 1	07/03/97	23.4	20.6	1299	7.1	134	11	115	2	318	24	228	31	28	379	0.5	0.2			729	40	ZONE 7
DUBLIN SUB-BASIN: LOWER	2S/1W 36F 2	01/28/97	26	18.5	882	7.6	41	11	147	1	387	0	88	0	21	147	0.6	0.1	0.11	0.15	501	69	ZONE 7
DUBLIN SUB-BASIN: UPPER	2S/1W 36E 3	07/09/97	4.3	21	861		118	10	48	1	336	88	63	19	38	333	0.2	0.3			550	24	ZONE 7
MAY SUB-BASIN: UPPER	2S/2E 28O 1	06/26/97	4.2	19.1	1550	7.5	60	34	221	1	323	100	249	12	37	290	0.9	0.6			874	63	ZONE 7
MOCHO2 SUB-BASIN: LOWER	3S/2E 8 E1	08/08/97	43.8	24	780	8.2	47	55	40		337		56	17		343	20				460	20	DWR
MOCHO2 SUB-BASIN: UPPER	3S/1E 1H 3	07/10/97	27.7	20	1412	7.2	70	31	226	2	538	98	189	29	30	302	1	0.4			943	62	ZONE 7
SPRING SUB-BASIN: UPPER	2S/2E 27P 2	06/26/97	1	22.1	4620	7.6	111	47	965	3	204	0	1731	5	27	473	33.1	0.5			2990	82	ZONE 7

VALUES IN MG/L
TEMPERATURE IS DEGREES CELCIUS
DTW IS DEPTH TO WATER IN FEET



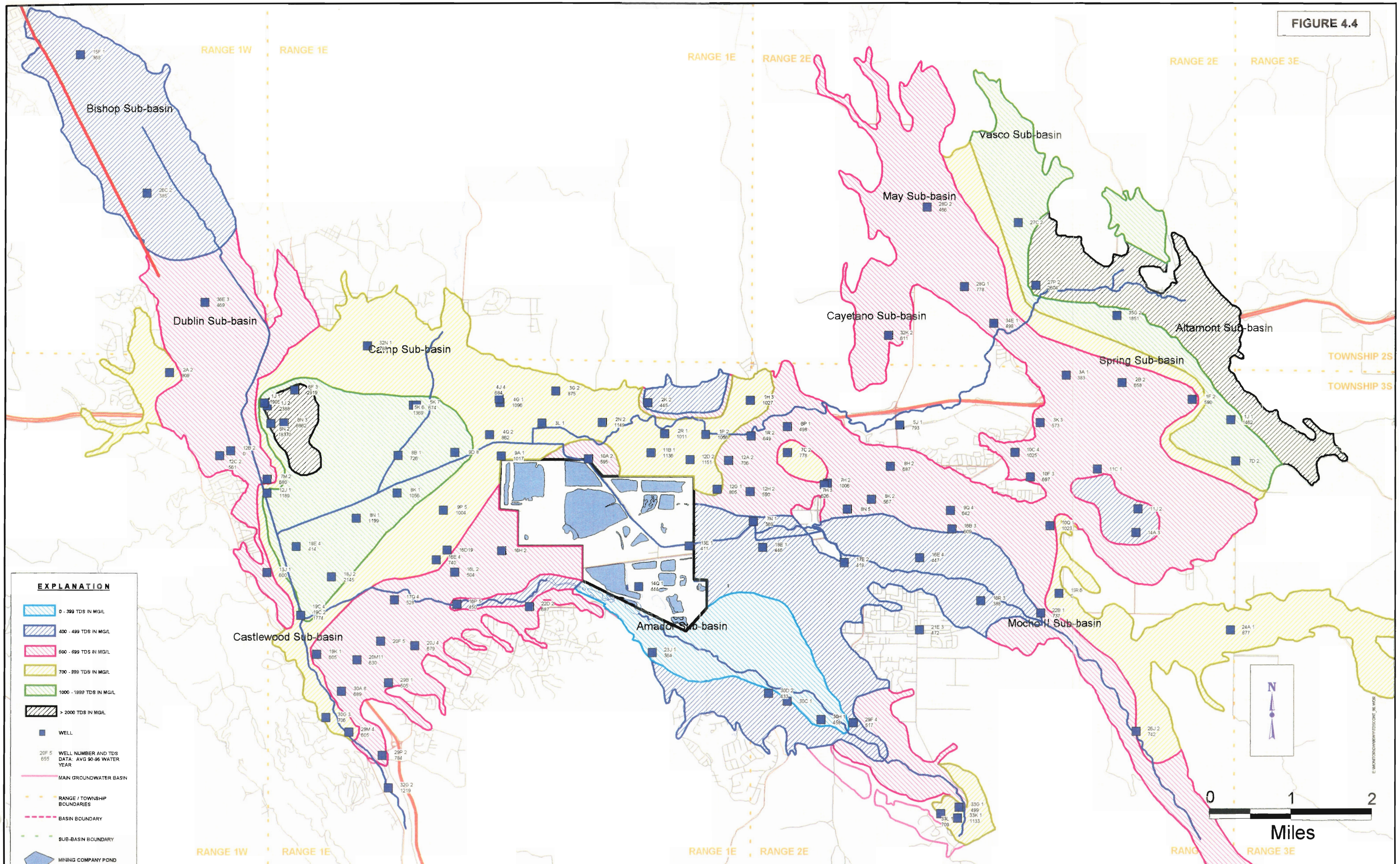
ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN BY: STEVEN J. ELLIS
DESIGNED BY: STEVEN J. ELLIS
CHECKED BY:
APPROVED BY:

WATER RESOURCES ENGINEERING
MONITORING WELL PROGRAM NETWORK
1997 WATER YEAR

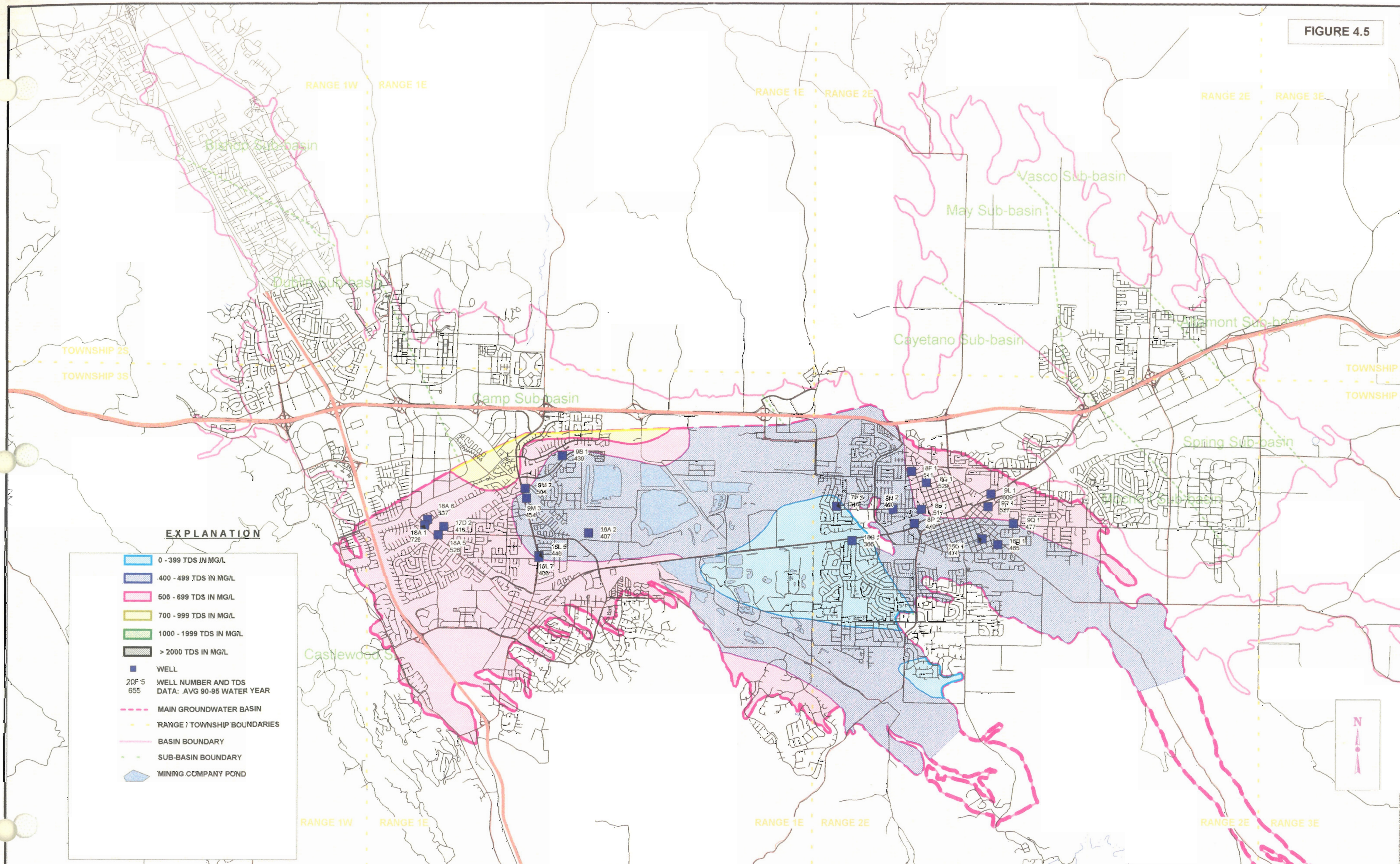
SCALE: 1" = 6000' (ON ORIGINAL)
DATE: 15 JANUARY 1997
FILE NO.: H:\SMP\FIG4-1.WOR

FIGURE 4.4



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

FIGURE 4.5

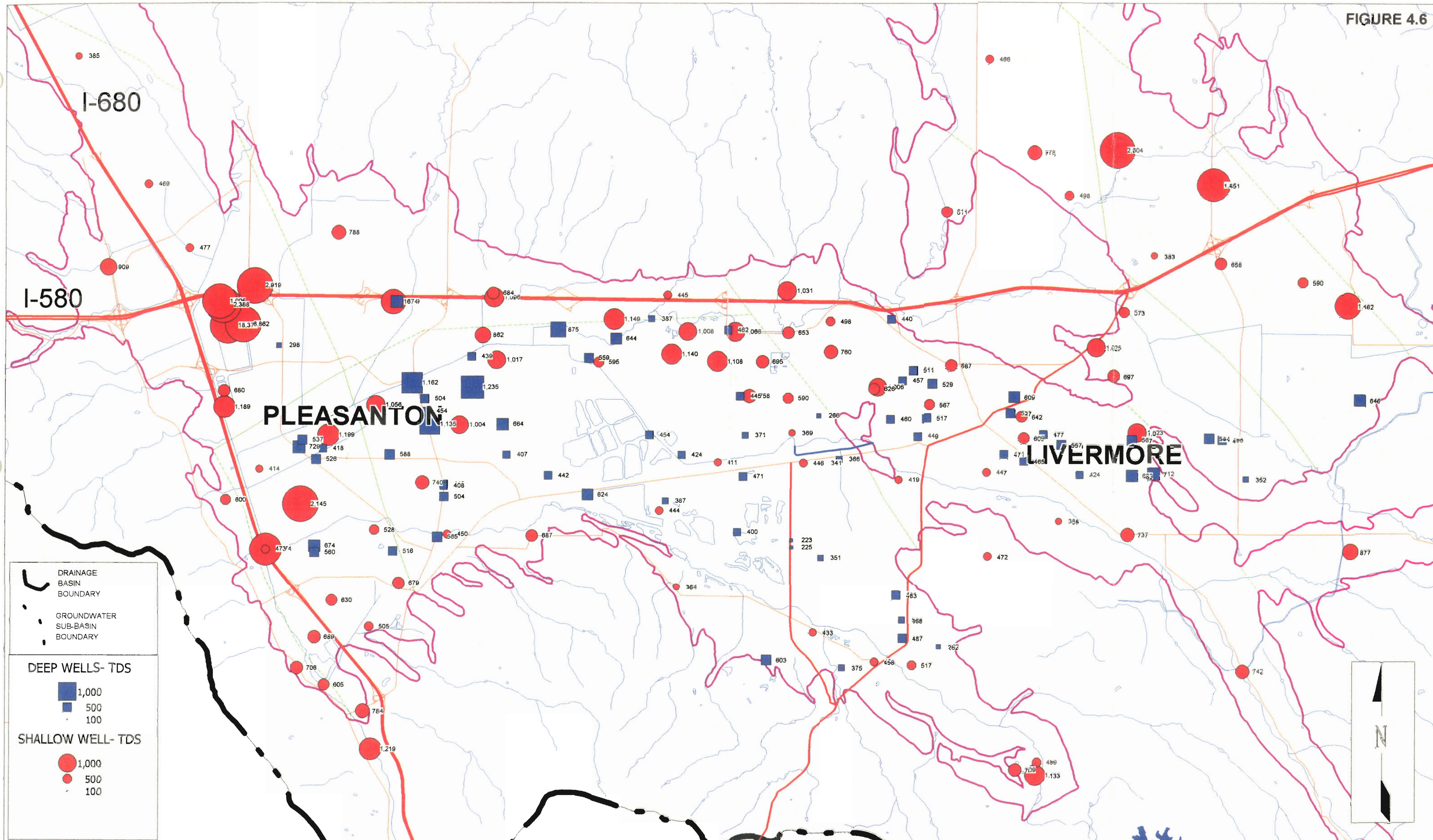


ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN BY: GERALD GATES
DESIGNED BY: S. LUNN, G. GATES
CHECKED BY:
APPROVED BY:

WATER RESOURCES ENGINEERING
MAIN BASIN LOWER AQUIFER TDS CONTOURS
AVERAGE 1990-1995 TOTAL DISOLVED SOLIDS

SCALE: 1" = 6000' (ON ORIGINAL)
DATE: 7 JULY 1997
FILE NO.: H:\SMP\FIG4-7.WOR



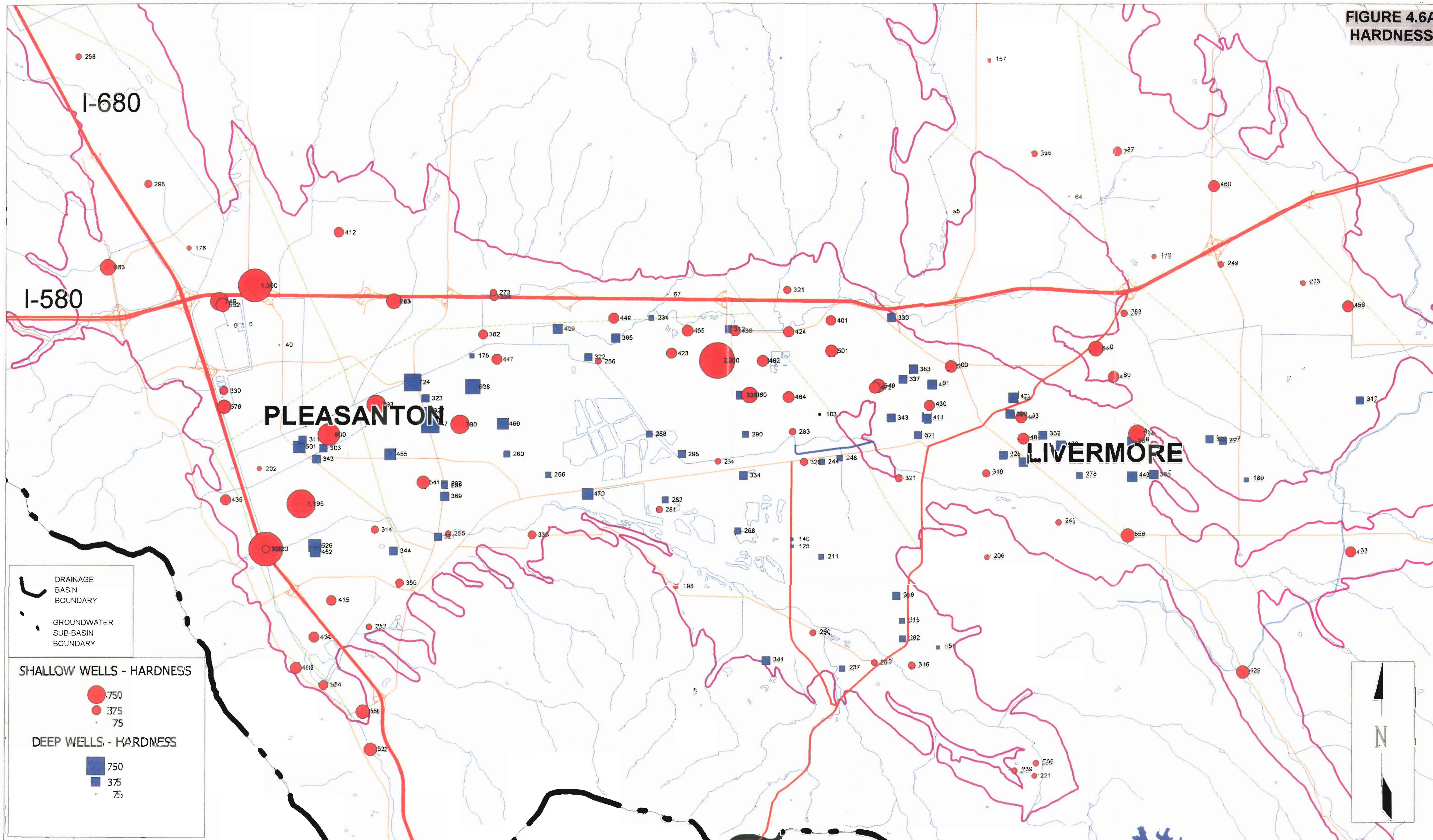
ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	GERALD GATES
DESIGNED	GERALD GATES
CHECKED	DAVID LUNN
APPROVED	

WATER RESOURCES ENGINEERING

AVERAGE TDS OF MONITORED WELLS
1997 WATER YEAR

SCALE	1" = 1 MILE
DATE	5 MAY 1998
FILE NO.	H:\smp\FIG4-2.WOR



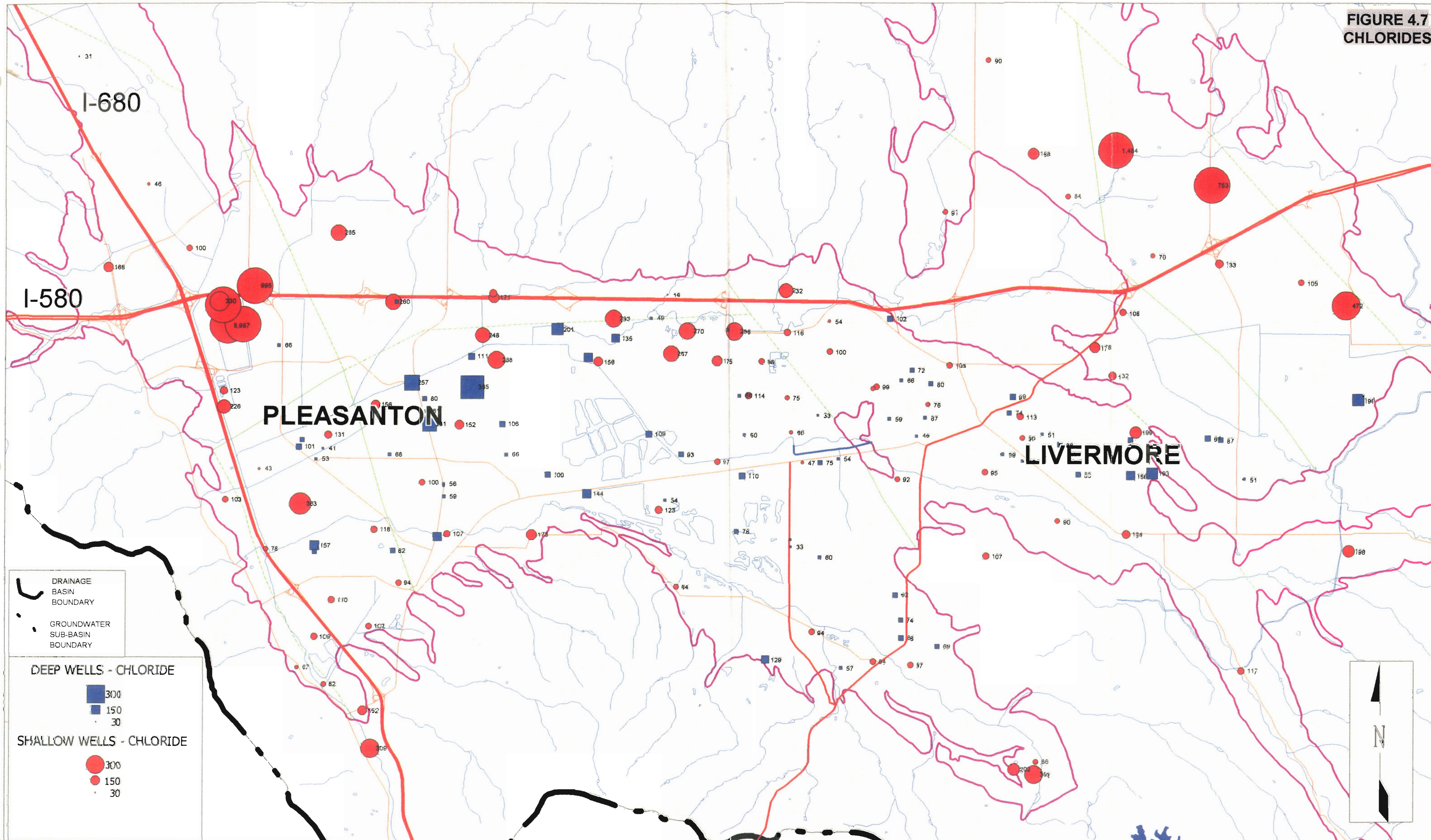
ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	GERALD GATES
DESIGNED	GERALD GATES
CHECKED	DAVID LUNN
APPROVED	

WATER RESOURCES ENGINEERING

AVERAGE HARDNESS OF MONITORED WELLS
1997 WATER YEAR

SCALE	1" = 1 MILE
DATE	5 MAY 1998
FILE NO.	B.151 | Smp-F1S4-3.WOR



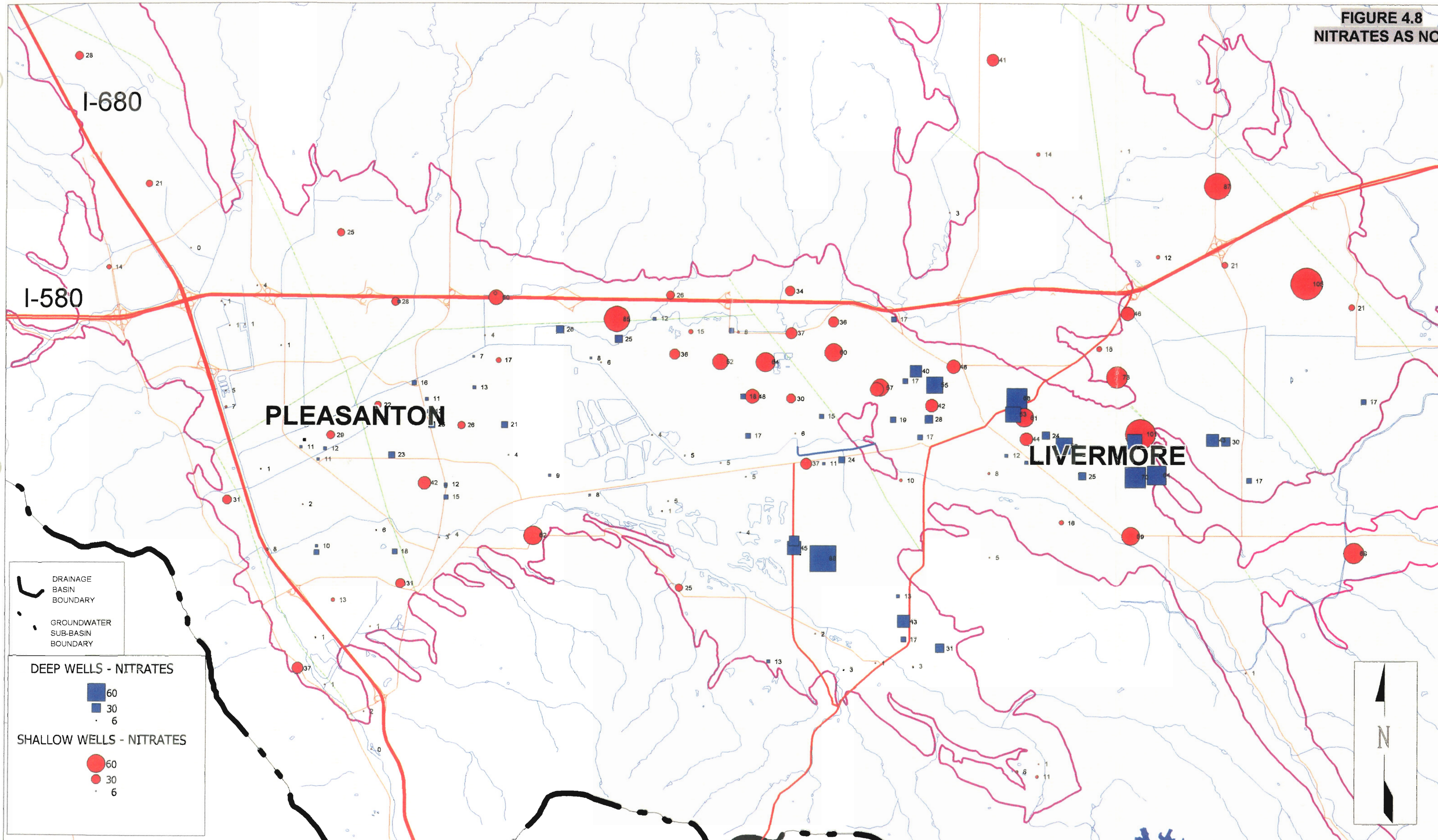
ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	GERALD GATES
DESIGNED	GERALD GATES
CHECKED	DAVID LUNN
APPROVED	

WATER RESOURCES ENGINEERING

AVERAGE CHLORIDE OF MONITORED WELLS
1997 WATER YEAR

SCALE	1" = 1 MILE
DATE	5 MAY 1998
FILE NO.	H:\smp\FIG4-5.WOR



ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	GERALD GATES
DESIGNED	GERALD GATES
CHECKED	DAVID LUNN
APPROVED	

WATER RESOURCES ENGINEERING

AVERAGE NITRATES OF MONITORED WELLS
1997 WATER YEAR

SCALE	1" = 1 MILE
DATE	5 MAY 1998
FILE NO.	B-151 | smp\FIG4-4.WOR

represent wells with higher concentrations. Upper aquifer values are represented by red-orange circles and lower aquifer values are represented by blue squares. The 1990-1995 average concentration values are printed next to the symbols. These figures demonstrate that the groundwater quality varies with respect to each of these constituents throughout the basin, and that significant variability exists between some wells that are in close proximity to each other.

Upper Aquifer Water Quality

Figure 4.4 shows that upper aquifer TDS values vary significantly throughout the groundwater basin. The contour map shows that groundwater quality is typically best in areas adjacent to the artificial recharge reaches of the local streams. Along the Arroyo Valle southeast of the mining area, TDS is generally less than 400 mg/L. Along much of the Arroyo Mocho, TDS is generally less than 500 mg/L due to the artificial stream recharging operations.

Groundwater of the Bishop subbasin and the northern area of the Dublin subbasin have TDS values between 400 and 500 mg/L, while the main portion of the Dublin subbasin exhibits TDS in excess of 2,000 mg/L. The lower TDS is believed to be the result of irrigation in northern Dublin and San Ramon with low TDS water supplied by East Bay Municipal Utility District (EBMUD). The 800-1,000 mg/L TDS groundwater in the southern portion of the Dublin subbasin is a result of the groundwater flowing through salt-bearing ancient lake deposits in the south Dublin and northwest Pleasanton areas. This relatively high TDS water is of concern to the extent that it is calculated to move into the shallow aquifer portion of the Bernal sub-basin at about 1 TAF/Y degrading the water in that basin, as was discussed in Section 3.3.

Groundwater in the Camp subbasin contains TDS between 700 and 900 mg/L, and may contain pockets of elevated arsenic concentrations due to the presence of alluvial material eroded from the formations in the Tassajara and Alameda Creak drainage basins. Runoff from these two drainage basins that has historically recharged the groundwater basin may also be a source of arsenic. The Spring subbasin, and to some extent the May subbasin, groundwater has TDS in excess of 2,000 mg/L as a result of inflow from the old marine sediments that occur northeast of Livermore.

The Mocho 2 subbasin is divided horizontally in terms of water quality. To the north, the groundwater exhibits the high TDS characteristics of the Arroyo Las Positas, with concentrations approaching 1,000 mg/L. To the south, the groundwater quality is similar to the Arroyo Mocho water quality, with concentrations barely exceeding 500 mg/L. The beneficial effects of artificial stream recharge are evident in the southern Mocho 2 subbasin.

The East Amador subbasin has poor quality in the north, which is the result of recharge from Arroyo Las Positas, and possibly subsurface inflow from the Camp subbasin. To the south, in East Amador, the water is of noticeably better quality. This higher quality water is from artificial recharge along the Arroyo Valle. The West Amador subbasin has a similar groundwater quality distribution that is accentuated by the effects of the gravel mining operations that essentially separate the East Amador subbasin from the West Amador subbasin.

The normal flow of groundwater brings the waters of the Dublin, Camp, and West Amador subbasins together in the Bernal subbasin. As a result, the quality in the Bernal subbasin is not simple to characterize as the TDS varies from 300 mg/L to over 2,000 mg/L. To the north, the effect of the higher TDS Dublin subbasin is seen. In the southeast, the lower TDS recharge water from the Arroyo Valle is evident.

Lower Aquifer Water Quality

Water quality in the lower Mocho 2 subbasin varies from 400 to 600 mg/L and exhibits the same profile as the upper aquifer, suggesting that vertical mixing is occurring within the two aquifers. See Section 3.4 for additional information regarding aquifer mixing.

The lower East Amador subbasin has good quality water consisting of 300 to 400 mg/L TDS. This is probably the result of historic recharge from the Arroyo Valle and Arroyo Mocho (Figure 4.5). The lower West Amador subbasin has similar water quality.

Unlike the upper aquifer in the Bernal subbasin, the lower Bernal subbasin water quality is less variable, ranging from 400 to 700 mg/L TDS. This is most likely the result of lower aquifer pumpage and associated vertical and horizontal mixing.

Groundwater Quality Trends

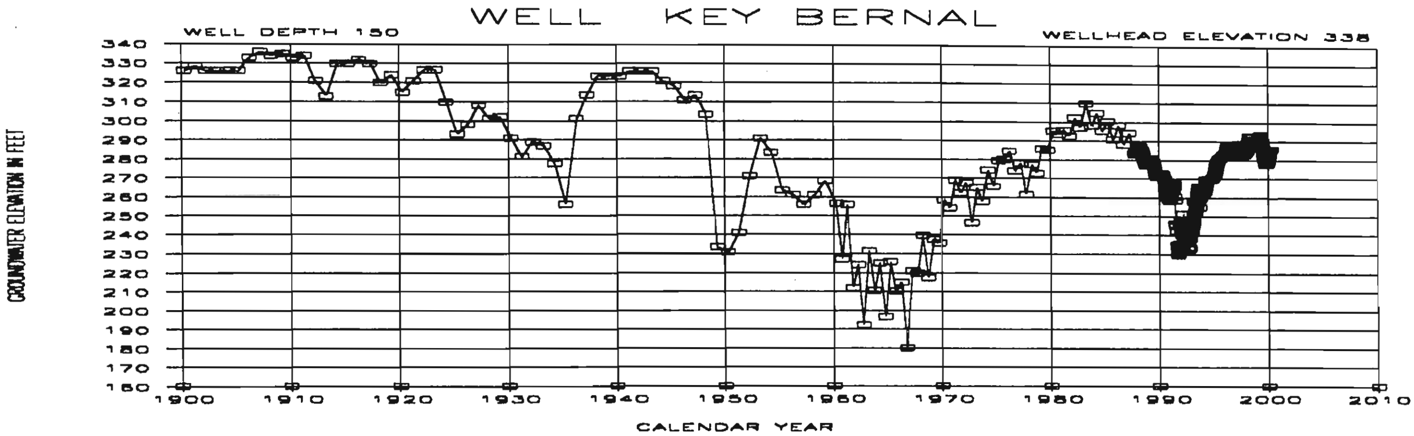
Long-term groundwater quality trends can be difficult to detect. Multiple factors can influence annual groundwater quality including changes in basin level, proximity and volume of groundwater extraction and recharge, and variable recharge water quality. Historic water level and quality records are useful for tracking transport of water within the aquifer and external influences on the groundwater (e.g., streams, mining pits, etc.). Zone 7 tracks trends in key basin areas by routinely producing hydrochemographs of single wells or grouped wells (composite hydrochemographs). Hydrochemographs are time series graphs of individual groundwater water quality constituents.

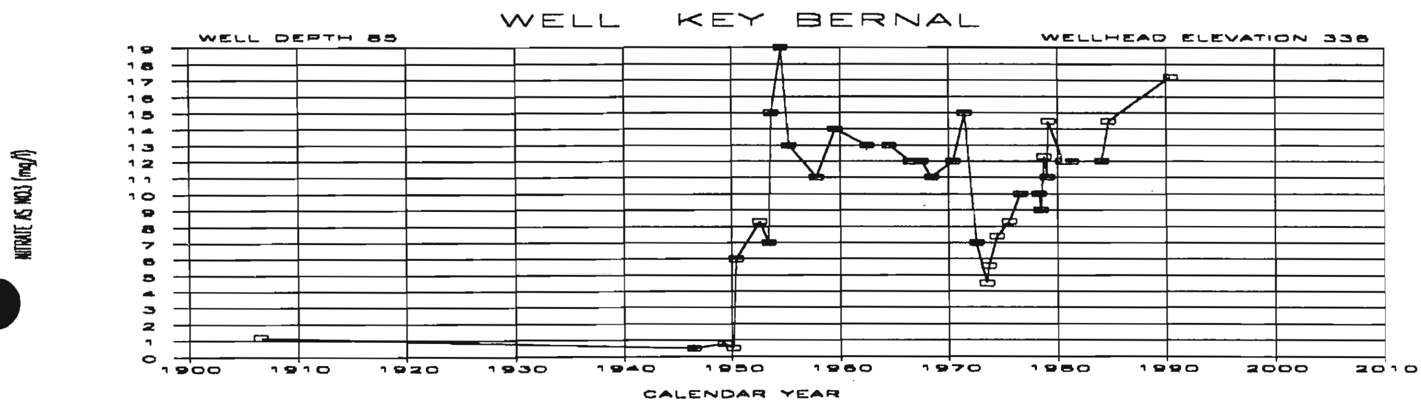
Figure 4.9 contains several composite hydrochemographs representing the Bernal subbasin. Figure 4.10 exhibits hydrochemographs for well 3S/2E 8P 2, a Cal Water well in Livermore, representative of the Mocho 2 subbasin. The data for these two wells span over half a century and show a variable, but overall upward trend in chloride and TDS concentrations. The rate of water quality degradation varies geographically in the basin, and by constituent.

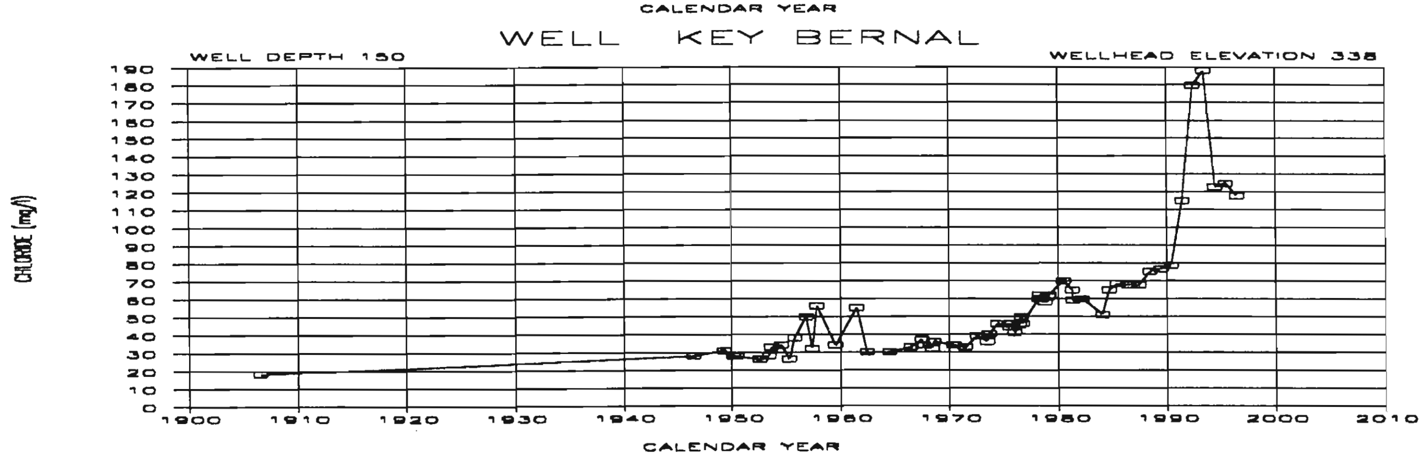
06/27/2000

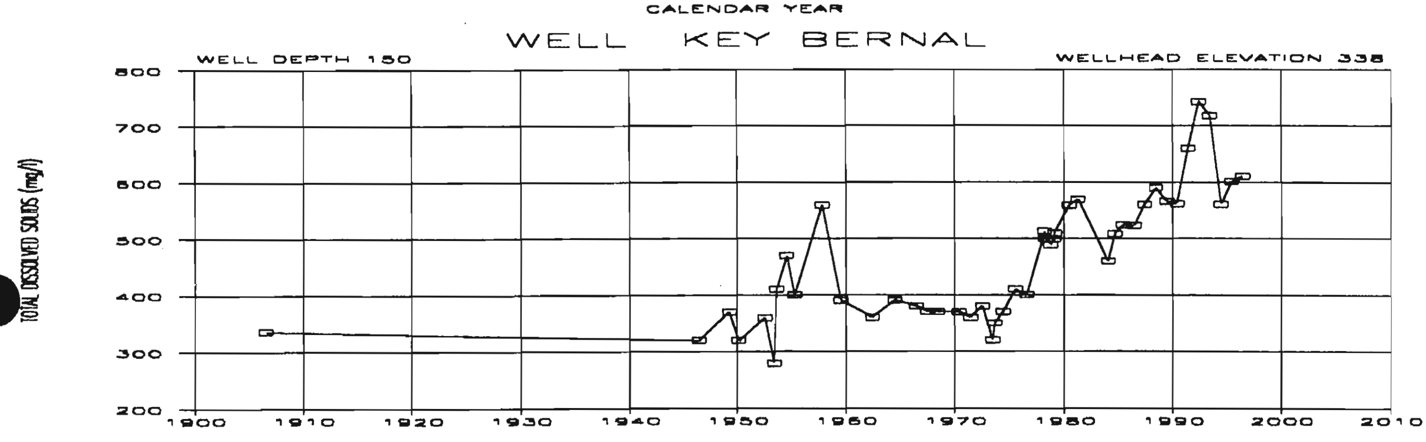
FIGURE 4.9

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER HYDROCHEMOGRAPH









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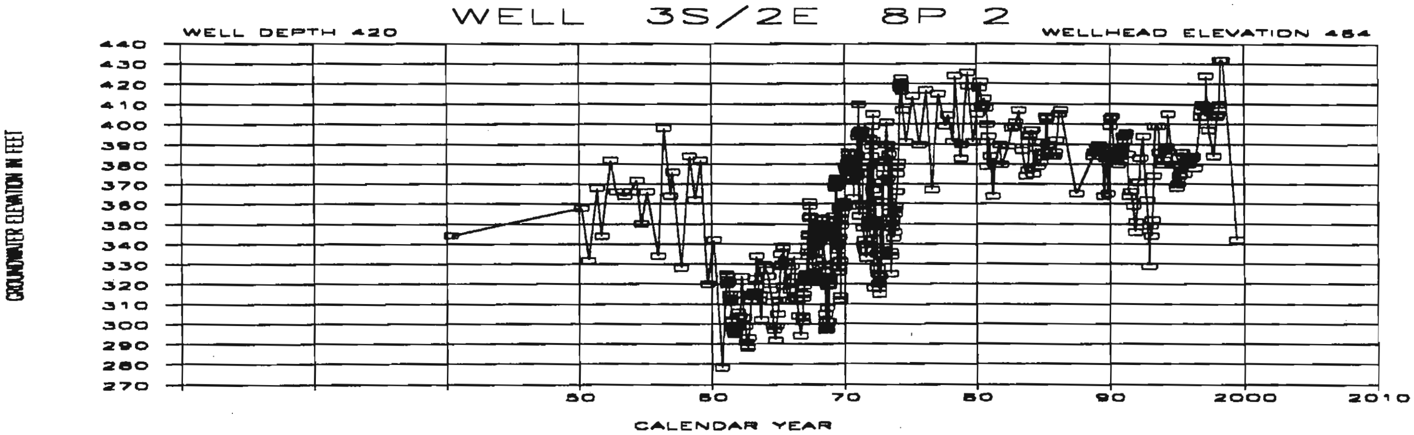
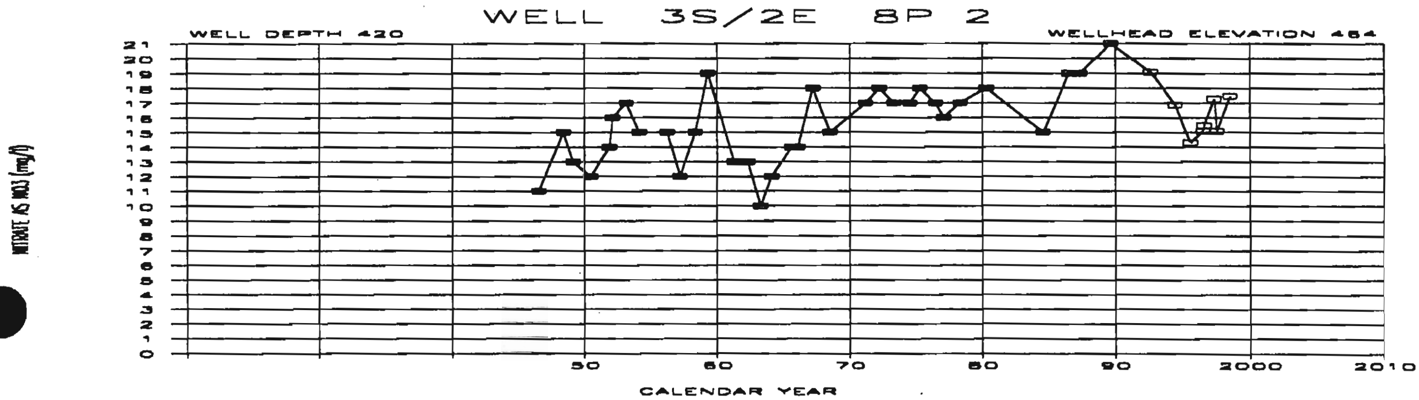
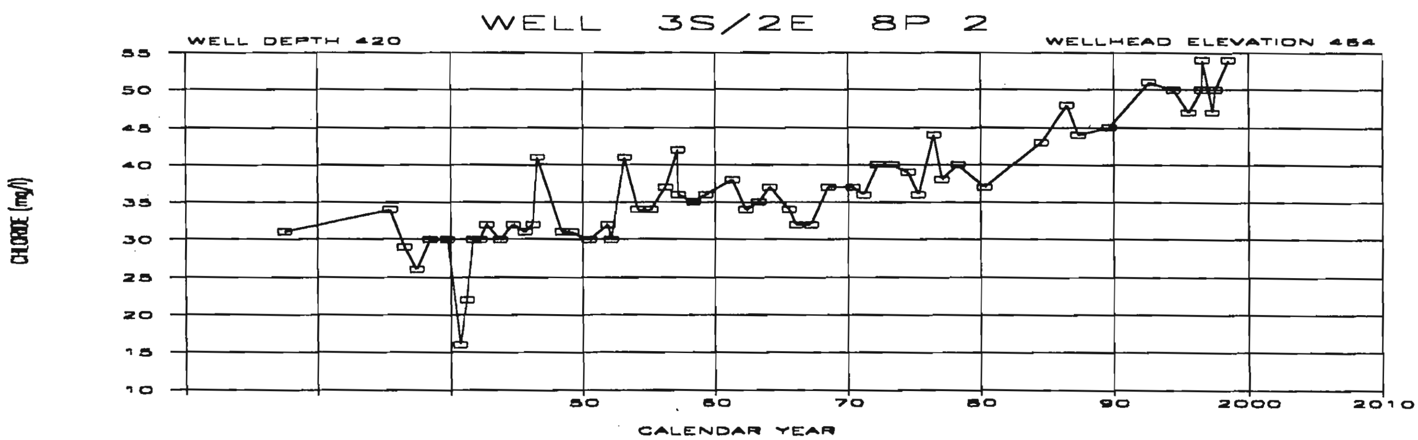
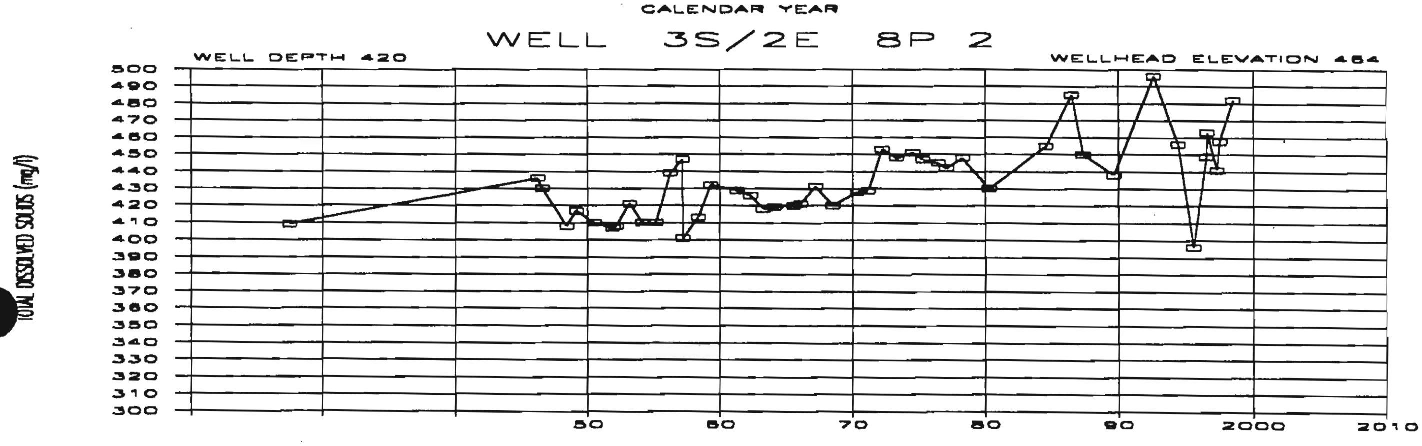
ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER HYDROCHEMOGRAPH

FIGURE 4.10









WELL: 3S/2E 8P 2

4.5 Production Wells

The City of Pleasanton, California Water Service, San Francisco Water District (SFWD), and Zone 7 all use municipal supply wells to partially or entirely supply municipal and industrial water customers with potable water. The City of Pleasanton, California Water Service, Dublin San Ramon Services District (DSRSD) and the City of Livermore each has an annual groundwater pumping quota, that in aggregate total about 80% of the average safe natural yield of the groundwater basin. However, DSRSD and the City of Livermore are not currently pumping groundwater from the basin. SFWD does not have a pumping quota, but is limited by the relatively fixed demand of their customers. Zone 7 also does not have a maximum pumping quota. However, Zone 7 purchases water and artificially recharges it into the basin to refill the basin and offset its withdrawals. Zone 7's hydrologic inventory tracks the artificial recharge and extraction by Zone 7.

A list of the basin's municipal supply wells, along with the estimated production capacity and current status of each well, is given in Table 4.4. Groundwater pumping quantity and TDS from Zone 7 and retailer municipal supply wells are also summarized in Table 4.5. Reference H provides additional water quality detail for the municipal wells, including hydrochemographs of TDS, chlorides and nitrates. These graphs provide further evidence of the generally increasing concentrations of dissolved salts and minerals throughout the Main Basin groundwater.

Zone 7

Historically, Zone 7 has pumped groundwater solely as seasonal demand dictated, and when needed to meet daily peak demand. Zone 7 has seven wells it can use to pump groundwater for municipal supply. Historic average production from Zone 7's active wells has been approximately 2,500 AF/yr, but has varied from 0 to 7,850 AF/yr for 1987-97 depending on available surface water and annual basin management and delivered water strategies in place. Future plans call for even higher groundwater production by Zone 7.

TDS levels in Zone 7 production wells ranged from 390 to 740 mg/L in 2003, with a flow weighted average of 490 mg/L. The large variation in water quality, seen in the Hopyard Well No.6 (3S/1E 18A6) data is the result of this well being tested as an aquifer storage and recovery (ASR) well. During 1997-98, varying quantities of treated SBA water was injected into this well and the surrounding aquifer and then subsequently pumped during times of higher demand. This particular well operation was part of a pilot test being conducted for possible integration of ASR features into future well projects. Operations in the ASR mode are currently suspended until the cause of clogging of the well that reduced its production capacity is identified.

ZONE 7
WATER RESOURCES ENGINEERING
MUNICIPAL SUPPLY WELLS - 2004

PURVEYOR	WELL	STATE WELL	HP	GPM	STATUS
City of Pleasanton	#5	3S/1E 16L 5	200	2000	ACTIVE
	#6	3S/1E 16L 7	200	2150	ACTIVE
	#7	3S/1E 18A 5	150	1900	INACTIVE
	#8	3S/1E 16A 2	450	3200	ACTIVE
Calif. Water Service					
	004-01	3S/2E 8H 1	50		INACTIVE - N
	005-01	3S/2E 16B 1	20	70	ACTIVE
	008-01	3S/2E 8P 1	25	370	ACTIVE
	009-01	3S/2E 9Q 1	40	730	ACTIVE
	010-01	3S/2E 8F 1	60	725	ACTIVE
	012-01	3S/2E 9P 1	60	850	ACTIVE
	014-01	3S/2E 8N 2	50	1000	ACTIVE
	015-01	3S/2E 16C 1	60	975	ACTIVE
	017-01	3S/2E 9L 1	50	460	ACTIVE
	019-01	3S/2E 8G 1	60	620	ACTIVE
	020-01	3S/2E 18B 1	60	280	ACTIVE
	024-01	3S/2E 7P 3	100	450	ACTIVE
	031-01	3S/2E 7R 3	125	750	ACTIVE
Zone 7	Hopyard 1	3S/1E 18A 1	150	700	ACTIVE
	Hopyard 4	3S/1E 17D 2	150	700	ACTIVE
	Hopyard 6	3S/1E 18A 6	500	3900	ACTIVE
	Mocho 1	3S/1E 9M 2	300	2300	ACTIVE
	Mocho 2	3S/1E 9M 3	250	2200	ACTIVE
	Mocho 3	3S/1E 9M 4		4000	ACTIVE
	Mocho 4	3S/1E 8H 18		3700	ACTIVE
	Stoneridge	3S/1E 9B 1	700	4000	ACTIVE
Camp Parks	Well 1	3S/1E 8H 2	100	550	INACTIVE
	Well 2	3S/1E 8H 3	60	500	INACTIVE
	Well 3	3S/1E 8H 4	60	450	INACTIVE
	Well 4	3S/1E 8H 5	60	NA	DESTROYED
DSRSD		3S/1W 1B 1	40	150	DESTROYED 1984
		3S/1W 1G 2	NA	NA	DESTROYED 1980
		3S/1W 1H 2	NA	NA	DESTROYED 1985
City of Livermore		3S/1E 1P 3		520	INACTIVE
SFWD (Upper Castlewood)	#4	3S/1E 19A 1	30		ACTIVE
	#3	3S/1E 19A 2	30		ACTIVE
	#2	3S/1E 19A 3	30		ACTIVE
	#1	3S/1E 19A 5	30	400	INACTIVE
Fairgrounds		3S/1E 20B 2	40	500	ACTIVE
		3S/1E 20C 3	50	300	ACTIVE
Castlewood Golf Course (Lower)		3S/1E 29E 3	25	350	ACTIVE
		3S/1E 29E 4	50	500	ACTIVE

TABLE 4.5

Municipal GW Pumping and TDS

	STATION	HISTORIC ANNUAL AVG. PRODUCTION in AF	2003 PRODUCTION in AF	GROUNDWATER TDS (mg/l)		
				HISTORIC		
				MIN.	MAX.	2003
PLEASANTON						
3S/IE 16L5	PLEAS #5	1031	585	321	526	460
3S/1E 16L 7	PLEAS #6	1184	656	326	540	460
3S/1E 18A 5	PLEAS #7	545	0	311	714	
3S/1E 16A 2	PLEAS #8	738	2432	376	458	390
TOTAL PLEASANTON						414
CALIFORNIA WATER SERVICE COMPANY (CWS)						
3S/2E 7R 3	CWS# 31(7R3)		313			433
3S/2E 16B 1	CWS# 5(16B1)	52	84	405	530	523
3S/2E 8P 1	CWS# 8(8P 1)	187	450	362	599	535
3S/2E 9Q 1	CWS# 9(9Q 1)	231	0	424	549	524
3S/2E 8F 1	CWS#10 (8F1)	289	0	402	629	
3S/2E 9P 1	CWS#12 (9P1)	92	506	394	590	588
3S/2E 8N 2	CWS#14 (8N2)	482	1044	422	515	485
3S/2E 16C 1	CWS#15 (16C)	339	241	436	511	499
3S/2E 9L 1	CWS#17 (9L1)	66	0	346	670	
3S/2E 8G 1	CWS#19 (8G1)	120	218	391	613	582
3S/2E 18B 1	CWS#20 (18B)	119	402	286	413	387
3S/2E 7P 3	CWS#24 (7P3)	597	717	253	320	282
TOTAL CWS						460
ZONE 7						
3S/1E 18A 1	HOP 1	121	0	233	1015	
3S/1E 17D 2	HOP 9		23	330	534	459
3S/1E 18A 6	HOP 6	402	2280	216	640	503
3S/1E 9M 2	MOCHO 1	448	720	280	993	705
3S/1E 9M 3	MOCHO 2	583	738	326	968	546
3S/1E 9M 4	MOCHO 3		1072	470	644	580
3S/1E 8H 18	MOCHO 4		754	348	470	432
3S/1E 9B 1	STONERIDGE_1	1253	2643	325	525	405
TOTAL ZONE7						496
SFWD						
SF O-line		420	420	501	860	860

City of Pleasanton

The City of Pleasanton currently pumps groundwater from three municipal wells. A fourth well (3S/1E 18A5) has been inactive pending repair or rehabilitation. Pleasanton's current agreement with Zone 7 specifies their groundwater pumping quota as 3,500 AF/yr. The maximum pumpage occurred in 1991 when the city pumped 1,357 million gallons (MG) or 4,165 AF of groundwater (under drought conditions). As shown in Table 4.5, the average TDS of groundwater pumped from Pleasanton's wells in 2003 ranged from 390 to 460 mg/L and averaged approximately 415 mg/L.

California Water Service, Inc.

California Water Service (CWS) currently pumps groundwater from 11 of their 13 wells. High nitrate levels have restricted pumping from some of the CWS wells. Groundwater from those wells must be blended with treated surface water to reduce the total nitrate concentration prior to distribution to the transmission system. CWS's contract with Zone 7 specifies an independent pumping quota of 3,069 AF/yr. During 2003, TDS levels from CWS wells ranged from 280 to 590 mg/L with a flow weighted average TDS of 460 mg/L (Table 4.5).

San Francisco Water District

San Francisco Water District currently supplies municipal groundwater to the upper Castlewood Country Club area from the SFWD well field located along Valley Avenue in Pleasanton. Well number 19A3 is currently the primary source of groundwater with the remaining wells available to accommodate peak flow demands. SFWD 2003 municipal supply groundwater averaged 860 mg/L TDS.

Dublin San Ramon Services District

Although DSRSD has an independent pumping quota of 645 AF/yr in the Main Basin, they currently have no production wells of their own. However, they do manage the Camp Parks well field for the U.S. Army, which consists of three wells located near the intersection of Santa Rita and Stoneridge Avenues. These shallow wells were formerly used to supply potable water to the Camp Parks Army facility in Dublin but are now idle. Camp Parks now receives treated water from a Zone 7 turnout. The Camp Parks well field overlaps Zone 7's Mocho well field in aerial extent. However, the wells are generally not completed in the same aquifers with the Mocho wells being completed deeper than the Camp Parks wells. DSRSD has the option to purchase the Mocho No. 4 production well from Zone 7.

As shown in Figures 4.4 and 4.5, TDS is relatively high in the shallow groundwater in the vicinity of the Camp Parks well field. Because of the location of the well field and the high levels of TDS in the groundwater in this location, this site has been considered a potential site for a wellhead demineralization project (see Chapter 10).

City of Livermore

The City of Livermore possesses an independent pumping quota of 31 AF/yr, but has no municipal wells connected to their M & I distribution system. Livermore has a single well located at the Livermore Municipal Airport and has used it in the past to supply irrigation water to the city-operated Las Positas golf course.

4.6 Delivered Water Quality and Variability

The relationship between imported water, groundwater quality, and Zone 7 delivered water quality was introduced at the beginning of this chapter. Since 75–85% of the water delivered by Zone 7 is imported water, and because the quality of the imported water varies as a function of annual climatic conditions as well as seasonally, Zone 7 delivered water quality varies correspondingly.

The quality of Zone 7 deliveries also varies as a function of the surface water to groundwater ratio. The ratio of groundwater to surface water can vary by season, by day, and by turnout depending on demand. Table 4.6 shows typical summer and winter water ratio percentages of Zone 7 deliveries under three climatic conditions: dry, average and wet years.

Table 4.6
Typical Delivered Water TDS
Under Historic Basin Management Strategy

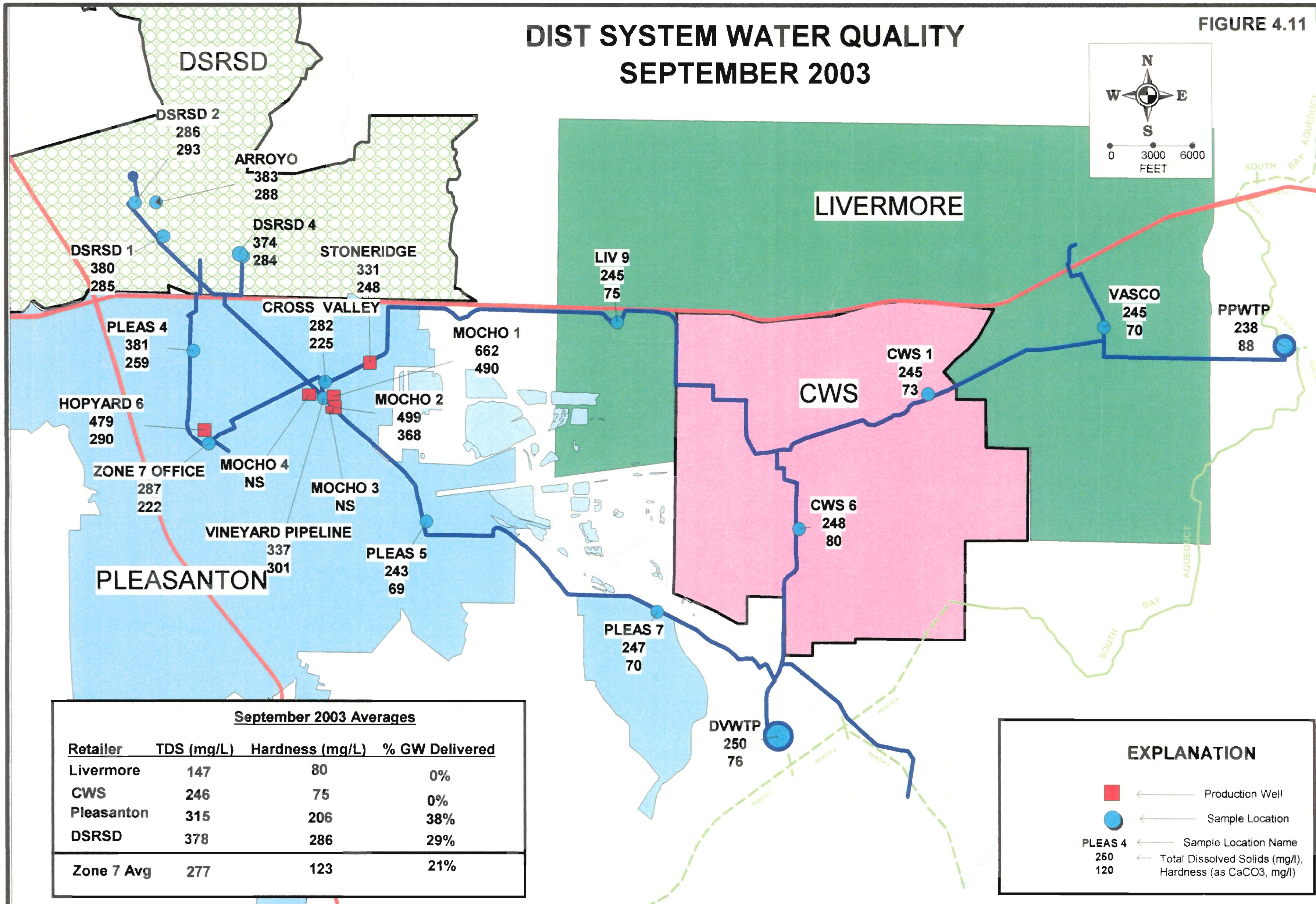
Climatic Conditions	Delivered Water %SBA Winter	Delivered Water %SBA Summer	Zone 7delivered (mg/L) Winter	Zone 7delivered (mg/L) Summer
Dry	30%	30%	470	470
Average	100%	90%	270	240
Wet	100%	90%	170	180

Climatic Conditions	SBA TDS (mg/L) Winter	SBA TDS (mg/L) Summer	GW TDS
Dry	500	500	450
Average	270	220	450
Wet	170	150	450

Water quality also varies within the Zone 7 distribution system. The blend of surface to groundwater varies between turnouts because of the locations of the wells relative to the turnouts and because of their intermittent use. Figure 4.11 shows TDS and hardness

DIST SYSTEM WATER QUALITY
SEPTEMBER 2003

FIGURE 4.11



September 2003 Averages

Retailer	TDS (mg/L)	Hardness (mg/L)	% GW Delivered
Livermore	147	80	0%
CWS	246	75	0%
Pleasanton	315	206	38%
DSRSD	378	286	29%
Zone 7 Avg	277	123	21%

EXPLANATION

- Production Well
- Sample Location
- PLEAS 4 — Sample Location Name
- 250 / 120 — Total Dissolved Solids (mg/l), Hardness (as CaCO3, mg/l)

ZONE 7 WATER AGENCY 5997 PARKSIDE DRIVE, PLEASANTON CA 94588	DRAWN BY: A. Florendo DESIGNED BY: SSegura CHECKED BY: S. Segura APPROVED BY: D. Lunn	WATER RESOURCES DISTRIBUTION SYSTEM WATER QUALITY TOTAL DISSOLVED SOLIDS (mg/l) & HARDNESS(as CaCO3, mg/l)	SCALE: 1" = 10,000' DATE: 10 October 2003 FILE NO.: E:\PROJECTS\SMP\SMP REPORT\CHAPTER4\DISTWQ FIG4.11.WOR

FIGURE 4.11

variation in the distribution system under one groundwater water production scenario. Because Zone 7 production wells are all located in the western portion of the basin, the City of Pleasanton and DSRSD receive most of the groundwater pumped by Zone 7. California Water Service, the City of Livermore and the untreated customer demands are met almost entirely using imported surface water and local surface water.

California Water Service and the City of Pleasanton also operate wells and blend groundwater with their Zone 7 deliveries adding to the variability of *their* delivered water quality. Typical percentages of each type of water (i.e., surface water, Zone 7 pumped groundwater, retailer pumped groundwater) delivered by each retailer to their customers is shown in Figure 4.12.

Figure 4.13 shows Zone 7 treated water deliveries and annual average TDS for 1974 through 1997. The figure shows five graphs. The first graph shows the annual amount of surface water delivered. The second graph shows the annual amount of groundwater delivered. The third and fourth graphs show the annual average TDS of surface water and groundwater, respectively. The annual average TDS of imported surface varied from 100 to nearly 600 mg/L between 1974 and 1997, while the TDS of the delivered groundwater varied between 400 and 550 mg/L.

The fifth graph shows the annual average TDS of the total Zone 7 deliveries. The result of all the annual variations, many of which are not under Zone 7 control, is that the TDS of the delivered water can vary considerably on an annual basis. Similarly, Figure 4.14 illustrates the extent to which TDS can vary on a monthly basis (using 1997 data). The monthly variation may change from year to year based upon climatic conditions and the ratio of surface water to groundwater delivered.

Another variable not immediately discernable from these figures is which wells Zone 7 chooses to pump from. Historically, Zone 7 has typically chosen to pump from wells with the lowest TDS water, to deliver the highest quality groundwater available. As will be discussed in Chapter 8 in more detail regarding ASR wells, while viable in the short-term, this basin management strategy, without other offsetting measures, is not sustainable and will result in continued groundwater degradation.

4.7 Tertiary and RO Recycled Water Quality

To date there has been relatively limited use of recycled water in the Livermore-Amador Valley due in part to concerns about impacts on groundwater quality. The May 1992 Livermore-Amador Valley Water Recycling Study, the December 1993 RWQCB Master Water Recycling Permit, and this Salt Management Plan provide a framework where additional water recycling could be implemented while protecting groundwater beneficial uses.

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FIGURE 4.12

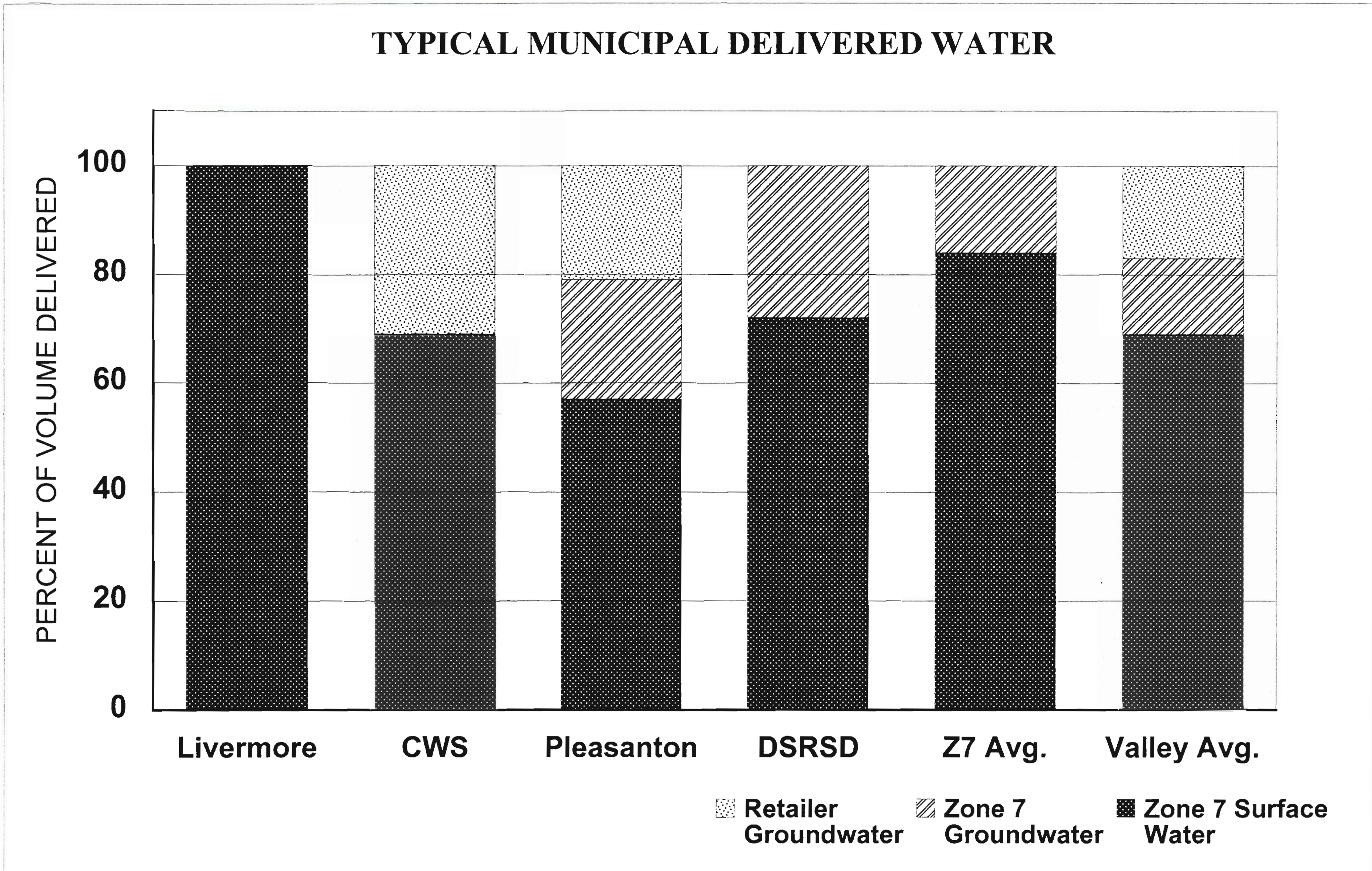

FIGURE 4.13

TREATED WATER DELIVERIES & WATER QUALITY
1974-97 WATER YEARS

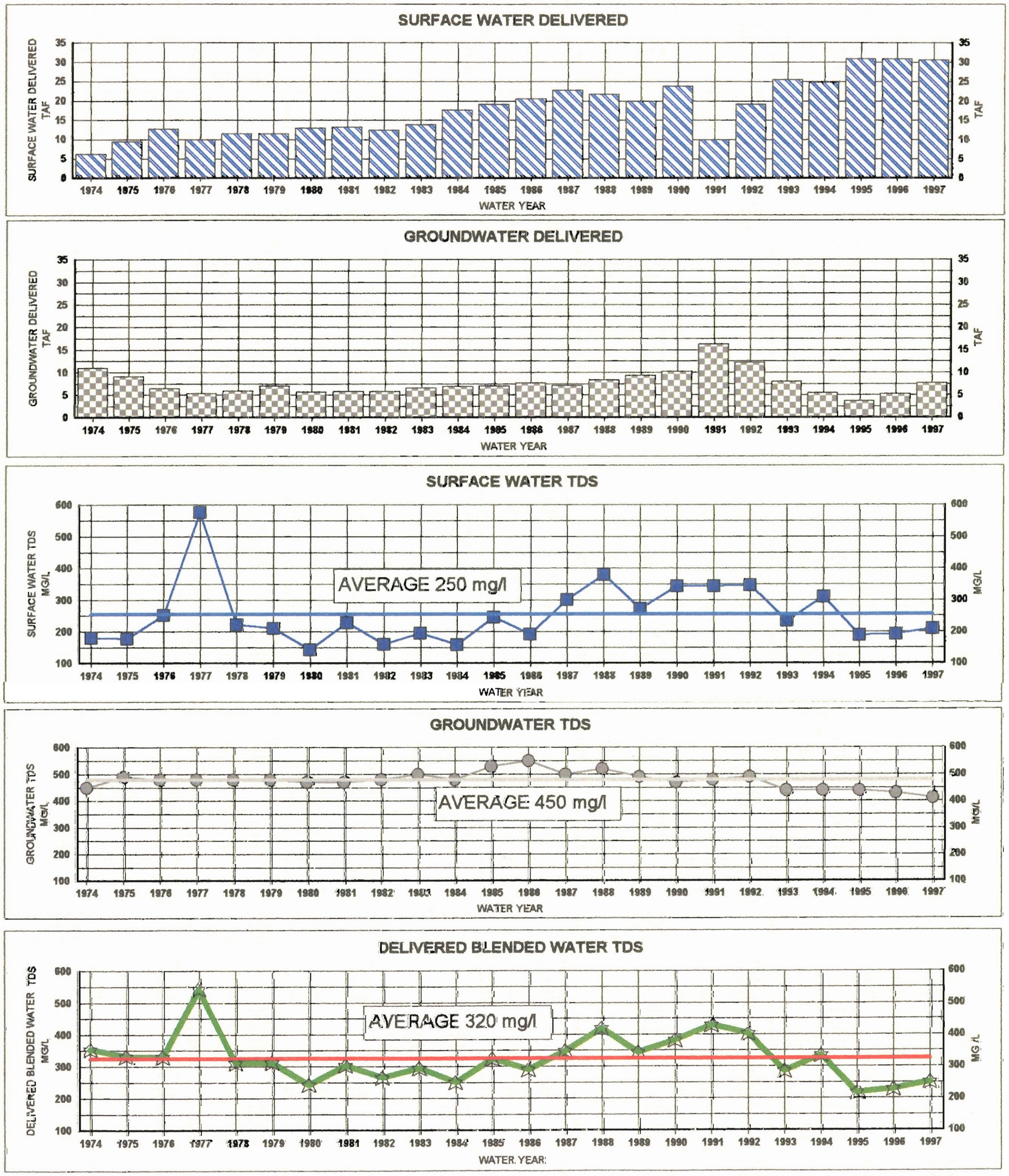

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FIGURE 4.14

TREATED WATER DELIVERIES & WATER QUALITY
1997 WATER YEAR

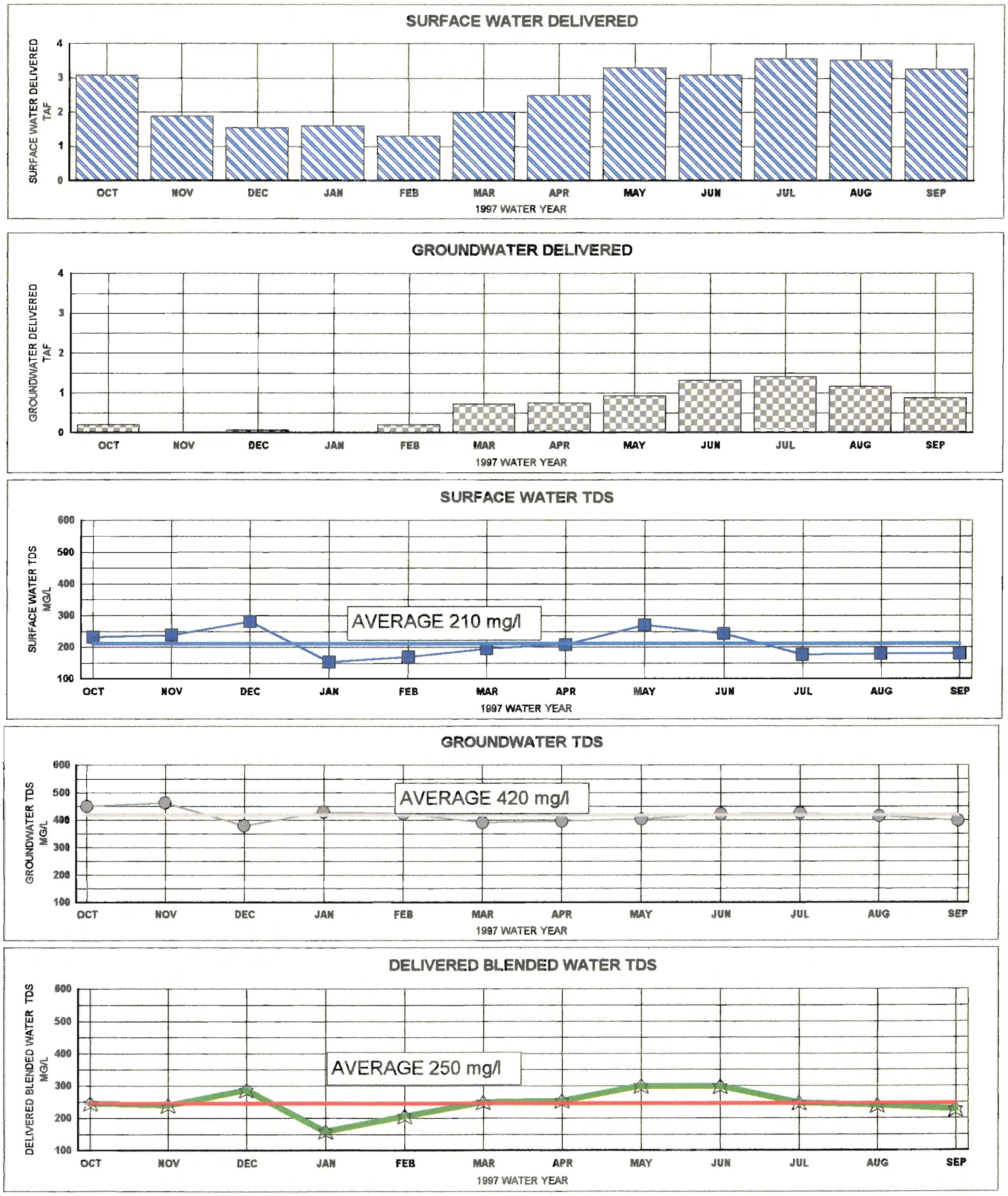

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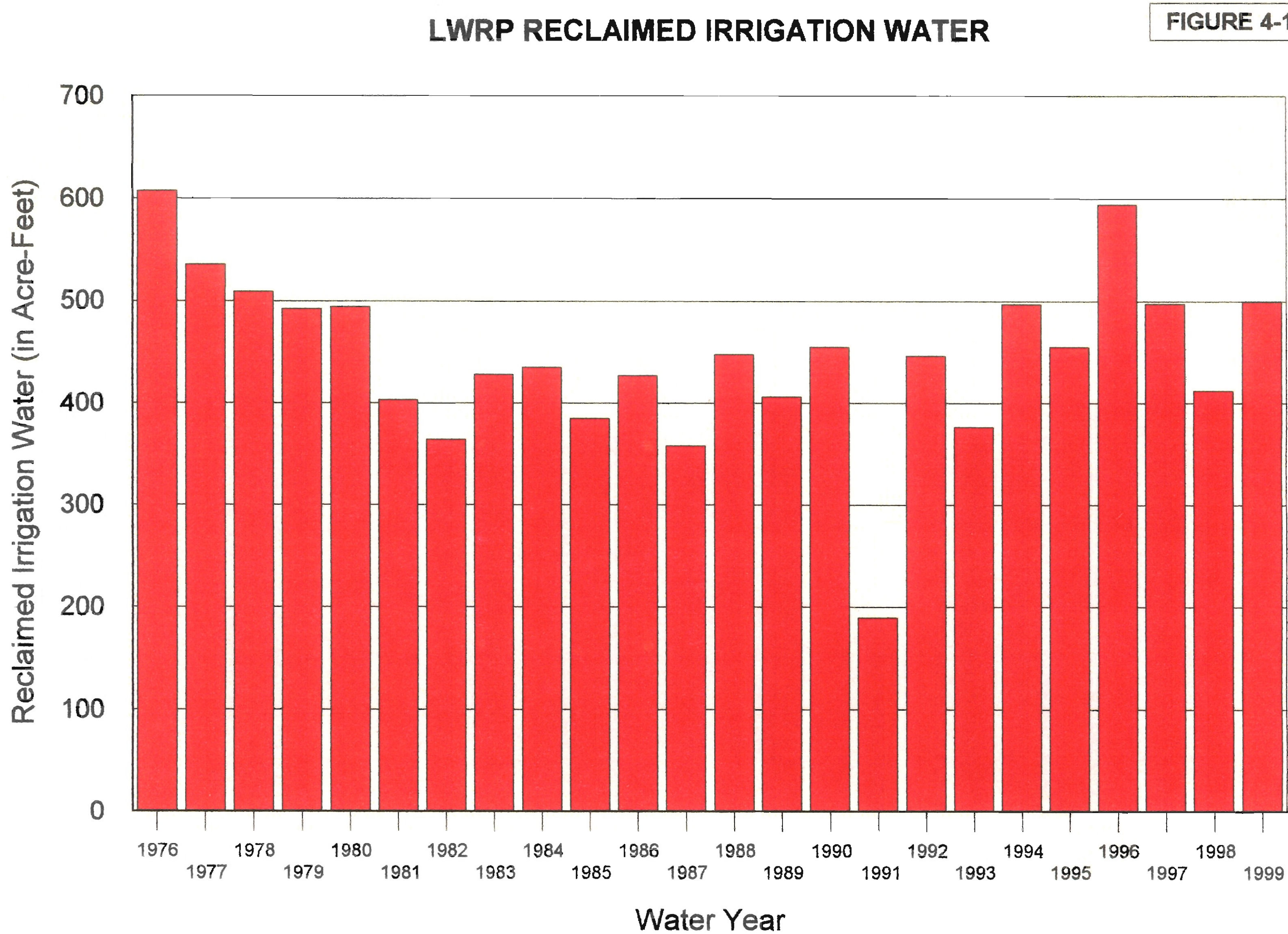
FIGURE 4-15


LWRP RECLAIMED IRRIGATION WATER
Reclaimed Irrigation Water (in Acre-Feet)
700
600
500
400
300
200
100
0
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year

Historically, the Livermore Water Reclamation Plant (LWRP) has recycled about 450 AF/year of tertiary recycled water (disinfected, filtered, secondary treated effluent). The annual volumes of recycled water spray irrigated on the Las Positas Golf course are shown in Figure 4.15. LWRP recycled water had an average TDS of 560 mg/L during the 1999 calendar year which is about twice the concentration in the long-term average 320 mg/L Zone 7 delivered water. This is as expected due to the typical 200 to 300 mg/L "salt increment" added to potable water as it is used in a household for various domestic purposes.

A portion of this recycled water is applied over the Main Basin where 100% of the applied salts are assumed to reach the Main Basin while the remainder is applied over a 33% salt impact zone (see discussion in Chapter 11 and Fig. 11.1).

Proposed expansion of Livermore tertiary recycled water deliveries to serve urban and agricultural development in North and South Livermore are summarized in Section 6.7. DSRSD began delivering tertiary recycled water (membrane filtered, ultraviolet disinfected) for irrigation of the Dublin Sports Grounds in 1999. Chapter VI also describes DSRSD plans to distribute tertiary recycled water for irrigation in DSRSD and EBMUD service areas north of I-580 as part of the DSRSD EBMUD Water Recycling Authority (DERWA) project. A majority of this irrigation will take place outside of the Main Basin and have minimal impact to the Main Basin salt load.

Both Livermore and DSRSD have constructed reverse osmosis (RO) recycled water demineralization facilities with a future goal of injecting RO treated recycled water into the groundwater basin for groundwater replenishment, to improve groundwater quality, and to offset net salt loading. The Livermore RO facility has a design capacity of 0.75 mgd and the DSRSD facility of 2.5 mgd. Performance studies of both facilities have been conducted to document the water quality of the RO product water. Due to concerns expressed by the general public neither of these groundwater injection projects is operating.

Table 4.7 compares key constituents of Zone 7 treated water, Zone 7 untreated inlet water, LWRP tertiary recycled water, LWRP RO product water, and the water quality results from a 16 week DSRSD performance evaluation testing of the CWR RO facility. Reference I presents the more detailed water quality comparison.