HOPKINS GROUNDWATER CONSULTANTS, INC.

PRELIMINARY HYDROGEOLOGICAL STUDY

NORTHEAST PLEASANT VALLEY BASIN
SURFACE WATER AND
GROUNDWATER STUDY
SOMIS, CALIFORNIA

Prepared for:
CALLEGUAS MUNICIPAL WATER DISTRICT

November 2008

HOPKINS
GROUNDWATER
CONSULTANTS, INC.
THE WATER RESOURCE SPECIALISTS

November 7, 2008
Project No. 03-007-07

Calleguas Municipal Water District
2100 Olsen Road
Thousand Oaks, California 91360

Attention: Mr. Henry Graumlich
Manager of Special Projects

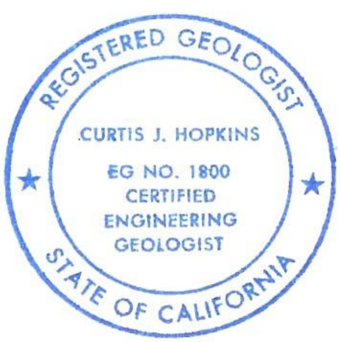
Subject: Preliminary Hydrogeological Study of the Pleasant Valley Groundwater Basin in Somis, California.

Dear Mr. Graumlich:

Hopkins Groundwater Consultants, Inc. (Hopkins) is pleased to provide this final report summarizing the findings, conclusions, and recommendations developed from the subject preliminary hydrogeological study of conditions that are resulting in groundwater recharge to the northeast Pleasant Valley Groundwater Basin. The study findings indicate that the Arroyo Los Posas surface flows percolate into the ground in the Somis area which is defined by the study as the Pleasant Valley Forebay. The resulting groundwater elevation rise, water quality change, and isotopic fingerprint, measured at the City of Camarillo Well B location indicate a direct connection to recharge from the increased surface water inflows since 1994. We trust the information contained in this report sufficiently describes our understanding of groundwater basin conditions in the northeast Pleasant Valley Groundwater Basin based on available data. If you have any questions or need any additional information, please give us a call.

Sincerely,

HOPKINS GROUNDWATER CONSULTANTS, INC.



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EXECUTIVE SUMMARY

The preliminary groundwater study (Study) was conducted to develop a better understanding of the changing groundwater conditions observed in the northeast Pleasant Valley Groundwater Basin (PVB). The Study was conducted by Hopkins Groundwater Consultants, Inc. (Hopkins) in coordination with Calleguas Municipal Water District (CMWD) staff between October 2007 and December 2007. The Study consisted of; a) obtaining and analyzing existing groundwater and surface water data, b) collecting a groundwater sample from the City of Camarillo (City) Well B, and c) measuring surface flows and collecting a water sample from the Arroyo Los Posas.

The findings of the Study indicate that the Arroyo Los Posas percolates into the ground and ceases flowing most of the year in the vicinity of Somis, California. Available data indicate that the northeast PVB has been recovering since the mid 1990's and is being directly recharged by surface water infiltration along the arroyo. Historical water quality data indicate that the chemical character of groundwater sampled from the City's well has changed over the last 10 years and closely resembles the surface water quality in the arroyo. Tritium test results support the groundwater is a young age while the oxygen and hydrogen isotope analyses indicate the well water is of similar isotopic composition to historical surface water samples tested by other studies (Izbicki, 1997). The nitrogen isotope signatures indicate that the surface water and well water samples were very close in their isotopic ratios and tend to exhibit a nitrogen source that is likely dominated by nitrate from wastewater treatment plant effluent.

The Study concludes that the groundwater degradation and rapid water level rise documented in the City wells is a direct result of surface water recharge emanating from the Arroyo Los Posas. Recharge began when the East Los Posas Groundwater Basin (located upstream) was filled along the arroyo and began to overflow into the PVB in approximately 1994. The surface flows rapidly percolated through the coarse alluvial sediments that comprise the river bed and into the underlying Saugus and Los Posas Sand Formations that comprise the primary aquifer system in the PVB. Available data indicate that surface water inflow since the beginning of the 1990's has likely resulted in annual groundwater recharge on the order of 10,000 to 15,000 acre-feet per year. Water level data appear to indicate that subbasin boundaries may be present and restrict the lateral migration of water from the area of recharge which comprises the Pleasant Valley Forebay. The study concludes that water quality in this area of the PVB will likely not improve in the foreseeable future and that the City should consider the use of treatment to allow continued municipal use of this groundwater supply.

INTRODUCTION

This report summarizes the findings, conclusions, and recommendations developed from a preliminary hydrogeological study of groundwater recharge occurring in the northeast Pleasant Valley Groundwater Basin (PVB). The study was conducted by Hopkins Groundwater Consultants, Inc. (Hopkins) to assist the Calleguas Municipal Water District (CMWD) with developing an understanding of the conditions that are resulting in groundwater recharge from the Arroyo Las Posas/Calleguas Creek in an area recently recognized as the PVB Forebay. The area of study is located within the northeast portion of the PVB along the Arroyo Las Posas/Calleguas Creek reach which lies south of the Springville Fault Zone and north of the Camarillo Fault as shown on Plate 1 – Study Area Location Map.

The purpose of the study is to understand the changing groundwater conditions which are causing groundwater degradation in the northeast PVB and affecting the municipal use of groundwater in that area of the basin. The scope of work for the study was developed through conversations with Dr. Donald Kendall, General Manager with the CMWD, and Ms. Susan Mulligan, Manager of Engineering with the CMWD, and includes the following work tasks:

- Collect and review historical geology, hydrology, and hydrogeology data
- Develop a refined interpretation of the hydrogeology in the northeast portion of the Pleasant Valley Groundwater Basin
- Conduct creek flow measurements
- Collect creek water samples and well water samples for laboratory analysis
- Compile and present the data and study findings in this report

Included with this report are appendices that present technical information that was compiled and used by the study. These appendices include; Appendix A - Water Quality Data Appendix B – Aerial Photographs of Arroyo Las Posas, Appendix C - Stream Flow Survey, and Appendix D – Laboratory Test Results of Surface and Groundwater Analyses. A list of references used during the study is included at the end of this report.

FINDINGS

Historical Data

Initial work tasks for the study consisted of collecting and reviewing hydrogeological information in the northeastern PVB for the purpose of refining the historical understanding of the subsurface materials and geological structures that form the aquifer system in this area of the basin. Data were collected from sources that include the Ventura County Watershed Protection District (County), United Water Conservation District (UWCD), City of Camarillo (City), CMWD, United States Geological Survey (USGS), and California Division of Mines and Geology (CDMG). From these data we reviewed the local stratigraphy and previous interpretations developed by other studies, interpreted and correlated available well logs (State well driller reports and geophysical surveys), reviewed historical water level measurements and available groundwater quality test results as part of our analysis to understand groundwater movement within this portion of the basin. We reviewed historical stream flow data provided from monitoring locations upstream of the observed groundwater recharge area. Based on these data we developed the following findings, conducted additional field work, and performed the analyses presented in the following sections of this report.

Hydrogeology

Local Geology

The geologic formation materials that comprise the aquifers which have historically supported groundwater production in the study area consist of Quaternary geologic age young and older alluvium, the Quaternary/Tertiary age Saugus Formation and the Las Posas Sand Formation which have been grouped by others as the San Pedro Formation (SWRB, 1953). The young and older alluvium is comprised of largely unconsolidated sediment locally deposited by outwash from the Camarillo Hills and flows in the Arroyo Las Posas. These alluvial deposits unconformably lie on top of marine and nonmarine mudstone, sandstone, and conglomerate deposits that comprise the Saugus and underlying Las Posas Sand Formations.

Numerous agencies have conducted studies to understand the geological conditions in the vicinity of the study area. For this study Hopkins primarily utilized the surface geology mapped by T.W. Dibblee, Jr. and the geological formations defined by this source which are presented as Plate 2 – Surface Geology Map. This information was combined with geologic mapping provided by CDMG (CDMG, 1973) which is presented as Plate 3 – Study Area Geological Structures and includes an interpretation with numerous buried features in the study area. These data were subsequently correlated with well log information and projected into hydrogeological cross-sections that were constructed to define water bearing units (aquifers) within the study area. The location of wells within the study area that provided historical data and the location of the hydrogeological cross-sections constructed for this study are shown on Plate 4 - Hydrogeological Cross-Section and Well Location Map. The subsurface hydrogeology inferred from data sources available for this study is shown on Plates 5 and 6 – Hydrogeological Cross-Section A-A' and B-B', respectively.

As shown on Plate 2, the active channel of the Arroyo Los Posas emerges from the Las Posas Valley and crosses through the river-eroded gap (at Somis) into the Pleasant Valley area.

The river bed is comprised of Recent alluvium that is predominantly a very coarse-grained sand and fine gravel material. These alluvial deposits unconformably lie on top of the Saugus and Las Posas Sand Formations (and possibly older alluvial deposits) which have been uplifted and are exposed in the Las Posas Hills to the east and the Camarillo Hills to west (see Plate 2). In the Somis gap area surface water in the arroyo readily percolates into the river bed alluvium (which is believed to be on the order of 60 to 100 feet thick) and into the underlying aquifers in the Saugus and Las Posas Sand Formations. For the purpose of this study we have named the Somis gap groundwater recharge area the PVB Forebay, and we are defining a forebay as the portion of an unconfined alluvial aquifer that allows surface water percolation to recharge aquifer zones that become confined by overlying aquitard or aquiclude layers outside the area of recharge.

Groundwater Basin Boundaries

The groundwater basin boundaries have been defined and redefined through time as additional information becomes available. This is exemplified by the delineation of the East and West Las Posas Basin (ELPB and WLPB) which were originally defined as the North Las Posas Basin. The groundwater basin boundaries utilized by this study were provided from the newly updated Fox Canyon Groundwater Management Agency (FCGMA) Groundwater Management Plan (FCGMA, 2007). The location of groundwater basin boundaries in and around the study area is shown on Plate 4 along with the approximate location of the inferred PVB Forebay. The Springville Fault effectively defines the northern boundary of the PVB. However, it is unclear how other inferred geologic structures in and around the northeast portion of the PVB affect groundwater movement.

Groundwater Conditions

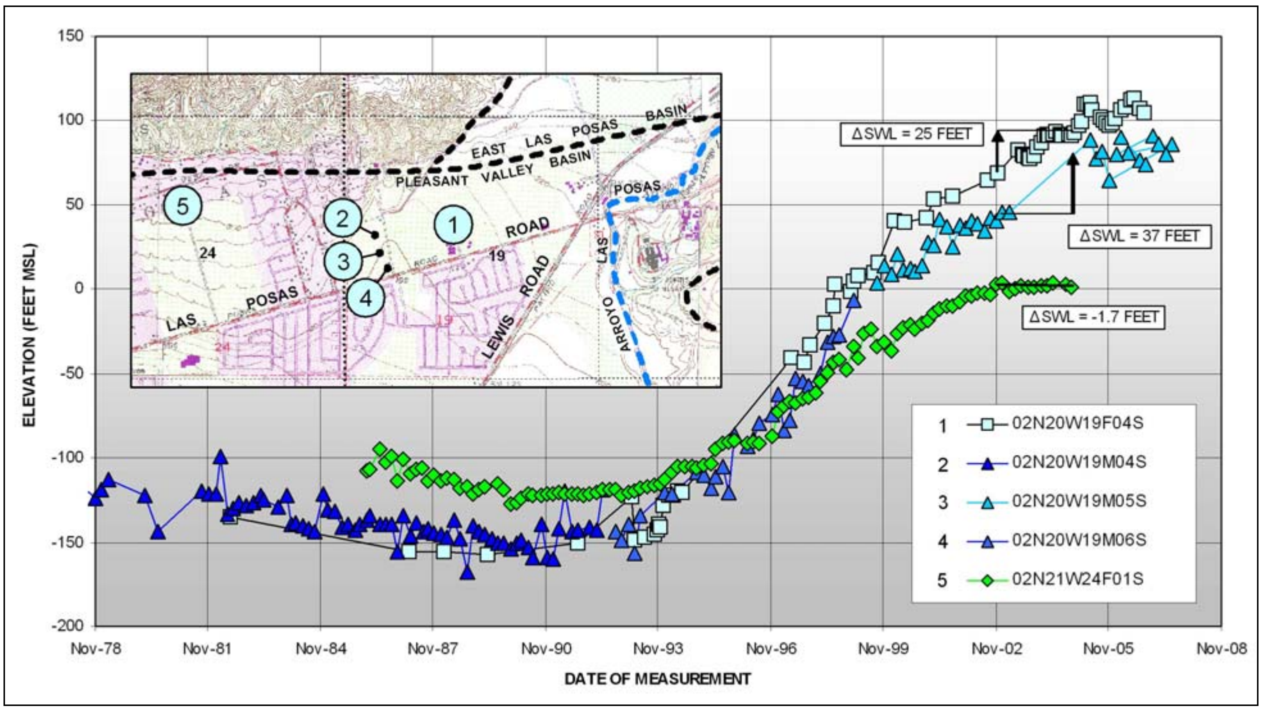
Groundwater conditions change over time as a response to recharge and discharge within the natural system. Historical changes in groundwater quality and groundwater levels have been monitored by the State, County, Cities, and UWCD. Available data from these sources have been combined to provide the basis of the analysis in this study.

Water Levels

Groundwater level measurements collected upstream of the study area provide important information for understanding the present conditions in the PVB Forebay. Groundwater levels measured in key wells located in the South Las Posas Basin and subsequently in the ELPB were observed to rise and then level off as the groundwater mound beneath the arroyo rose to the level of the active channel. The migration of the groundwater mound downstream along the arroyo is shown on Plate 7 – Groundwater Recharge Mound Hydrographs and is coincident with the live reach of the arroyo. Groundwater recharge within the live reach is supported year-round by discharges from shallow groundwater dewatering operations located in Simi Valley and wastewater effluent discharges to the arroyo from the Simi Valley wastewater treatment plant.

Water level data that indicate groundwater trends in the vicinity of the study area are provided by the 19 wells which are shown on Plate 8 – Groundwater Hydrographs. These data show water level trends from the mid 1980's through the year 2006. As indicated by these data, the water levels in the ELPB, and subsequently the PVB Forebay, have risen to levels substantially above sea level while wells in the surrounding areas have not. While all wells have shown a water level rise since the end of the 1986 to 1991 drought period, the recovery trend in most wells has flattened out in recent years. The water level trends observed in the PVB and WLPB wells indicate that natural recharge and pumping cutbacks have resulted in a general rise in basin water levels within the recent past (see Plate 8). However, the water levels in the PVB Forebay have continued to rise while the water levels in surrounding basins leveled off as the groundwater recharge and demand reached a balance.

Figure 1 – Forebay Water Level Trends



As previously mentioned, the North Las Posas Basin was segregated into the ELPB and WLPB which were largely delineated based on observed water level differences that indicated the presence of a flow barrier. As shown above in Figure 1, groundwater level recoveries at three well locations (City Well B [-19F04], Pleasant Valley Mutual Water Company wells [19M04, 05, 06], and a private well [24F01]) appear to show a diverging trend between 2002 and 2004 (the last 3 years of data). We believe this may indicate the presence of another undocumented groundwater barrier which may partition the basin and impound groundwater in a relatively small area around the forebay and impede flow into adjacent portions of the PVB.

Water level data from the years 1986, 1994, and 2004 were utilized to construct groundwater contour maps that indicate the inferred groundwater gradient changes over time. The maps are provided as Plates 9 through 11 – 1986, 1994, and 2004 Groundwater Elevation Contour Maps, respectively. The interpretation of available groundwater data was conducted by using some of the inferred geological structures shown on Plate 3. While the scarcity of data points required some speculation to project water level changes between wells, we believe these interpretations are reasonable to explain the considerable changes that have occurred over the 18-year period. As shown on Plate 11, there is clearly a mound that has developed in the forebay area that does not appear to affect wells located to the east or west of the inferred forebay boundaries.

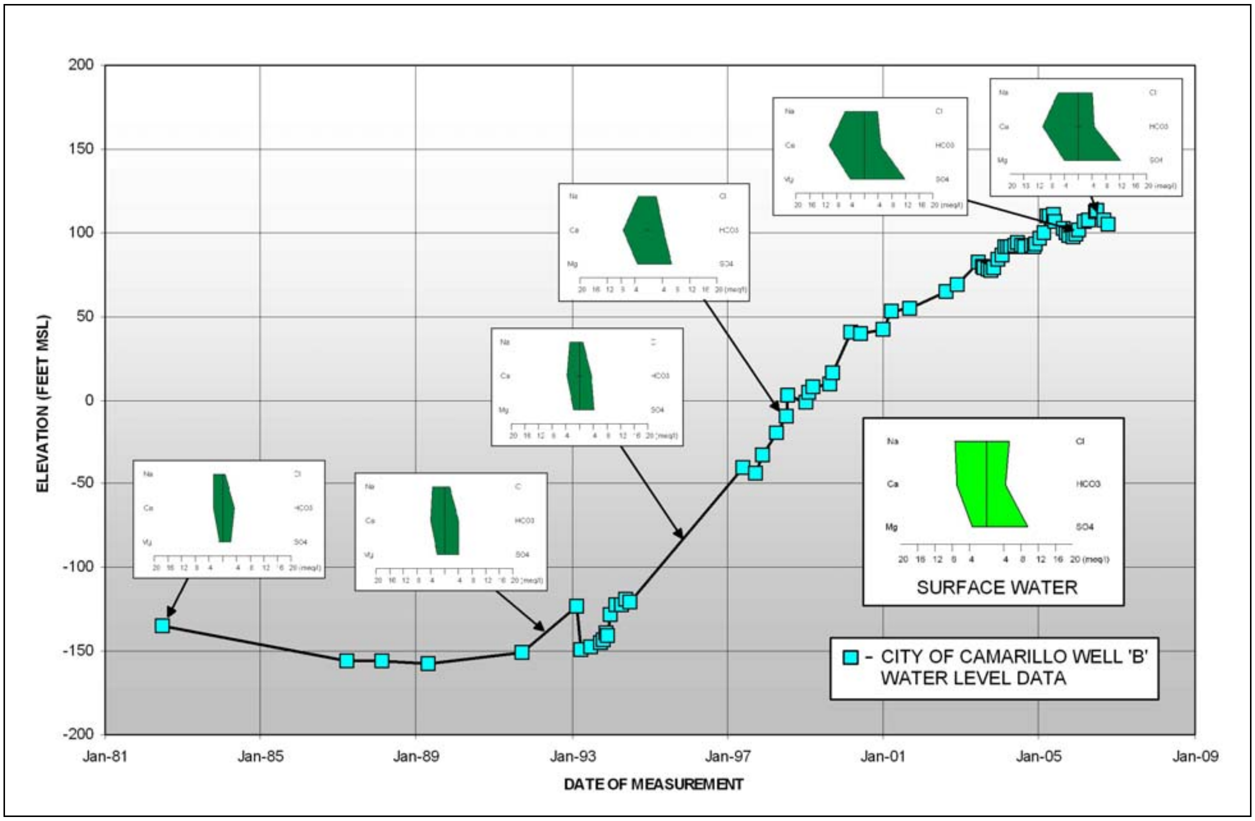
Future water level monitoring will be a key component to determine groundwater movement of recharge that originates in the PVB Forebay. However as shown on Plate 11, by 2004 the aggressive County well destruction program effectively removed 12 of the wells historically used for groundwater monitoring in the study area.

Water Quality

Groundwater quality is a dynamic property influenced by a combination of factors that include: a) the quality of the recharge sources (surface water infiltration, irrigation return flows, and subsurface inflow from adjacent basins, etc.), b) the mineralogy of the aquifer materials and their solubility under the specific aquifer conditions, c) the amount of time the water remains in the basin, and d) the dynamic changes in the aquifer that are caused by pumping. Sources of groundwater degradation in the PVB Forebay may include upwelling of poor quality water from the underlying bedrock (affecting the deepest aquifer zones during periods of low water levels), poor quality agricultural return flows, pore fluid seepage from silt and clay layers, subsurface inflows from the ELPB, and infiltration of surface flows from the Arroyo Las Posas. The primary sources of surface flow infiltration includes upstream discharges from shallow groundwater dewatering operations located in Simi Valley and wastewater effluent discharges to the arroyo from the Simi Valley wastewater treatment plant. These sources of surface flow blend with agricultural irrigation runoff and seasonal precipitation runoff prior to recharging the PVB Forebay.

The correlation between rising water levels and changes in the groundwater chemical character in City Well B is shown below in Figure 2. A stiff diagram comparison of the major anions and cations present in the surface water and groundwater samples collected for this study is shown on Plate 12 – Stiff Diagrams of Study Samples. As shown by the stiff diagrams on Figure 2 the present chemical character of the well water sample has changed to more closely resemble the surface water sample over the last 10 years ago.

Figure 2 – Groundwater Elevation and Chemical Character Change



Historical water quality data indicate that the groundwater in the study area ranges in quality and can generally be described as fair to poor quality for direct potable use. Appendix A contains graphical presentations of various general mineral constituents in all the City PVB wells. The total dissolved solids (TDS) concentration in the groundwater produced by the City wells has reportedly ranged from 366 to 1,420 milligrams per liter (mg/l). Plate A1 graphically presents available TDS data that begins in 1990. These data indicate that since the early 1990's there has been a significant increase in TDS concentration in both Wells A (State Well No. 02N20W19L05) and B (State Well No. 02N20W19F04) and only a minor increase in Well D (State Well No. 02N21W34C01). At the present time neither City Well A nor B can meet the State secondary maximum contaminant level (MCL) of 1,000 mg/l without blending or treatment. Plates A2, A3, and A4 show similar increasing trends for total hardness, sulfate, and chloride concentrations, respectively (see Appendix A). In recent years the groundwater produced from Wells A and B has exceeded the secondary MCL for sulfate (500 mg/l) while the sulfate concentration in Well D located in the main PVB remains below this level (see Plate A3).

Groundwater in the PVB is also demerited by concentrations of iron and manganese. Water produced from Well A exceeds the State secondary MCL's for both constituents by about 400 percent. Plates A5 and A6 (see Appendix A) show the historical trend for these two constituents in the City wells. These data indicate that water produced from Well D in the main PVB complies with drinking water standards for both constituents. The concentration of iron in groundwater from Well B is increasing but it is still below the MCL of 300 micrograms per liter (µg/l). The most recent data indicate that Well B has experienced a significant increase in manganese concentration and during the last 5 years values have ranged between 200 and 300 percent above the secondary MCL of 50 µg/l (see Plate B6).

The water produced from City Wells A and B presently has a calcium sulfate chemical character. However, through the years the chemical character has changed. The ionic composition in the groundwater from Well B varied through the 1990's and was tested as sodium-calcium bicarbonate (1990), sodium bicarbonate (1992), and calcium bicarbonate-sulfate (1995) (see Plate 12). The chemical character of groundwater from Well D has changed slightly from sodium-calcium bicarbonate (in the early 1990's) to the present calcium bicarbonate.

Changes in the produced water quality and chemical character are believed to result primarily from changes in pumping patterns and head conditions in the aquifer produced by these wells. The declining water quality in Well B appears to be a direct result of the rising water levels in the forebay portion of the basin. City Wells A and B produce from virtually the same aquifer zone(s) as well 02N20W19F02 shown in the hydrogeological cross-section on Plate 6. Well construction information is listed below in Table 1 – City Well Construction Details and indicates the well screen depths where the produced water quality is being degraded.

Table 1 – City Well Construction Details

STATE WELL NO.	CITY WELL NAME	CASING DIAMETER INCHES	PERFORATED INTERVAL (DEPTH IN FEET)
02N20W19F02	WELL C	18-INCH	444 TO 850
02N20W19L05	WELL A	18-INCH	467 TO 830
02N20W19F04	WELL B	18-INCH	449 TO 759
02N20W19F02	WELL D	18-INCH	700 TO 910

Surface Water Conditions

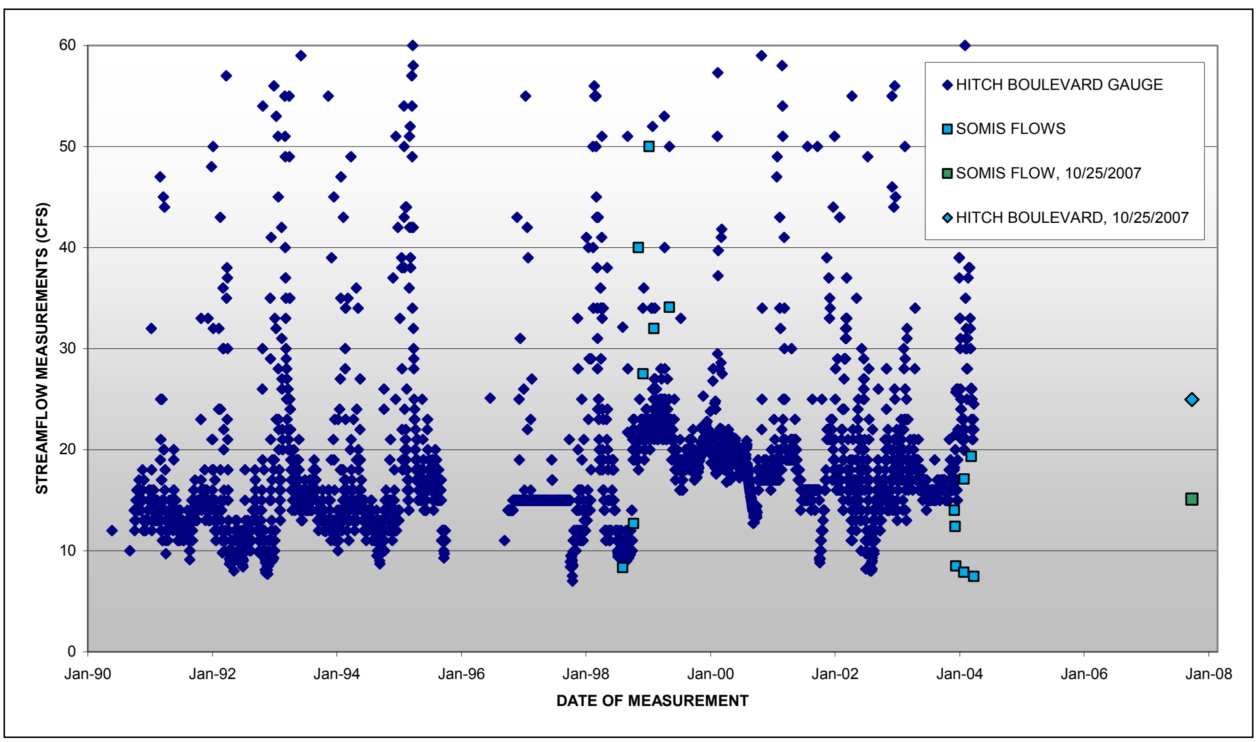
Surface water flows in the Arroyo Las Posas have recently been measured during detailed studies conducted for the Calleguas Creek Watershed Management Plan (WMP, 2004 and 2005). Data developed by these studies were utilized to understand the magnitude of flow that comes into the PVB Forebay area in the arroyo that is recharging the groundwater basin.

Stream Flow

Historical stream flow data have been collected by the County upstream of the study area where the Arroyo Las Posas flows under the Hitch Boulevard Bridge. Streambed conditions between the County gauging station and the Somis area where surface flows are recharging the PVB Forebay are shown on aerial photographs provided in Appendix B.

The Calleguas Creek Watershed Management Plan study (also referred to as the Conejo/Calleguas Creek Study [CCCS]) collected stream flow measurements at the Hitch Boulevard location as well as the same Somis gauging station that was used by this study. These data are presented along with the County stream flow data below in Figure 3.

Figure 3 – Stream Flow Measurements and Wastewater Discharges

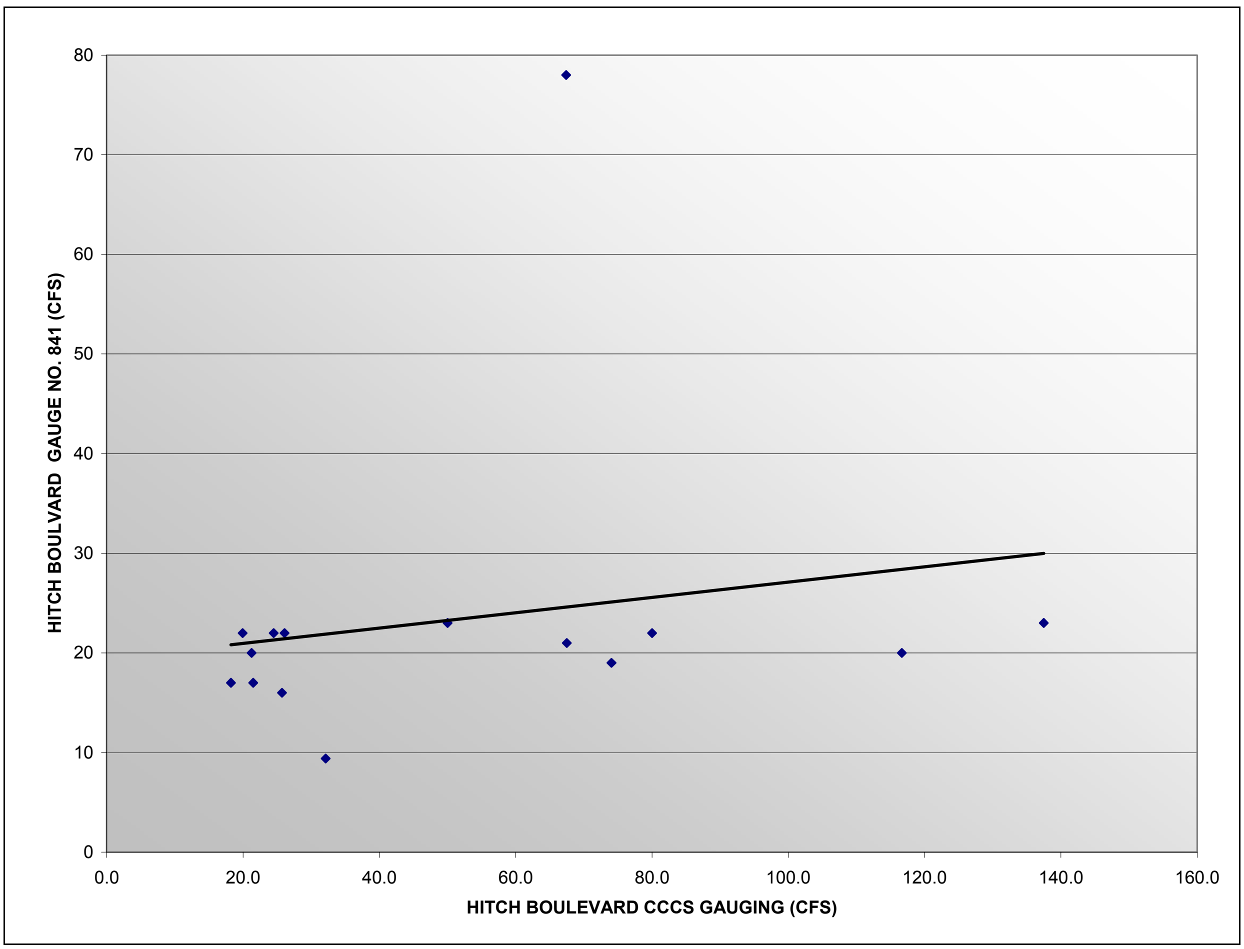


As shown by these data the arroyo commonly flows between 10 and 30 cubic feet per second (cfs). While summer flows are observed to dip below 10 cfs, winter flows often exceed

50 cfs (see Figure 3). Data available over the 13-year period between 1991 and 2003 indicate that over 24,000 acre-feet per year (afy) was measured by the County to flow past the Hitch Boulevard Gauge.

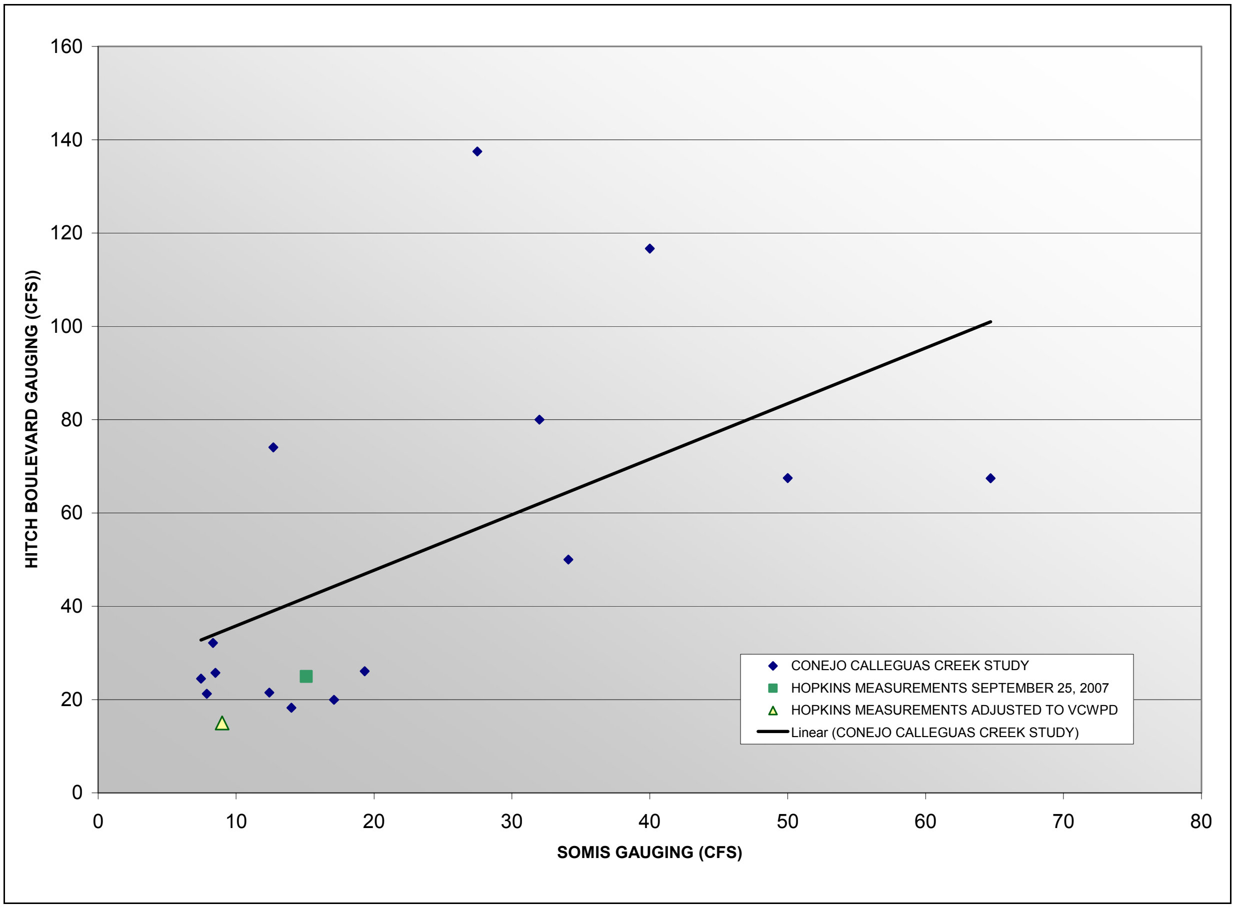
Stream flow measurements collected by in-stream methods were compared with the County Hitch Boulevard gauging station measurements (Station No. 841) and are presented below in Figure 4. As shown, the County gauge records are comparable at the lower flow rates but are considerably less than the watershed study measurements at higher flow rates. This variation may be a function of gauge position and/or configuration.

Figure 4 – Comparison of County Gauge and Watershed Study Data



To understand the magnitude of water that has historically been measured to pass Hitch Boulevard and flow into the PVB Forebay the watershed study measurements that were collected at both stations (Hitch Blvd. and Somis) on the same day were correlated. These data are presented on Figure 5 below and indicate that roughly 55 percent of the water that flows past the County station is presently reaching the PVB Forebay. These data suggest that on average over 13,000 afy of water flows across the Forebay where a majority percolates and recharges groundwater.

Figure 5 – Correlation of Stream Flow Measurements



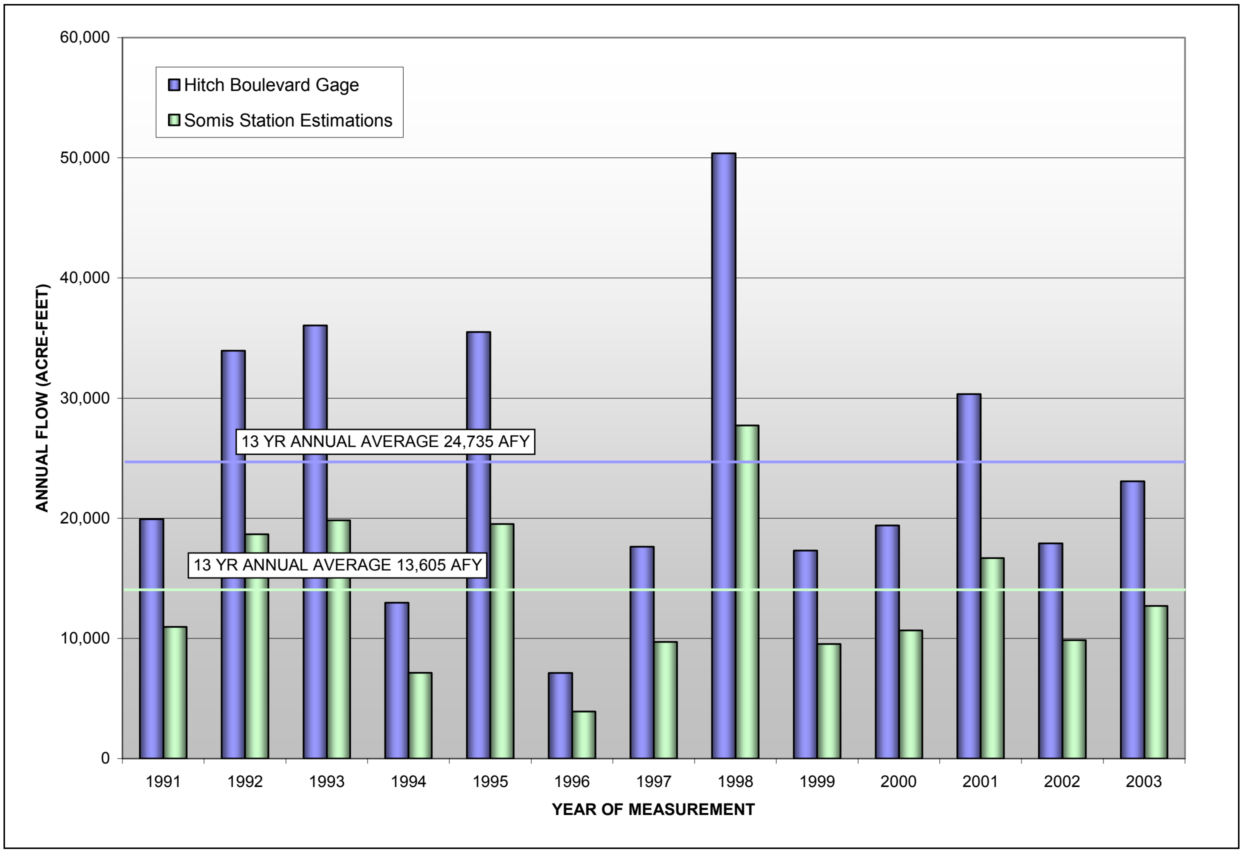
Based on the comparison of stream flow measurement methods (see Figure 4) the annual flow volumes shown in Figure 6 (which is calculated from daily County data) may be low. The factors that may presently influence the ability to accurately estimate historical flow volumes into the PVB Forebay are believed to include:

1. Prior to repair of the County gauge in 2004, many of the low flow measurements were not being accurately recorded by the station,

2. The average of 5 measurements during 2004 indicated that approximately 60 percent of the flow was passing the Somis gauging location,

3. Infiltration that is recharging the PVB Forebay upstream of the Somis station would not be measured at the present gauging location.

Figure 6 – Annual Stream Flow into PVB Forebay



Field Sampling and Laboratory Testing

Stream Flow Measurements

Field work conducted for this study was intended to generate information that would validate available historical data and obtain a recent comparison of flows at the Somis station. On September 25, 2007 Hopkins conducted 2 measurements of flow in the Arroyo Las Posas. Measurements were conducted downstream of the Hitch Boulevard Bridge near the existing County gauging station (No. 841) and approximately 200 feet south of a private bridge near the town of Somis, California. The stream flow measurement locations are indicated on Plate 7.

The survey measurement results are tabulated and provided in Appendix C along with photographs that document surface flow conditions at the time of the study and the stream flow measurement locations.

Utilizing a surveyor's tape and depth gauge, the creek bottom profile and water level was measured and recorded at each station. Depth measurements were collected at approximate 1 foot intervals (except where physical conditions required a different spacing). Subsequently these data were utilized to approximate the cross-sectional area of the creek at each location. An impeller type stream flow meter that provided electronic readings of flow velocity in feet-per-second was used to gauge the flow rate of the stream. The surveyor's tape was used as a guide for the location of the stream flow measurements. Flow rates were measured and recorded across the creek at approximate 1 foot intervals except where flow anomalies required a different spacing. The '6-tenths method' recommended by the USGS for stream flow-rate measurement was utilized to determine impeller depth setting and obtain an average flow of the stream at each point of measurement. The USGS asserts that an overall average flow rate of a column of water in a stream can be estimated by the measurement collected at a depth below the water surface that is equal to 0.6 times the total water depth.

The resulting stream flow readings are included on Figure 5 along with historical data and indicate that 25 cfs and 15 cfs were flowing at the Hitch Boulevard and Somis gauging stations, respectively. These data indicate that at the time of the study the flow at the Somis station was approximately 60 percent of the upstream measurement.

Subsequent comparison of the field measurement results of this study with County data collected by the automated gauge at Hitch Boulevard indicated that the County gauge measured approximately 60 percent of the flow measured for this study (15 cfs versus 25 cfs). To discern the origin of the discrepancy in flow calculation results, field verification measurements were performed by Hopkins and County staff on October 28, 2008. The results of both measurements were virtually identical and indicate a consistent bias in the instrumentation and/or method of measurement. Because the County utilizes a higher quality instrument for its measurements, we believe the County measurement is likely more accurate. A data point representing the County measurement at Hitch Boulevard and the adjusted value for the Somis Station measurement (60 percent flow) is included on Figure 5.

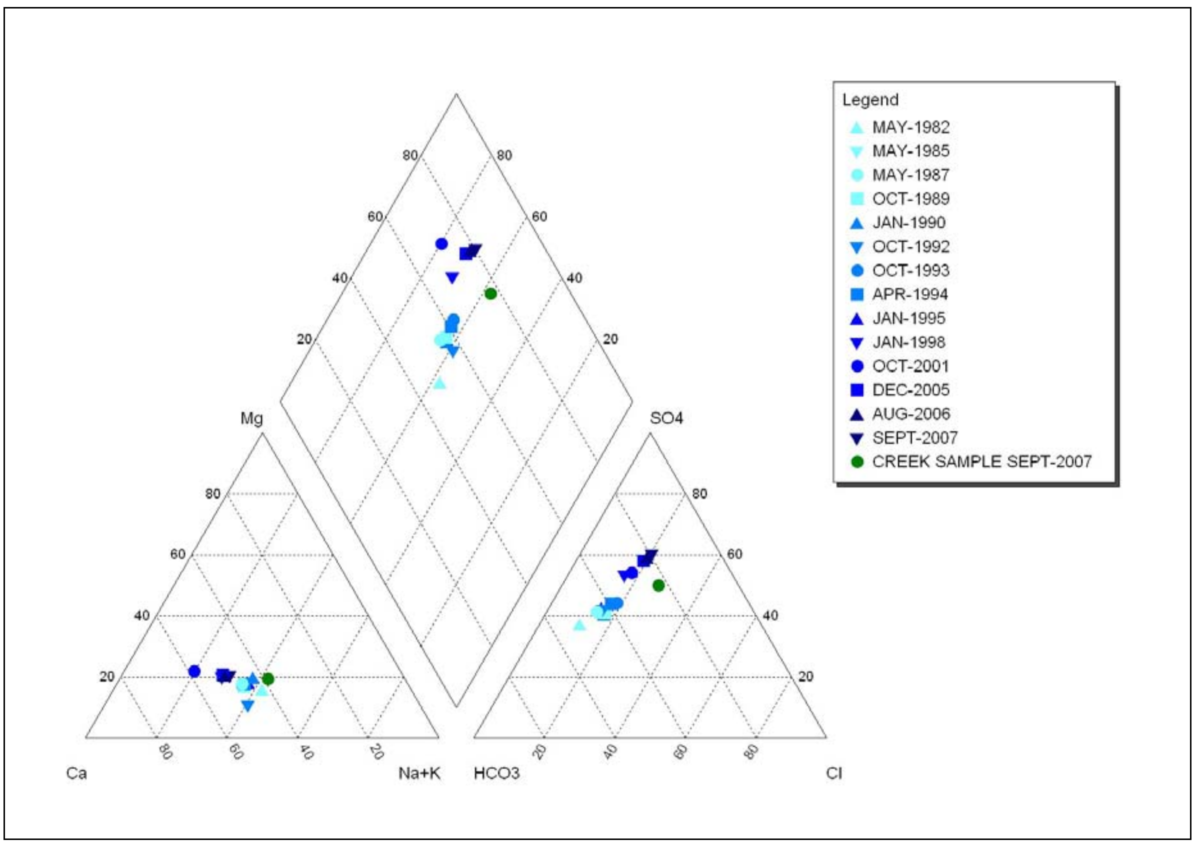
Water Quality Sampling and Testing

Prior to stream flow measurement, Hopkins collected samples of surface water from the Arroyo Las Posas at the Somis Gauging Station. After stream flow activities were concluded Hopkins collected samples of groundwater from the City of Camarillo's Well B. Samples were collected and preserved in accordance with laboratory specifications and submitted to FGL Environmental (FGL) of Santa Paula, California (for general-mineral analysis), Zymax Forensics (Zymax) of San Luis Obispo, California (for deuterium, nitrate and oxygen isotope analyses), and Isotech of Champaign, Illinois (for tritium analysis). Copies of the laboratory report forms presenting test results are provided in Appendix D. The creek water quality likely reflects the influence of the rainfall event that occurred 3 days prior to the sampling event. The creek flow rates were observed to be noticeably greater after the rain event than the flows observed 1 week prior to the scheduled sampling.

General Mineral

Laboratory test results for the surface water sample indicate the Arroyo Las Posas flow at the time of the study had a sodium calcium-sulfate chemical character with a specific conductance of 1,700 micromhos per centimeter (mmhos/cm) and a total dissolved solids concentration of 1,180 mg/l. The creek water has a relatively high iron concentration of 840 μg/l.

Figure 7 – Trilinear Diagram of City Well B Water Quality Data



Laboratory test results for groundwater samples indicate the groundwater in the northeast PVB is historically of a calcium-sulfate chemical character. The groundwater from City Well B has a specific conductance of 1,930 mmhos/cm and a total dissolved solids concentration on the order of 1,440 mg/l. Data acquired from the study were combined with historical water quality data from City Well B to provide a graphical presentation of the major anions and cations in the water samples which is shown above in Figure 7. As indicated by these data, the water quality in the City well has migrated over time toward the quality of the arroyo and has been influenced by changes in the arroyo recharge. A notable separation in quality is seen between the 1995 and 1998 sample events and can be seen as a grouping of chemical character prior to and after the time of these samples (see Figure 7).

Tritium

Tritium (^{3}H or T) is a radioactive isotope naturally produced in the atmosphere. The most important source of tritium for modern groundwater studies has been from thermonuclear weapons testing between 1952 and 1969. Tritium in groundwater is not significantly affected by geochemical processes, however given a half-life of 12.3 years, the usefulness of tritium as an age dating isotope diminishes over time. The most important use of tritium has historically been to distinguish between water that entered aquifers prior to 1953 and water that was in contact with the atmosphere after 1953. Because of the variable source of tritium and uncertainties due to possible mixing, tritium can not be used by this study for age dating in the conventional way.

Laboratory test results of the present tritium levels in the surface water and groundwater samples are presented below in Table 2 – Tritium Test Results. These results suggest the well water may be a blend of groundwater sources but also that a large component of the groundwater produced from the City well is from recent recharge.

Table 2 – Tritium Test Results

SAMPLE IDENTIFICATION	TRITIUM (TU)	STANDARD DEVIATION
CREEK SAMPLE	3.87	0.23
CITY WELL B SAMPLE	2.84	0.22

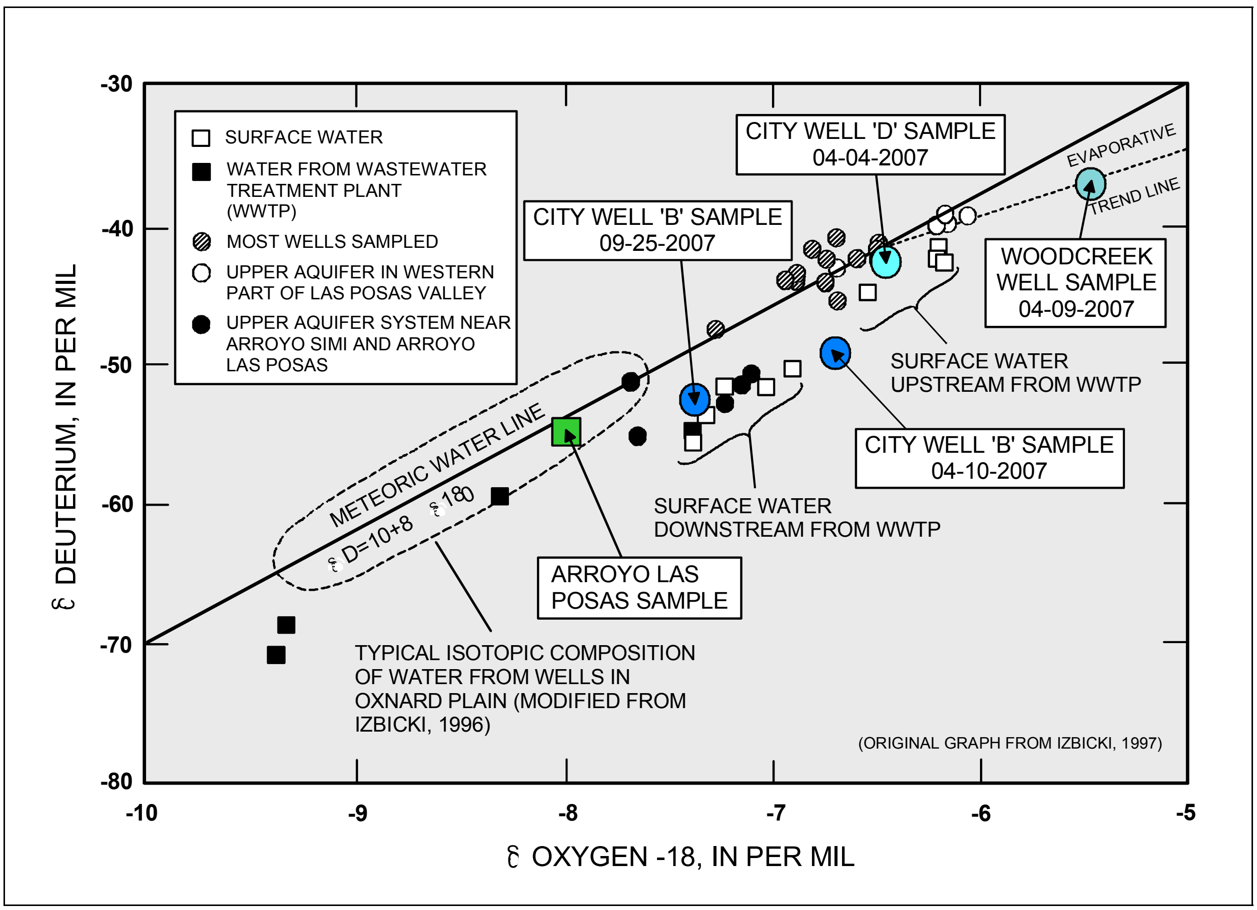
TU - Tritium Unit

Oxygen-18 (δ^{18}O), Deuterium (δD), and Nitrogen (δ^{15}N)

Isotopes are different forms of the same element which differ only in the number of neutrons contained in the nucleus of the atom. Although radioactive isotopes, like tritium, are unstable, most isotopes are stable. While different isotopes of an element have a nearly identical chemical behavior, the different physical properties can cause a slight variation in reaction rates and result in isotopic fractionation. Fractionation caused by physical and anthropogenic processes can result in different isotopic ratios forming in the same compound to create a specific "isotopic fingerprint."

The water samples collected during the study were analyzed for isotopes of oxygen, hydrogen, and nitrogen. The purpose of isotopic testing was to allow a comparison of present surface water and groundwater isotopic fingerprints with those from historical studies and to determine if upstream discharges from wastewater treatment plants can be linked to the recharge of groundwater in the PVB Forebay.

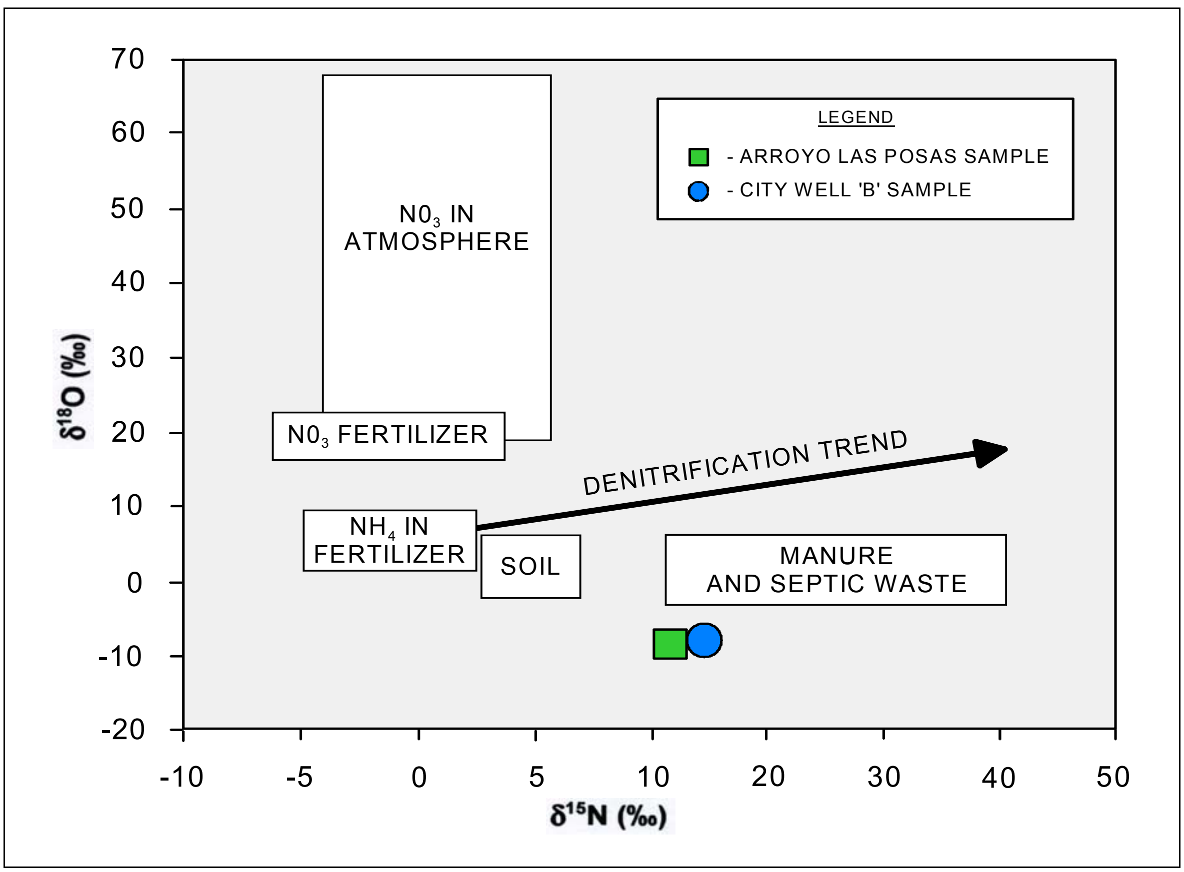
Figure 8 – Delta Oxygen-18 as a Function of Delta Deuterium



The alternating process of evaporation and condensation of water in the atmosphere occurs as part of the hydrologic cycle and results in fractionation of the naturally occurring oxygen and hydrogen isotopes. Past studies of local groundwater and surface waters have utilized these isotopes to evaluate the source and movement of water through aquifer systems within proximate groundwater basins (Izbicki, 1996 and 1997). Figure 8, shown above, compares the sample results obtained from this study with the results of water sampling conducted by the USGS in the Oxnard Plain and Las Posas Valley.

As indicated by these results, the groundwater sample has an isotopic fingerprint that closely resembles the surface water sampled downstream of the regional wastewater treatment plant during the 1997 study. The surface water samples were coincidentally taken at the same time the groundwater recharge from the Arroyo Los Posas was initially sustained in the PVB Forebay. As previously mentioned, the surface water sample for this study was collected within 3 days after a significant rain event. The surface water sample collected during the study appears to show the influence from rainwater. We anticipate that sampling of water in the arroyo will likely yield seasonal results that reflect the source(s) contributing most to its flow.

Figure 9 – Typical Isotope Signatures of Nitrate from Various Sources



Nitrogen in the atmosphere contains about one atom of the stable isotope ^{15}N per 273 atoms of ^{14}N. During various biochemical reactions that involve nitrogen, fractionation occurs. The fractionation processes are complex and not fully understood. However, nitrogen isotopes have been used to identify sources of nitrogen in natural waters. The interpretation of such results may be somewhat controversial (Drever, 1982).

Nitrates produced from different sources carry distinctly different nitrogen and oxygen isotopic compositions which can be used for source identification. Provided in Figure 9 above are the general fields that represent the range of delta oxygen-18 versus delta nitrogen-15 where nitrogen fractionation may be used to link nitrate to a particular source. As indicated, the surface water sample and well water sample were very close in their isotopic ratios and tend to exhibit a nitrogen source that is likely dominated by nitrate from wastewater treatment plant effluent.

CONCLUSIONS AND RECOMMENDATIONS

The findings of the study indicate that flows in the Arroyo Los Posas are presently percolating into the riverbed in a reach between Somis and Camarillo and recharging groundwater in an area described as the PVB Forebay. Recent observations indicate that except for extremely high river flow events the entire flow in the arroyo goes underground into the coarse-grained alluvial deposits that readily transmit water into the underlying Saugus and Los Posas Sand Formations. These formations comprise the primary aquifer system in the PVB. Available data since 1991 indicate that average annual groundwater recharge from the arroyo is likely in the range of 10,000 to 15,000 afy (see Figure 5).

The study concludes that the groundwater degradation and rapid water level rise (about 250 feet) documented in City Wells A and B is a direct result of surface water recharge from the Arroyo Los Posas. Substantial recharge began when the ELPB filled along the arroyo and began to overflow into the PVB in approximately 1994 (or before). Historical water quality data indicate that the chemical character of groundwater sampled from the City's well has changed and closely resembles the surface water quality in the arroyo which is a combination of sources including; a) upstream discharges from shallow groundwater dewatering operations located in Simi Valley b) effluent discharges to the arroyo from the Simi Valley wastewater treatment plant c) agricultural irrigation runoff, and d) seasonal precipitation runoff. Over the last 10 years the groundwater quality degradation resulting from arroyo recharge has caused numerous chemical constituents in City Wells A and B to exceed the MCL standards for drinking water (i.e., TDS, sulfate, iron, manganese, see Appendix A).

Tritium test results support the groundwater is a young age while the oxygen and hydrogen isotope analyses indicate the well water is of similar isotopic composition to upstream surface water samples tested by other studies (Izbicki, 1997)(see Figure 8). The nitrogen isotope signatures of the groundwater and surface water samples are characteristic of a legacy waste water effluent source (see Figure 9). This is consistent with the observation that the arroyo base flows have been sustained largely by year-round discharges from upstream wastewater treatment plants after the winter storm flows subside (see Plate 3).

Water level data appear to indicate that potential groundwater flow boundaries may restrict the lateral flow of groundwater from the area of recharge located northeast of the City in the Somis area. The study concludes that water quality in this area of the PVB will likely not improve in the foreseeable future and that the City must consider the use of a treatment facility that can restore the potable quality of this groundwater supply. To the extent the PVB Forebay is connected to the main portion of the PVB south of the Camarillo Fault, water level and water quality changes of similar magnitude can be anticipated to occur.

If the PVB Forebay is constrained by no-flow/low-flow barriers that impede the lateral movement of groundwater then the water level will likely continue to rise until the partitioned portion of the basin fills. Upon filling the forebay could refuse some portion of the recharge and the surface flow could continue downstream and would cross the confined portion of the PVB (where it cannot percolate into the basin) and subsequently would flow to the ocean.

We recommend that future groundwater basin management efforts establish new monitoring wells to replace the County key wells destroyed in the 2004 well destruction program. Future basin monitoring efforts should reestablish a network of appropriately distributed wells that will facilitate the observation of groundwater conditions. Monitoring points may be established by seeking to obtain permission and access to allow measurement of existing well facilities within or proximate to the northeast PVB. The location of existing wells at the time of the study is indicated on Plate 13 – Proposed Monitoring Well Location Map. We recommend augmenting the areal distribution of these potential existing monitoring facilities with new monitoring wells constructed to facilitate future observations proximate to the PVB Forebay. The proposed areas for future monitoring well construction are shown on Plate 13. We recommend a well siting study be conducted to identify suitable locations for monitoring well construction within or proximate to the areas shown on Plate 13.

CLOSURE

This report has been prepared for the exclusive use of the Calleguas Municipal Water District and its agents for specific application to groundwater recharge in the northeast Pleasant Valley Groundwater Basin located in Somis, California. The findings, conclusions, and recommendations presented herein were prepared in accordance with generally accepted hydrogeological practices. No other warranty, express or implied is made.

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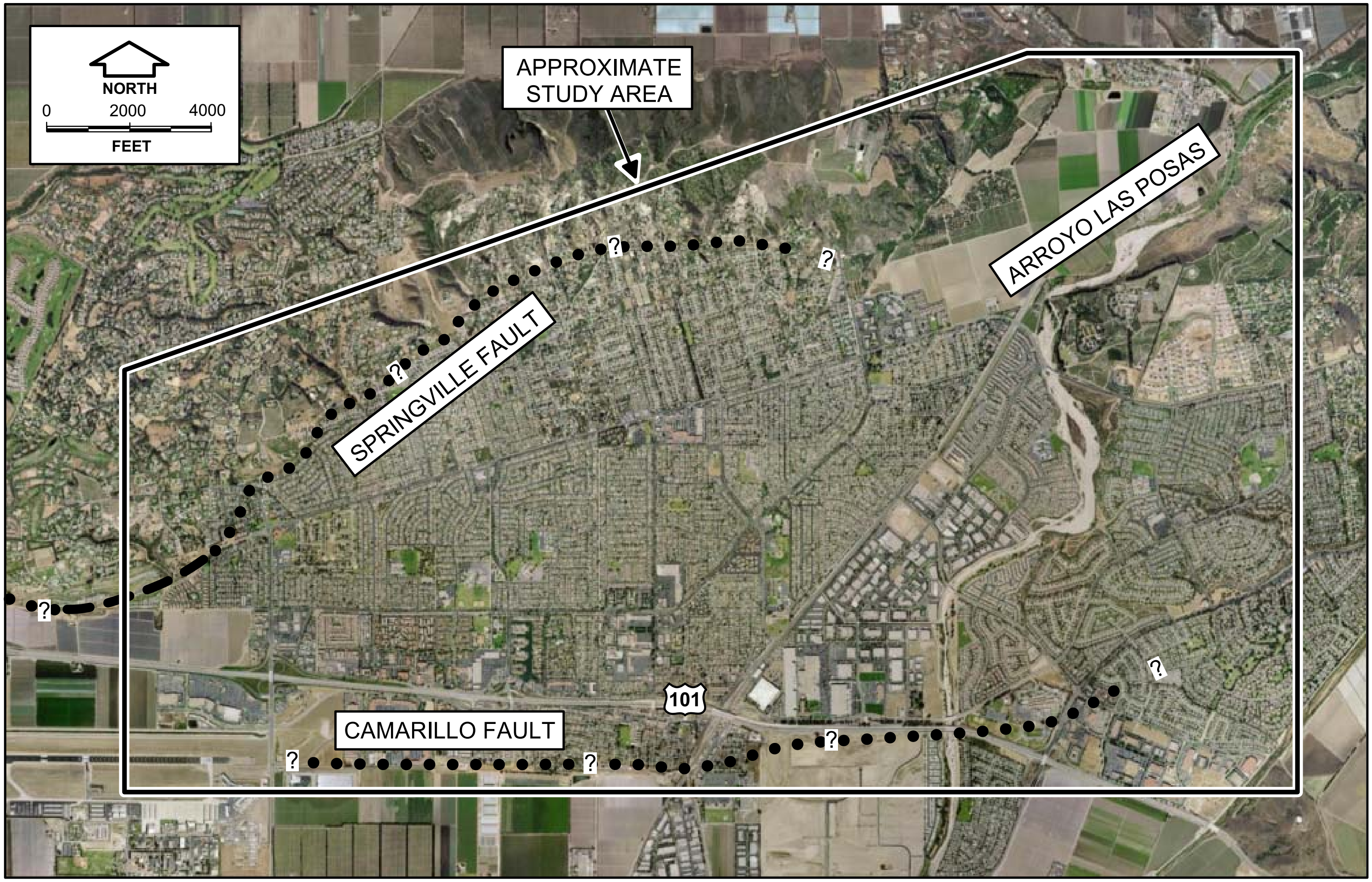
PLATES



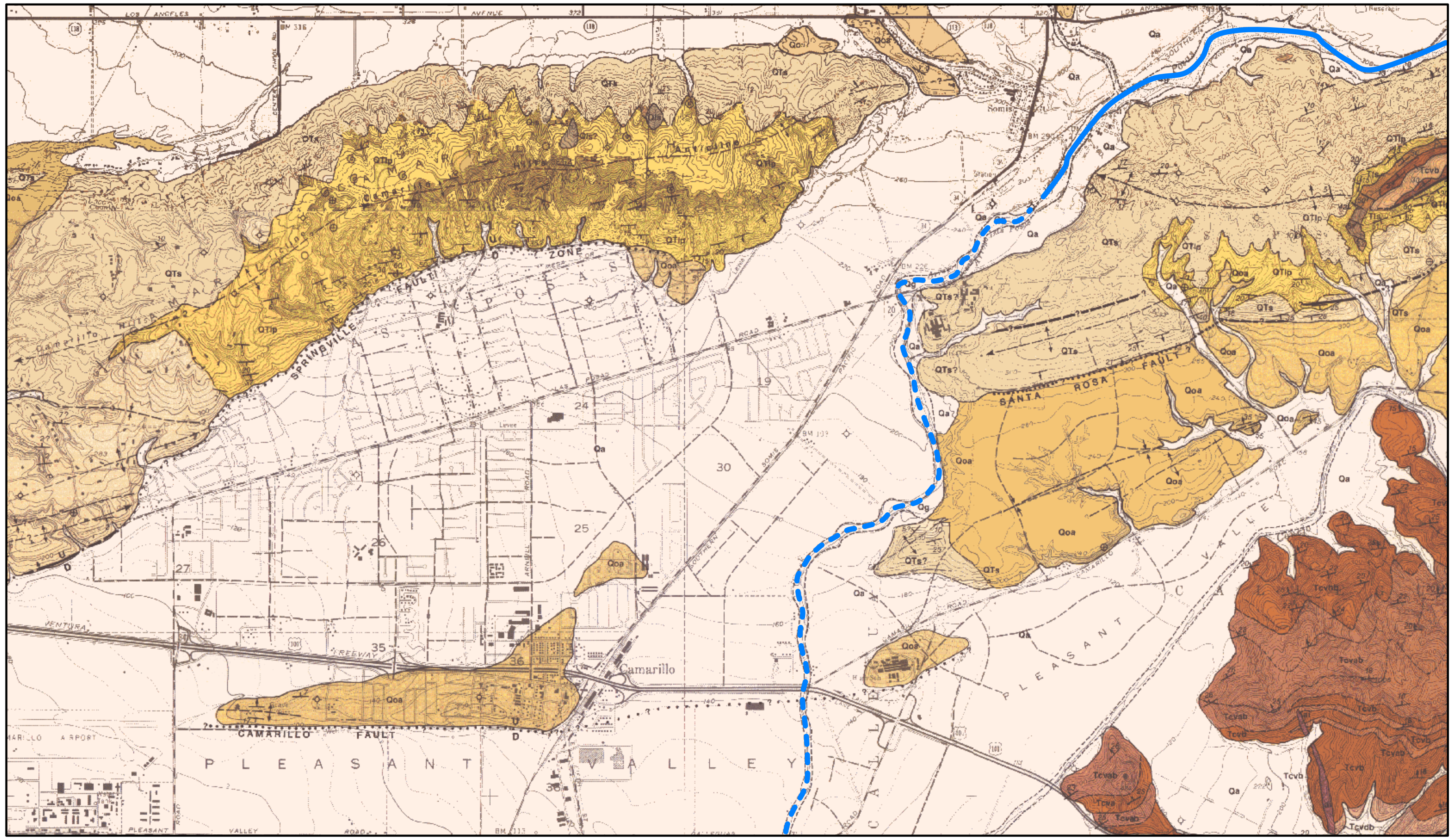
November 2008
Project No. 03-007-07

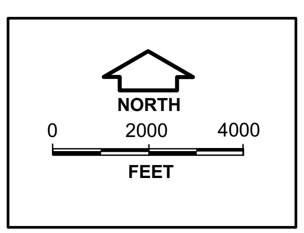
STUDY AREA LOCATION MAP
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

HOPKINS GROUNDWATER CONSULTANTS

PLATE 1

HOPKINS
GROUNDWATER
CONSULTANTS





LEGEND

Qa / Qg	**SURFICIAL SEDIMENTS -** **Qa** - valley and floodplain deposits of silt, sand and gravel; **Qg** - stream channel deposits of gravel, sand and silt
Qoa	**OLDER DISSECTED SURFICIAL SEDIMENTS -** remnants of weakly consolidated stream terrace and alluvial fan deposits of silt, sand and gravel
QTs	**SAUGUS FORMATION -** light gray to light brown pebble-cobble gravel, sand and clay
QTlp	**LAS POSAS SAND -** light gray to yellow-tan, fine to medium-grained massive sand

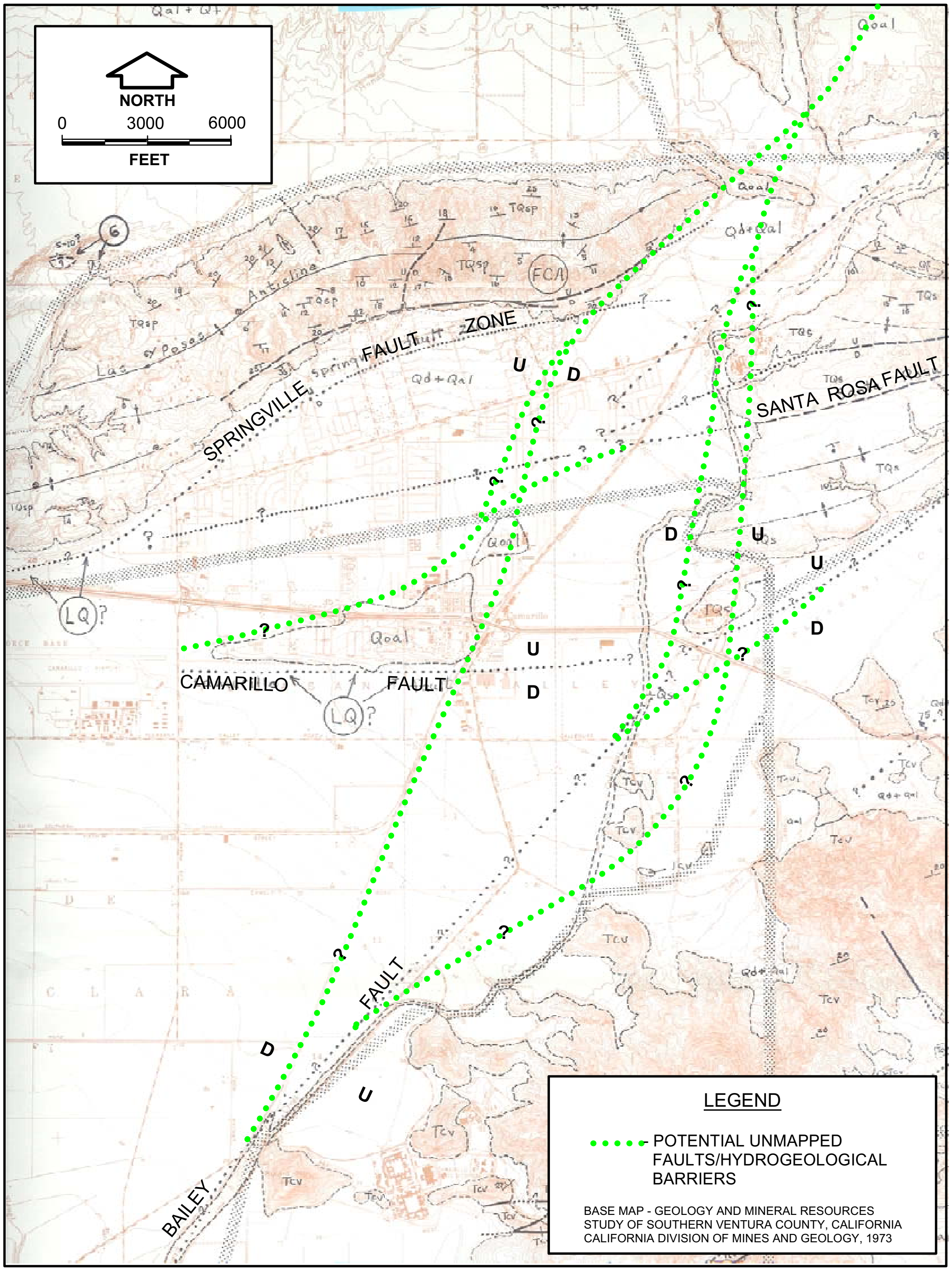
SYMBOLS

- Formation contact - dashed where inferred or indefinite
- Anticline - arrow on axis indicates direction of plunge
- Syncline - arrow on axis indicates direction of plunge
- Fault - dashed where indefinite or inferred, dotted where concealed
- Strike and dip of stratified rocks:
  - 45 / 25 inclined (approximate)
  - 49 overturned bedding
  - vertical bedding
- ARROYO LAS POSAS (SOLID WHERE PERENNIAL DASHED WHERE EPHEMERAL)

(Geology by THOMAS W. DIBBLEE, 1990 GEOLOGIC MAP OF THE CAMARILLO AND NEWBURY PARK, SANTA PAULA, AND MOORPARK QUADRANGLES)

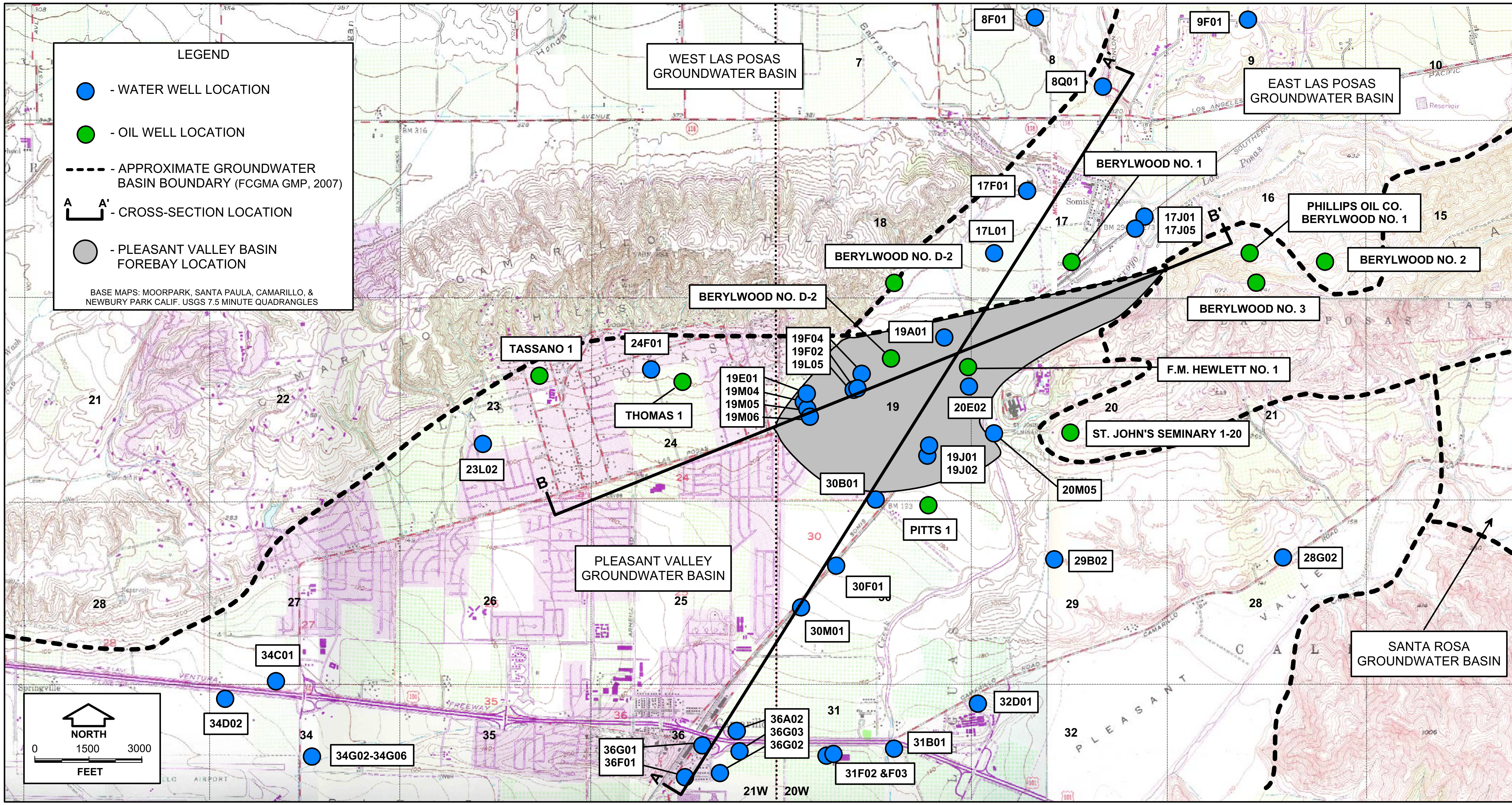
SURFACE GEOLOGY MAP
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE 2



STUDY AREA GEOLOGICAL STRUCTURES
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

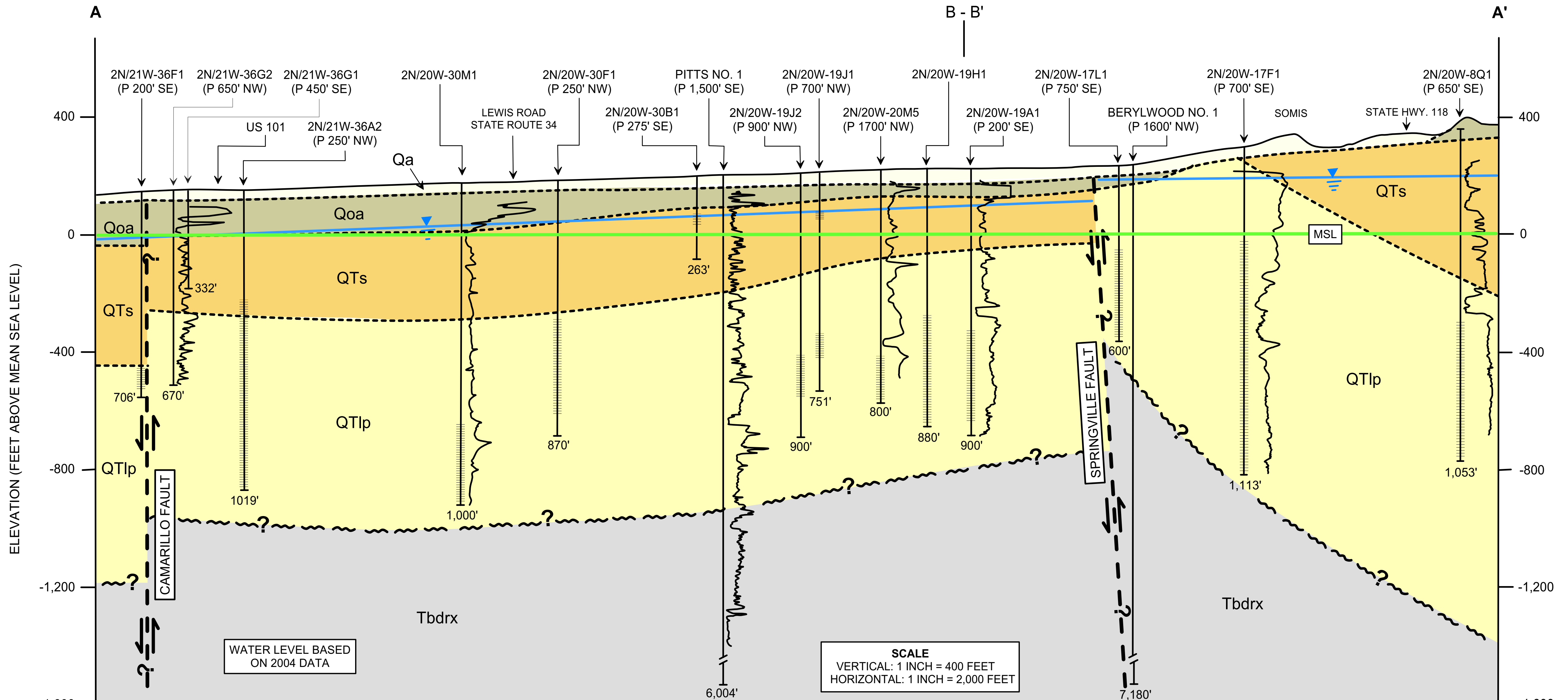
PLATE 3



HYDROGEOLOGICAL CROSS-SECTION AND WELL LOCATION MAP
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE 4

HOPKINS GROUNDWATER CONSULTANTS



LEGEND

Qa	**SURFICIAL SEDIMENTS -** valley and floodplain deposits of silt, sand and gravel
Qoa	**OLDER DISSECTED SURFICIAL SEDIMENTS -** remnants of weakly consolidated stream terrace and alluvial fan deposits of silt, sand and gravel
QTs	**SAUGUS FORMATION -** light gray to light brown pebble-cobble gravel, sand and clay
QTlp	**LAS POSAS SAND -** light gray to yellow-tan, fine to medium-grained massive sand
Tbdrx	**UNIDENTIFIED BEDROCK -** effective base of alluvial aquifer

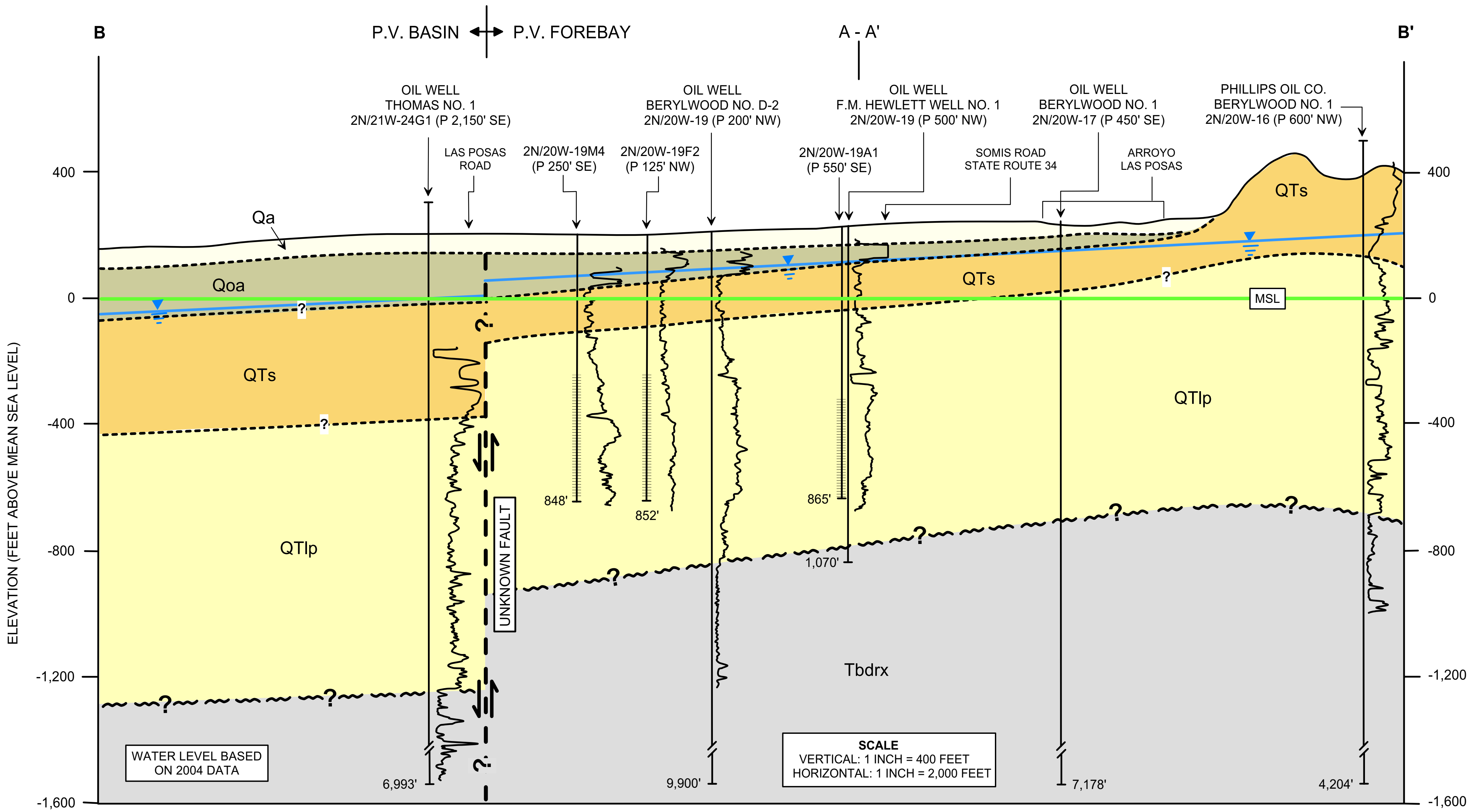
SYMBOLS

- Formation Contact
- Fault - Arrows indicate direction of slip
- Alluvium\Bedrock Contact
- Water Level
- MSL — Mean Sea Level

HYDROGEOLOGICAL CROSS-SECTION A-A'
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE 5

HOPKINS GROUNDWATER CONSULTANTS



LEGEND

Qa	**SURFICIAL SEDIMENTS -** valley and floodplain deposits of silt, sand and gravel
Qoa	**OLDER DISSECTED SURFICIAL SEDIMENTS -** remnants of weakly consolidated stream terrace and alluvial fan deposits of silt, sand and gravel
QTs	**SAUGUS FORMATION -** light gray to light brown pebble-cobble gravel, sand and clay
QTlp	**LAS POSAS SAND -** light gray to yellow-tan, fine to medium-grained massive sand
Tbdrx	**UNIDENTIFIED BEDROCK -** effective base of alluvial aquifer

SYMBOLS

Formation Contact

Fault - Arrows indicate direction of slip

Alluvium\Bedrock Contact

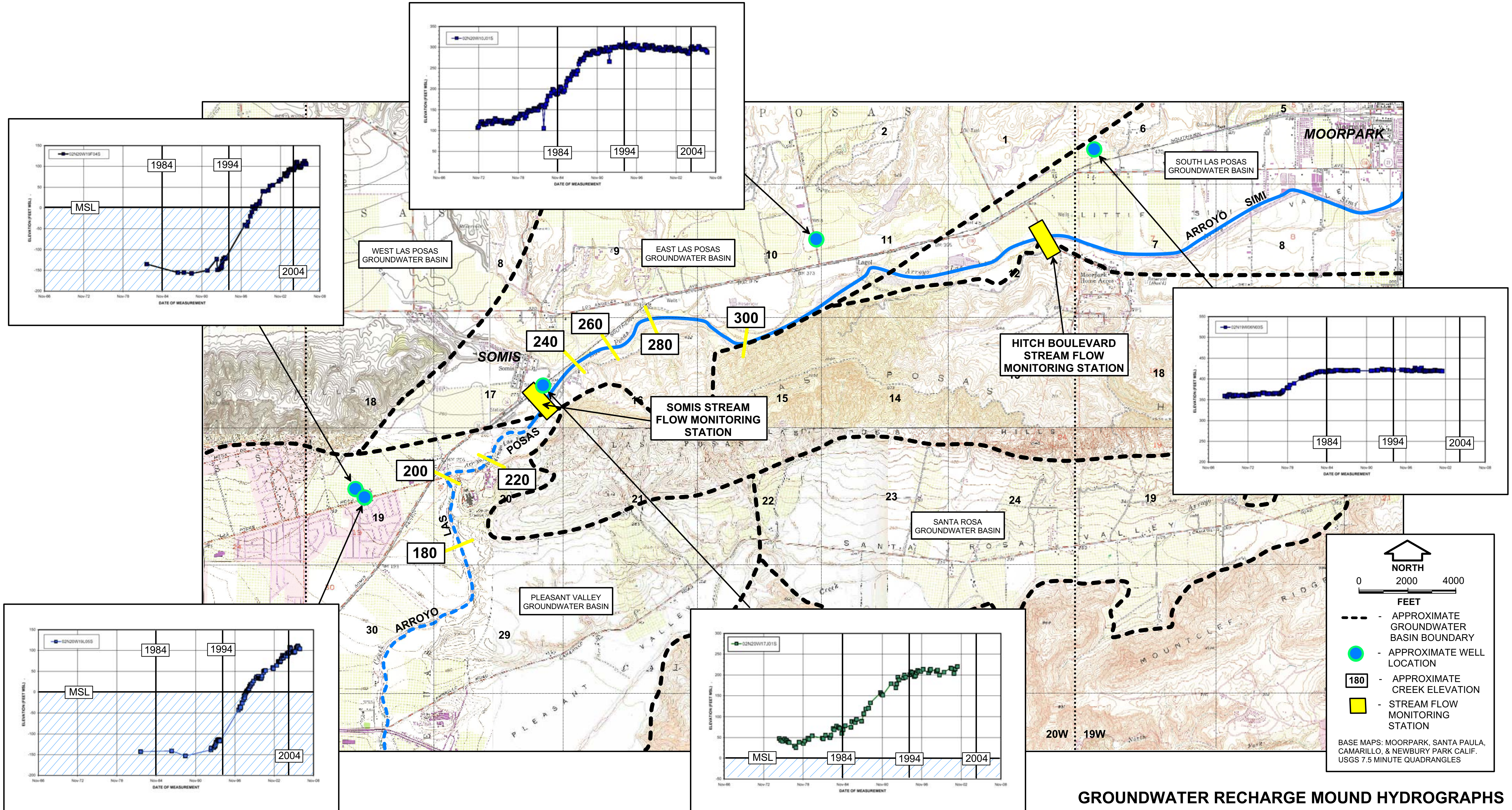
Water Level

MSL Mean Sea Level

2N/20W-19A1 (P 550' SE) WELL PROJECTED 550 FEET SOUTHEAST

HYDROGEOLOGICAL CROSS-SECTION B-B'
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

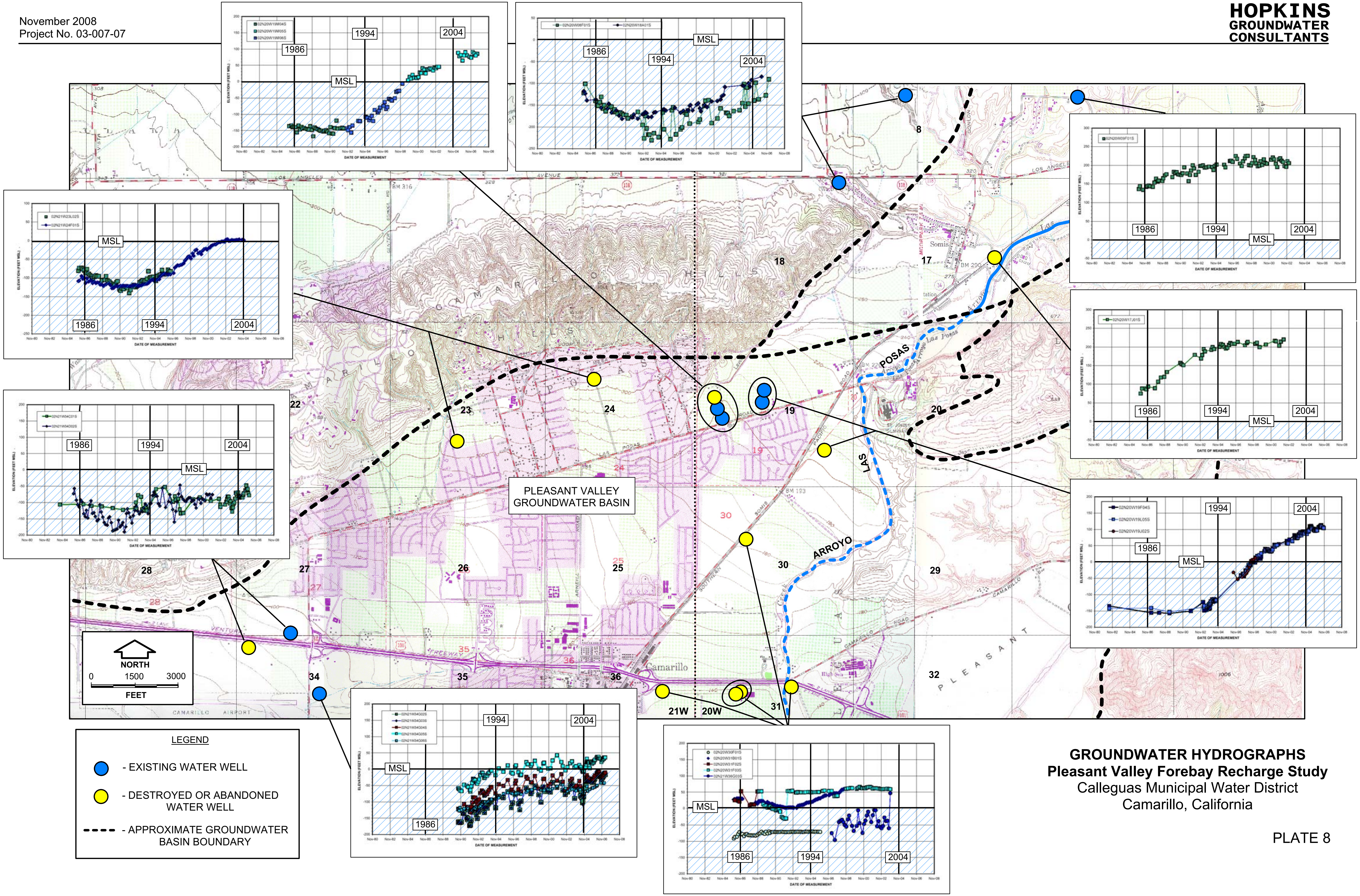
PLATE 6



GROUNDWATER RECHARGE MOUND HYDROGRAPHS
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE 7

HOPKINS
GROUNDWATER CONSULTANTS



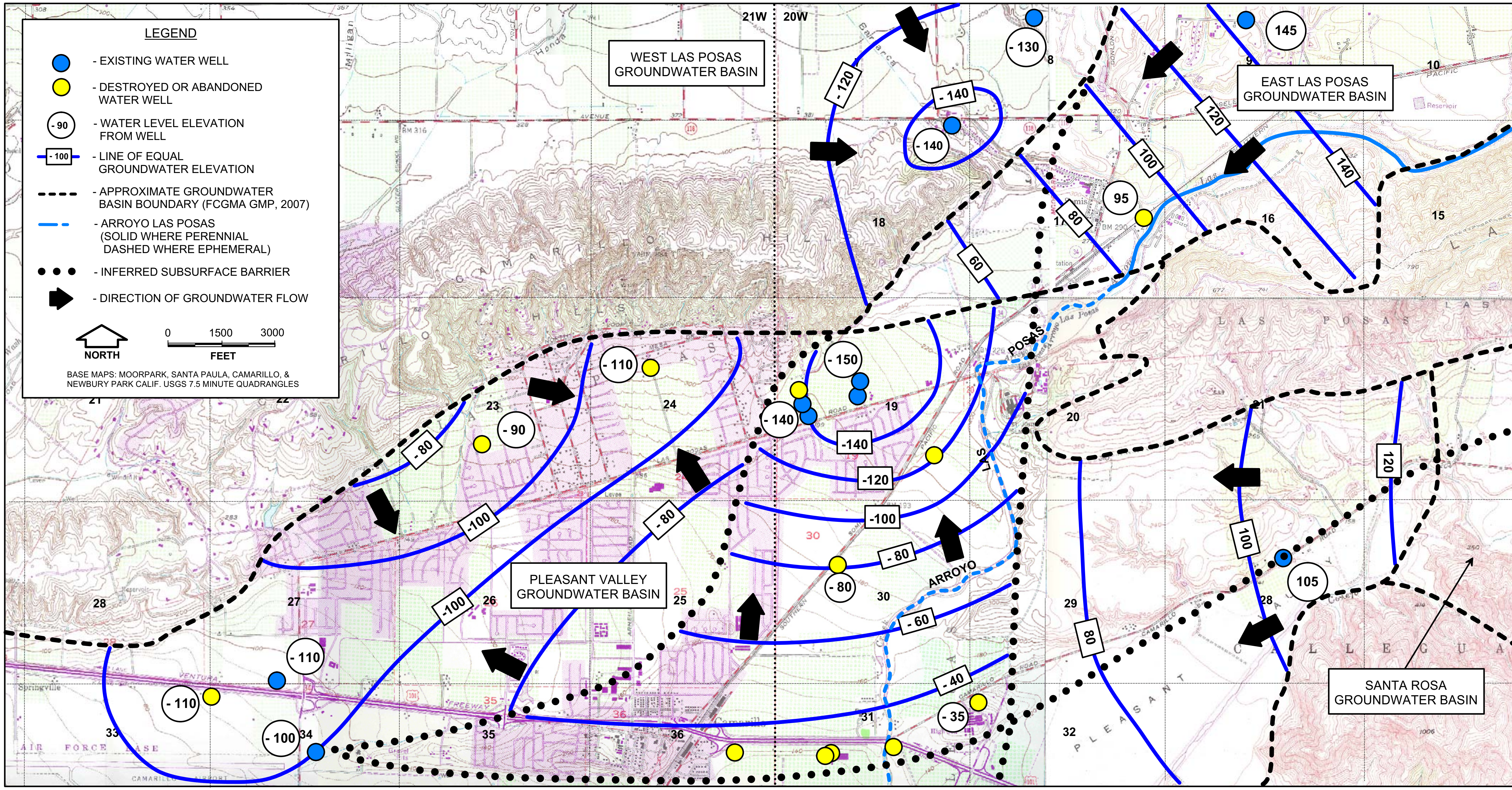
GROUNDWATER HYDROGRAPHS

Pleasant Valley Forebay Recharge Study

Calleguas Municipal Water District

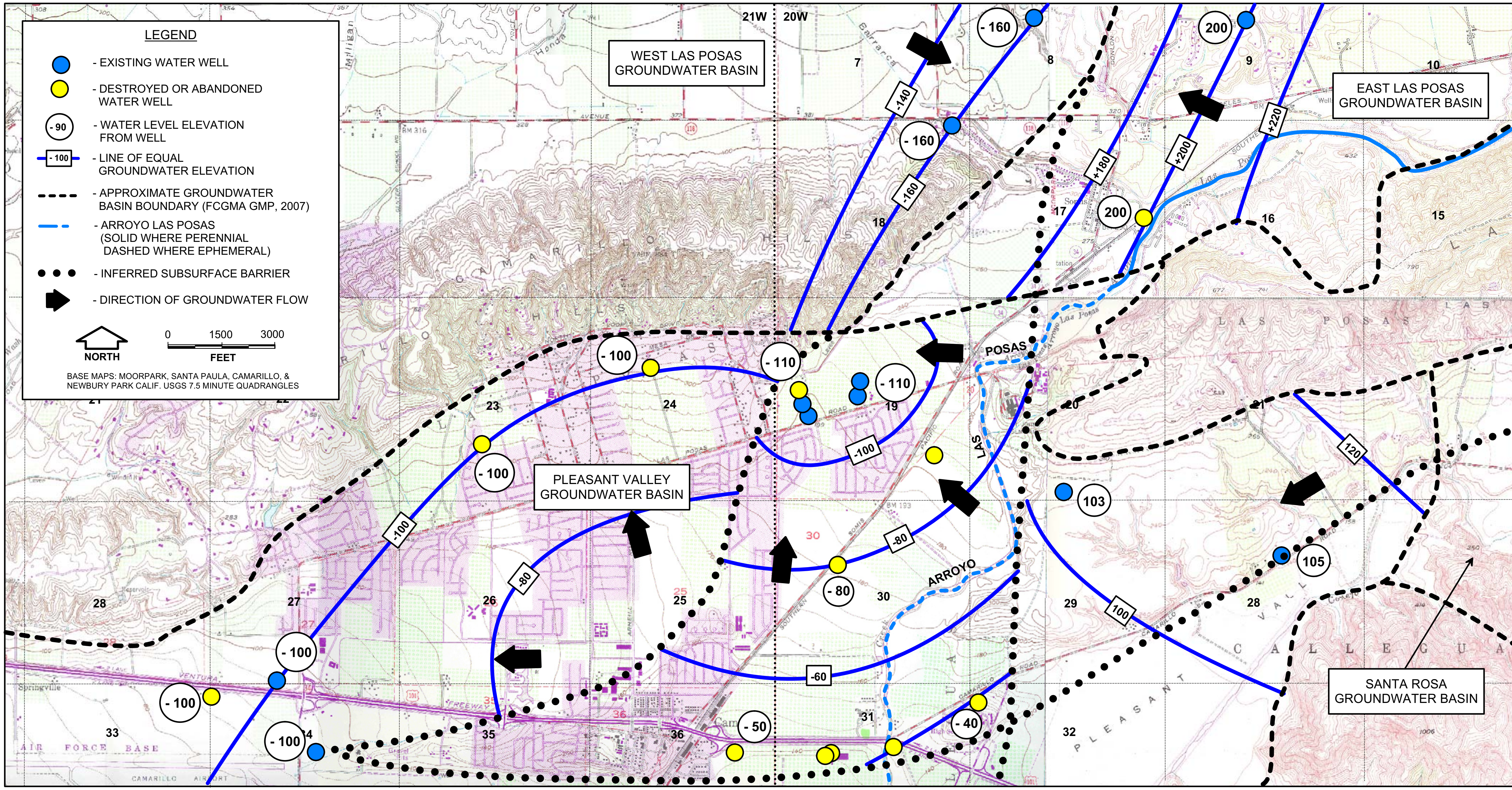
Camarillo, California

PLATE 8



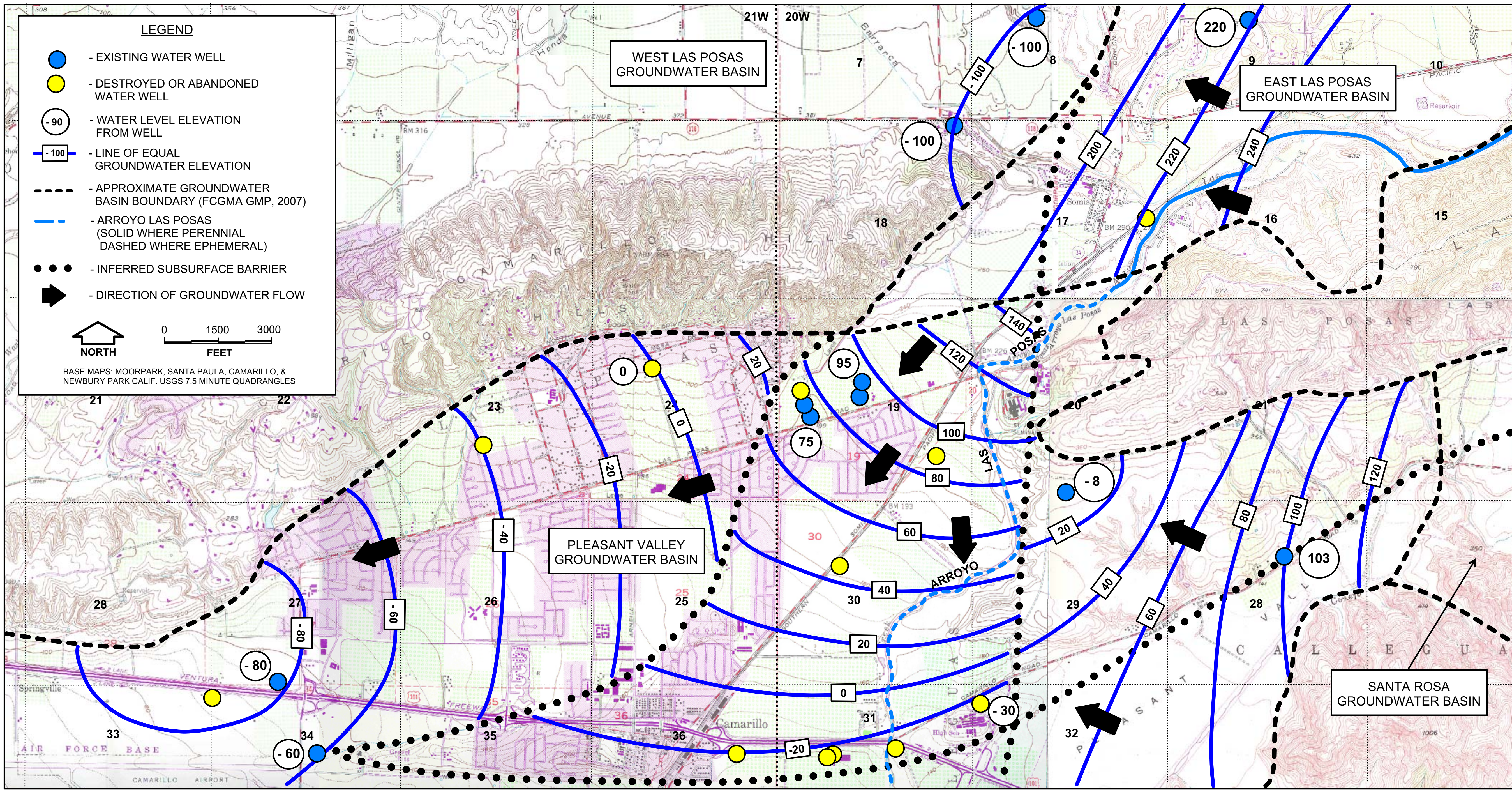
1986 GROUNDWATER
ELEVATION CONTOUR MAP
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE 9



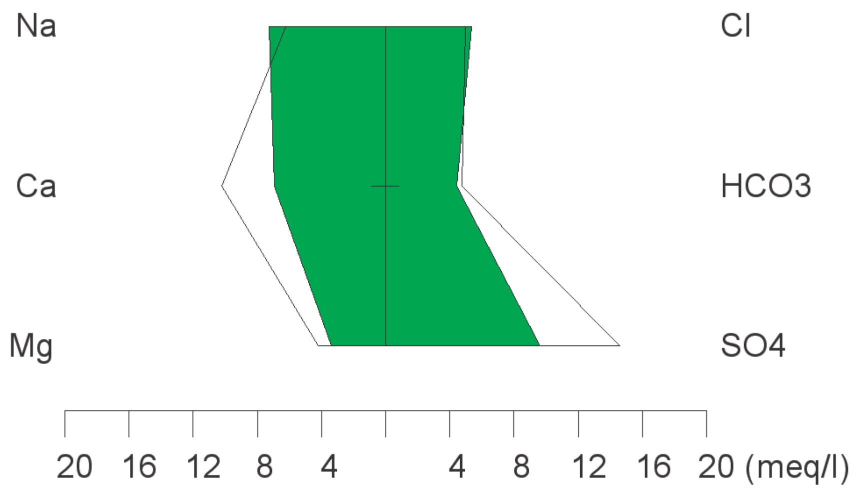
1994 GROUNDWATER
ELEVATION CONTOUR MAP
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

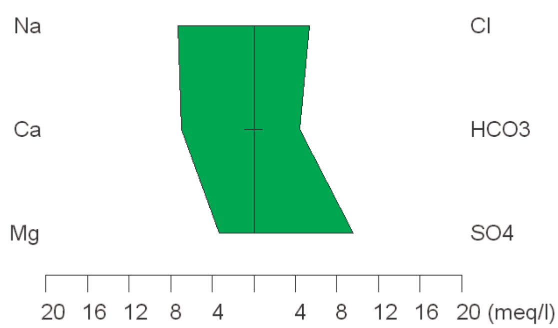
PLATE 10



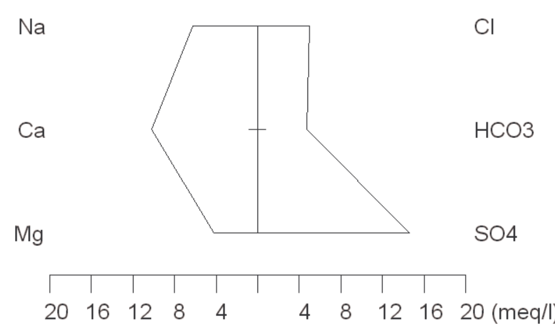
2004 GROUNDWATER ELEVATION CONTOUR MAP
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE 11





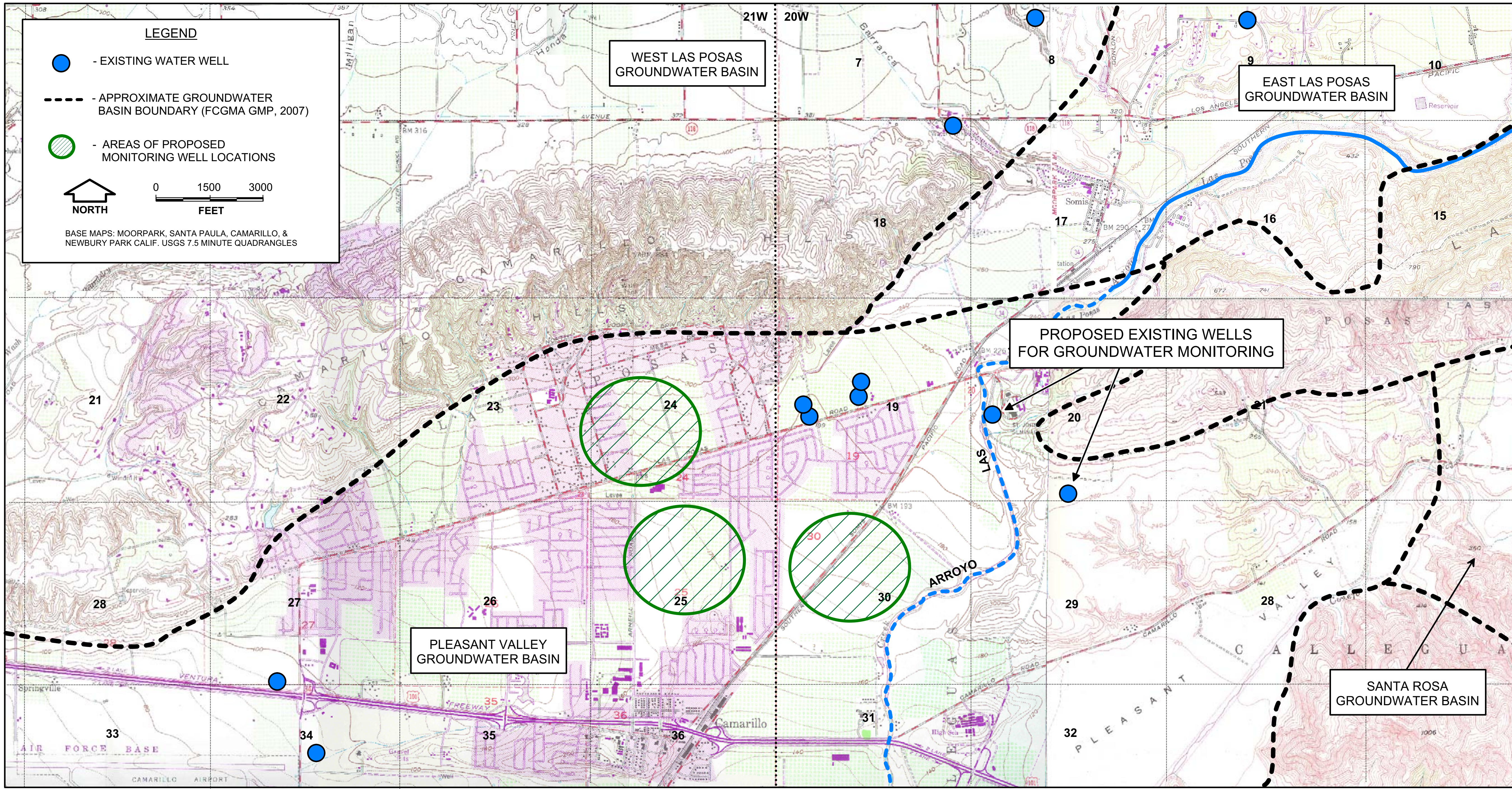
CREEK SAMPLE



WELL SAMPLE

STIFF DIAGRAMS OF STUDY SAMPLES
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

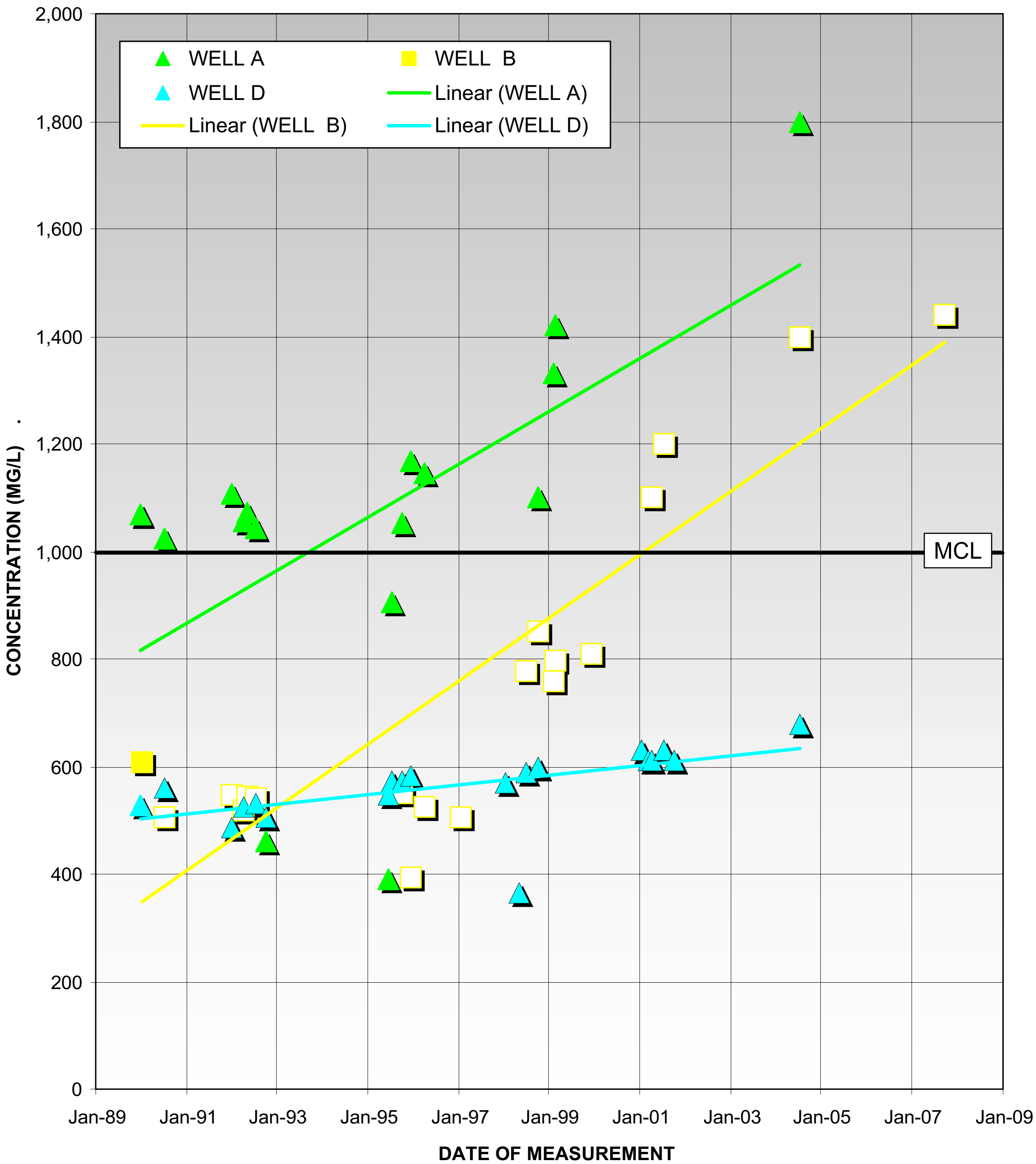
HOPKINS GROUNDWATER CONSULTANTS



PROPOSED MONITORING WELL LOCATION MAP
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

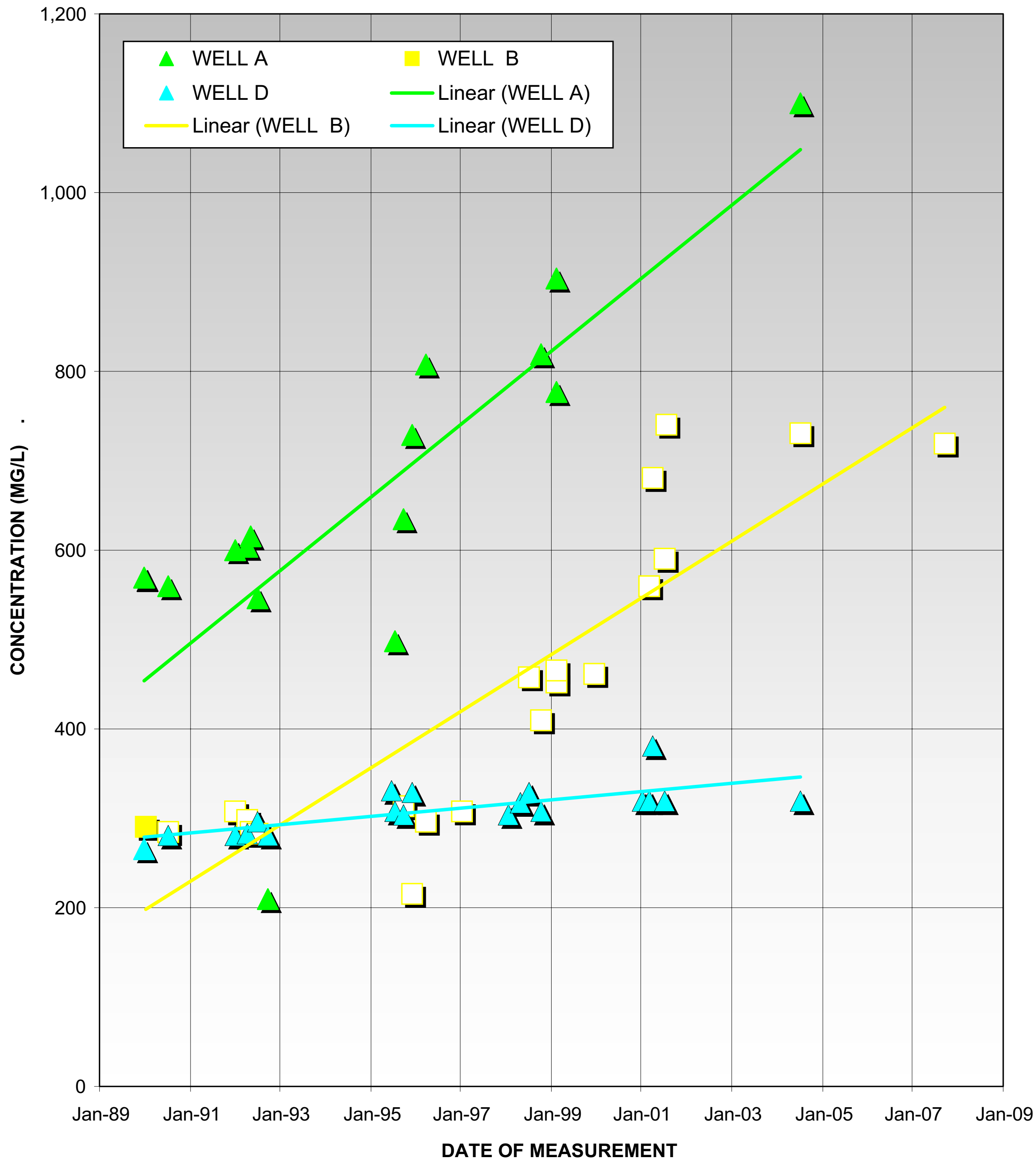
PLATE 13

APPENDIX A
WATER QUALITY DATA



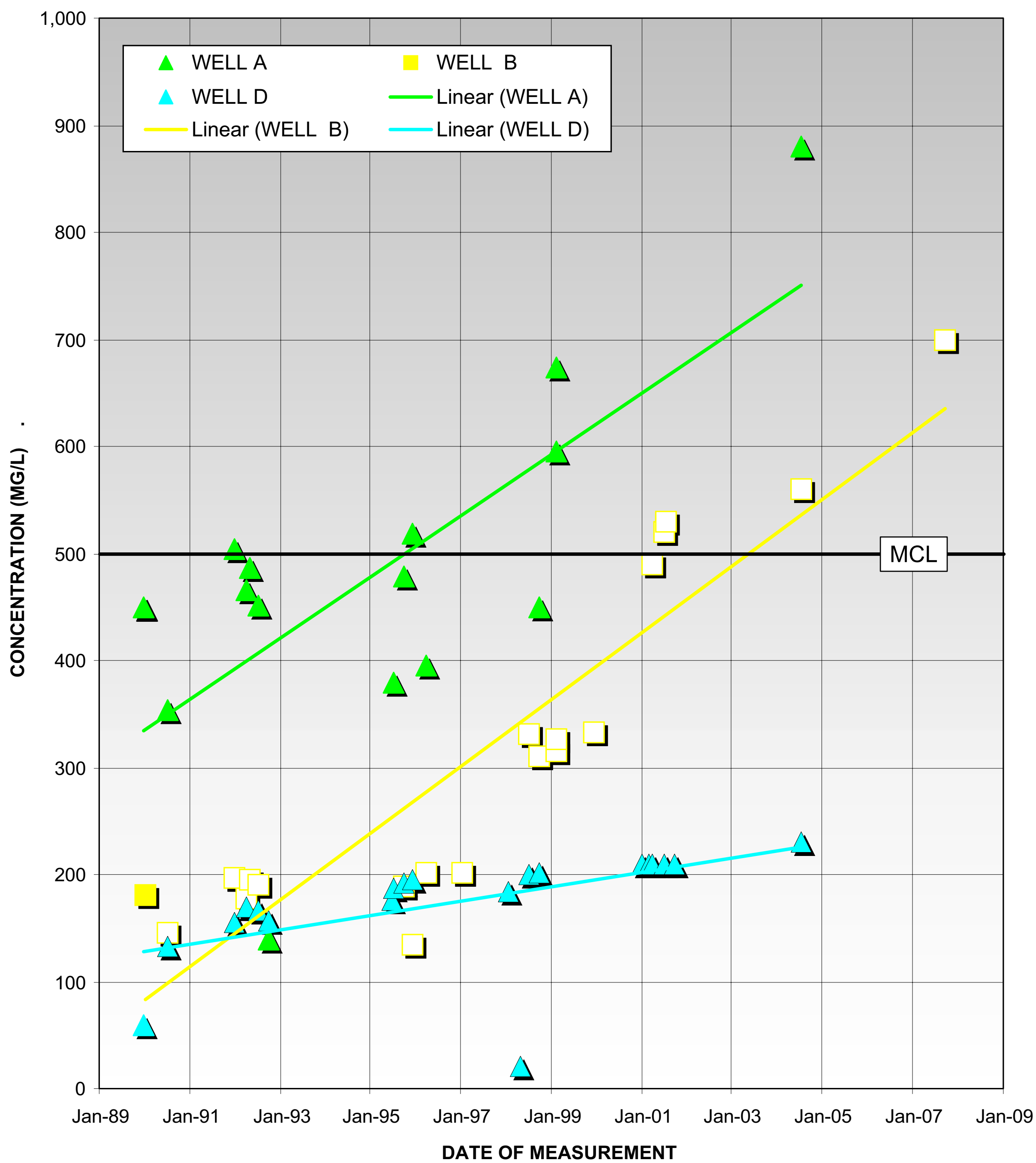
TOTAL DISSOLVED SOLIDS
CITY OF CAMARILLO WELLS
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE A1



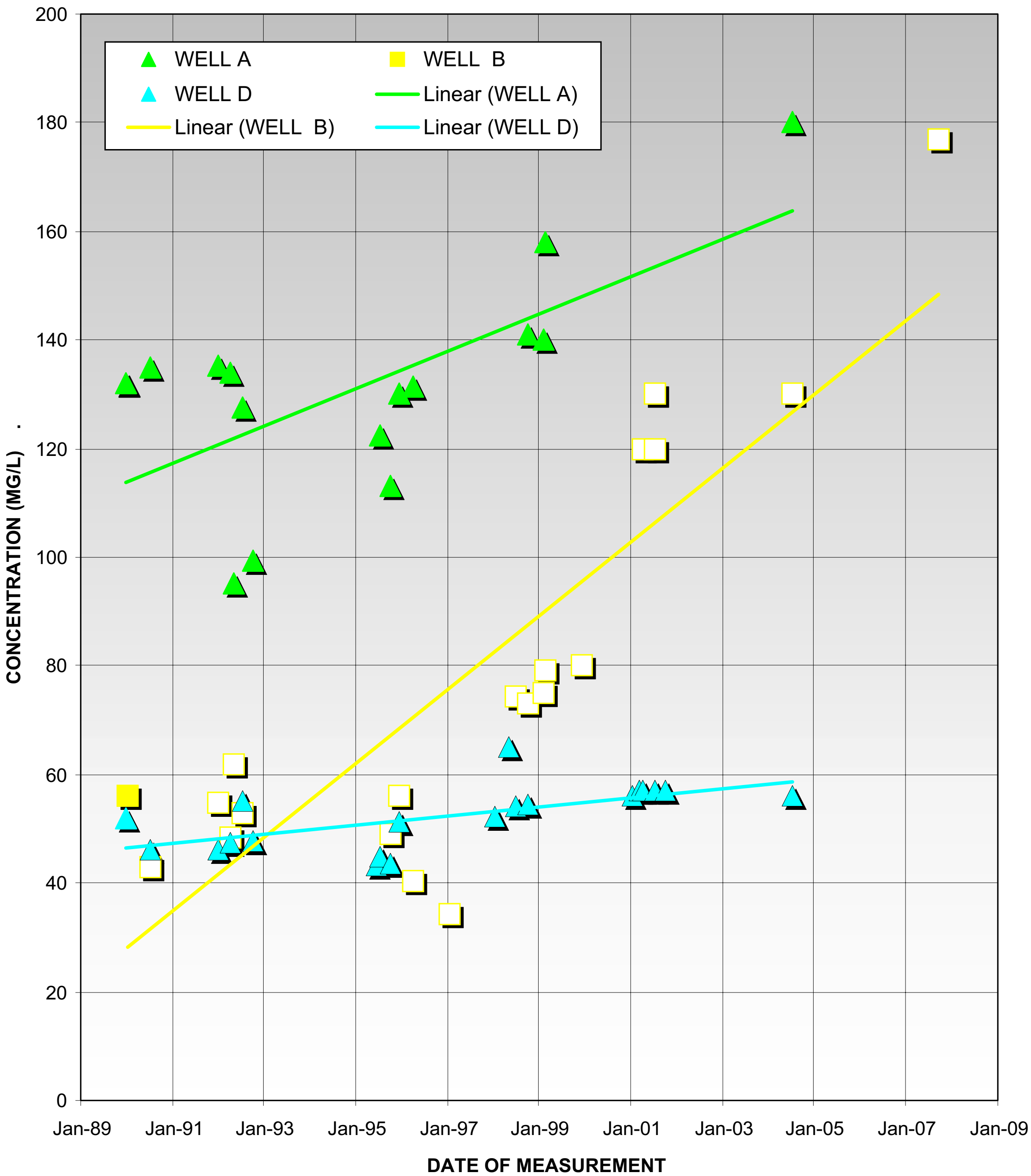
TOTAL HARDNESS (AS CaC03)
CITY OF CAMARILLO WELLS
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE A2



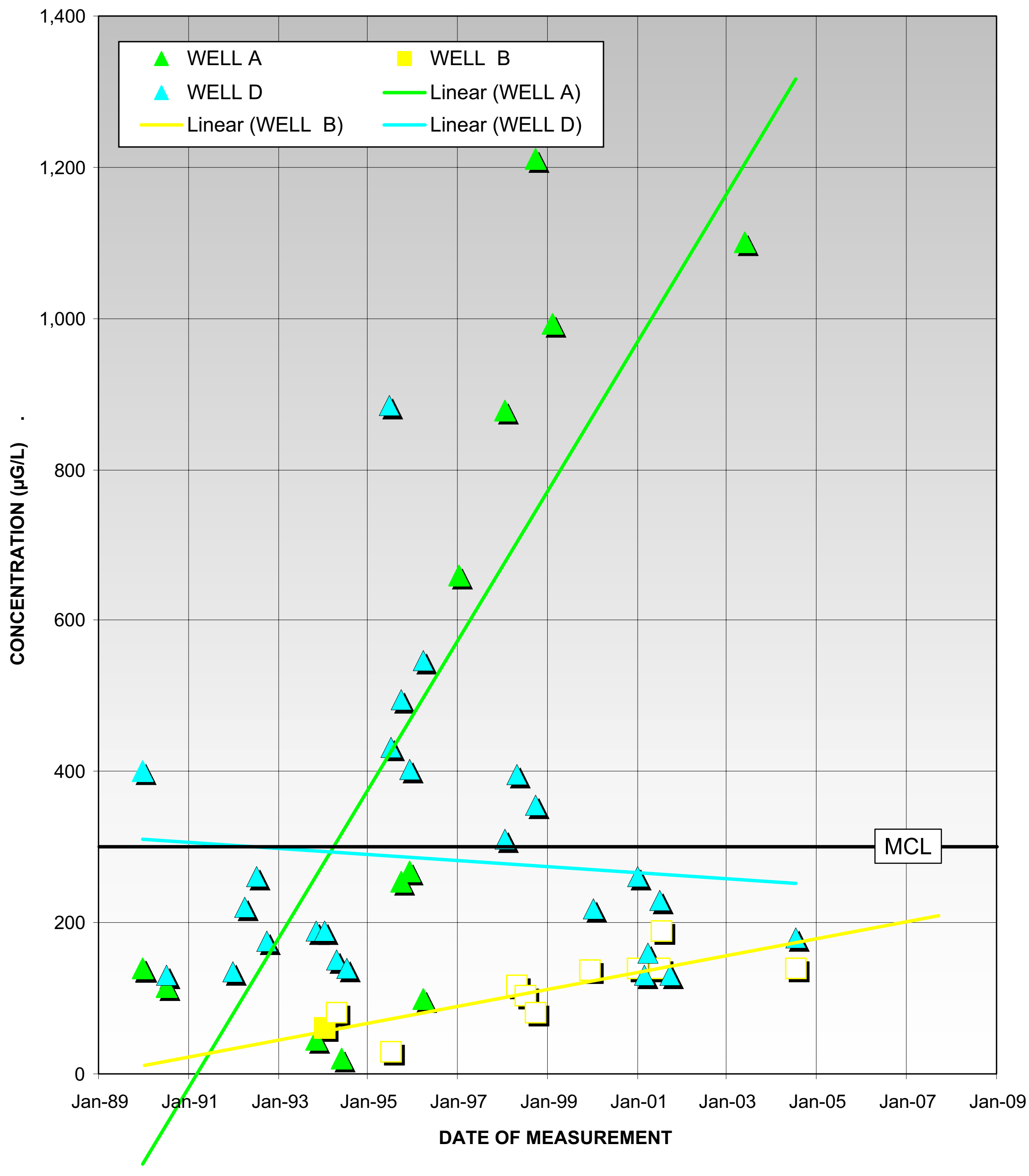
SULFATE
CITY OF CAMARILLO WELLS
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE A3



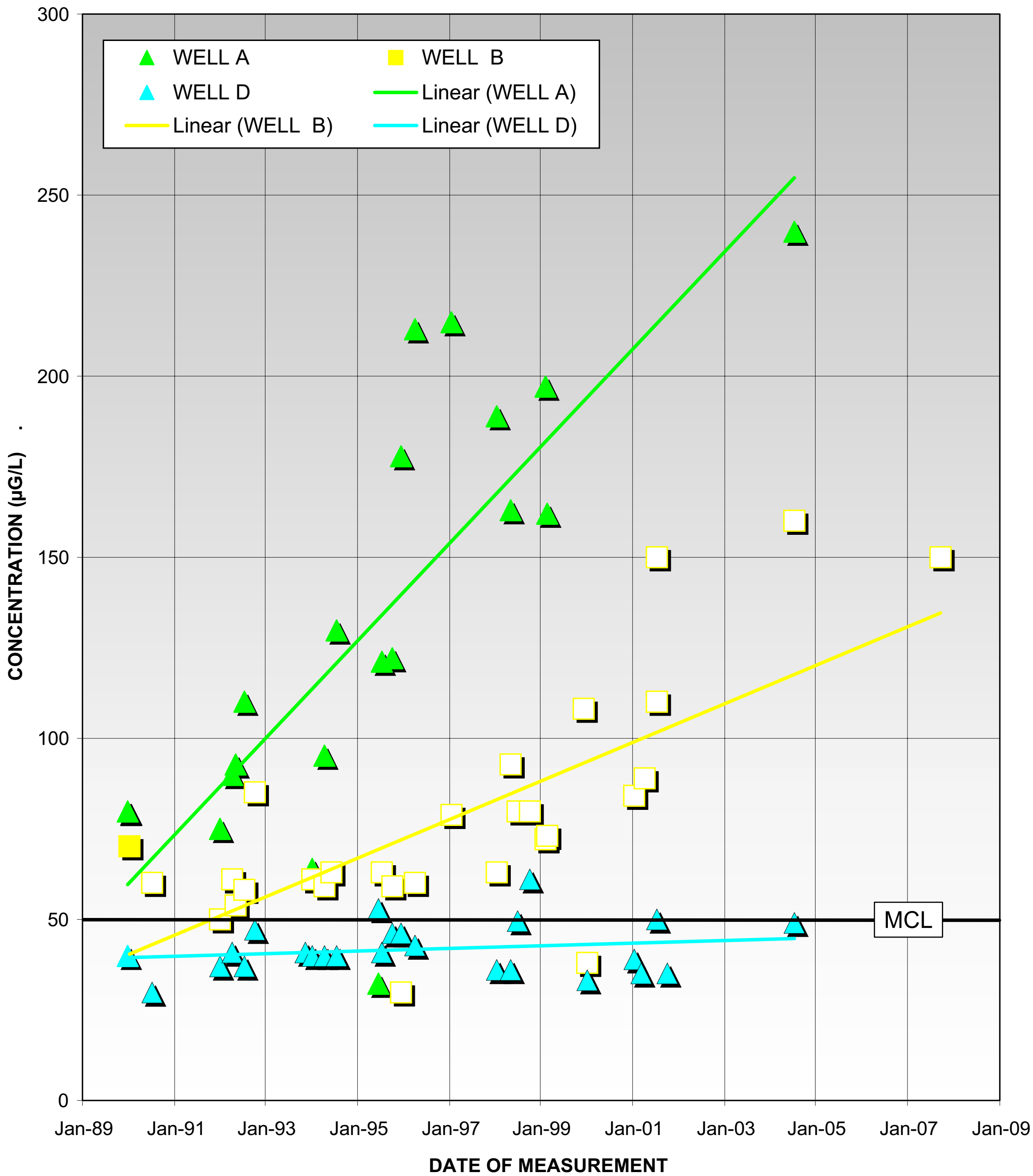
CHLORIDE
CITY OF CAMARILLO WELLS
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE A4



IRON
CITY OF CAMARILLO WELLS
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

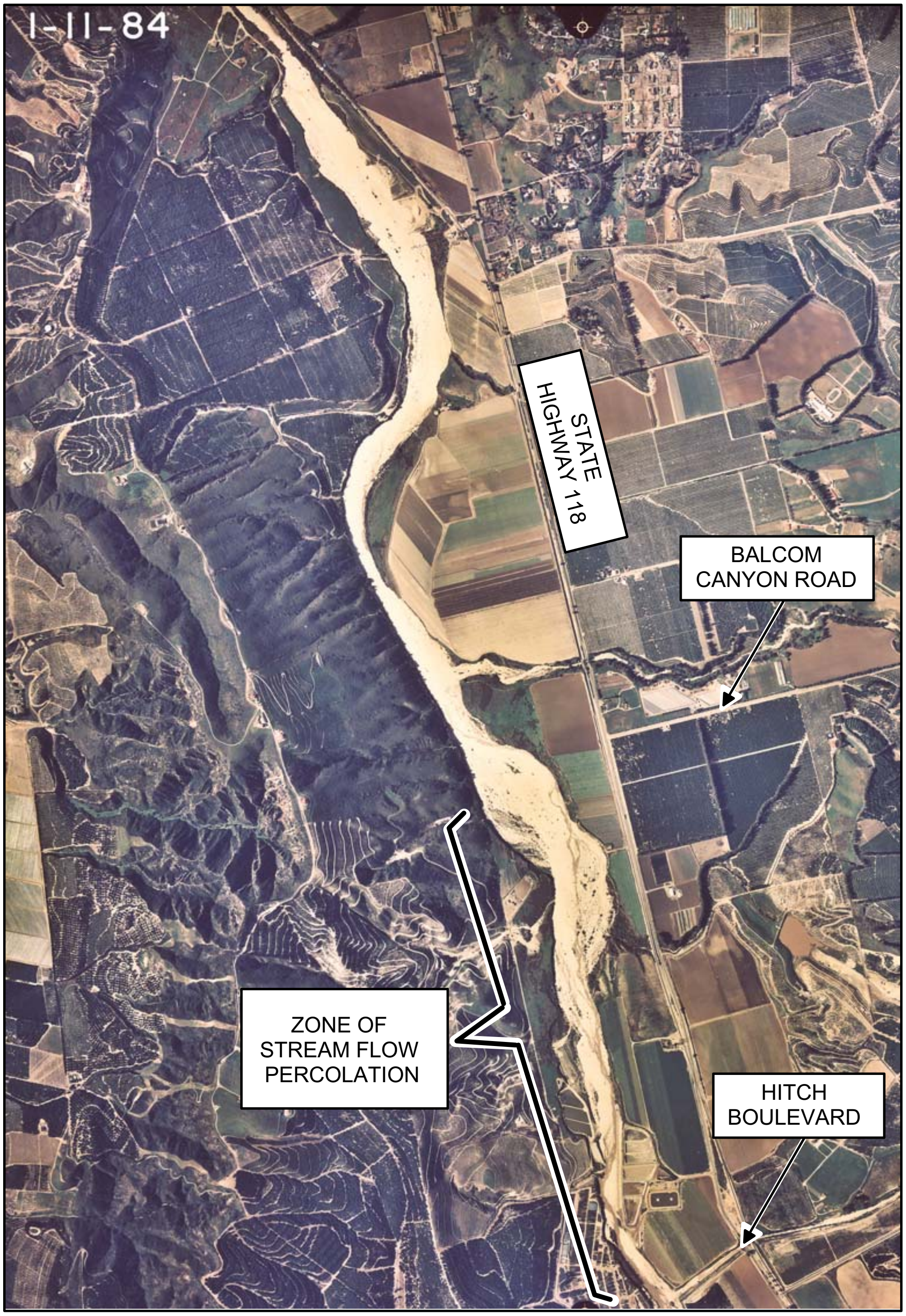
PLATE A5



MANGANESE
CITY OF CAMARILLO WELLS
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

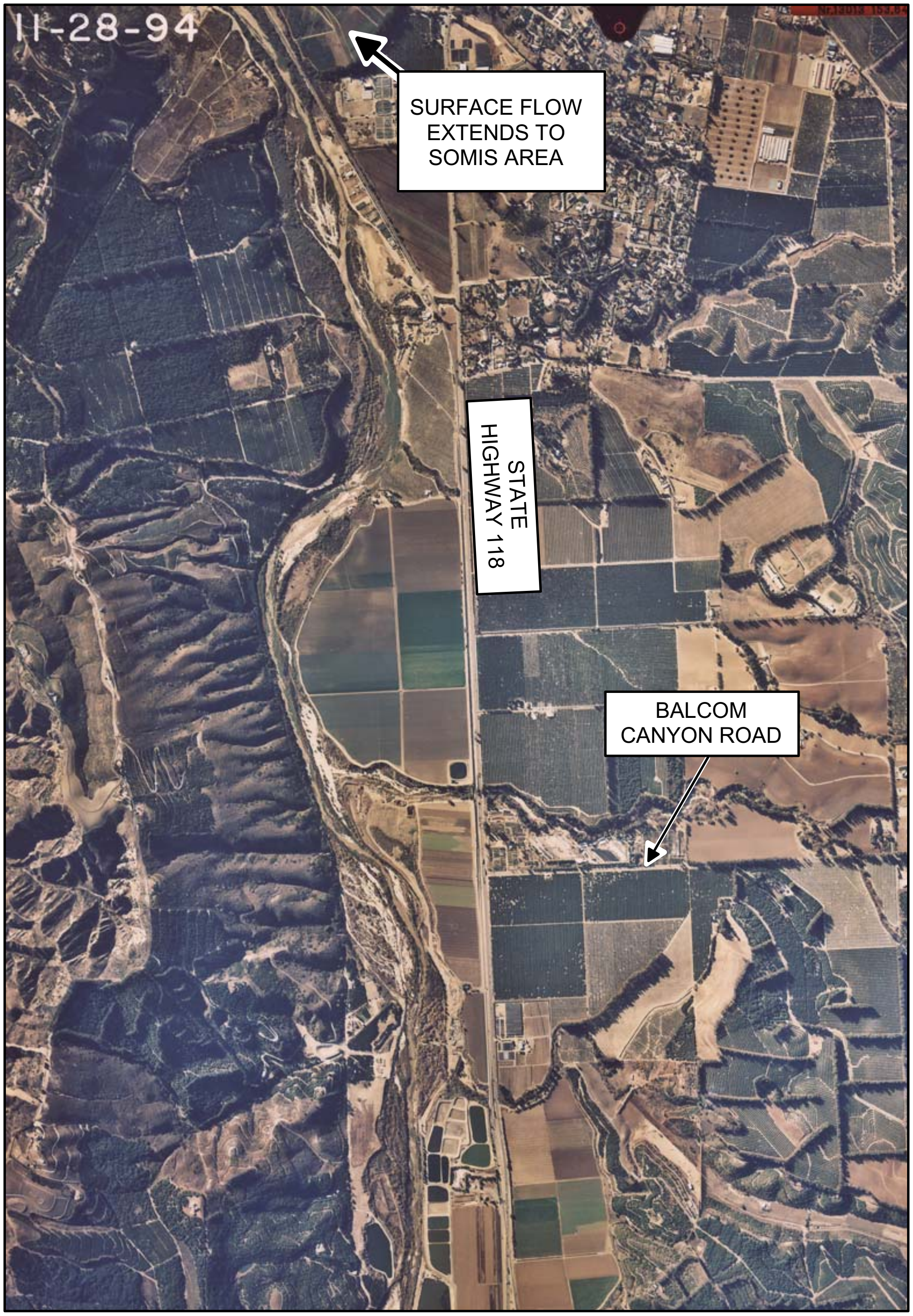
PLATE A6

APPENDIX B
AERIAL PHOTOGRAPHS OF ARROYO LAS POSAS



JANUARY 1984

HOPKINS GROUNDWATER CONSULTANTS



NOVEMBER 1994

2005 (MONTH UNKNOWN)

PLATE B3

APPENDIX C
STREAM FLOW SURVEY

Table C1 – Stream Flow Data

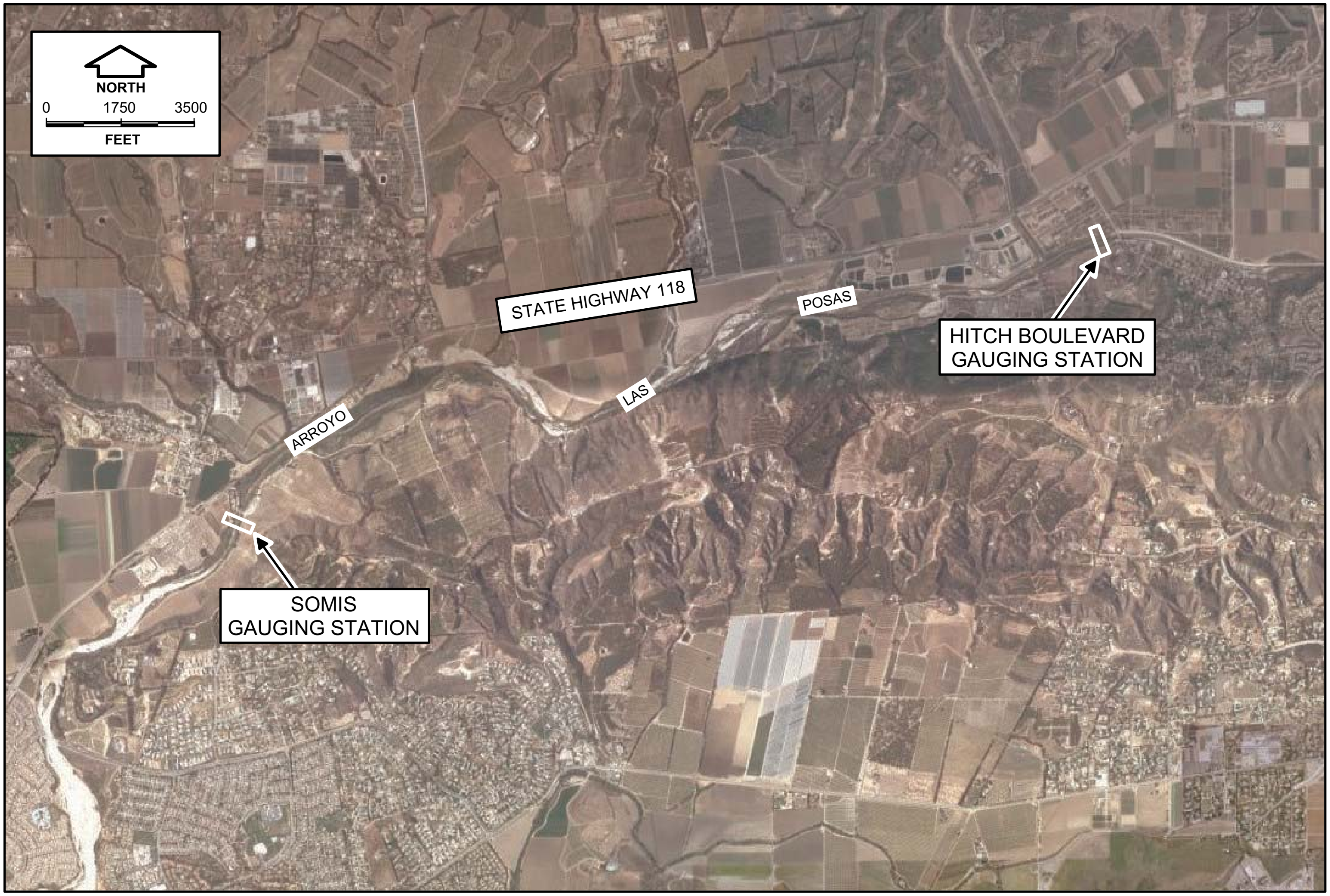
ARROYO LAS POSAS AT HITCH BOULEVARD GAUGING STATION			
SECTION	AREA (SQUARE FEET)	VELOCITY (FEET/SEC)	FLOW RATE (CFS)
1	0.350	1.45	0.508
2	0.338	1.93	0.651
3	0.430	1.83	0.787
4	0.500	1.67	0.835
5	0.580	1.95	1.131
6	0.688	2.05	1.409
7	0.615	1.62	0.996
8	0.465	1.65	0.767
9	0.445	1.88	0.837
10	0.490	1.70	0.833
11	0.450	1.96	0.882
12	0.450	2.13	0.959
13	0.440	2.08	0.915
14	0.495	2.59	1.282
15	0.655	2.50	1.638
16	0.580	2.28	1.322
17	0.655	2.15	1.408
18	0.880	2.60	2.288
19	1.045	2.40	2.508
20	1.020	2.45	2.499
21	0.465	1.11	0.516
TOTAL RATE OF FLOW (CFS)			24.971
TOTAL RATE OF FLOW (GPM)			11,207

ARROYO LAS POSAS AT SOMIS GAUGING STATION			
SECTION	AREA (SQUARE FEET)	VELOCITY (FEET/SEC)	FLOW RATE (CFS)
1	0.410	2.38	0.976
2	0.565	2.62	1.480
3	0.510	2.97	1.515
4	0.525	2.88	1.512
5	0.515	2.79	1.437
6	0.585	3.02	1.767
7	0.600	3.45	2.070
8	0.793	2.77	2.195
9	1.025	2.09	2.142
TOTAL RATE OF FLOW (CFS)			15.094
TOTAL RATE OF FLOW (GPM)			6,774

Table C2 – Stream Flow Data

DATE	HOPKINS MEASUREMENTS[1] HITCH BOULEVARD (CFS)	HOPKINS MEASUREMENTS[1] SOMIS (CFS)	VCWPD STREAM GAUGE READING HITCH BOULEVARD (CFS)	VCWPD MEASUREMENTS[2] HITCH BOULEVARD (CFS)
09/25/2007	25	15	15	NA[3]
10/28/2008	25	NA[3]	NA[3]	15

[1] – Measurement conducted with an impeller actuated flow meter.
[2] – Measurement conducted with a Pygmy meter having an axial cup actuator.
[3] – Not Available



STREAM GAUGING STATION LOCATION MAP
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE C1

November 2008
Project No. 03-007-07

HOPKINS GROUNDWATER CONSULTANTS

HITCH BOULEVARD GAUGING STATION
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE C2

SOMIS GAUGING STATION
Pleasant Valley Forebay Recharge Study
Calleguas Municipal Water District
Camarillo, California

PLATE C3

STREAM FLOW MEASUREMENTS AT HITCH BOULEVARD GAUGING STATION

STREAM FLOW MEASUREMENTS AT SOMIS GAUGING STATION

PRE-SURVEY CONDITION AT SOMIS STATION

TERMINATION OF STREAM FLOW

APPENDIX D
LABORATORY TEST RESULTS OF SURFACE AND GROUNDWATER ANALYSES

FGL ENVIRONMENTAL
GENERAL MINERAL ANALYSIS

October 25, 2007

Hopkins Groundwater Consultants Inc.
P. O. Box 3596
Ventura, CA 93006-3596

Lab ID : SP 0710727
Customer : 2-20807

Laboratory Report

Introduction: This report package contains total of 7 pages divided into 3 sections:

Case Narrative	(2 Pages)	: An overview of the work performed at FGL.
Sample Results	(2 pages)	: Results for each sample submitted.
Quality Control	(3 pages)	: Supporting Quality Control (QC) results.

Case Narrative

This Case Narrative pertains to the following samples:

Sample Description	Date Sampled	Date Received	FGL Lab ID #	Matrix
03-007-07 Creek Sample No.1	09/25/2007	09/25/2007	SP 0710727-001	SW
03-007-07 Well Sample No.2	09/25/2007	09/25/2007	SP 0710727-002	GW

Sampling and Receipt Information: All samples were received, prepared and analyzed within the method specified holding except those as listed in the table below. The holding time for pH is listed as immediate. Logistically this is very difficult to obtain. FGL policy is to analyze all samples requiring pH on the same day of receipt at the laboratory. If this presents any problem please call.

Lab ID	Analyte/Method	Required Holding Time	Actual Holding Time
SP 0710727-001	pH	15	406.2 Minutes
SP 0710727-002	pH	15	259.2 Minutes

All samples arrived on ice. All samples were checked for pH if acid or base preservation is required (except for VOAs). For details of sample receipt information, please see the attached Chain of Custody and Condition Upon Receipt Form.

Quality Control: All samples were prepared and analyzed according to the following tables:

Inorganic - Metals QC

200.7	10/01/2007:210057	All analysis quality controls are within established criteria.
	10/01/2007:209567	All preparation quality controls are within established criteria.

October 25, 2007
Hopkins Groundwater Consultants Inc.

Lab ID : SP 0710727
Customer : 2-20807

Inorganic - Wet Chemistry QC

2320B	09/28/2007:209945	All analysis quality controls are within established criteria.
	09/28/2007:209470	All preparation quality controls are within established criteria.
2510B	09/26/2007:209813	All analysis quality controls are within established criteria.
	09/26/2007:209352	All preparation quality controls are within established criteria.
2540 C,E	09/27/2007:209399	All preparation quality controls are within established criteria.
300.0	10/10/2007:210483	All analysis quality controls are within established criteria.
	10/08/2007:209789	All preparation quality controls are within established criteria.
4500-H B	09/25/2007:209335	All preparation quality controls are within established criteria.
4500HB	09/25/2007:209800	All analysis quality controls are within established criteria.
4500NO2B	09/25/2007:209804	All analysis quality controls are within established criteria.
	09/26/2007:209343	All preparation quality controls are within established criteria.
4500NO3F	09/27/2007:210013	All analysis quality controls are within established criteria.
	09/27/2007:209403	All preparation quality controls are within established criteria.
5540C	09/25/2007:209799	All analysis quality controls are within established criteria.
	09/25/2007:209337	All preparation quality controls are within established criteria.

Certification: I certify that this data package is in compliance with NELAC standards, both technically and for completeness, except for any conditions listed above. Release of the data contained in this data package is authorized by the Laboratory Director or his designee, as verified by the following electronic signature.

Approved By **Kelly A. Dunnahoo, B.S.**

Digitally signed by Kelly A. Dunnahoo, B.S.
Title: Laboratory Director
Date: 2007-10-25

October 25, 2007

Lab ID : SP 0710727-001
Customer ID : 2-20807

Hopkins Groundwater Consultants Inc.
P. O. Box 3596
Ventura, CA 93006-3596

Sampled On : September 25, 2007-10:43
Sampled By : B. Cosner
Received On : September 25, 2007-16:55
Matrix : Surface Water

Description : 03-007-07 Creek Sample No.1
Project : Water Monitoring

Sample Results - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral P:1'4								
Total Hardness	516	2.5	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Calcium	139	1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Magnesium	41	1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Potassium	8	1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Sodium	167	1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Total Cations	17.8	0.1	meq/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Boron	0.7	0.1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Copper	ND	10	ug/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Iron	840	50	ug/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Manganese	180	10	ug/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Zinc	ND	20	ug/L		200.7	10/01/07:209567	200.7	10/01/07:210057
SAR	3.2	0.1	meq/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Total Alkalinity (as CaCO3)	220	10	mg/L		2320B	09/28/07:209470	2320B	09/28/07:209945
Hydroxide	ND	10	mg/L		2320B	09/28/07:209470	2320B	09/28/07:209945
Carbonate	ND	10	mg/L		2320B	09/28/07:209470	2320B	09/28/07:209945
Bicarbonate	270	10	mg/L		2320B	09/28/07:209470	2320B	09/28/07:209945
Sulfate	460	10	mg/L		300.0	10/08/07:209789	300.0	10/10/07:210483
Chloride	189	5	mg/L		300.0	10/08/07:209789	300.0	10/10/07:210483
Nitrate	30.7	0.4	mg/L		4500NO3F	09/27/07:209403	4500NO3F	09/27/07:210013
Nitrite as N	ND	0.1	mg/L		4500NO2B	09/26/07:209343	4500NO2B	09/25/07:209804
Fluoride	0.3	0.1	mg/L		300.0	10/08/07:209789	300.0	10/10/07:210483
Total Anions	19.8	0.1	meq/L		2320B	09/28/07:209470	2320B	09/28/07:209945
pH	7.2	---	units		4500-H B	09/25/07:209335	4500HB	09/25/07:209800
Specific Conductance	1700	1	umhos/cm		2510B	09/26/07:209352	2510B	09/26/07:209813
Total Dissolved Solids	1180	20	mg/L		2540 C,E	09/27/07:209399	2540C	09/28/07:209924
MBAS (foaming agents)	ND	0.1	mg/L		5540C	09/25/07:209337	5540C	09/25/07:209799
Aggressiveness Index	12.1	0	--		4500-H B	09/25/07:209335	4500HB	09/25/07:209800
Langlier Index	0.2	0	--		4500-H B	09/25/07:209335	4500HB	09/25/07:209800

ND=Non-Detected. PQL=Practical Quantitation Limit. Containers: (P) Plastic Preservatives: H2SO4 pH < 2, HNO3 pH < 2

FGL ENVIRONMENTAL

ANALYTICAL CHEMISTS

October 25, 2007

Hopkins Groundwater Consultants Inc.
P. O. Box 3596
Ventura, CA 93006-3596

Lab ID : SP 0710727-002
Customer ID : 2-20807

Sampled On : September 25, 2007-13:10
Sampled By : B. Cosner
Received On : September 25, 2007-16:55
Matrix : Ground Water

Description : 03-007-07 Well Sample No.2
Project : Water Monitoring

Sample Results - Inorganic

Constituent	Result	PQL	Units	Note	Sample Preparation		Sample Analysis	
					Method	Date/ID	Method	Date/ID
General Mineral P:1'4								
Total Hardness	719	2.5	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Calcium	204	1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Magnesium	51	1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Potassium	5	1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Sodium	143	1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Total Cations	20.7	0.1	meq/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Boron	0.5	0.1	mg/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Copper	ND	10	ug/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Iron	180	50	ug/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Manganese	150	10	ug/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Zinc	ND	20	ug/L		200.7	10/01/07:209567	200.7	10/01/07:210057
SAR	2.3	0.1	meq/L		200.7	10/01/07:209567	200.7	10/01/07:210057
Total Alkalinity (as CaCO3)	230	10	mg/L		2320B	09/28/07:209470	2320B	09/28/07:209945
Hydroxide	ND	10	mg/L		2320B	09/28/07:209470	2320B	09/28/07:209945
Carbonate	ND	10	mg/L		2320B	09/28/07:209470	2320B	09/28/07:209945
Bicarbonate	290	10	mg/L		2320B	09/28/07:209470	2320B	09/28/07:209945
Sulfate	700	10	mg/L		300.0	10/08/07:209789	300.0	10/10/07:210483
Chloride	177	5	mg/L		300.0	10/08/07:209789	300.0	10/10/07:210483
Nitrate	ND	0.4	mg/L		4500NO3F	09/27/07:209403	4500NO3F	09/27/07:210013
Nitrite as N	ND	0.1	mg/L		4500NO2B	09/26/07:209343	4500NO2B	09/25/07:209804
Fluoride	0.1	0.1	mg/L		300.0	10/08/07:209789	300.0	10/10/07:210483
Total Anions	24.3	0.1	meq/L		2320B	09/28/07:209470	2320B	09/28/07:209945
pH	7.1	---	units		4500-H B	09/25/07:209335	4500HB	09/25/07:209800
Specific Conductance	1930	1	umhos/cm		2510B	09/26/07:209352	2510B	09/26/07:209813
Total Dissolved Solids	1440	20	mg/L		2540 C,E	09/27/07:209399	2540C	09/28/07:209924
MBAS (foaming agents)	ND	0.1	mg/L		5540C	09/25/07:209337	5540C	09/25/07:209799
Aggressiveness Index	12.2	0	--		4500-H B	09/25/07:209335	4500HB	09/25/07:209800
Langlier Index	0.2	0	--		4500-H B	09/25/07:209335	4500HB	09/25/07:209800

ND=Non-Detected. PQL=Practical Quantitation Limit. Containers: (P) Plastic Preservatives: H2SO4 pH < 2, HNO3 pH < 2

October 25, 2007
Hopkins Groundwater Consultants, Inc.

Lab ID : SP 0710727
Customer : 2-20807

Quality Control - Inorganic

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Metals								
Boron	200.7	10/01/2007:209567	MS	mg/L	4.000	91.5 %	75-125	
			MSD	mg/L	4.000	92.6 %	75-125	
			MSRPD	mg/L	800.0	1.0%	≤20.0	
	200.7	10/01/2007:210057	CCV	ppm	5.000	94.9 %	90-110	
			CCB	ppm		0.065	0.10	
			CCV	ppm	5.000	92.1 %	90-110	
			CCB	ppm		0.032	0.10	
Calcium	200.7	10/01/2007:209567	MS	mg/L	12.50	69.7 %	<¼	
			MSD	mg/L	12.50	63.9 %	<¼	
			MSRPD	mg/L	800.0	0.5%	≤20.0	
	200.7	10/01/2007:210057	CCV	ppm	25.00	93.9 %	90-110	
			CCB	ppm		0.02	1.0	
			CCV	ppm	25.00	93.3 %	90-110	
			CCB	ppm		0.02	1.0	
Copper	200.7	10/01/2007:209567	MS	ug/L	800.0	90.9 %	75-125	
			MSD	ug/L	800.0	90.5 %	75-125	
			MSRPD	ug/L	800.0	0.4%	≤20.0	
	200.7	10/01/2007:210057	CCV	ppm	1.000	93.8 %	90-110	
			CCB	ppm		0.0019	0.01	
			CCV	ppm	1.000	92.7 %	90-110	
			CCB	ppm		0.0019	0.01	
Iron	200.7	10/01/2007:209567	MS	ug/L	4000	88.7 %	75-125	
			MSD	ug/L	4000	89.0 %	75-125	
			MSRPD	ug/L	800.0	0.3%	≤20.0	
	200.7	10/01/2007:210057	CCV	ppm	5.000	92.9 %	90-110	
			CCB	ppm		-0.0119	0.05	
			CCV	ppm	5.000	92.3 %	90-110	
			CCB	ppm		-0.0097	0.05	
Magnesium	200.7	10/01/2007:209567	MS	mg/L	12.50	85.8 %	75-125	
			MSD	mg/L	12.50	83.4 %	75-125	
			MSRPD	mg/L	800.0	0.6%	≤20.0	
	200.7	10/01/2007:210057	CCV	ppm	25.00	91.4 %	90-110	
			CCB	ppm		0.02	1.0	
			CCV	ppm	25.00	90.8 %	90-110	
			CCB	ppm		0.02	1.0	
Manganese	200.7	10/01/2007:209567	MS	ug/L	800.0	87.9 %	75-125	
			MSD	ug/L	800.0	87.7 %	75-125	
			MSRPD	ug/L	800.0	0.2%	≤20.0	
	200.7	10/01/2007:210057	CCV	ppm	1.000	92.4 %	90-110	
			CCB	ppm		0.0016	0.01	
			CCV	ppm	1.000	91.6 %	90-110	
			CCB	ppm		0.0017	0.01	
Potassium	200.7	10/01/2007:209567	MS	mg/L	12.50	103 %	75-125	
			MSD	mg/L	12.50	102 %	75-125	
			MSRPD	mg/L	800.0	0.6%	≤20.0	
	200.7	10/01/2007:210057	CCV	ppm	25.00	94.5 %	90-110	
			CCB	ppm		-0.02	1.0	
			CCV	ppm	25.00	93.7 %	90-110	
			CCB	ppm		0.05	1.0	
Sodium	200.7	10/01/2007:209567	MS	mg/L	12.50	70.3 %	<¼	
			MSD	mg/L	12.50	59.2 %	<¼	
			MSRPD	mg/L	800.0	0.8%	≤20.0	
	200.7	10/01/2007:210057	CCV	ppm	25.00	90.7 %	90-110	
			CCB	ppm		0.15	1.0	
			CCV	ppm	25.00	89.7 %	90-110	

October 25, 2007 | Lab ID : SP 0710727

Hopkins Groundwater Consultants, Inc. | Customer : 2-20807

Quality Control - Inorganic

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Metals								
Sodium	200.7	10/01/2007:210057	CCB	ppm		0.21	1.0	
Zinc			MS	ug/L	2000	90.2 %	75-125	
			MSD	ug/L	2000	90.9 %	75-125	
			MSRPD	ug/L	800.0	0.8%	≤20.0	
	200.7	10/01/2007:210057	CCV	ppm	1.000	91.9 %	90-110	
			CCB	ppm		0.0057	0.02	
			CCV	ppm	1.000	92.0 %	90-110	
			CCB	ppm		0.0063	0.02	
Wet Chem								
Alkalinity (as CaCO3)	2320B	09/28/2007:209470	Dup	mg/L		0.3%	3.42	
	2320B	09/28/2007:209945	ICV	mg/l	234.9	101 %	90-110	
			CCV	mg/l	234.9	100 %	90-110	
Bicarbonate	2320B	09/28/2007:209470	Dup	mg/l		0.3%	4.78	
Carbonate			Dup	mg/l		0.0	10	
Chloride	300.0	10/08/2007:209789	LCS	mg/L	25.00	105 %	90-110	
			MS	mg/L	500.0	116 %	86-128	
			MSD	mg/L	500.0	116 %	86-128	
			MSRPD	mg/L	100.0	0.05%	≤23.0	
	300.0	10/10/2007:210483	CCB	ppm		0.06	1	
			CCV	ppm	25.00	108 %	90-110	
			CCB	ppm		0.06	1	
			CCV	ppm	25.00	109 %	90-110	
Conductivity	2510B	09/26/2007:209813	ICB	umhos/cm		0.1	1	
			CCV	umhos/cm	998.0	101 %	95-105	
			CCV	umhos/cm	998.0	101 %	95-105	
E. C.	2510B	09/26/2007:209352	Blank	umhos/cm		ND	<1	
			Dup	umhos/cm		0.1%	0.372	
Fluoride	300.0	10/08/2007:209789	LCS	mg/L	2.500	110 %	90-110	
			MS	mg/L	50.00	118 %	81-126	
			MSD	mg/L	50.00	119 %	81-126	
			MSRPD	mg/L	100.0	0.4%	≤12.1	
	300.0	10/10/2007:210483	CCB	ppm		0.000	0.1	
			CCV	ppm	2.500	109 %	90-110	
			CCB	ppm		0.000	0.1	
			CCV	ppm	2.500	110 %	90-110	
Hydroxide	2320B	09/28/2007:209470	Dup	mg/l		0.0	10	
MBAS	5540C	09/25/2007:209337	MS	mg/L	1.000	100 %	90-110	
			MSD	mg/L	1.000	100 %	90-110	
			MSRPD	mg/L	1.000	0.0	≤0.1	
	5540C	09/25/2007:209799	CCB	mg/L		0.000	0.1	
			CCV	mg/L	1.000	100 %	99-101	
Nitrate + Nitrite as N	4500NO3F	09/27/2007:209403	MS	mg/L	4.000	61.0 %	5-285	
			MSD	mg/L	4.000	61.0 %	5-285	
			MSRPD	mg/L	4.000	0.0%	≤30.4	
	4500NO3F	09/27/2007:210013	CCB	mg/l		-0.011	0.1	
			CCV	mg/l	4.000	96.8 %	90-110	
			CCB	mg/l		-0.005	0.1	
			CCV	mg/l	4.000	95.5 %	90-110	
Nitrite as Nitrogen	4500NO2B	09/25/2007:209804	CCV	mg/L	0.1522	95.7 %	90-110	
			CCB	mg/L		-0.0007	0.1	
			CCV	mg/L	0.1522	96.6 %	90-110	
			CCB	mg/L		-0.0007	0.1	
	4500NO2B	09/26/2007:209343	MS	mg/L	0.4568	23.4 %	1-173	
			MSD	mg/L	0.4568	22.8 %	1-173	
			MSRPD	mg/L	0.4568	0.0028	≤0.1	
pH	4500-H B	09/25/2007:209335	Dup	units		0.8%	4.80	
	4500HB	09/25/2007:209800	CCV	units	8.000	101 %	95-105	

October 25, 2007 | Lab ID : SP 0710727

Hopkins Groundwater Consultants, Inc. | Customer : 2-20807

Quality Control - Inorganic

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Wet Chem								
pH	4500HB	09/25/2007:209800	CCV	units	8.000	100 %	95-105	
Solids, Total Dissovled			Blank	mg/L		20	20	
			LCS	mg/L	1000	99.6 %	90-110	
			LCS	mg/L	1000	103 %	90-110	
			Dup	mg/L		1.6%	10.0	
Sulfate	300.0	10/08/2007:209789	LCS	mg/L	50.00	104 %	90-110	
			MS	mg/L	1000	115 %	78-137	
			MSD	mg/L	1000	115 %	78-137	
			MSRPD	mg/L	100.0	0.2%	≤12.3	
	300.0	10/10/2007:210483	CCB	ppm		1.08	2	
			CCV	ppm	50.00	106 %	90-110	
			CCB	ppm		1.06	2	
			CCV	ppm	50.00	106 %	90-110	

Definition

ICV	: Initial Calibration Verification - Analyzed to verify the instrument calibration is within criteria.
ICB	: Initial Calibration Blank - Analyzed to verify the instrument baseline is within criteria.
CCV	: Continuing Calibration Verification - Analyzed to verify the instrument calibration is within criteria.
CCB	: Continuing Calibration Blank - Analyzed to verify the instrument baseline is within criteria.
Blank	: Method Blank - Prepared to verify that the preparation process is not contributing contamination to the samples.
LCS	: Laboratory Control Standard/Sample - Prepared to verify that the preparation process is not affecting analyte recovery.
MS	: Matrix Spikes - A random sample is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.
MSD	: Matrix Spike Duplicate of MS/MSD pair - A random sample duplicate is spiked with a known amount of analyted. The recoveries are an indication of how that sample matrix affects analyte recovery.
Dup	: Duplicate Sample - A random sample with each batch is prepared and analyzed in duplicate. The relative percent difference is an indication of precision for the preparation and analysis.
MSRPD	: MS/MSD Relative Percent Difference (RPD) - The MS relative percent difference is an indication of precision for the preparation and analysis.
ND	: Non-detect - Result was below the DQO listed for the analyte.
<¼	: High Sample Background - Spike concentration was less than one forth of the sample concentration.
DQO	: Data Quality Objective - This is the criteria against which the quality control data is compared.

FGL ENVIRONMENTAL

CHAIN OF CUSTODY
AND ANALYSIS REQUEST DOCUMENT

ORIGINAL

CLIENT DETAILS — SECTION I

Client: HOPKINS GROUNDWATER

☐ New Customer   Customer Number: ______

Address: P.O. BOX 3596
VENTURA, CA 93006

Phone: 805-653-5306

FAX: 805-653-5346

Project name: ______

Contact person: C. HOPKINS

Billing Information (if different from above)

Name: ______

Address: ______

Phone: ______

FAX: ______

Contact person: ______

Purchase order/contract/FGL quote number: ______

Pre Log Required: yes ______   Frequency: Monthly ☐ Weekly ☐ Quarterly ☐ Other ☐ ______

SAMPLING — SECTION II

Sampler (s): B. COSNER

Comp Sampler Set up Date: ______ Time: ______

Time: ______ Mileage: ______

Shipping Charge: ______ Pickup Charge: ______

REPORT INFORMATION — SECTION III

Rush Analysis (surcharge will apply):

☐ 5 Day ☐ 4 Day ☐ 3 Day ☐ 2 Day ☐ 24 hour

Rush pre-approval by lab: ______ inital

Electronic Data Transfer: yes ______ no ______

If yes, To: State ______ Client ______ Other ______

Lab number: 710727

SAMPLE INFORMATION — SECTION IV

Sample Number	Location/Description	Date Sampled	Time Sampled	Type of Sampling: Composite(C) Grab(G)	Number of Containers	Type of Containers: (G) Glass (P) Plastic (V) VOA (MT) Metal Tube	(P) Potable (NP) Non-Potable	(SW) Surface Water (GW) Ground Water (WW) Wastewater (MW) Monitoring Well (TB) Travel Blank (DW) Drinking Water	(S) Soil (SLG) Sludge (SLD) Solid (O) Oil	BacT: (Sys) System (SRC) Source (W) Waste	BacT: Routine (ROUT) Repeat (RPT) Other (OTH) Replace (RPL)	(LT) Leaf Tissue (PET) Petiole Tissue (PRD) Produce	Preservative: (1) NaOH + ZnAc, (2) NaOH, (3) HCl, (4) H2SO4, (5) HNO3, (6) Na2S2O3, (7) Other	ANALYSES REQUESTED: GEN-MIN
1	03-007-07 CREEK SAMPLE NO. 1	09-25-07	10:43	G	3	P	P	SW					4,5	X
2	03-007-07 WELL SAMPLE NO. 2	09-25-07	13:10	G	3	P	P	GW					4,5	X

To Lab D/I:

REMARKS — SECTION V

CUSTODY — SECTION VI

Relinquished by and subject to the terms and conditions on the reverse of this document:

		Date	Time
Relinquished by	B. Cosner (signature)	09-25-07	16:31
Received by	(signature)	9-25-07	16:31
Relinquished by	(signature)	9-25-07	1655
Received by	(signature)	9/25/07	1655
Relinquished by			
Received by			
Relinquished by			
Received by			

CORPORATE OFFICE & LABORATORY
P.O. Box 272/853 Corporation Street
Santa Paula, CA 93061-0272
Tel. (805) 659-0910
FAX: (805) 525-4172

OFFICE & LABORATORY
2500 Stagecoach Road
Stockton, CA 95215
Tel (209) 942-0181
FAX (209) 942-0423

FIELD OFFICE
Visalia, California
Tel: (559) 734-9473
Mobile: (559) 737-2399
FAX (559) 734-8435

Santa Paula - Condition Upon Receipt (Attach to COC)

Sample Receipt:

1. Number of ice chests/packages received: OTC
   Note as OTC if received over the counter unpackaged.
2. Were samples received in a chilled condition? Temps: ROI / ____ / ____ / ____ / ____
   Acceptable is above freezing to 6° C. Also acceptable is received on ice (ROI) for the same day of sampling or received at room temperature (RRT) if sampled within one hour of receipt. Client contact for temperature failures must be documented below. If many packages are received at one time check for tests/H.T.'s/rushes/Bacti's to prioritize further review. Please notify Microbiology personnel immediately of bacti samples received.
3. Do the number of bottles received agree with the COC? **(Yes)** No N/A
4. Were samples received intact? (i.e. no broken bottles, leaks etc.) **(Yes)** No
5. Were sample custody seals intact? **(N/A)** Yes No

Sign and date the COC, obtain LIMS sample numbers, select methods/tests and print labels.

Sample Verification, Labeling and Distribution:

1. Were all requested analyses understood and acceptable? **(Yes)** No
2. Did bottle labels correspond with the client's ID's? **(Yes)** No
3. Were all bottles requiring sample preservation properly preserved? **(Yes)** No N/A FGL
4. Were all analyses within holding times at time of receipt? **(Yes)** No
5. Have rush or project due dates been checked and accepted? **(N/A)** Yes No

Attach labels to the containers and include a copy of the COC for lab delivery.

Sample Receipt, Login and Verification completed by (initials): [signature]

Discrepancy Documentation:

Any items above which are "No" or do not meet specifications (i.e. temps) must be resolved.

1. Person Contacted:______________________ Phone Number:______________
   Initiated By:______________________ Date:____________
   Problem:

   Resolution:

2. Person Contacted:______________________ Phone Number:______________
   Initiated By:______________________ Date:____________
   Problem:

   Resolution:

ZYMAX FORENSICS
DELTA OXYGEN-18, DELTA DEUTERIUM, AND DELTA NITROGEN-15 ANALYSES

ZymaX FORENSICS

REPORT OF ANALYTICAL RESULTS

Client:	Brian Cosner Hopkins Groundwater Consultants P.O.B. 3596 Ventura, CA 93006-3596
Lab Number:	40702
Received:	9/26/2007
Matrix:	Water
Project:	Isotopes
Project Number:	03-007-07
Collected by:	Client
Sample Description:	See Below
Analyzed:	10/26/2007
Method:	CF-IRMS

$\delta^{18}O$ δD

LAB NUMBER	SAMPLE DESCRIPTION	$\delta^{18}O$ ‰	δD ‰
40702-1	03-007-07 Creek Sample No.1	-8.0	-55.0
40702-2	03-007-07 Well Sample No.2	-7.4	-52.6
Analytical Precision (1-sigma)		0.2	0.7

Submitted by,
Zymax Forensics, a DPRA company

River He, PhD
Isotope Lab Manager

40702-1h2o.xls
RH D12.03 04

ZymaX FORENSICS

REPORT OF ANALYTICAL RESULTS

Client:	Brian Cosner Hopkins Groundwater Consultants P.O.B. 3596 Ventura, CA 93006-3596	Lab Number:	40702
		Received:	9/26/2007
		Matrix:	Water
Project:	Isotopes	Sample Description:	See Below
Project Number:	03-007-07	Analyzed:	10/31/2007
Collected by:	Client	Method:	CF-IRMS

$\delta^{15}N$ $\delta^{18}O$ (Nitrate)

LAB NUMBER	SAMPLE DESCRIPTION	$\delta^{15}N$ ‰
40702-1	03-007-07 Creek Sample No.1	10.9
40702-2	03-007-07 Well Sample No.2	12.4
Analytical Precision (1-sigma)		0.4

Submitted by,
Zymax Forensics, a DPRA company

River He, PhD
Isotope Lab Manager

40702-1NO3.xls
RH

ISOTECH LABORATORIES
TRITIUM ANALYSIS

Isotech Water Data

Job 8883

Project 03-007-07

Isotech Lab No.	Sample Name	Tritium TU	Std. Dev.
124384	Creek Sample #1	3.87	0.23
124385	03-007-07 Well Sample #2	2.84	0.22