Chino Basin

Optimum Basin Management Program

2008 State of the Basin Report

Final Report

Prepared for

Chino Basin Watermaster

Prepared by

WILDERMUTH ENVIRONMENTAL INC.

NOVEMBER 2009

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Acronyms, Abbreviations, and Initialisms

µg/L	micrograms per liter
1,1,1-TCA	1,1,1-trichloroethane
1,1-DCE	1,1-dichloroethene
1,2,3-TCP	1,2,3-trichloropropane
1,2-DCA	1,2-dichloroethane
AF	acre-feet
AFY	acre-feet per year
B&V	Black & Veatch, Inc.
Basin Plan	Water Quality Control Plan for the Santa Ana River Basin
CAO	Cleanup and Abatement Order
CBWM ID	Chino Basin Watermaster Well Identification
CDA	Chino Desalter Authority
CDFM	cumulative departure from mean precipitation
CDPH	California Department of Public Health (formerly the Department of Health Services)
CIM	California Institution for Men
cis-1,2-DCE	cis-1,2-dichloroethene
COPC	Constituents of Potential Concern
CVWD	Cucamonga Valley Water District
DLR	detection limit for reporting
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EMP	Evaluation Monitoring Program
EPA	US Environmental Protection Agency
ft	feet
ft-bgs	feet below ground surface
ft-brp	feet below reference point (*e.g.* static surveyed measurement point)
GE	General Electric
GIS	Geographic Information System
GRCC	Groundwater Recharge Coordination Committee
HCMP	Hydraulic Control Monitoring Program
IEUA	Inland Empire Utilities Agency

Acronyms, Abbreviations, and Initialisms

InSAR	Synthetic Aperture Radar Interferometry
ISOB	Initial State of the Basin
JCSD	Jurupa Community Services District
M&RP	Monitoring and Reporting Program
MCL	maximum contaminant level
mg/L	milligrams per liter
MSL	Milliken Sanitary Landfill
MVSL	Mid-Valley Sanitary Landfill
MVWD	Monte Vista Water District
MWDSC	Metropolitan Water District of Southern California
MZ	Management Zone
NDMA	N-nitrosodimethylamine
NO_3 - N	Nitrate expressed as nitrogen
NPL	National Priorities List
OBMP	Optimum Basin Management Program
OIA	Ontario International Airport
PBMZ	Prado Basin Management Zone
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
ROD	Records of Decision
RP	Regional Plant
RWQCB	Regional Water Quality Control Board
SARWC	Santa Ana River Water Company
SOB	State of the Basin
SWP	State Water Project
SWQIS	State Water Quality Information System
TCE	trichloroethene
TDS	total dissolved solids
TOC	total organic carbon
US EPA	US Environmental Protection Agency
USGS	US Geological Survey
USL	Upland Sanitary Landfill

Acronyms, Abbreviations, and Initialisms

VOC	volatile organic chemical
Watermaster	Chino Basin Watermaster
WEI	Wildermuth Environmental, Inc.
WQS	water quality standard

ES-1 Summary and Background

The baseline for the ISOB was on or about July 1, 2000—the point in time that represents the start of Optimum Basin Management Program (OBMP) implementation. The State of the Basin (SOB) reports serve as a metric for measuring OBMP implementation progress. This current SOB report contains water level, water quality, ground-level, and other data through 2007/08 and describes Watermaster activity through fall 2008.

The intent of this report is twofold:

- During Watermaster fiscal year 2000/01, several OBMP-spawned investigations and initiatives commenced, encompassing groundwater level and quality, ground level, annual recharge assessment, recharge master planning, hydraulic control, desalter planning and engineering, and meter installation. This report describes the progress made in these activities through the fall of 2008.
- This report also describes the general state of the basin with respect to groundwater levels, groundwater quality, subsidence, recharge, and hydraulic control.

ES-2 Section 2 – General Hydrologic Condition

The Chino Basin covers about 220 square miles. Figure 2-1 shows the location of the Chino Basin within the context of the Santa Ana River watershed. The watershed of the Chino Basin is almost identical to the Santa Ana River at Prado, the exception being the addition of the Temescal Creek watershed that enters the Prado Dam reservoir just upstream of the dam and for practical purposes contributes negligible inflow to the Chino Basin. In total, the watershed area for streams crossing the Chino Basin is about 1490 square miles.

The Chino Basin has a semi-arid Mediterranean climate. Precipitation is a major source of local groundwater recharge for the Basin and thus, the availability of this recharge can be understood by analyzing long-term precipitation records.

The hydrologic regime in the Chino Basin has important implications for water supply and groundwater management. The occurrence of long dry periods, characteristic of the region's climate, limit the recharge of precipitation and storm water recharge for years at a time and requires management strategies that conserve precipitation and storm water recharge whenever available. The amount of stormwater produced per unit of precipitation has increased over time due to urbanization and will continue to increase in the future as the remaining undeveloped and agricultural land uses are converted to developed uses.

ES-3 Section 3 – Basin Operations and Groundwater Monitoring

Future re-determinations of safe yield for the Chino Basin will be based largely on accurate estimations of groundwater production, artificial recharge, and basin storage changes over time. Watermaster is actively improving its programs to track production, recharge, and groundwater levels (storage). A meter installation program has improved production estimates in the agricultural areas. Watermaster continues to implement comprehensive, high-frequency, groundwater-level monitoring programs across the basin to support various OBMP-related activities. Since 2003, Watermaster has been installing pressure transducers/data loggers in many of the wells it monitors for water levels to improve data quality. In addition, nine (9) nested sets of monitoring wells have been installed in the southern Chino Basin for the HCMP and provide highly detailed, depth-specific piezometric (and water quality) data. It is likely that additional monitoring wells will need to be constructed in southern Chino Basin as private wells (that are currently being used for monitoring by Watermaster) are destroyed as agricultural land uses convert to urban.

The following are the general trends in groundwater production:

- There was a basin-wide increase in the number of wells producing over 1,000 AFY between 1978 and 2008. This is consistent with (1) the land use transition from agricultural to urban, (2) the trend of increasing imported water costs, and (3) the use of desalters.
- Since the implementation of the OBMP in 2000, the number of active production wells just north of the Santa Ana River has decreased. This is consistent with the conversion of land use from agricultural to urban that has been occurring in the area.
- Since the implementation of the OBMP in 2000, desalter pumping has commenced and has progressively increased; in 2007/08, desalter pumping reached a historical high of 26,972 AF.
- Since the implementation of the OBMP in 2000, the number of wells that produce over 1,000 AFY on the west side of Chino Basin (west of Euclid Avenue) has decreased. This is consistent with (1) the implementation of the MZ1 Interim Management Plan, which reduced pumping by up to 3,000 AFY in the Chino area, and (2) the reduced pumping by the City of Pomona, the Monte Vista Water District, and the City of Chino Hills from 2003 to 2008 as these agencies have been participating in in-lieu recharge for the Dry Year Yield program.
- Agricultural Pool pumping continues to decline. In 2007/08, total production for the Agricultural Pool fell to 30,910 AF, the lowest production on record for the pool. In accordance with the hypothesis that urbanization is the cause of decreased agricultural production, Appropriative Pool production tends to increase at approximately the same rate that Agricultural Pool production decreases.

As required by the Peace Agreement and summarized in the OBMP Recharge Master Plan, Watermaster initiated the Chino Basin Groundwater Recharge Program. This is a comprehensive program to enhance water supply reliability and improve the groundwater quality of local drinking water wells throughout the Chino Basin by increasing the recharge of storm water, imported water, and recycled water.

There are 21 Chino Basin recharge facilities described in the OBMP Recharge Master Plan, Phase II Report (WEI, 2001).

The following are the general trends in groundwater recharge:

- Since 2000, total storm water recharge has averaged approximately 4,600 AFY. During 2006/07 and 2007/08, total storm water recharge in the Chino Basin was approximately 4,600 and 9,900 AF, respectively.

- Since 2000, the total supplemental water recharge—consisting of imported and recycled waters—has averaged approximately 11,500 AFY. During 2006/07 and 2007/08, total supplemental water recharge in the Chino Basin was approximately 6,350 and 2,400 AF, respectively.

The Chino Basin groundwater level analysis for fall 2008 revealed notable pumping depressions in the groundwater level surface that interrupt the general flow pattern surrounding the Chino I & Chino II Desalter well fields. There are also discernible groundwater level depressions in the northern portion of MZ1 (Montclair and Pomona areas) and directly southwest of the Jurupa Hills due to local groundwater production.

Watermaster has developed a Geographic Information System model to estimate groundwater storage changes from groundwater level contour maps. This model was utilized to estimate storage changes during the period following OBMP implementation. During the 2006 to 08 period, storage changed by about -54,000 AF. The total change in storage since implementation of the OBMP (2000-08) is approximately -62,000 AF.

With regard to hydraulic control, since 2000, pumping at the Chino I Desalter well field has generally flattened the regional hydraulic gradient within the shallow aquifer system around the western half of the Chino I Desalter well field and has created a capture zone surrounding the eastern half of the well field. Piezometric data suggest a significant reduction in the southward component of the hydraulic gradient around the western half of the Chino I Desalter well field but do not indicate a gradient reversal (northward component) and, hence, do not yet provide compelling evidence for complete hydraulic control at the Chino I Desalter well field. The ultimate fate of groundwater that flows past the Chino I Desalter well field is continued flow southward toward Prado Basin where groundwater rises to become surface water in the tributaries of Prado Basin.

ES-4 Section 4 – Groundwater Quality

Watermaster continues to monitor water quality in the basin and stores these data in a relational database, which also includes all of the historical data that Watermaster has been able to acquire for wells in the region. Watermaster has instituted a cooperative process whereby water quality data are acquired on a routine basis from the appropriators. This alleviates some of the data quality control issues with downloading data from the state water quality database.

Groundwater quality in Chino Basin is generally very good with better groundwater quality found in the northern portion of Chino Basin where recharge occurs. Salinity (TDS) and nitrate-nitrogen concentrations increase in the southern portion of Chino Basin. Between July 2003 and June 2008, 32 percent of the wells south of Highway 60 had TDS concentrations below the secondary MCL, an improvement from the 20 percent reported in the 2006 State of the Basin Report (period of July 2001 through June 2006). In some places, wells with low TDS concentrations are proximate to wells with higher TDS concentrations, suggesting a vertical stratification of water quality. Between July 2003 and June 2008, about 69 percent of the wells sampled south of Highway 60 had nitrate-nitrogen concentrations greater than the MCL, an improvement from the 80 percent reported in the 2006 State of the Basin Report (period of July 2001 through June 2006). However, please note that these statistical improvements may be an artifact of sampling occurrence and frequency.

Other constituents that impact groundwater quality from a regulatory or Basin Plan standpoint include certain VOCs, arsenic, and perchlorate. As discussed in Section 4.3.4, there are a number of point source releases of VOCs in the Chino Basin that are in various stages of investigation or cleanup. There are also known point source releases of perchlorate (Milliken Valley Sanitary Landfill, Stringfellow, etc.), and non-point source related perchlorate contamination appears to have resulted from natural and anthropogenic sources. Arsenic at levels above the WQS appears to be limited to the deeper aquifer zone near the City of Chino Hills. Hexavalent chromium, while not currently a groundwater quality issue in the Chino Basin, may become so, depending on the promulgation of future standards.

The Initial State of the Basin and subsequent State of the Basin Reports discussed the need for future long-term monitoring. Due to commercial and residential development in the Chino Basin area; many of the private agricultural wells south of State Route 60 that have been used for monitoring activities are being destroyed as land is developed. In response to the loss of historically utilized wells, Watermaster developed a water quality key well program. This program designates a series of wells across a wide areal distribution for long-term monitoring activities. This key well monitoring program provides a good representation of the areal groundwater quality in this portion of the basin. Watermaster's program relies on municipal producers, government agencies, and private consultants to supply their groundwater quality data on a cooperative basis. Watermaster supplements these data with data obtained through its own sampling and analysis program of private wells in the area generally south of State Route 60. As with past water quality monitoring, the results will be added to the Watermaster database.

Point sources of concern are critical to the overall quality of Chino Basin groundwater. To ensure that Chino Basin groundwater remains a sustainable resource, it is of the utmost importance that Watermaster closely monitor point sources and emerging contaminates. It is recommended that Watermaster continue to work closely with the RWQCB and potentially responsible parties within the Chino Basin. This will allow for up-to-date understanding of groundwater quality, investigations, remediation activities, and potential mutually beneficial remedial options through Chino Basin desalting facilities.

ES-5 Section 5 – Ground-Level Monitoring

Implementation of the MZ1 Plan began in 2008. The MZ1 Plan calls for (1) the continued scope and frequency of monitoring implemented during the IMP within the MZ1 Managed Area and (2) expanded monitoring of the aquifer system and land subsidence in other areas of the Chino Basin where the Interim Management Plan (IMP) indicated concern for future subsidence and ground fissuring. The expanded monitoring efforts outside of the MZ1 Managed Area are consistent with the requirements of PE1.

Watermaster's current ground-level monitoring program includes:

- *Piezometric Levels.* Piezometric levels are an important part of the ground-level monitoring program because piezometric changes are the mechanism for aquifer-system deformation and land subsidence.
- *Aquifer-System Deformation.* Watermaster records aquifer-system deformation at the Ayala Park Extensometer facility where two extensometers record the vertical component of aquifer-system compression and/or expansion once every 15 minutes.
- *Vertical Ground-Surface Deformation.* Watermaster monitors vertical ground-surface deformation via the ground-level surveying and remote sensing (InSAR) techniques established during the IMP.
- *Horizontal Ground-Surface Deformation.* Watermaster monitors horizontal ground-surface displacement across the eastern side of the subsidence trough and the adjacent area east of the barrier/fissure zone. These data, obtained by electronic distance measurements (EDMs), are used to characterize the horizontal component of land surface displacement caused by groundwater production on either side of the fissure zone.

The conclusions and recommendations for Watermaster's basin-wide ground-level monitoring program are provided below:

- Land subsidence does not appear to be a concern in the eastern and northernmost portions of Chino Basin. In these areas, the underlying aquifer system is composed primarily of coarse-grained sediments that are not prone to compaction.

- Land subsidence and the potential for ground fissuring are major concerns in the western and southern portions of the Chino Basin. In these areas, the underlying aquifer system consists of interbedded, fine-grained sediment layers (aquitards) that can drain and compact when groundwater levels decline in the adjacent coarse-grained aquifers. Ground fissuring has occurred in the past where land subsidence was differential (i.e. steep gradient of subsidence). Ground fissuring is the main subsidence-related threat to infrastructure.

- Land subsidence has been persistent across most of the western and southern portions of the Chino Basin since, at least, 1987 when land subsidence monitoring began. In many of these areas, land subsidence continues even during periods of groundwater level recovery, indicating that thick, slowly-draining aquitards are compacting in response to the large historical drawdowns of 1935 to 1978.

- Pumping-induced drawdown has caused accelerated occurrences of land subsidence in the recent past, including subsidence in the City of Chino during the early 1990s and, currently, in the vicinity of the Chino I Desalter well field. Watermaster should anticipate similar occurrences of land subsidence in areas (1) that are prone to subsidence and (2) where drawdown will occur in the future.

- Watermaster will continue its basin-wide ground-level monitoring program, using InSAR and ground-level surveys. Watermaster will consider expanding the ground-level surveys to cover the area of the proposed Chino Creek Desalter Well Field. This is an area that is prone to subsidence, where drawdown is planned near where ground fissuring has occurred in the past, and where InSAR data is not currently available. Watermaster will also consider expanding the ground-level surveys to cover the Pomona and Ontario Areas. In general, InSAR data coverage is continuous and of high quality throughout both areas, so ground-level surveys would primarily provide supporting and confirmation data for the InSAR and would occur at a frequency of once every three to five years.

- Watermaster will consider installing low-cost piezometer/extensometer facilities at appropriate locations in all Areas of Subsidence Concern. This type of facility has been successfully constructed and tested at Ayala Park in Chino. Such facilities record the requisite data (1) to monitor land subsidence and groundwater levels at high resolution and accuracy, (2) to provide the information necessary to characterize the elastic and/or inelastic nature of any land subsidence occurring in an area, and (3) to provide the information necessary to characterize aquifer and aquitard properties that could be used in a predictive computer-simulation model of subsidence.

- Watermaster will consider building and calibrating predictive computer-simulation models of subsidence across all Areas of Subsidence Concern in the Chino Basin. These models would provide information on the rates and ultimate magnitude of land subsidence that could be associated with various basin management planning scenarios (i.e. pumping and recharge patterns). This information would be valuable to affected Watermaster parties.

- Because ground fissuring caused by differential land subsidence is the main threat to infrastructure, Watermaster will periodically inspect for signs of ground fissuring in areas that are experiencing differential land subsidence. In addition, Watermaster will consider monitoring the horizontal strain across these zones of potential ground fissuring in an effort to better understand and manage ground fissuring.

1.1 Background

The Chino Basin Watermaster (Watermaster) completed the *Initial State of the Basin* (ISOB) Report in October 2002. The baseline for the ISOB was on or about July 1, 2000—the point in time that represents the start of Optimum Basin Management Program (OBMP) implementation. The ISOB and subsequent State of the Basin (SOB) reports serve as a metric for measuring OBMP implementation progress. This current SOB report contains water level, water quality, ground-level, and other data through 2007/08 and describes Watermaster activity through fall 2008.

The OBMP was developed for the Chino Basin (see Figure 1-1 for the location of Chino Basin and its management zones) pursuant to the Judgment (Chino Basin Municipal Water District v. City of Chino, et al.) and the February 19, 1998 ruling (WEI, 1999). Pursuant to the OBMP Phase 1 Report, the Peace Agreement and associated Implementation Plan, and the November 15, 2001 Court Order, Watermaster staff has prepared this State of the Basin (SOB) Report. The intent of this report is twofold:

- During Watermaster fiscal year 2000/01, several OBMP-spawned investigations and initiatives commenced, encompassing groundwater level and quality, ground level, annual recharge assessment, recharge master planning, hydraulic control, desalter planning and engineering, and meter installation. This report describes the progress made in these activities through the fall of 2008.
- This report also describes the general state of the basin with respect to groundwater levels, groundwater quality, ground surface levels (subsidence), recharge, and hydraulic control.

1.2 Report Organization

Executive Summary: The Executive Summary provides a brief overview of the OBMP and its results.

Section 1 – Introduction: This section describes the project background, summarizes the project objectives, and provides an outline.

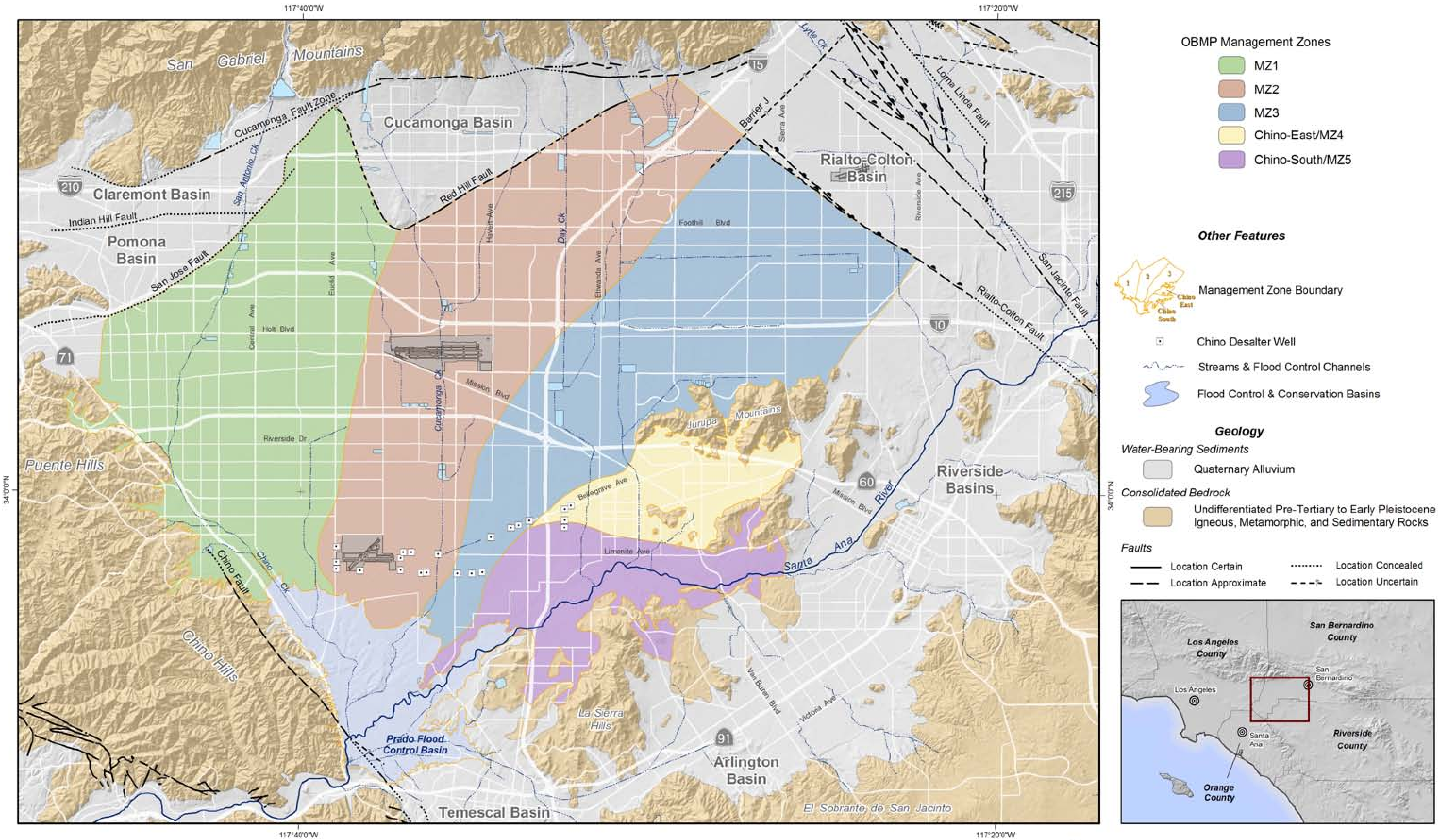
Section 2 – General Hydrologic Condition: Section 2 describes the general hydrologic condition of the Chino Basin.

Section 3 – Basin Operations and Groundwater Level Monitoring: Section 3 describes Basin operations, including groundwater level, groundwater quality, groundwater production, recharge, and ground surface monitoring efforts.

Section 4 – Groundwater Quality: Section 4 describes historical and current groundwater quality and lists and describes point sources of concern.

Section 5 – Ground Level Monitoring: Section 5 describes ground surface monitoring in the Basin using InSAR and traditional leveling surveys, describes areas of subsidence concern, and presents the results of the subsidence analyses.

Section 6 – References: Section 6 contains the references consulted in this investigation.



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File: Figure_1-1.mxd

2008 State of the Basin Report
Introduction

Chino Groundwater Basin
Management Zones

Figure 1-1

The Chino Basin covers about 220 square miles. Figure 2-1 shows the location of the Chino Basin within the context of the Santa Ana River watershed. The watershed of the Chino Basin is almost identical to the Santa Ana River at Prado, the exception being the addition of the Temescal Creek watershed that enters the Prado Dam reservoir just upstream of the dam and for practical purposes contributes negligible inflow to the Chino Basin. The Santa Ana River watershed area tributary to the Chino Basin at the MWD Crossing is about 852 square miles. The area tributary to the Chino Basin down stream of the MWD Crossing is about 414 square miles and includes the watershed areas of San Antonio and Chino Creeks, Cucamonga Creek, Day Creek, the East Etiwanda and San Sevaine Creeks, and small drainages from the Riverside and Arlington areas south of the Santa Ana River. In total, the watershed area for streams crossing the Chino Basin is about 1490 square miles. The time of concentration[1] for the Santa Ana River at the MWD Crossing is estimated to be between one to two days. By contrast the time of concentrations for streams discharging from north to south over the Chino Basin is a few hours.

2.1 Precipitation

The Chino Basin has a semi-arid Mediterranean climate. Precipitation is a major source of local groundwater recharge for the Basin and thus, the availability of this recharge can be understood by analyzing long-term precipitation records. Four precipitation stations in the Basin were used to characterize the long-term precipitation patterns in the Basin. The location of the precipitation station used herein to construct the Claremont/Montclair hybrid (combined records of 1034 and 1137)[2] station and the Ontario hybrid (combined records of 1017 and 1075) station records are shown in Figure 2-1. A third station of historical prominence in the Santa Ana watershed, the San Bernardino Hospital station, was used to characterize the historical precipitation upstream of the Chino Basin. The location of the San Bernardino Hospital station (2146) is shown in Figure 2-1. Table 2-1 lists annual statistics for the stations utilized in this characterization.

Figure 2-2 illustrates the annual precipitation time series and the cumulative departure from the mean (CDFM) precipitation for the 1900 to 2008 period at the Claremont/Montclair hybrid precipitation station. During this period, four series of dry-wet cycles are apparent: prior to 1904 through 1922; 1922 through 1946; 1946 through 1983, and 1983 through 1998. A fifth cycle appears to have started in 1998 and continues through present. The records of the Ontario hybrid and San Bernardino Hospital stations also show the same patterns of dry-wet cycles as the Claremont/Montclair hybrid station during the historic period (see Figures 2-3 and 2-4).

The long-term average annual precipitation for these stations are 17.8 inches at the Claremont/Montclair hybrid station (1900 through 2008), 15.4 inches at the Ontario hybrid

[1] The time of concentration is the time it takes for runoff from the most distant upstream part of the watershed to reach a specified point of interest.

[2] These two precipitation stations are close to each other, their overlapping records are highly correlated, and their records have been combined to produce a hybrid record of over 100 years duration.

station (1914 through 2008) and 16.4 inches at the and San Bernardino Hospital station (1900 through 2008). The ratio of dry years to wet years is about three to two. That is, for every ten years about six years will have below average precipitation and four years will have greater than average precipitation.

The safe yield of the Chino Basin is based on the hydrology during 1965 through 1974, a period of ten years (base period). This base period contains two wet years in 1965 and 1969 with annual precipitation depths of 24 and 26 inches, respectively, at the Claremont/Montclair hybrid station, and 19.8 and 25.6 inches, respectively at the Ontario hybrid station. This base period falls within the longest dry period on record (1946 to 1976). The average annual precipitation for the base period at the Claremont/Montclair hybrid station was 16.3 inches, or 1.5 inches less than the long-term annual average. The average annual precipitation for the base period at the Ontario hybrid station was 14.7 inches, or 0.6 inches less than the long-term annual average. The base period was preceded by a 20-year dry period that was punctuated with a few wet years (1952, 1954, 1957 and 1958).

The Peace Agreement period runs from 2000 to the present, an eight-year period. The Peace Agreement period contains three wet years in 2001, 2004, and 2005 with 19.7, 22.1, and 29.2 inches, respectively, as measured at the Claremont/Montclair hybrid station. The Peace Agreement period lies within a dry period that appears to have started in 1998 and continues to the present. The average annual precipitation for the Peace Agreement period at the Claremont/Montclair hybrid station was 16.6 inches, or 1.2 inches less than the long-term annual average.

2.2 Surface Water Discharge

The principal surface water features of the Chino Basin include the Santa Ana River and its tributaries in the reach between the MWD Crossing and Prado Dam. The main tributaries in this reach of the river include the San Antonio/Chino Creeks, Cucamonga Creek, Day Creek, and East Etiwanda/San Sevaine Creeks. Figure 2 1 shows the locations of these surface water features for the Chino Basin. Figure 2-1 shows the locations of two USGS discharge monitoring stations, one located at the MWD Upper Feeder Crossing of the Santa Ana River (11066460) that measures the discharge into the Chino Basin, and one located just downstream of Prado Dam (11074000) that measures the discharge exiting the watershed at the downstream end of the from the Chino and Temescal Basins.

Figure 2-5 shows the annual time history of storm flow for the Santa Ana River at below Prado Dam from water year 1919/20 to 2007/08 (October to September). Figure 2-5 also has a plot of the CDFM for precipitation at the Ontario hybrid station. Figure 2-5 demonstrates that that the relationship of precipitation to stormwater runoff changed significantly around water year 1977/78, such that more runoff per unit of precipitation was produced after 1977/78. To see this, note the positive slope of the CDFM (indicative of a wet period) during the 1936/37 to 1944/45 period. During this period, about 49 inches of precipitation occurred above the mean precipitation of 15.4 inches per year. From 1977/78 to 1982/83, another wet period, there was about 51 inches of precipitation above the mean but there was much more storm water discharge than occurred between 1937 and 1945. A similar observation can be made about the 1991/92 to 1997/98 period.

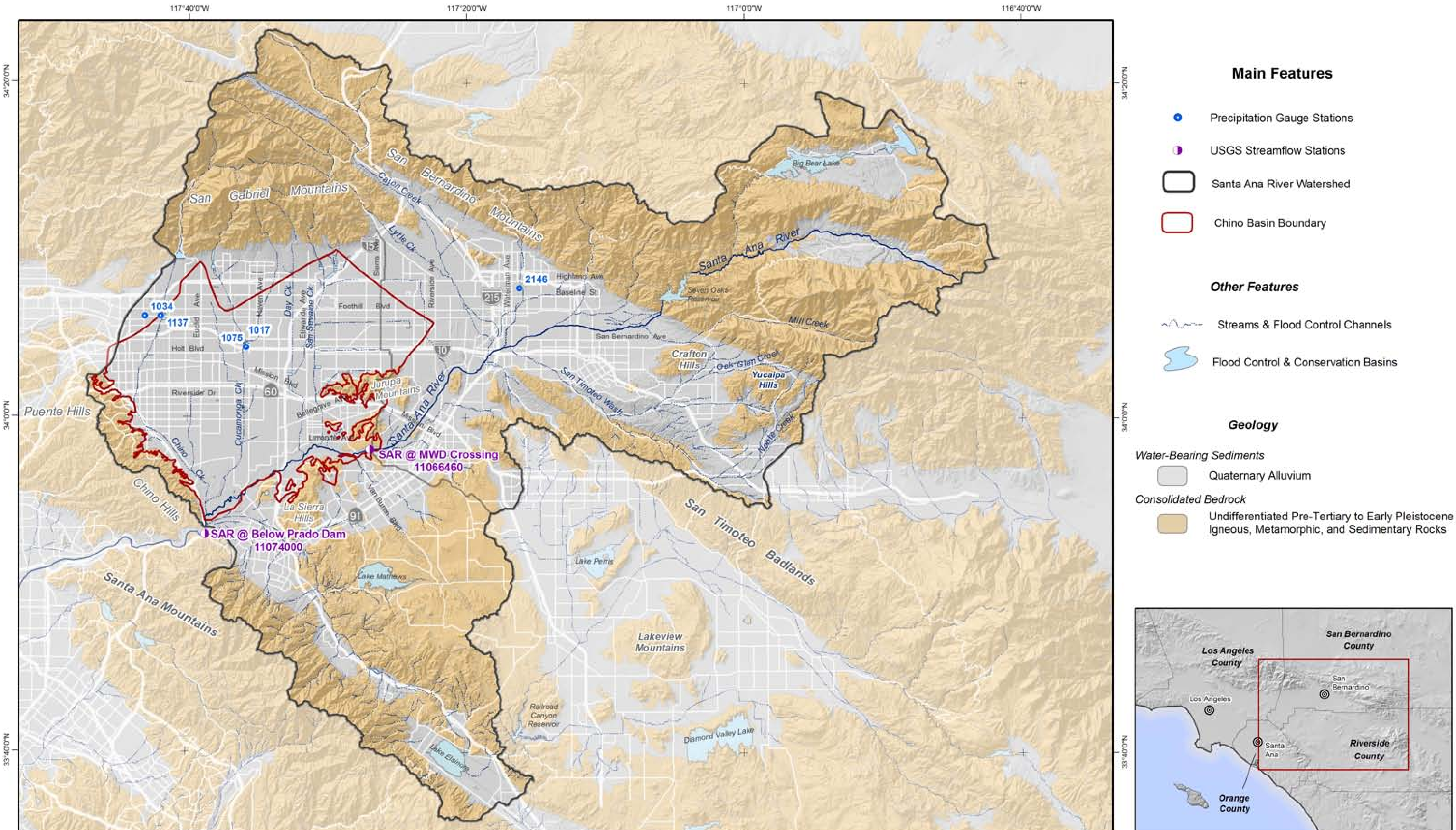
To further illustrate the change in rainfall-runoff relationship, a double mass analysis can be used. A double mass analysis is an arithmetic plot of the accumulated values of observations for two related variables that are paired in time and thought to be related. As long as the relationship between the two variables remains constant, the double mass curve will appear as a straight line (constant slope). A change in slope indicates that the relationship has changed where the break in slope denotes the timing of that change. Figure 2-6 is a double mass curve plot of precipitation at the Claremont/Montclair hybrid, Ontario, and San Bernardino Hospital precipitation stations versus storm water discharge at below Prado Dam for the 1919/20 through 2007/08 period. Note that the slope of the double mass curve after water year 1976/77 is much steeper than prior to 1976/77. The change in curvature denotes that a significant change occurred in the rainfall–runoff relationship. Figure 2-7 is a double mass curve plot of precipitation at the Claremont/Montclair hybrid station and Ontario precipitation stations versus storm water discharge generated in the watershed between the MWD Crossing and Prado Dam. The relationship of storm water discharge and precipitation in Figure 2-7 is similar to that shown in Figure 2-6 with Chino Basin producing about 75 percent of the storm water between the MWD Crossing and Prado Dam. Two observations can be regarding the time history of surface water discharge of the Santa Ana River: 1) there is a steady increase in the baseflow of the river starting around the 1970s and 2) there is an increase in the magnitude of storm water discharge starting in the late 1970s. These changes in discharge have occurred due to urbanization of the watershed. The increase in non-stormwater discharge is due to primarily to increases in recycled water discharges to the Santa Ana River. The increase in stormwater discharge is due to the modification of the land surface caused by the conversion from agricultural to urban uses, lining of stream channels, and other associated improvements in drainage systems.

2.3 Summary/Characterization of Current Hydrologic Regime

The hydrologic regime in the Chino Basin has important implications for water supply and groundwater management. The occurrence of long dry periods, characteristic of the region's climate, limit the recharge of precipitation and storm water recharge for years at a time and requires management strategies that conserve precipitation and storm water recharge whenever available. The amount of stormwater produced per unit of precipitation has increased over time due to urbanization and will continue to increase in the future as the remaining undeveloped and agricultural land uses are converted to developed uses.

Table 2-1
Annual Statistics of Long-Term Records at Precipitation Stations in the Chino Basin
(inches)

Area	Montclair/Claremont	S B Hospital	Ontario
Period of Record	1900 to 2008	1900 to 2008	1914 to 2008
Annual Average	17.78	16.36	15.38
Maximum	37.58	35.65	37.41
Minimum	5.39	5.95	3.84
Standard Deviation	7.66	6.83	7.05
Mean + 1 Standard Deviation	25.44	23.19	22.43
Coefficient of variation	43%	42%	46%



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File: Figure_2-1.mxd

0 2 4 6 8 Miles
0 3 6 9 12 KM

2008 State of the Basin Report
General Hydrologic Condition

Santa Ana River Watershed Tributary to the Chino Basin

Figure 2-1

Figure 2-2
Annual Precipitation in the Claremont/Montclair Area

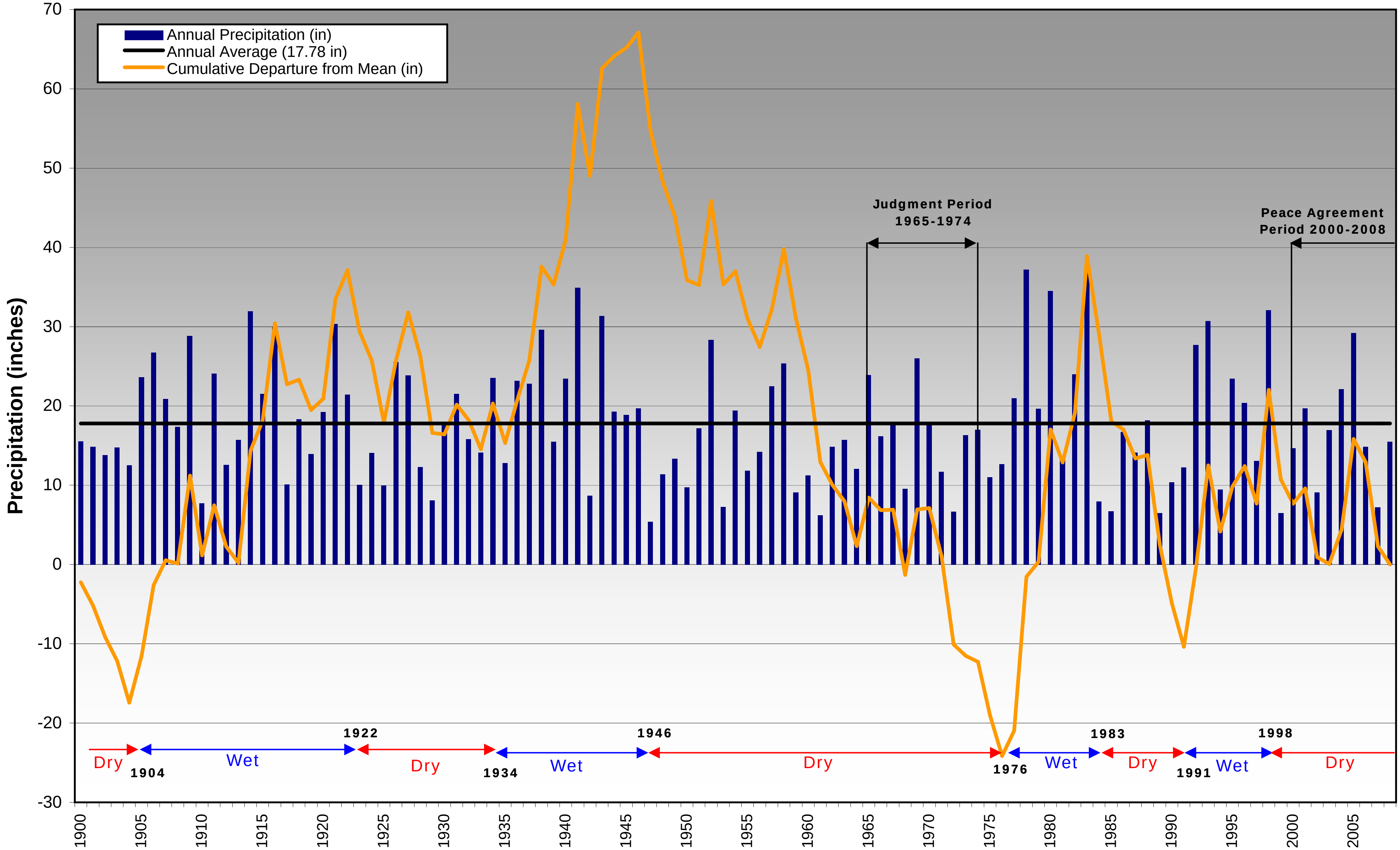

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Figure 2-3
Annual Precipitation in the Ontario Area

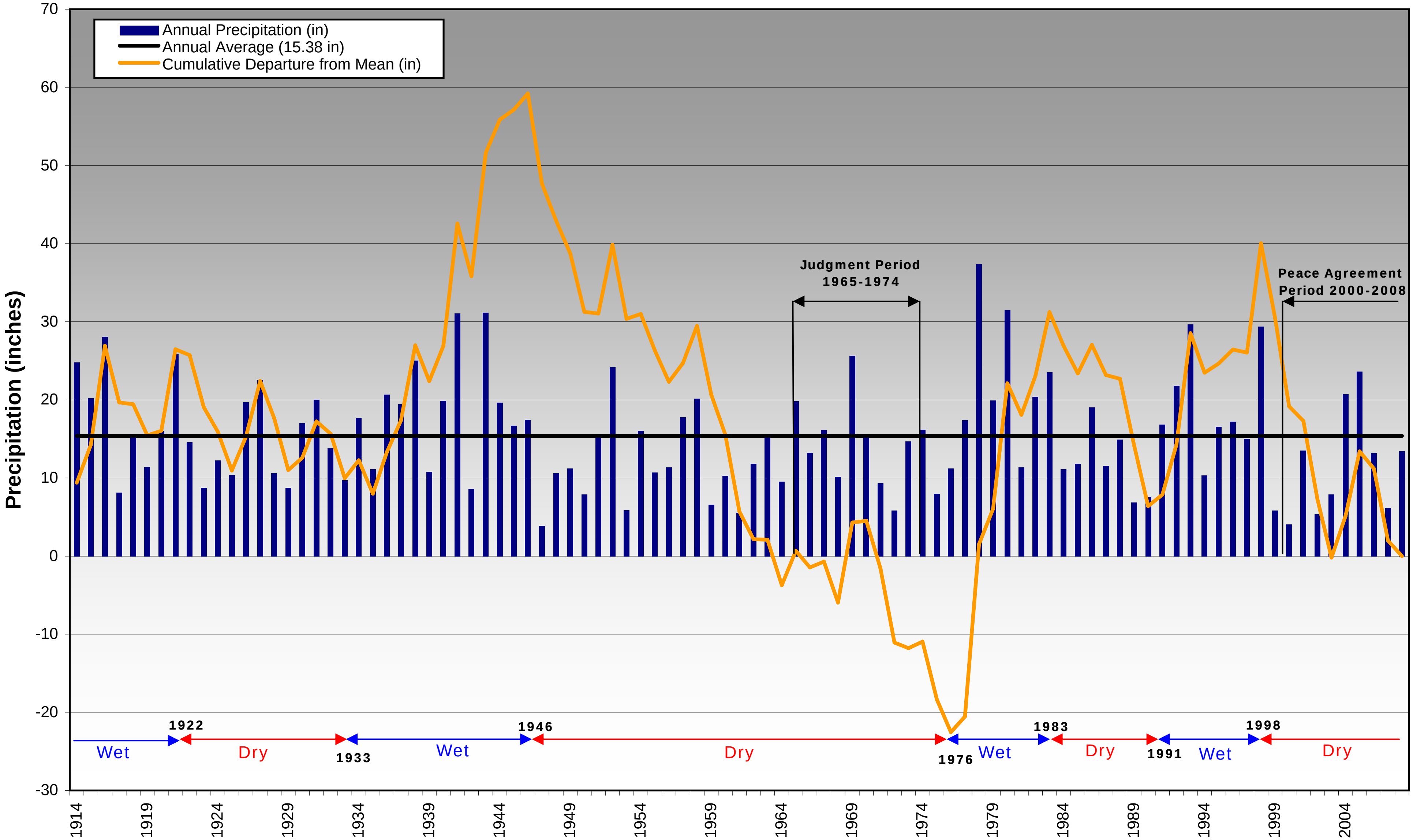

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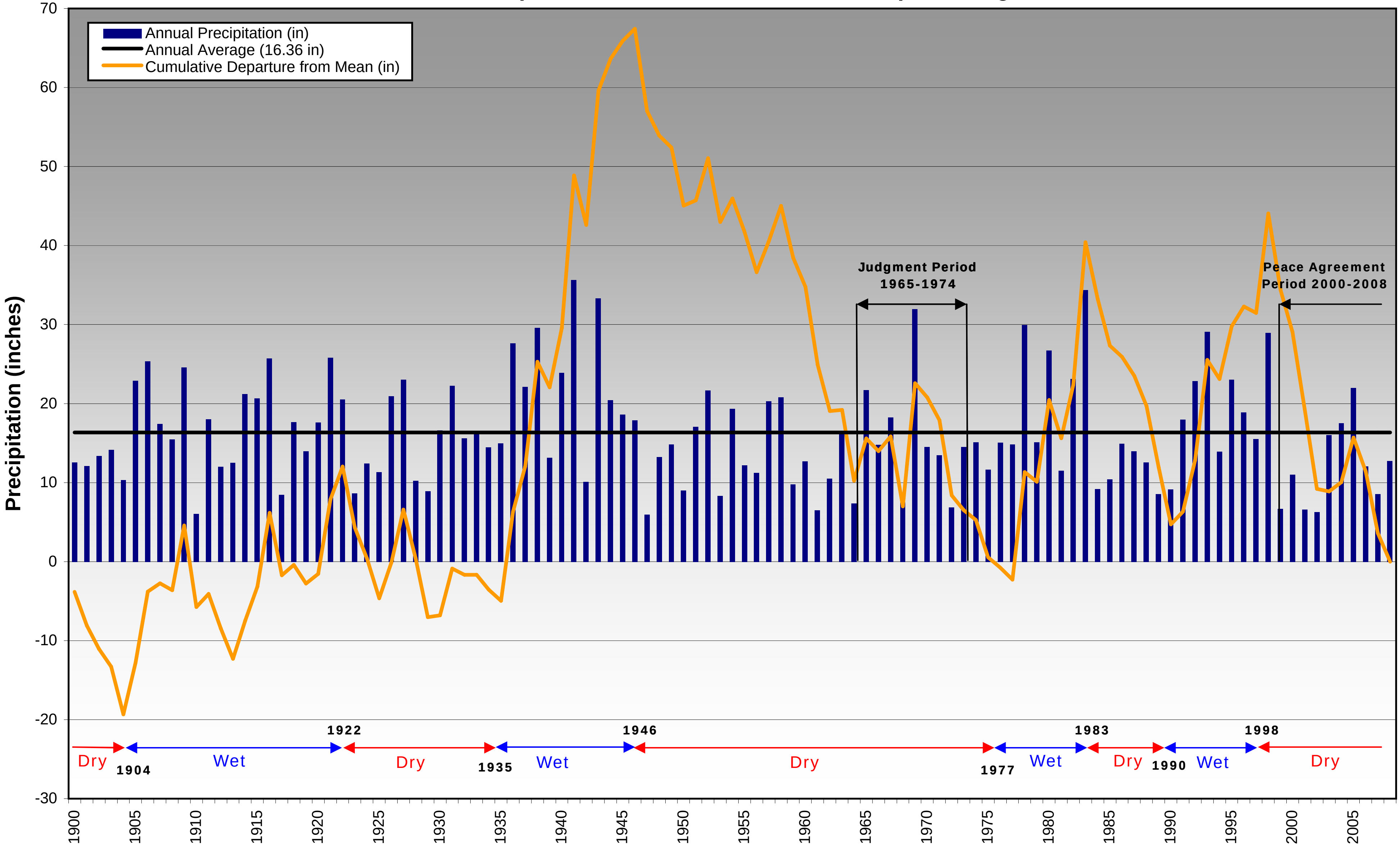
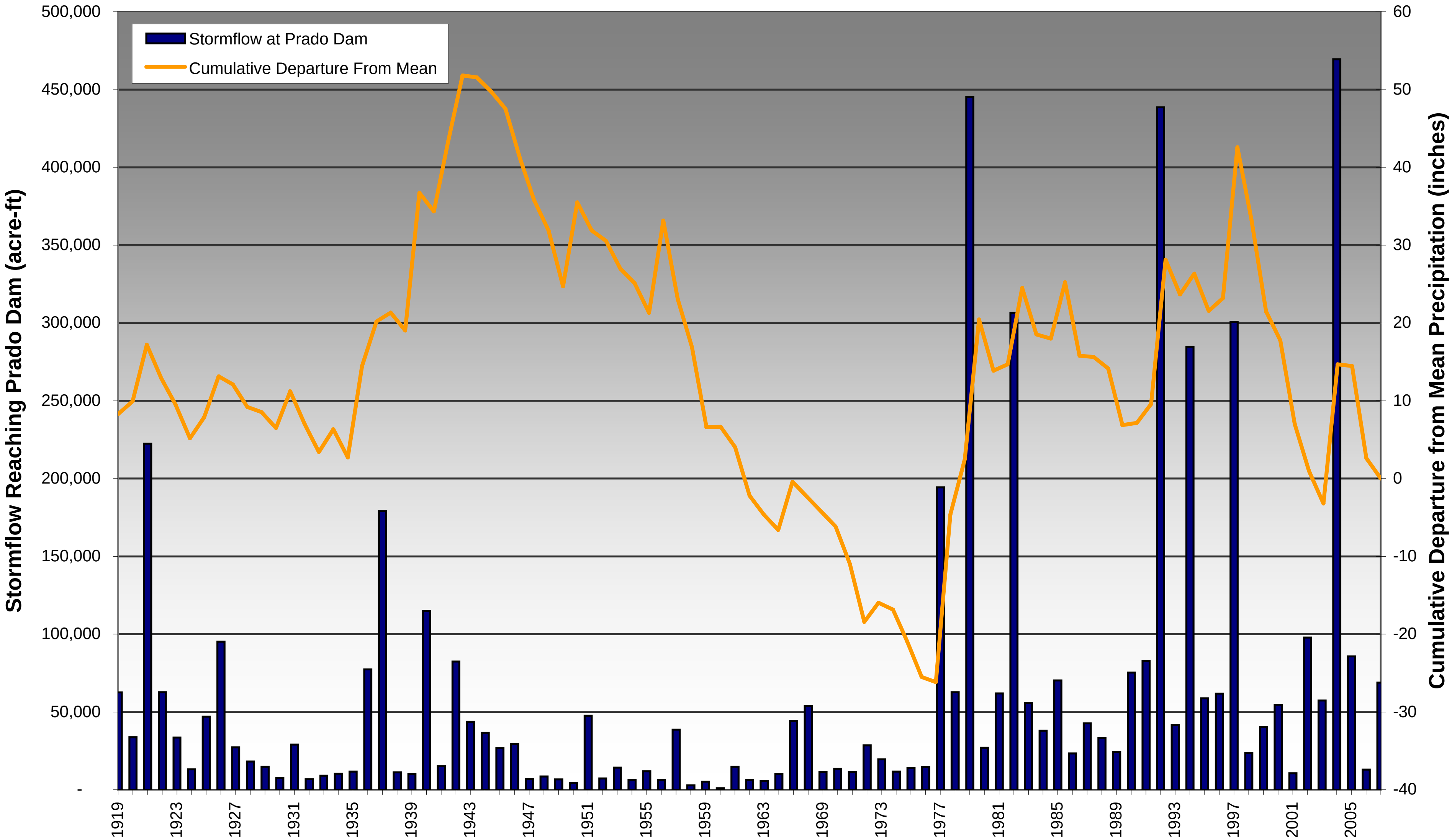
Figure 2-4
Annual Precipitation at the San Bernardino Hospital Gauge



SOB_08hydrology.xls -- SB_Hospital_Chart-fig2-4

WILDERMUTH ENVIRONMENTAL INC.

Figure 2-5
Annual Stormflow Measured at below Prado Dam
Water Year 1919/20 - 2007/08



Figs_2-5_to_2-7.xls -- Fig 2-5 Stormflow and CDFM

Figure 2-6
Double Mass Curve of Precipitation
vs Storm Flow Measured at below Prado Dam
Water Years 1919/20 through 2007/08

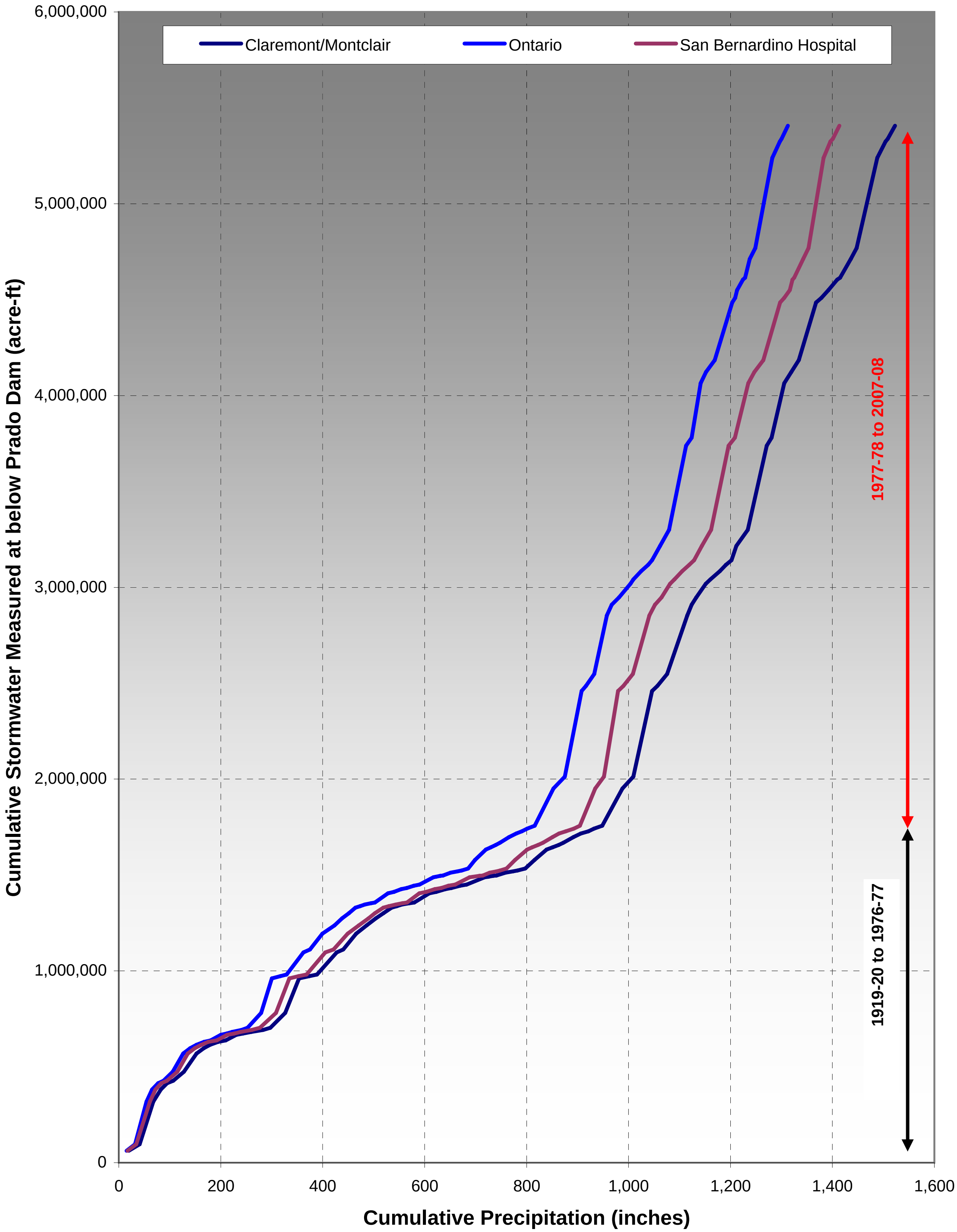
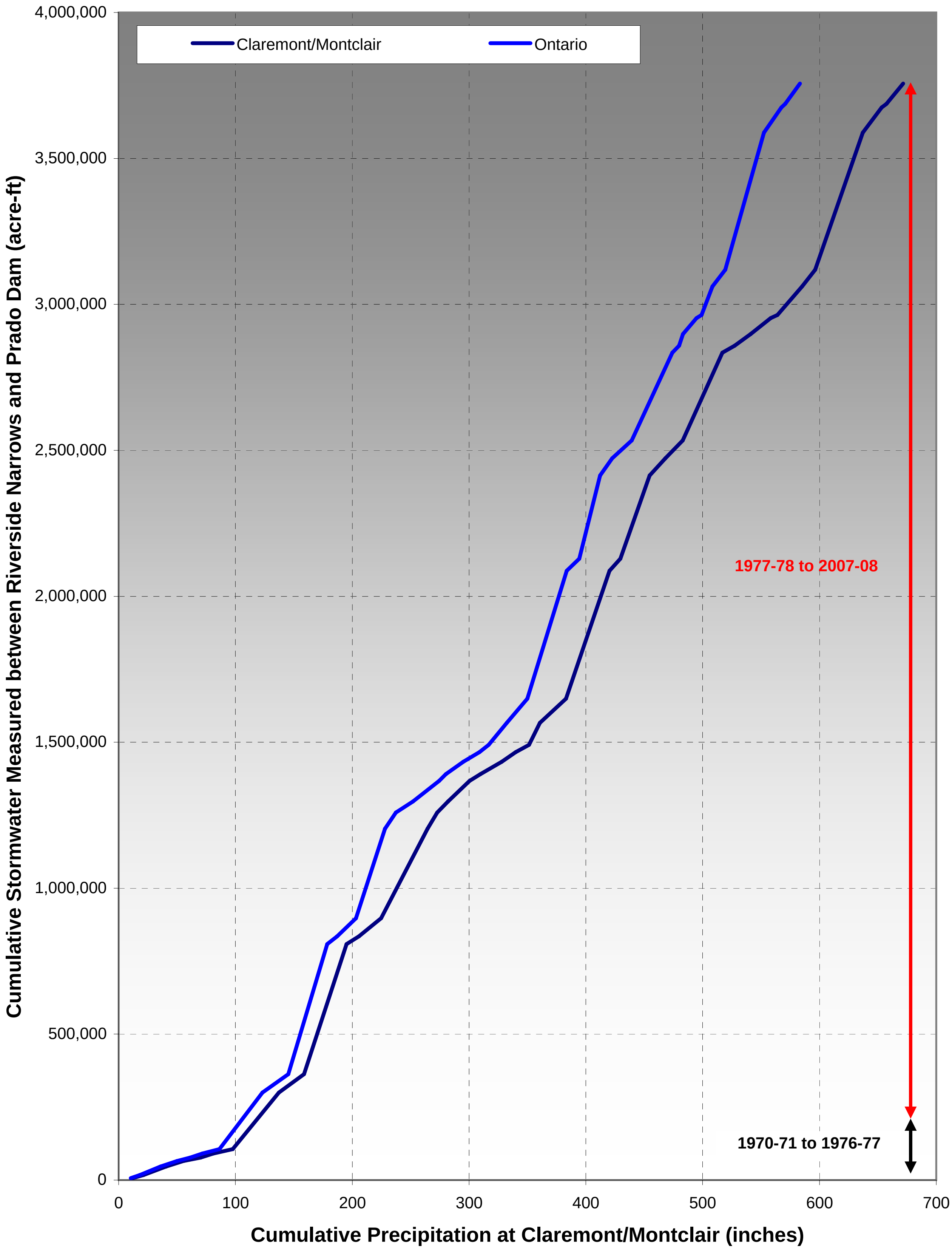


Figure 2-7
Double Mass Curve of Precipitation in Chino Basin vs Storm Flow Generated between Riverside Narrows and Prado Dam
Water Years 1970/71 through 2007/08



Figs_2-5_to_2-7.xls -- Fig 2-7 DM StormRNtoPD vPrecip

Section 3 – Basin Operations and Groundwater Monitoring

3.1 Background

The OBMP states that the re-determination of safe yield and the estimation of losses from groundwater storage programs require comprehensive groundwater-level mapping across the basin, analyses of groundwater level time histories at wells, and accurate estimations of groundwater production and artificial recharge activities. Pursuant to the Peace Agreement, Watermaster will re-determine safe yield and establish loss rates from storage in 2010.

The monitoring of basin activities—such as groundwater production and artificial recharge—and potential responses to those activities—such as changes in groundwater levels and storage—is a major component of *OBMP Program Element 1 – Develop and Implement a Comprehensive Monitoring Program*. Program Element 1 was developed, in part, to address the first impediment to *OBMP Goal 1 – Enhance Basin Water Supplies*: "Unless certain actions are taken, safe yield of the Basin will be reduced […] due to groundwater outflow from the southern part of the Basin." (WEI, 1999) This impediment speaks to the possibility of increased groundwater outflow to the Santa Ana River as a result of (1) reduced groundwater production in the southern part of the basin as agricultural land is converted to urban uses and (2) increased groundwater storage due to other management activities, such as artificial recharge and storage and recovery programs. That is, increased groundwater levels in the southern Chino Basin (via reduced groundwater production and/or increased groundwater storage) may result in increased groundwater discharge to the Santa Ana River (i.e. loss of basin yield). This potential loss of safe yield needs to be computed periodically and used in the administration of the Judgment; otherwise, the Chino Basin could be overdrafted.

This section describes the physical state of the Chino Basin with respect to groundwater pumping, artificial recharge, groundwater levels, and groundwater storage. Special attention is given to changes that have occurred since the implementation of the OBMP (2000) and since the last State of the Basin Report (2006).

3.2 Groundwater Flow System

The physical nature of groundwater occurrence and movement with regard to basin boundaries, recharge, groundwater flow, and discharge is described below.

3.2.1 Groundwater Recharge, Flow, and Discharge

While considered one basin from geologic and legal perspectives, the Chino Basin can be hydrologically subdivided into at least five flow systems that act as separate and distinct hydrologic units. Each flow system can be considered a management zone, and the management zones delineated in the OBMP were determined based on these hydrologic units (WEI, 1999), as shown in Figure 1-1. Each management zone has a unique hydrology, and water resource management activities that occur in one management zone have limited impacts on the other management zones.

The predominant sources of recharge to Chino Basin groundwater reservoirs are percolation of direct precipitation and returns from applied water. The following is a list of other potential sources of recharge:

- Infiltration of flow within unlined stream channels overlying the basin
- Underflow from fractures within the bounding mountains and hills
- Artificial recharge of urban runoff, storm water, imported water, and recycled water at recharge basins
- Underflow from seepage across the bounding faults, including the Red Hill Fault (from Cucamonga basin), the San Jose Fault (from the Claremont Heights and Pomona basins), and the Rialto-Colton Fault (from the Rialto-Colton Basin)
- Deep percolation of precipitation and returns from use
- Intermittent underflow from the Temescal Basin

In general, groundwater flow mimics surface drainage patterns: groundwater flows from the forebay areas of high elevation (areas in the north and east flanking the San Gabriel and Jurupa Mountains) towards areas of discharge near the Santa Ana River within the Prado Flood Control Basin.

In detail, groundwater discharge throughout Chino Basin primarily occurs via:

- Groundwater production
- Rising water within Prado Basin (and potentially other locations along the Santa Ana River, depending on climate and season)
- Evapotranspiration within Prado Basin (and potentially other locations along the Santa Ana River, depending on climate and season) where groundwater is near or at the ground surface
- Intermittent underflow to the Temescal Basin

3.3 Monitoring Programs

3.3.1 Groundwater Pumping Monitoring

Since its establishment in 1978, Watermaster has collected information to develop groundwater production estimates. Appropriative Pool and Overlying Non-Agricultural Pool estimates are based on flow meter data that are provided by producers on a quarterly basis. Agricultural Pool estimates are based on water duty methods and meter data. The Watermaster Rules and Regulations require groundwater producers that produce in excess of 10 acre-feet per year (AFY) to install and maintain meters on their well(s). In 2000, Watermaster initiated a meter installation program for Agricultural Pool wells and a meter-reading program that required at least one reading per year.

In the OBMP Phase I Report (WEI, 1999), it was estimated that up to 600 private wells would need to be equipped with meters. Watermaster staff completed meter installation on the majority of these wells and began reading meters in 2003. Some agricultural wells were not metered due to the anticipated conversion of land from agricultural to urban uses. As of

December 2008, Watermaster had installed or repaired meters at 326 active agricultural wells. Watermaster records production data from these meters on a quarterly basis. These data are then entered into Watermaster's database. Figure 3-1 shows the locations of all active wells in fiscal 2007/08 by pool.

3.3.2 Artificial Recharge Monitoring

Figure 3-2 shows the locations of the basins used for artificial recharge in the Chino Basin. There are four types of water recharged within Chino Basin: imported water from the State Water Project (SWP), storm water, urban runoff, and recycled water. Deliveries of SWP water are monitored using water delivery records supplied by the Metropolitan Water District of Southern California (MWDSC) and the IEUA. Historically, the recharge of storm water and urban runoff was incidental to flood control operations, and many opportunities to measure and record this recharge were missed. Since the implementation of the OBMP, water level data sensors have been installed in each recharge basin. Recorded changes in recharge basin water levels during storm events coupled with elevation-area-volume curves and elevation-outflow relationships allow for the calculation of storm water and urban runoff recharge. Recycled water is recharged at seventeen of the recharge sites, most of which have multiple basins. The IEUA monitors and reports recycled water quality and recharge volumes. Groundwater quality within the vicinity of the recycled water recharge basins is measured and reported quarterly by the IEUA.

3.3.3 Groundwater Level Monitoring

Groundwater level monitoring was inadequate prior to OBMP implementation. Problems with historical groundwater level monitoring included an inadequate areal distribution of wells in monitoring programs, short time histories, questionable data quality, and insufficient resources to develop and conduct a comprehensive program.

The OBMP defined a new, comprehensive groundwater level monitoring program. The program start-up occurred in two steps: an initial survey from 1998 to 2001, followed by long-term monitoring at a set of key wells.

Watermaster has three active groundwater level monitoring programs operating in the Chino Basin: (1) a semiannual basin-wide well monitoring program, (2) a key well monitoring program that is associated with the Chino I/II Desalter well fields and the HCMP, and (3) a piezometric monitoring program that is associated with land subsidence and ground fissuring in Management Zone 1 (MZ1). Monitoring frequency varies with each program. Figure 3-3 shows the locations and measurement frequencies of all the wells that are currently used in Watermaster's groundwater level monitoring programs. In addition to its field programs, Watermaster collects groundwater level data from municipal producers, government agencies, and private entities. All collected water level measurements are entered into Watermaster's relational database.

3.3.3.1 Basin-wide Groundwater Level Monitoring Program

The objective of the basin-wide groundwater level monitoring program is to collect groundwater level data from all wells in the Chino Basin that can be reliably monitored. These wells are shown in Figure 3-2, symbolized by their measurement frequencies. Wells in the other groundwater level monitoring programs (see Sections 3.3.3.2 and 3.3.3.3 below) are, by definition, also part of the basin-wide monitoring program. In total, the basin-wide program consists of about 900 wells. Watermaster staff measures water levels at about 450 private wells at least twice per year (spring and fall). At the remaining wells, water levels are measured by other agencies, including:

- California Department of Toxic Substances and Control (Stringfellow Superfund Site)
- Orange County Water District (Prado Basin)
- Santa Ana Regional Water Quality Control Board (various remediation sites)
- USGS (special investigations)
- County of San Bernardino (landfill monitoring)
- Private Consultants (various remediation sites)

Watermaster collects data for these wells twice per year; though, for some of these wells, data are collected more frequently as part of other monitoring programs (see below).

3.3.3.2 Key Well Water Level Program

Watermaster developed and implemented a key well monitoring program in the southern portion of the Chino Basin. The objective of this program is to increase measurement frequency and data quality at a reduced but representative network of wells. This network of wells and the monitoring program must satisfy the requirements for monitoring desalter impacts to local producers and for determining hydraulic control (see Section 3.6.4 for a description of the HCMP).

In the Chino Basin, development has led to the conversion of land from agricultural to urban uses and has resulted in the destruction of wells that were previously included in Watermaster's key well water level monitoring program. As key wells are lost to development, nearby wells are evaluated for suitability as key well replacements. Currently, there are 159 wells in the key well water level monitoring program. Manual water levels measurements are done monthly at 95 of these wells. The remaining 64 wells contain pressure transducers/data loggers that automatically record water levels once every 15 minutes.

3.3.3.3 MZ1 Monitoring Program

The MZ1 monitoring program is an intensive aquifer-system monitoring program that was implemented beginning in Watermaster fiscal year 2001/02 to provide information that could be used by Watermaster to determine the causes of subsidence in MZ1 and develop a long-term subsidence management plan for MZ1. In fiscal 2002/03, an aquifer system monitoring facility was constructed at Ayala Park in the City of Chino. This facility includes multi-depth piezometers that record depth-specific head once every 15 minutes. In addition, about 30 production and monitoring wells that surround this facility are equipped with pressure transducers that record water levels once every 15 minutes. All of these data are uploaded to Watermaster's water level database. Several of these wells are also included in the key well water level monitoring program.

3.4 Groundwater Pumping

3.4.1 Historical Groundwater Pumping

Table 3-1 lists Watermaster's records of Chino Basin production by pool for the period fiscal 1977/78 through fiscal 2007/08. Figure 3-4 depicts the distribution of production by pool. Over this period, annual groundwater production has ranged from a high of about 198,000 AF (fiscal 2006/07) to a low of about 123,000 AF (fiscal 1982/83) and has averaged about 154,000 AFY since fiscal 1977/78. The distribution of production by pool has shifted since 1977. Agricultural Pool production, which is mainly concentrated in the southern portion of the basin, dropped from about 54 percent of total production in 1977-78 to about 19 percent in 2007/08. During the same period, Appropriative Pool production, which is mainly concentrated in the northern half of the basin, increased from about 40 percent of total production in 1977-78 to about 79 percent in 2007/08 (sum of production for the appropriative pool and the Chino Desalter Authority [CDA]). Increases in Appropriative Pool production have approximately kept pace with declines in agricultural production. Production in the Overlying Non-Agricultural Pool declined from about 5 percent of total production in fiscal 1977/78 to about 2 percent in the mid-1980s, rose to about 4 percent through the 1990s, and recently decreased to about 2 percent in 2003-04 where it remained through fiscal 2007/08.

Figures 3-5 through 3-9 illustrate the location and magnitude of groundwater production at wells in the Chino Basin for fiscal years 1977/78, 1999/2000, 2005/06, 2006/07, and 2007/08, respectively. A close review of these figures indicates:

- There was a basin-wide increase in the number of wells producing over 1,000 AFY between 1978 and 2008. This is consistent with (1) the land use transition from agricultural to urban, (2) the trend of increasing imported water costs, and (3) the use of desalters.
- Since the implementation of the OBMP in 2000, the number of active production wells just north of the Santa Ana River has decreased. This is consistent with the land use transition from agricultural to urban that has been occurring in the area.
- Since the implementation of the OBMP in 2000, desalter pumping has commenced and progressively increased; in fiscal 2007/08, desalter pumping reached a historical high of 26,972 AFY.
- Since the implementation of the OBMP in 2000, the number of wells that produce over 1,000 AFY on the west side of Chino Basin (west of Euclid Avenue) has decreased. This is consistent with (1) the implementation of the MZ1 Interim Management Plan, which reduced pumping by up to 3,000 AFY in the Chino area, and (2) reduced pumping by the City of Pomona, the Monte Vista Water District, and the City of Chino Hills from 2003 to 2008, as these agencies have been participating in in-lieu recharge for the Dry-Year Yield Program.

3.4.2 Agricultural Pool Pumping

Agricultural Pool pumping has declined steadily since 1978 (see Figure 3-1). In fiscal 2007/08, total production for the Agricultural Pool fell to 30,910 AF—the Agricultural Pool's lowest production on record. Since OBMP implementation in 2000, Agricultural Pool production has decreased from about 40,000 AF in fiscal 2000/01 (24 percent of total basin production) to about 31,000 AF in fiscal 2007/08 (19 percent of total basin production).

3.4.3 Overlying Non-Agricultural Pool Pumping

Since OBMP implementation in 2000, Overlying Non-Agricultural Pool production has accounted for less than 5 percent of total basin production, ranging from about 2,300 AF (1 percent of total production in fiscal 2004/05) to 8,000 AF (5 percent of total production in fiscal 2000/01). In fiscal 2007/08, Overlying Non-Agricultural production of about 3,400 AF accounted for 2 percent of total basin production.

3.4.4 Appropriative Pool Pumping

Since OBMP implementation in 2000, average production by the Appropriative Pool, excluding desalter production, has been about 122,000 AFY, which accounts for about 70 percent of total basin production.

The CDA operates two desalter facilities (Chino I and Chino II) that are supplied with raw groundwater from 22 wells. The desalter facilities belong to the Appropriative Pool. In fiscal 2007/08, the CDA desalters produced more water than in any previous year (26,972 AF). Since the CDA began pumping in 2000, its production has accounted for about 16 percent of total Appropriative Pool production and about 8 percent of total basin production. During 2005/06, the Chino II Desalter facility became operational, and as a result, CDA groundwater production increased by about 60 percent from the previous year. Average annual production by the CDA since 2000 has been about 14,800 AFY.

Since OBMP implementation in 2000, average annual production by the Appropriative Pool, including desalter production, has been about 137,000 AFY. Approximately 130,000 AF were produced in fiscal 2007/08. As a percent of total basin production, Appropriative Pool production increased from about 72 percent in fiscal 2000/01 to about 79 percent in fiscal 2007/08.

3.5 Artificial Recharge

Watermaster initiated the Chino Basin Groundwater Recharge Program as required by the Peace Agreement. This program is an integral part of Watermaster's OBMP and is summarized in the OBMP Recharge Master Plan. This comprehensive program aims to enhance water supply reliability and improve the groundwater quality of local drinking water wells throughout the Chino Basin by increasing the recharge of storm water, imported water, and recycled water.

Below, the physical volumes of water percolated at recharge basins in the Chino Basin are discussed. Specific source waters include storm water and supplemental water, which consists of State Water Project (SWP) water and recycled water.

3.5.1 Recharge Facilities

There are 21 recharge facilities described in the OBMP Recharge Master Plan, Phase II Report (B&V & WEI, 2001). Table 3-2 lists the operable recharge facilities in the Chino Basin and summarizes annual wet water recharge (by type) for the period of July 1, 2000 through June 30, 2008. Figure 3-2 shows the locations of the groundwater recharge facilities. Detailed descriptions of these facilities and their operating characteristics can be found in *Chino Basin Recharge Facilities Operating Procedures* (GRCC, 2006).

3.5.2 Regulatory Requirements for Recharge in the Chino Basin

The general recharge requirements for the Chino Basin are outlined in Section 5.1 of the Chino Basin Peace Agreement – Recharge and Replenishment. The requirements of the Peace Agreement are further discussed and expanded on in the OBMP Recharge Master Plan (WEI, 2001).

The Recycled Water Groundwater Recharge Program, which is being implemented by the IEUA and Watermaster, is subject to the following requirements:

- California Regional Water Quality Control Board, Santa Ana Region. Monitoring and Reporting Program (M&RP) No. R8-2005-0033 for IEUA and Chino Basin Watermaster. Phase 1 Chino Basin Recycled Water Groundwater Recharge Project, San Bernardino County. April 15, 2005.
- California Regional Water Quality Control Board, Santa Ana Region. Order No. R8-2007-0039. Water Recycling Requirements for Inland Empire Utilities Agency and Chino Basin Watermaster, Chino Basin Recycled Groundwater Recharge Program, Phase I and Phase II Projects, San Bernardino County. June 29, 2007.

3.5.3 Historical Recharge

3.5.3.1 Storm Water Recharge

Storm Water recharge is monitored by the IEUA pursuant to the Chino Basin Recharge Facilities Operating Procedures (GRCC, 2006). Transducers have been installed in each recharge basin that receives storm water. The percolation rate in each basin is measured directly and used in conjunction with established elevation-storage-area tables to calculate recharge.

Since 2000, total storm water recharge has averaged approximately 4,600 AFY. During fiscal years 2006/07 and 2007/08, total storm water recharge in Chino Basin was approximately 4,600 and 9,900 AF, respectively (see Table 3-2).

3.5.3.2 Supplemental Water Recharge

SWP water for artificial recharge is currently available to the region from the MWDSC. The MWDSC delivers SWP water into the Chino Basin from the Foothill Feeder, which flows from east to west across the northern half of the Chino Basin. During fiscal 2006/07, total SWP water recharge in Chino Basin was approximately 6,500 AF. During fiscal 2007/08, there was no SWP water recharge in the Chino Basin. The aggregate average SWP water recharge that has occurred since the OBMP was implemented is about 10,100 AFY.

During fiscal 2007/08, the Banana, Hickory, 7th and 8th Street, and Ely Basins were used to recharge recycled water. During fiscal years 2006/07 and 2007/08, total recycled water recharge in Chino Basin was approximately 3,000 and 2,400 AF, respectively. The aggregate average recycled water recharge that has occurred since the OBMP was implemented is about 1,000 AFY.

During fiscal years 2006/07 and 2007/08, supplemental water recharge—consisting of imported and recycled waters—was approximately 6,350 and 2,400 AF, respectively. The aggregate average supplemental water recharge that has occurred since the OBMP was implemented is about 11,500 AFY.

3.6 Groundwater Levels

This subsection analyzes groundwater levels at wells in the various management zones (MZs) throughout the Chino Basin and discusses changes in groundwater storage since the implementation of the OBMP in 2000 and since the 2006 State of the Basin report.

3.6.1 Historical Groundwater Level Trends

Figure 3-10 shows the locations of wells with groundwater level time histories discussed herein and the Chino Basin management zone boundaries. Wells were selected based on length of record, density of data points, quality of data, geographical distribution, and aquifer system. Wells are identified by their local name (usually owner abbreviation and well number) or their Watermaster ID (CBWM ID) if privately owned.

Figures 3-11 through 3-15 are groundwater level time history charts for the wells shown in Figure 3-10. Some of the short-term groundwater level fluctuations shown in these figures result from the inclusion of static and dynamic observations. Below, by management zone, the behavior of groundwater levels at specific wells is compared to climate, groundwater production, wet water recharge activities, and other factors as appropriate.

To compare groundwater levels to climate, a cumulative departure from mean precipitation (CDFM) curve has been plotted on the groundwater level time history charts. Positive sloping lines on the CDFM curve show wet years or wet periods. Negatively sloping lines show dry years or dry periods. For example, the period from 1978 to 1983 was an extremely wet period, and it is represented by a positively sloping line. To compare groundwater levels to pumping and recharge activities, bar charts that show groundwater production and wet water recharge by management zone have been superimposed on the groundwater level time history charts.

3.6.1.1 Management Zone 1

MZ1 is an elongate region, running generally north-south, and comprises the westernmost area of the Chino Basin. It is bounded by MZ2 to the east, various basin-boundary faults to the north, and sedimentary bedrock outcrops to the west and south.

Figure 3-11 shows groundwater level time histories for the following wells: Monte Vista Water District Well 10 (MVWD-10), City of Pomona Well 11 (P-11), City of Chino Well 10 (C-10), and Chino Hills Wells 15A and 16 (CH-15A and CH-16). The Montclair, College Heights, Upland, and Brooks Street Basins are located in the northern portion of MZ1 and are the primary sites for artificial recharge.

Wells MVWD-10 and P-11 exhibit representative groundwater levels for the northern portion of MZ1. An analysis of static groundwater levels at these wells shows a decline from 1995 to 2001, a period of increased groundwater production in MZ1. Since 2001, water levels have risen by about 100 feet at MVWD-10 and by about 45 feet at P-11. This increase is most likely attributed to a decrease in local production and an increase in wet water recharge in MZ1 since 2001.

Well C-10 is located in central MZ1. Water levels at C-10 peak in the mid-1990s but decline by about 20 feet from 1995 to 2000, which is likely due to increased groundwater production in MZ1. Unlike other wells in MZ1 that experienced significant water level recovery from 2000 to 2006, C-10's water levels remained essentially unchanged. Since 2006, water levels have risen by approximately 20 feet. This increase is due to a decrease in local production and an increase in wet water recharge.

Water levels measured at CH-15A are representative of the shallow aquifer system in the southern portion of MZ1. The recent land subsidence investigation (Section 5) has shown that in southern MZ1, the aquifer system is hydrologically stratified. The shallow aquifer system is unconfined to semi-confined while the deep aquifer system is confined. Water levels in CH-15A have historically been stable at around 80-90 ft-bgs and have experienced small variations in response to nearby pumping. Though, since 2000, water levels have risen by about 10 feet. This is primarily due to the decrease in local production associated with the MZ1 Interim Management Plan.

CH-16 is perforated in the confined deep aquifer system, which is characterized by large changes in piezometric pressure due to nearby pumping. In 2003 and 2004, during a series of pumping tests conducted by Watermaster in southern MZ1, water levels in CH-16 dropped by approximately 100 feet, and the period of recovery lasted several months. These tests demonstrated that piezometric levels in CH-16 (and the deep aquifer system in general) are heavily influenced by changes in pumping from local wells screened within the deep aquifer system. The static water levels at CH-16 declined by about 100 feet from 1995 to 2000 and subsequently recovered by about 140 feet from 2000 to 2006. At the end of 2008, static water levels had declined by about 30 feet from the 2006 highs with a maximum drawdown of about 60 feet observed in the summer of 2008.

3.6.1.2 Management Zone 2

Management Zone 2 (MZ2) is a large, central, elongate area of the Chino Basin (see Figure 3-10). Figure 3-12 shows groundwater level time histories for Cucamonga Valley Water District (CVWD) Wells CB-3 and CB-5 (CVWD CB-3 and CVWD CB-5), City of Ontario Well 16 (O-16), CBWM ID 600394, and Hydraulic Control Monitoring Program Wells 2/1 and 2/2 (HCMP-2/1, and HCMP-2/2). These wells are aligned north to south, approximately along a groundwater flow line. The San Sevaine, Etiwanda, Lower Day, Victoria, Turner, and Ely Basins are located in the northern and central regions of MZ2 and are the primary sites for artificial recharge.

The groundwater level time histories for the northernmost wells—CVWD CB-3 and CB-5 and O-16—show a general water level increase following 1978, which is likely due to a combination of the 1978 to 1983 wet period, the reduction in overdraft following the implementation of the Chino Basin Judgment, and the start of artificial replenishment with imported water in the San Sevaine and Etiwanda Basins. Following the early 1990s, water levels at these wells began to decrease and have continued to decrease to present. The static water levels at CB-3 and CB-5 decreased by approximately 30 feet between 2003 and 2006. Long-term water level decreases in this area of MZ2 are likely due to decreased wet water recharge from 1996 to 2003 and increased groundwater production from 1995 to present.

Well CBWM ID 600394 is located in the central portion of MZ2, north of the Chino I Desalter well field. Water levels at this well have decreased by about 15 feet since 2000.

Wells HCMP 2/1 and HCMP 2/2 are located at the southern end of MZ2 near the Chino I Desalter well field. These wells were completed and the first measurements were recorded in early 2005. HCMP 2/1 is perforated in the shallow aquifer system, and HCMP 2/2 is perforated in the deep aquifer system. Contrary to that of of MZ1, the deeper aquifer in this MZ behaves much more like the shallow, unconfined aquifer, which is indicative of a greater degree of hydraulic communication between the two aquifer systems. Both wells exhibited similar groundwater level increases (15-20 feet) from 2005 to 2006. It is likely that this was due to changes in local production—especially at some of the nearby Chino I Desalter wells, which experienced a production decrease in 2005 and 2006. Since 2006, water levels have decreased by 5-10 feet in both wells.

3.6.1.3 Management Zone 3

Management Zone 3 (MZ3) consists of the area along the eastern boundary of the Chino Basin. It is bounded by MZ2 to the west, Chino-East (MZ4) and Chino-South (MZ5) to the south, and the Rialto-Colton Fault to the east (see Figure 3-10). Figure 3-13 shows water level time histories for Fontana Water Company Wells F30A and F35A (F30A and F35A), Milliken Landfill Well M-3 (M-3), County of San Bernardino MIL M-06B, CBWM ID 3602468, and HCMP Well 7/1 (HCMP 7/1). These wells are aligned northeast to southwest, approximately along a groundwater flow line. The RP-3 and Declez Basins are located in the central region of MZ3 and are the primary sites for artificial recharge.

Wells F30A and F35A are located in the northeastern portion of MZ3. The groundwater level time histories of these two wells show relatively stable water levels from 1978 until the late

1990s. From 2000 to 2006, the wells experienced a progressive decline in water levels of about 25 feet. This decline is likely due to increased production in MZ3. Their lack of responsiveness to climate is likely due to the absence of significant sources of recharge. Since 2006, water levels at F35A have remained relatively unchanged, and water levels at F30A have fluctuated ±5 to 10 feet.

Wells M-3/M-06B and CBWM ID 3602468 are located in the central portion of MZ3. From 2000 to 2006, a groundwater decline of about 30 feet was observed at these wells.

The southernmost well, HCMP-7/1, experienced a groundwater level decline of about 20 feet from 2005 to the end of 2008. Similar water level declines can be observed in most wells throughout MZ3. This regional drawdown in MZ3 is likely due to the steady increase in production within MZ3 over the past 30 years and a lack of artificial recharge.

3.6.1.4 Management Zone 4

MZ4 – also known as Chino-East – is bounded by the Jurupa Hills to the north, the Pedley Hills to the east, MZ5 to the south, and MZ3 to the west (see Figure 3-10). Figure 3-14 shows groundwater level time histories for HCMP Well 9/1 (HCMP-9/1), Jurupa Community Services District Well 10 (JCSD-10), and CBWM ID 3300718. There are no major recharge basins in MZ4, and very little groundwater production occurs in this area.

Groundwater levels at these wells decreased by about 30 feet between 2000 and 2008. These declines are likely due to groundwater production at nearby wells, including the Chino II desalter well field, which is located near the western boundary of the MZ.

3.6.1.5 Management Zone 5

MZ5 – also known as Chino-South – is bounded by MZ4 to the north, MZ3 to the west, the Riverside Narrows to the east, and various unnamed hills to the south (see Figure 3-10). Figure 3-15 shows groundwater level time histories for USGS Well Archibald-1, HCMP Well 8/1 (HCMP 8/1), and Santa Ana River Water Company Well 07 (SARWC-07). There are no groundwater recharge basins in MZ5, but the Santa Ana River is a major source of groundwater recharge.

These wells exhibit very little groundwater level variation due to the stabilizing effects of the Santa Ana River. Production in MZ5 decreased steadily from 1978 to 2008 due to the destruction of many private agricultural wells. Current production is approximately 3,000 AFY (see Figure 3-15). Groundwater levels in HCMP-8/1 and SARWC-07 have declined about 10-15 feet since 2006. This decline is likely due to the onset of pumping at nearby Chino II Desalter wells.

3.6.2 Current Groundwater Levels

The groundwater level data collected from the various monitoring programs described in Section 3.3 were used to create groundwater level elevation contour maps of the Chino Basin for fall 2000 (Figure 3-16), fall 2003 (Figure 3-17), fall 2006 (Figure 3-18), and fall 2008 (Figure 3-19). Appendix A is an E-sized water level map that includes the point data used to contour the fall 2008 groundwater levels. The following procedures were used in the creation of these maps:

- Extract the entire time history of groundwater level data from Watermaster's groundwater level database for all wells in the Chino Basin.
- Plot and explore groundwater elevation time histories for all wells.
- Choose one "static" groundwater level elevation data point per well that is representative of the fall 2008 period.
- Plot groundwater level elevation data on maps with background geologic/hydrologic features.
- Contour and digitize groundwater elevation data.

The groundwater elevation contours for fall 2008 (Figure 3-19) are generally consistent with past groundwater elevation contour maps (see, for example, Figures 3-16, 3-17, and 3-18). These maps show that groundwater generally flows in a south-southwest direction from the primary areas of recharge in the northern parts of the basin toward the Prado Flood Control Basin in the south. There are notable pumping depressions in the groundwater level surface that interrupt the general flow patterns in the northern portion of MZ1 (Montclair and Pomona areas) and directly southwest of the Jurupa Hills. There is a discernible depression in groundwater levels surrounding the Chino I & Chino II Desalter well fields.

Close inspection of the groundwater level data used to construct these maps suggests the existence of hydraulically distinct aquifer systems—primarily in MZ1 and the western parts of MZ2. Previous investigations have concluded that two distinct aquifer systems exist in these areas: a shallow unconfined to semi-confined aquifer and deeper confined aquifer. The groundwater levels shown in these maps correspond to the shallow aquifer system and do not reflect the piezometric levels of the deeper aquifers.

3.6.3 Changes in Groundwater Storage

Watermaster developed a GIS model to estimate groundwater storage changes from the groundwater level contour maps discussed above. In preparing this model, Watermaster compiled a comprehensive library of well driller's logs for wells in the Chino Basin. Lithologic descriptions of borehole cuttings and associated depth intervals were digitized and added to Watermaster's database. All lithologic descriptions were then assigned a value of specific yield based on USGS investigations (Johnson, 1967). These data were then used to estimate the average specific yield across each hydrostratigraphic layer in the Chino Basin (see Section 2 of this report for additional details).

The storage change model and the procedures for estimating storage change include:

- Create groundwater elevation contour maps of the Chino Basin for the beginning and ending of the period for which a storage change will be estimated (e.g. fall 2000, fall 2003, and fall 2006).
- Create three-dimensional raster surfaces (ESRI grids) of the groundwater elevation contour maps.

- Create a 400-meter by 400-meter grid (polygon shapefile) of the Chino Basin.
- Assign attributes to each grid cell for (1) surface area, (2) overlying management zone, (3) beginning groundwater elevation surface (e.g. fall 2003), (4) ending groundwater elevation surface (e.g. fall 2006), (5) top and bottom elevations for the model layers, and (6) the specific yield of sediments for each model layer.
- Export the attribute table of the 400-meter grid to spreadsheet format to calculate the volumetric storage change.

Figure 3-20 shows the 400x400-meter grid, symbolized by the storage change between fall 2000 and fall 2003. Basin-wide, the groundwater storage model estimates a change in storage of about -93,400 AF over this three-year period. Based on this figure, the following sub-areas experienced a decrease in storage:

- In the northwest near Pomona and Montclair
- In the northeast near Fontana and eastern Ontario and Rancho Cucamonga
- Near the Chino I Desalter well field, which began producing groundwater in 2000

And, the following sub-areas experienced an increase in storage:

- In the southwest within the City of Chino where pumping decreased in association with the land subsidence investigation and the Forbearance Agreement
- In the south, just north of the Santa Ana River, where many agricultural wells are being destroyed as land use transitions from agricultural to urban

Figure 3-21 shows the 400x400-meter grid, symbolized by the storage change between fall 2003 and fall 2006. Basin-wide, the groundwater storage model estimates a change in storage of about +46,500 AF over this three-year period. Based on this figure, the following sub-areas experienced a decrease in storage:

- In the northeast near Fontana as well as in eastern Ontario and Rancho Cucamonga in MZ2 and MZ3
- In the area directly west of the Jurupa Mountains in MZ3
- In the area immediately surrounding the eastern portions of the Chino I Desalter well field (During this period, increased production in this area was mainly due to the onset of pumping at the Chino I Desalter expansion wells.)

And, the following sub-areas experienced an increase in storage:

- In the northwest near Pomona and Montclair in MZ1 where pumping decreased in association with in-lieu recharge for the Dry-Year Yield program
- In the southwest within the City of Chino where pumping decreased in association with the land subsidence investigation and the Forbearance Agreement
- In the southern region of MZ2 on the west side of the Chino I Desalter well field
- In the south, just north of the Santa Ana River, where many agricultural wells are being destroyed as land use transitions from agricultural to urban

Figure 3-22 shows the 400x400-meter grid, symbolized by the storage change between fall 2006 and fall 2008. Basin-wide, the groundwater storage model estimates a change in storage of about -53,600 AF over this two-year period. Based on this figure, the following sub-areas experienced a decrease in storage:

- In the area directly west and southwest of the Jurupa Mountains in MZ3 (This area is influenced by groundwater production at wells owned by the Jurupa Community Services District.)
- In the area immediately surrounding the eastern portion of the Chino I Desalter well field (During this period, increased production in this area was mainly due to the continued pumping at the Chino I Desalter expansion wells.)
- In the area immediately surrounding the Chino II Desalter well field (During this period, increased production in this area was due to increased pumping at the Chino II Desalter wells.)

And, the following sub-areas experienced an increase in storage:

- In the northwest near Pomona and Montclair in MZ1 where pumping decreased in association with in-lieu recharge for the Dry-Year Yield program
- In the southwest where pumping decreased in association with the land subsidence investigation and the Forbearance Agreement
- In the south, just north of the Santa Ana River, where many agricultural wells are being destroyed as land use transitions from agricultural to urban

The total change in storage since implementation of the OBMP (2000-08) is approximately -62,000 AF.

3.6.4 Assessment of Hydraulic Control

The hydrologic conceptual model of Chino Basin describes an aquifer system where groundwater flows from areas of recharge in the Chino-North MZ (a grouping of the northern portions of MZs 1, 2, and 3) toward areas of historical surface discharge in the south near the Prado Basin and the Santa Ana River (WEI, 2006a). One of the intended purposes of the Chino Desalter well fields is to intercept (capture) groundwater originating in the Chino-North MZ before discharges to the Prado Basin or the Santa Ana River as surface water.

Piezometric data collected from monitoring and production wells in the southern portion of the Chino Basin during the period of 1997 through 2008 were analyzed to determine the state of hydraulic control. For a full discussion of hydraulic control, see the *Chino Basin Maximum Benefit Monitoring Program 2008 Annual Report* (WEI, 2009). Figure 3-23 shows groundwater elevation contours and data for the shallow aquifer system in spring 2000—prior to any significant pumping by the Chino I Desalter wells. The contours depict regional groundwater flow from the northeast to the southwest. Figure 3-24 shows groundwater elevation contours and data for the shallow aquifer system in spring 2006—after six years of pumping from the Chino I Desalter wells but prior to any significant pumping from the Chino II Desalter wells. Note that desalter pumping in 2006 interrupts the regional flow pattern of 2000. Specifically, the contours to the north and southeast of the desalter well field swing in towards the eastern half of the well field where the desalter wells are perforated primarily within the shallow aquifer system. Figure 3-26 shows groundwater elevation contours and data for the shallow aquifer system in spring 2008, approximately eight years after the commencement of Chino I Desalter pumping and two years after the commencement of Chino II Desalter pumping. The Chino II Desalter well field began producing groundwater in mid-2006, causing the contours to swing in toward the well field from the north and the southeast. The data continue to suggest a reduction in the southward component of the hydraulic gradient around the western half of the Chino I Desalter well field; however, the contours do not indicate a gradient reversal and, hence, do not provide compelling evidence for hydraulic control in this region.

Since 2000, pumping at the Chino I Desalter well field has generally flattened the regional hydraulic gradient within the shallow aquifer system around the western half of the Chino I Desalter well field and has created a capture zone surrounding the eastern half of the well field. Around the western half of the Chino I Desalter well field, piezometric data suggest a significant reduction in the southward component of the hydraulic gradient but do not indicate a gradient reversal (northward component) and, hence, do not yet provide compelling evidence for complete hydraulic control at the Chino I Desalter well field. Pumping at the Chino II Desalter well field, where all wells are perforated within the shallow and deep aquifer systems, began in mid-2006. A depression continues to develop in the piezometric surface. The ultimate fate of groundwater that flows past the western portion of the Chino I Desalter well field is continued flow southward toward the Prado Basin where groundwater rises to become surface water in the tributaries of the Prado Basin.

Table 3-1
Summary of Recharge and Discharge
(acre-ft)

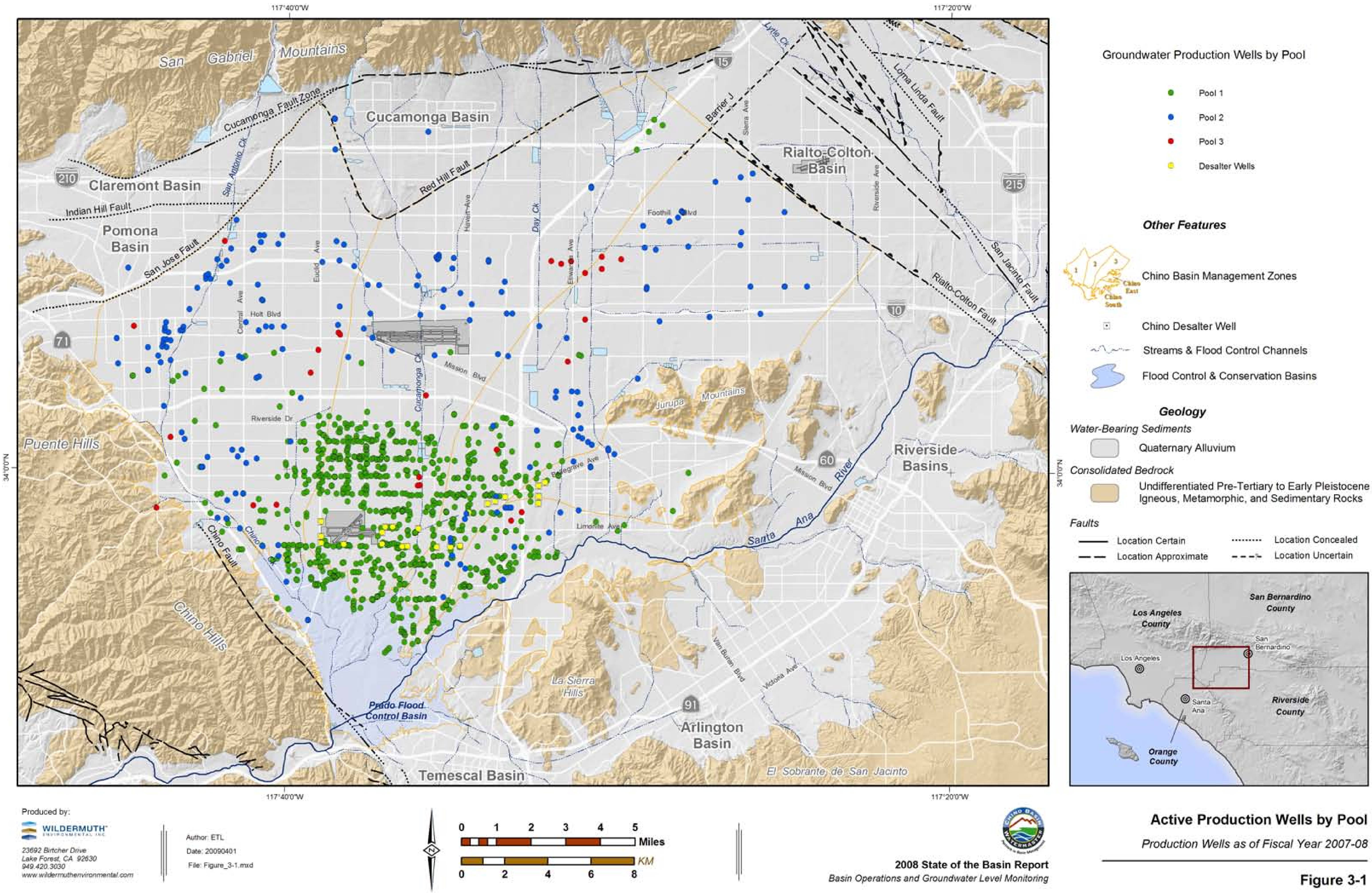
Fiscal Year	Wet Water Recharge to the Chino Basin									Discharge[7]										
	Safe Yield	Wet Water Recharge[1]							Total Inflow	Pumping						Pumping Distribution (% of Total)				
		Replenish	Cyclic or Conj Use	MZ1 Program	Recycled	New Storm Water[5]	Desalter Induced SAR Inflow[6]	Total		Appropriative Pool less CDA Desalters[2, 3, 4]	Chino Desalter Authority	Total Appropriative Pool	Agricultural Pool	Overlying Non-Ag Pool	Total	Appropriative Pool less CDA Desalters[2, 3, 4]	Chino Desalter Authority	Total Appropriative Pool	Agricultural Pool	Overlying Non-Ag Pool
1977 - 1978	140,000	10,680	0	0	0	0	0	10,680	150,680	60,659	0	60,659	83,934	10,082	154,675	39%	0%	39%	54%	7%
1978 - 1979	140,000	12,638	15,757	0	0	0	0	28,395	168,395	60,597	0	60,597	73,688	7,127	141,412	43%	0%	43%	52%	5%
1979 - 1980	140,000	2,507	14,243	0	0	0	0	16,751	156,751	63,834	0	63,834	69,369	7,363	140,566	45%	0%	45%	49%	5%
1980 - 1981	140,000	12,228	8,662	0	0	0	0	20,890	160,890	70,726	0	70,726	68,040	5,650	144,416	49%	0%	49%	47%	4%
1981 - 1982	140,000	16,609	5,047	0	0	0	0	21,656	161,656	66,731	0	66,731	65,117	5,684	137,532	49%	0%	49%	47%	4%
1982 - 1983	140,000	13,188	15,501	0	0	0	0	28,689	168,689	63,481	0	63,481	56,759	2,395	122,635	52%	0%	52%	46%	2%
1983 - 1984	140,000	13,777	7,960	0	0	0	0	21,737	161,737	70,558	0	70,558	59,033	3,208	132,799	53%	0%	53%	44%	2%
1984 - 1985	140,000	12,188	8,709	0	0	0	0	20,897	160,897	76,912	0	76,912	55,543	2,415	134,870	57%	0%	57%	41%	2%
1985 - 1986	140,000	16,332	2,095	0	0	0	0	18,427	158,427	80,859	0	80,859	52,061	3,193	136,113	59%	0%	59%	38%	2%
1986 - 1987	140,000	10,086	9,921	0	0	0	0	20,007	160,007	84,662	0	84,662	59,847	2,559	147,068	58%	0%	58%	41%	2%
1987 - 1988	140,000	2,494	0	0	0	0	0	2,494	142,494	91,579	0	91,579	57,865	2,958	152,402	60%	0%	60%	38%	2%
1988 - 1989	140,000	7,407	0	0	0	0	0	7,407	147,407	93,617	0	93,617	46,762	3,619	143,998	65%	0%	65%	32%	3%
1989 - 1990	140,000	0	0	0	0	0	0	0	140,000	101,344	0	101,344	48,420	4,856	154,620	66%	0%	66%	31%	3%
1990 - 1991	140,000	3,291	503	0	0	0	0	3,793	143,793	86,658	0	86,658	48,085	5,407	140,150	62%	0%	62%	34%	4%
1991 - 1992	140,000	3,790	1,761	0	0	0	0	5,551	145,551	91,982	0	91,982	44,682	5,240	141,904	65%	0%	65%	31%	4%
1992 - 1993	140,000	12,535	1,677	0	0	9,041	0	23,253	163,253	86,367	0	86,367	44,092	5,464	135,923	64%	0%	64%	32%	4%
1993 - 1994	140,000	8,859	7,634	0	0	0	0	16,493	156,493	80,798	0	80,798	44,298	4,586	129,682	62%	0%	62%	34%	4%
1994 - 1995	140,000	0	10,300	0	0	0	0	10,300	150,300	93,419	0	93,419	55,022	4,327	152,768	61%	0%	61%	36%	3%
1995 - 1996	140,000	82	0	0	0	0	0	82	140,082	101,606	0	101,606	43,639	5,424	150,669	67%	0%	67%	29%	4%
1996 - 1997	140,000	0	17	0	0	0	0	17	140,017	110,163	0	110,163	44,809	6,309	161,281	68%	0%	68%	28%	4%
1997 - 1998	140,000	8,323	0	0	0	0	0	8,323	148,323	97,435	0	97,435	43,344	4,955	145,734	67%	0%	67%	30%	3%
1998 - 1999	140,000	5,697	0	0	0	0	0	5,697	145,697	107,723	0	107,723	47,538	7,006	162,267	66%	0%	66%	29%	4%
1999 - 2000	140,000	1,001	0	0	507	0	0	1,508	141,508	126,645	0	126,645	44,401	7,774	178,820	71%	0%	71%	25%	4%
2000 - 2001	140,000	30	0	6,500	500	0	3,995	7,030	147,030	113,437	7,989	121,426	39,954	8,084	169,464	67%	5%	72%	24%	5%
2001 - 2002	140,000	0	0	6,500	505	0	4,729	7,005	147,005	121,489	9,458	130,947	39,494	5,548	175,989	69%	5%	74%	22%	3%
2002 - 2003	140,000	0	0	6,499	185	0	5,220	6,684	146,684	120,557	10,439	130,996	38,487	4,853	174,336	69%	6%	75%	22%	3%
2003 - 2004	140,000	4,020	2,463	3,558	48	0	5,303	10,089	150,089	136,834	10,605	147,439	41,978	2,915	192,332	71%	6%	77%	22%	2%
2004 - 2005	140,000	4,380	0	7,877	158	12,500	4,927	24,915	164,915	127,811	9,854	137,665	34,450	2,327	174,441	73%	6%	79%	20%	1%
2005 - 2006	140,000	33,756	0	1,554	1,304	12,999	4,944	49,613	189,613	124,315	16,479	140,794	33,900	3,026	177,720	70%	9%	79%	19%	2%
2006 - 2007	140,000	32,991	0	0	2,989	4,770	7,907	40,750	180,750	130,826	26,356	157,182	37,295	3,369	197,846	66%	13%	79%	19%	2%
2007 - 2008	140,000	0	0	0	2,340	10,243	8,092	12,583	152,583	103,078	26,972	130,050	30,910	3,440	164,400	63%	16%	79%	19%	2%
Totals	4,340,000	248,888	112,249	32,489	8,536	49,553	45,114	451,715	4,791,715	2,946,702	118,152	3,064,853	1,552,816	151,162	4,768,832					
Average	140,000	8,029	3,621	1,048	275	1,598	1,455	14,571	154,571	95,055	14,769	98,866	50,091	4,876	153,833	59%	8%	63%	35%	3%
Max	140,000	33,756	15,757	7,877	2,989	12,999	8,092	49,613	189,613	136,834	26,972	157,182	83,934	10,082	197,846	73%	16%	79%	55%	7%
Min	140,000	0	0	0	0	0	0	0	140,000	60,597	0	60,597	33,900	2,327	122,635	39%	0%	39%	19%	1%

[1] Includes only water actually spread
[2] Includes only actual water produced and does not include MWD exchanges
[3] Includes adjustment for Ontario production of 633 AF in FY 2001-02
[4] Includes adjustment for Jurupa, Niagara, and Chino production correction of 1,030 AF in FY 2002-03
[5] Includes 9,041 acre-ft of surface water recharge in the Chino Basin that would otherwise have recharged the Claremont Heights Basin in FY 1992-93; and CBFIP stormwater capture of 12,500 acre-ft/yr beginning in FY 2004-05.
[6] Watermaster has assumed that half of the desalter pumping has been replenished by induced recharge in the Santa Ana River through FY 2004-05 and that 30 percent of the desalter pumping has been replenished by induced recharge in the Santa Ana River in FY 2005-06
[7] The only discharge considered herein is pumping, the other discharges are assumed netted out in the safe yield

Table 3-2
Summary of Annual Wet Water Recharge in the Chino Basin

Basin Name	2000/2001				2001/2002				2002/2003				2003/2004			
	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge
Banana Basin	390	0	0	390	184	0	0	184	366	0	0	366	188	0	0	188
Declez Basin	--	0	0	0	--	0	0	0	--	0	0	0	--	0	0	0
Etiwanda Conservation Ponds	--	0	0	0	--	0	0	0	--	0	0	0	--	0	0	0
Hickory Basin	37	0	0	37	105	0	0	105	551	0	0	551	224	0	0	224
Jurupa Basin	--	0	0	0	--	0	0	0	--	0	0	0	--	0	0	0
RP-3 Basins	--	0	0	0	--	0	0	0	--	0	0	0	--	0	0	0
Turner Basin	167	0	0	167	100	0	0	100	192	0	0	192	0	0	0	0
7th and 8th Street Basins	--	0	0	0	--	0	0	0	--	0	0	0	--	0	0	0
Brooks Street Basin	0	0	0	0	104	0	0	104	676	0	0	676	--	0	0	0
College Heights Basins	--	0	0	0	--	0	0	0	--	0	0	0	--	0	0	0
Ely Basins	--	0	500	500	--	0	505	505	--	0	185	185	--	0	48	48
Etiwanda Spreading Basins	--	0	0	0	--	0	0	0	--	0	0	0	--	2,812	0	2,812
Lower Day Basin	--	0	0	0	--	0	0	0	--	0	0	0	--	0	0	0
Montclair Basins	2,890	6,530	0	9,420	773	6,500	0	7,273	1,328	6,499	0	7,827	--	3,558	0	3,558
San Sevaine	--	0	0	0	--	0	0	0	--	0	0	0	--	1,211	0	1,211
Upland Basin	--	0	0	0	--	0	0	0	--	0	0	0	--	0	0	0
Victoria Basin	--	0	0	0	--	0	0	0	--	0	0	0	--	0	0	0
Totals:	3,484	6,530	500	10,514	1,266	6,500	505	8,271	3,113	6,499	185	9,797	412	7,582	48	8,042

Basin Name	2004/2005				2005/2006				2006/2007				2007/2008			
	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge
Banana Basin	459	0	0	459	221	206	529	956	226	783	643	1,652	278	0	157	435
Declez Basin	--	0	0	0	737	0	0	737	0	0	0	0	730	0	0	730
Etiwanda Conservation Ponds	--	197	0	197	--	0	0	0	0	0	0	0	0	0	0	0
Hickory Basin	653	0	0	653	517	623	586	1,726	536	212	646	1,394	949	0	625	1,574
Jurupa Basin	--	0	0	0	--	0	0	0	0	0	0	0	0	0	0	0
RP-3 Basins	--	0	0	0	767	0	0	767	802	0	0	802	511	0	0	511
Turner Basin	297	310	0	607	2,575	346	0	2,921	406	313	1237	1,956	1542	0	0	1,542
7th and 8th Street Basins	--	0	0	0	1,271	0	0	1,271	640	0	0	640	959	0	1,054	2,013
Brooks Street Basin	--	0	0	0	524	2033	0	2,557	205	1604	0	1,809	475	0	0	475
College Heights Basins	--	0	0	0	108	5,432	0	5,540	1	3,125	0	3,126	172	0	0	172
Ely Basins	--	0	158	158	1,531	0	188	1,719	631	0	466	1,097	1,603	0	562	2,165
Etiwanda Spreading Basins	--	2,137	0	2,137	20	2,488	0	2,508	0	1,160	0	1,160	10	0	0	10
Lower Day Basin	--	107	0	107	624	2,810	0	3,434	78	2,266	0	2,344	303	0	0	303
Montclair Basins	--	7,887	0	7,887	1,296	5,536	0	6,832	355	10,681	0	11,036	859	0	0	859
San Sevaine	--	1,621	0	1,621	2,072	9,172	0	11,244	244	5,749	0	5,993	749	0	0	749
Upland Basin	--	0	0	0	214	5,922	0	6,136	195	7068	0	7,263	312	0	0	312
Victoria Basin	--	0	0	0	330	0	0	330	260	0	0	260	427	0	0	427
Totals:	1,409	12,258	158	13,825	12,807	34,568	1,303	48,678	4,579	32,961	2,992	40,532	9,879	0	2,398	12,277



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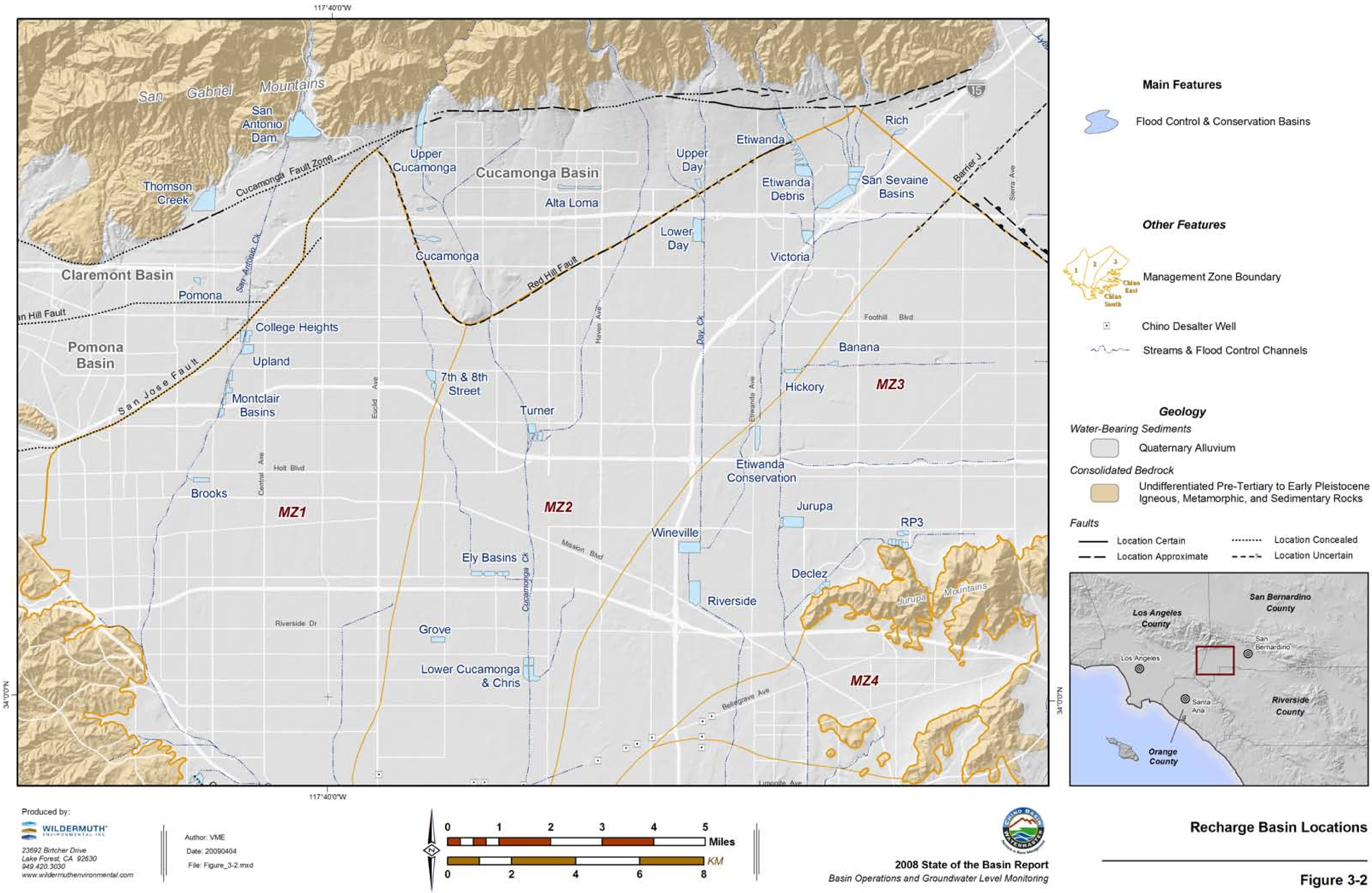
2008 State of the Basin Report
Basin Operations and Groundwater Level Monitoring

Active Production Wells by Pool
Production Wells as of Fiscal Year 2007-08

Figure 3-1



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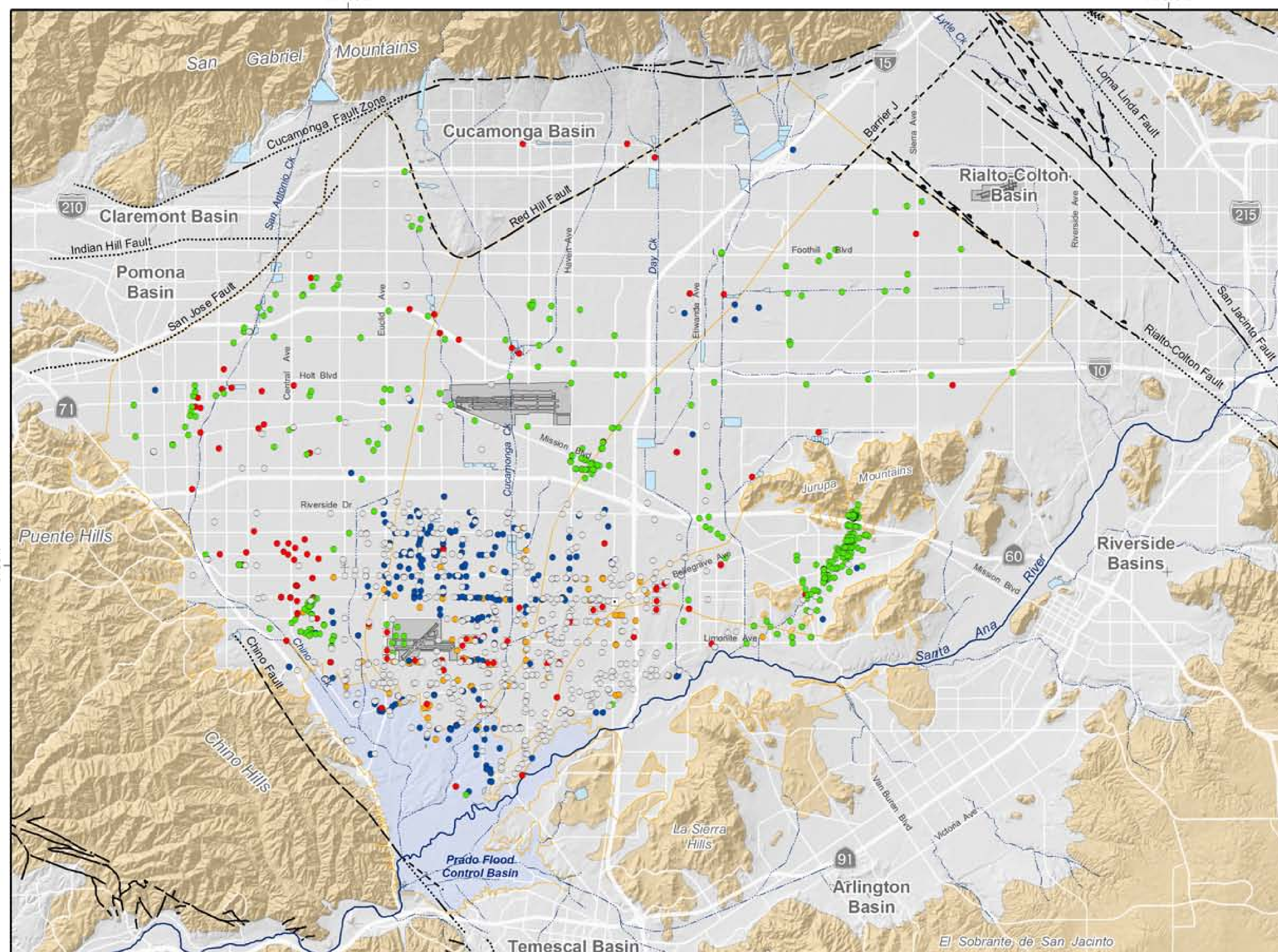
2008 State of the Basin Report
Basin Operations and Groundwater Level Monitoring

Recharge Basin Locations

Figure 3-2



Basin-Wide Monitoring Program
by Measurement Frequency

- Monthly Measurement (84 wells)
- Semi-Annual Measurement (212 wells)
- Measurement by Transducer (134 wells)
- Owner Measures Water Level (476 wells)
- Unable to Obtain Water Level (510 wells)

Other Features

- Management Zone Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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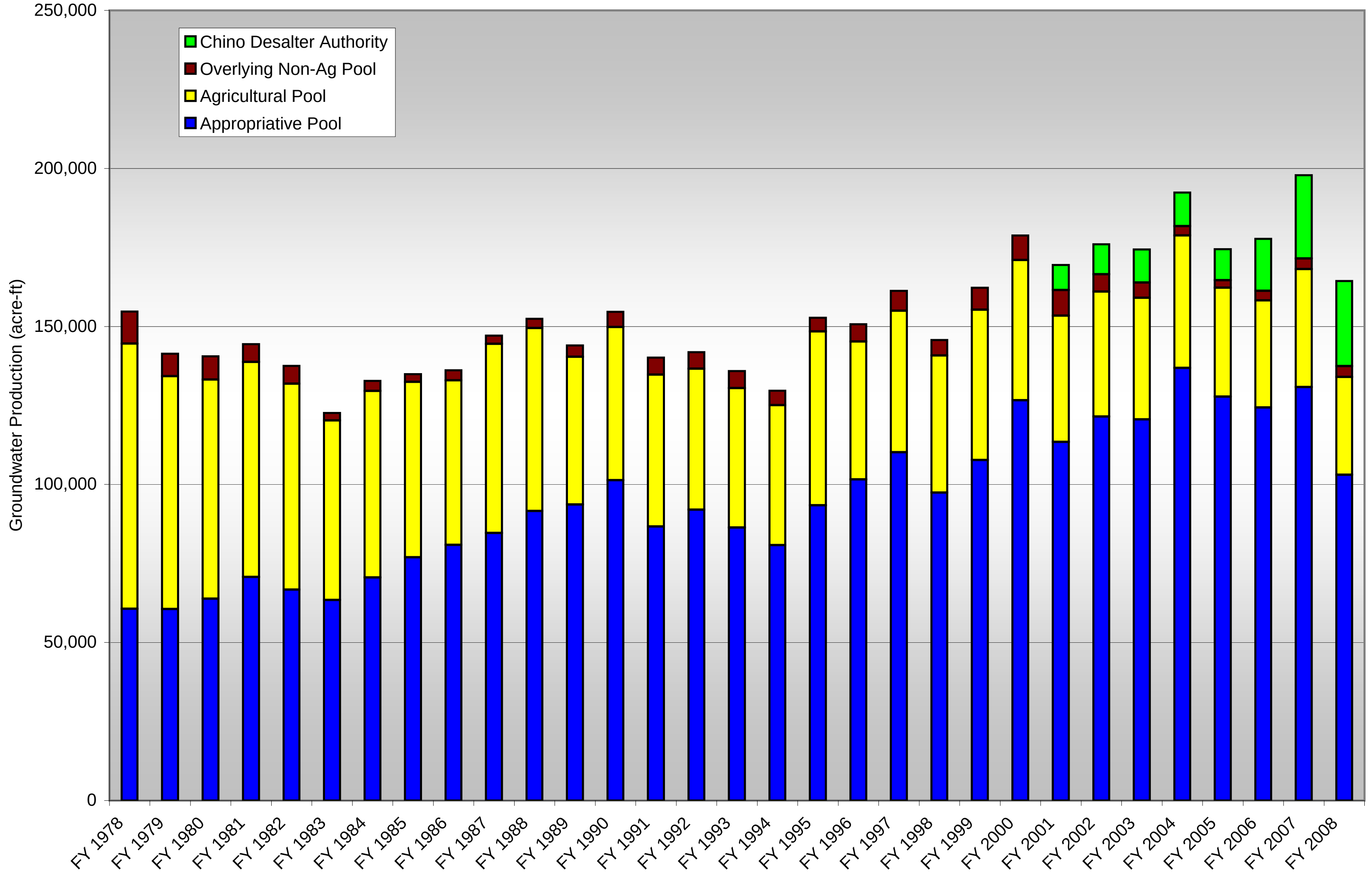
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Basic Operations and Groundwater Level Monitoring

Groundwater Level Monitoring Network
Well Locations and Measurement Frequency

Figure 3-3

Figure 3-4
Distribution of Groundwater Production by Pool



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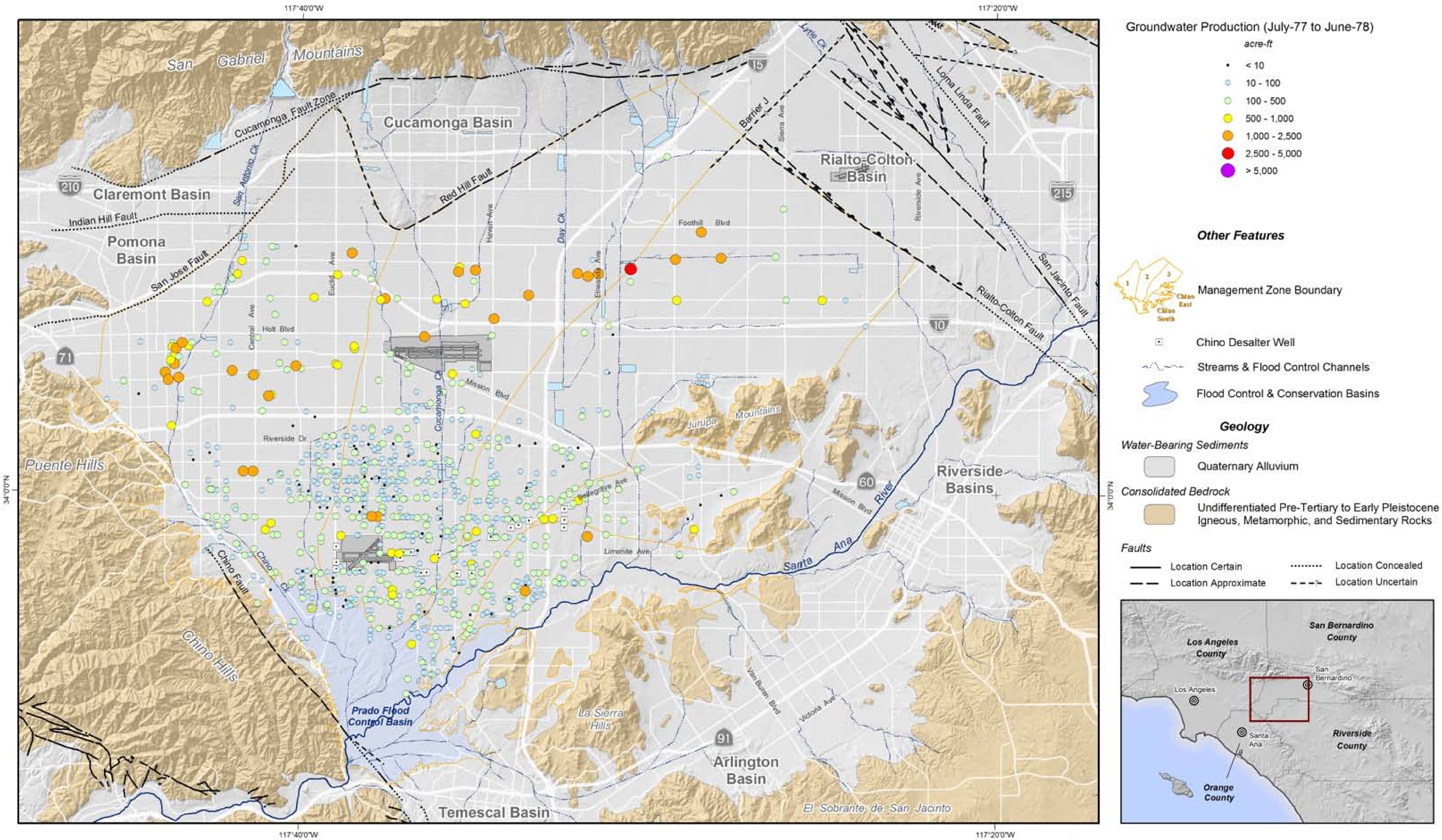

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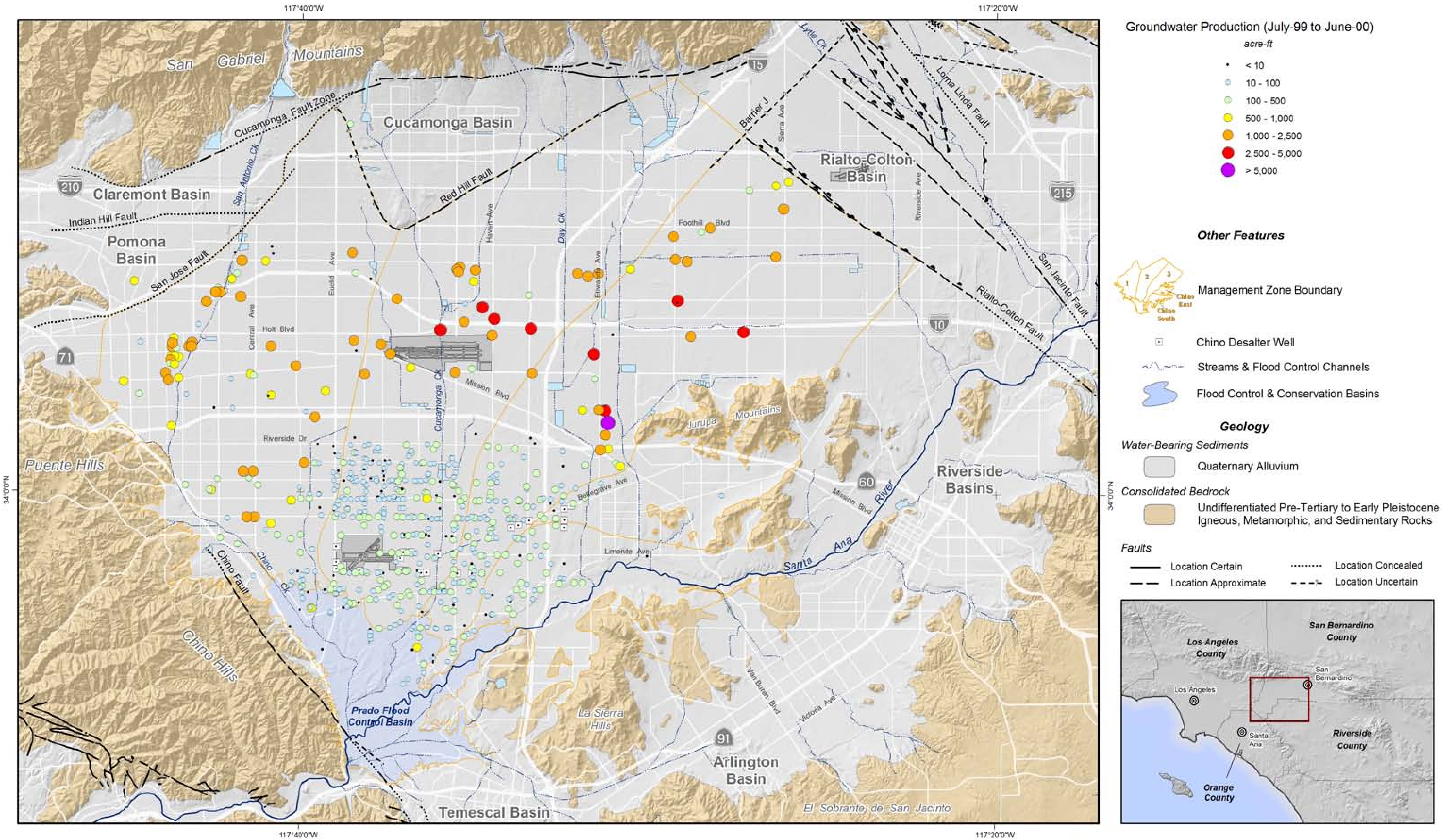
Date: 20090420
File: Figure_3-5.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Pumping

Groundwater Production by Well
Fiscal Year 1977-1978

Figure 3-5



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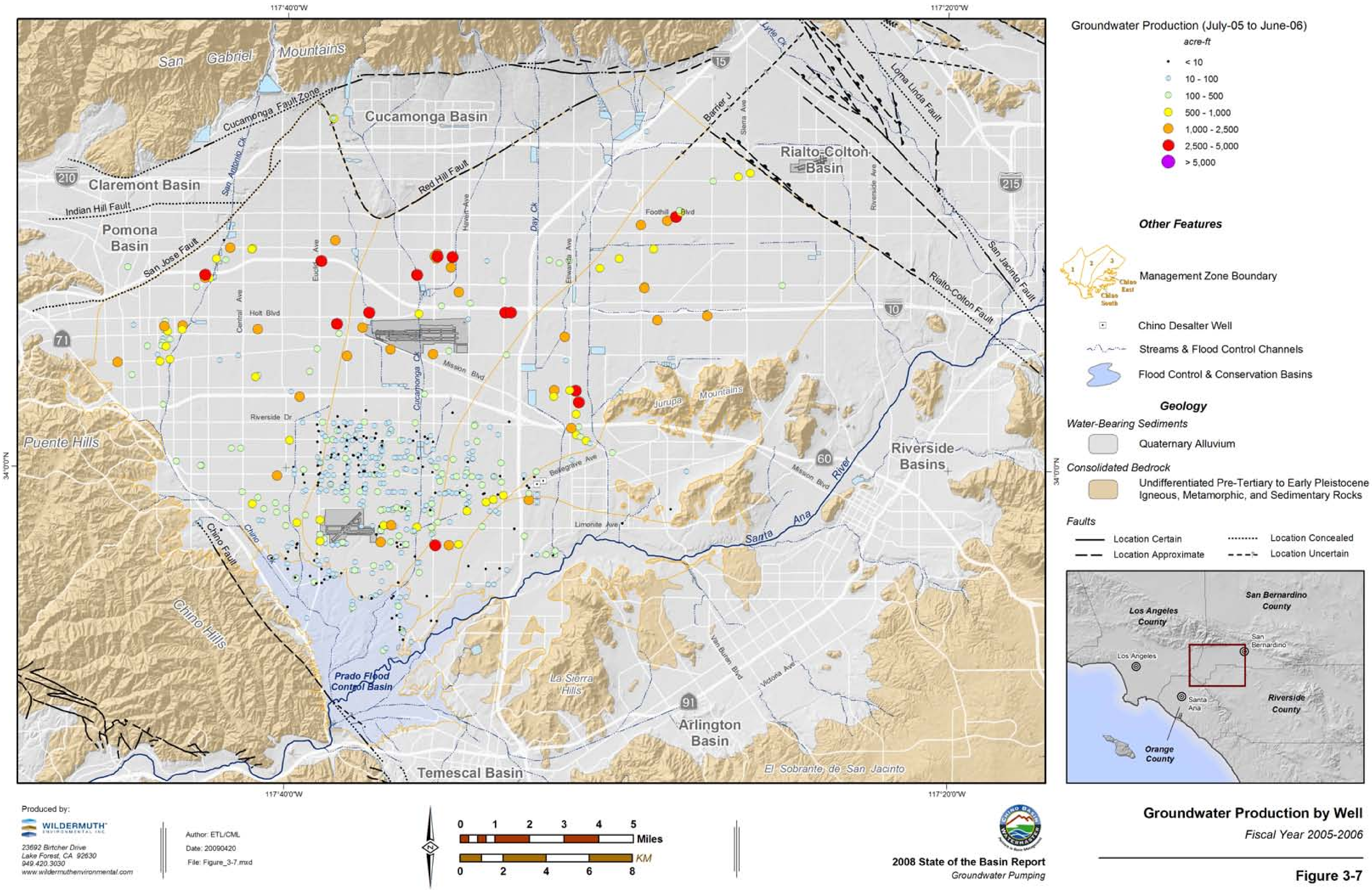
2008 State of the Basin Report
Groundwater Pumping

Groundwater Production by Well
Fiscal Year 1999-2000

Figure 3-6



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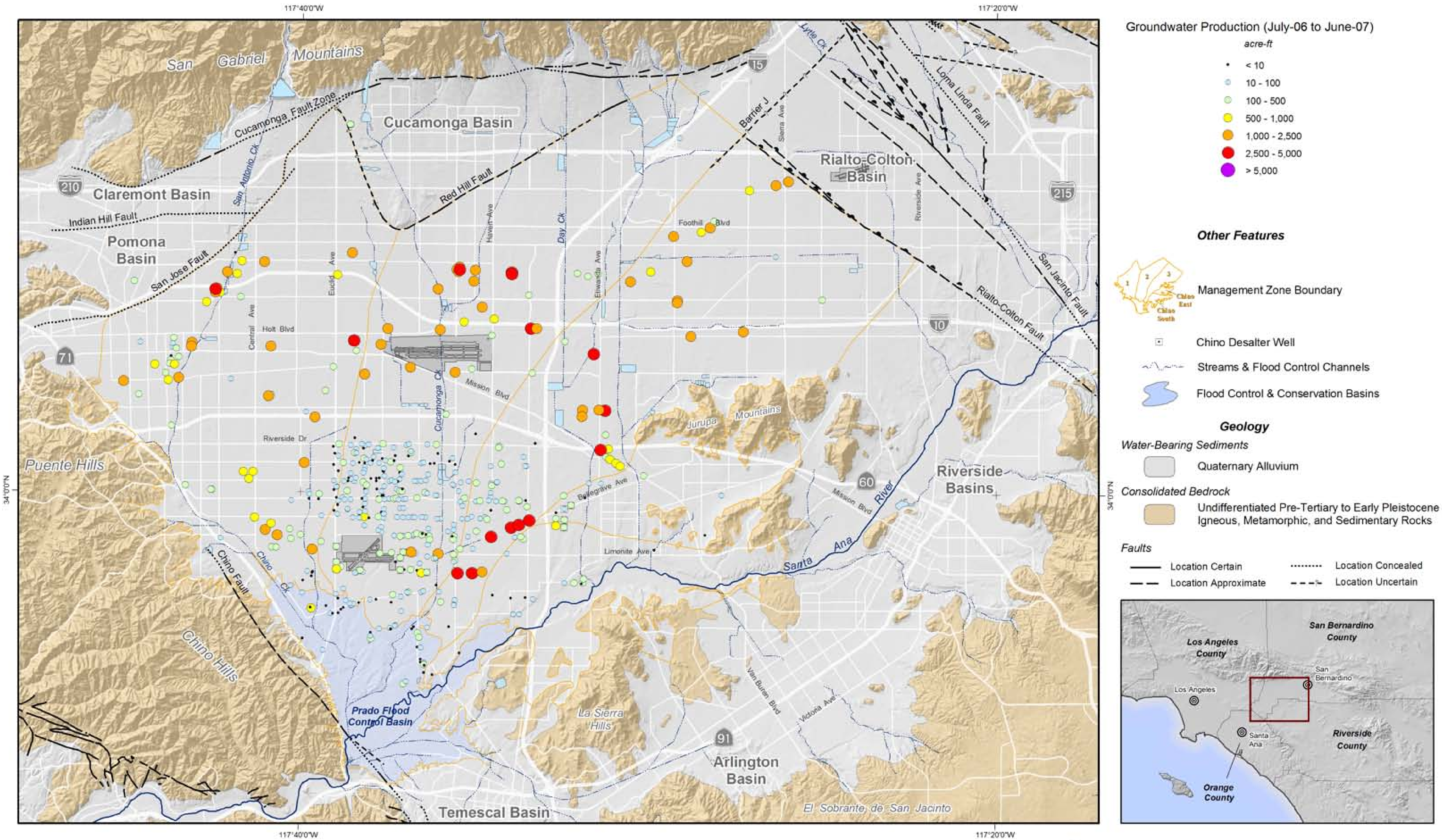
2008 State of the Basin Report
Groundwater Pumping

Groundwater Production by Well
Fiscal Year 2005-2006

Figure 3-7



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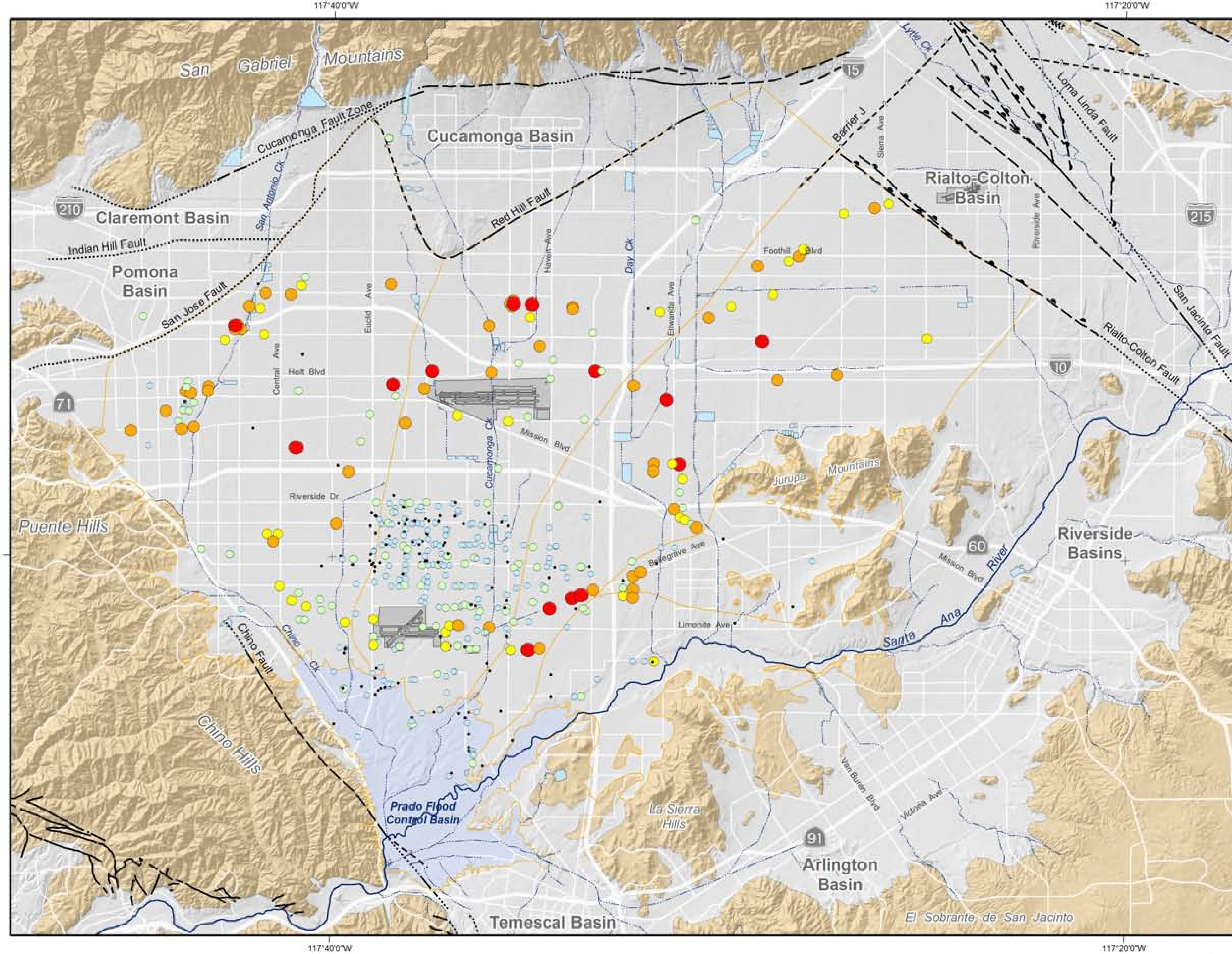
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Pumping

Groundwater Production by Well
Fiscal Year 2006-2007

Figure 3-8



Groundwater Production (July-07 to June-08)

acre-ft

- < 10
- 10 - 100
- 100 - 500
- 500 - 1,000
- 1,000 - 2,500
- 2,500 - 5,000
- > 5,000

Other Features

Management Zone Boundary

Chino Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain | Location Concealed

Location Approximate | Location Uncertain

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0 1 2 3 4 5 Miles

0 2 4 6 8 KM

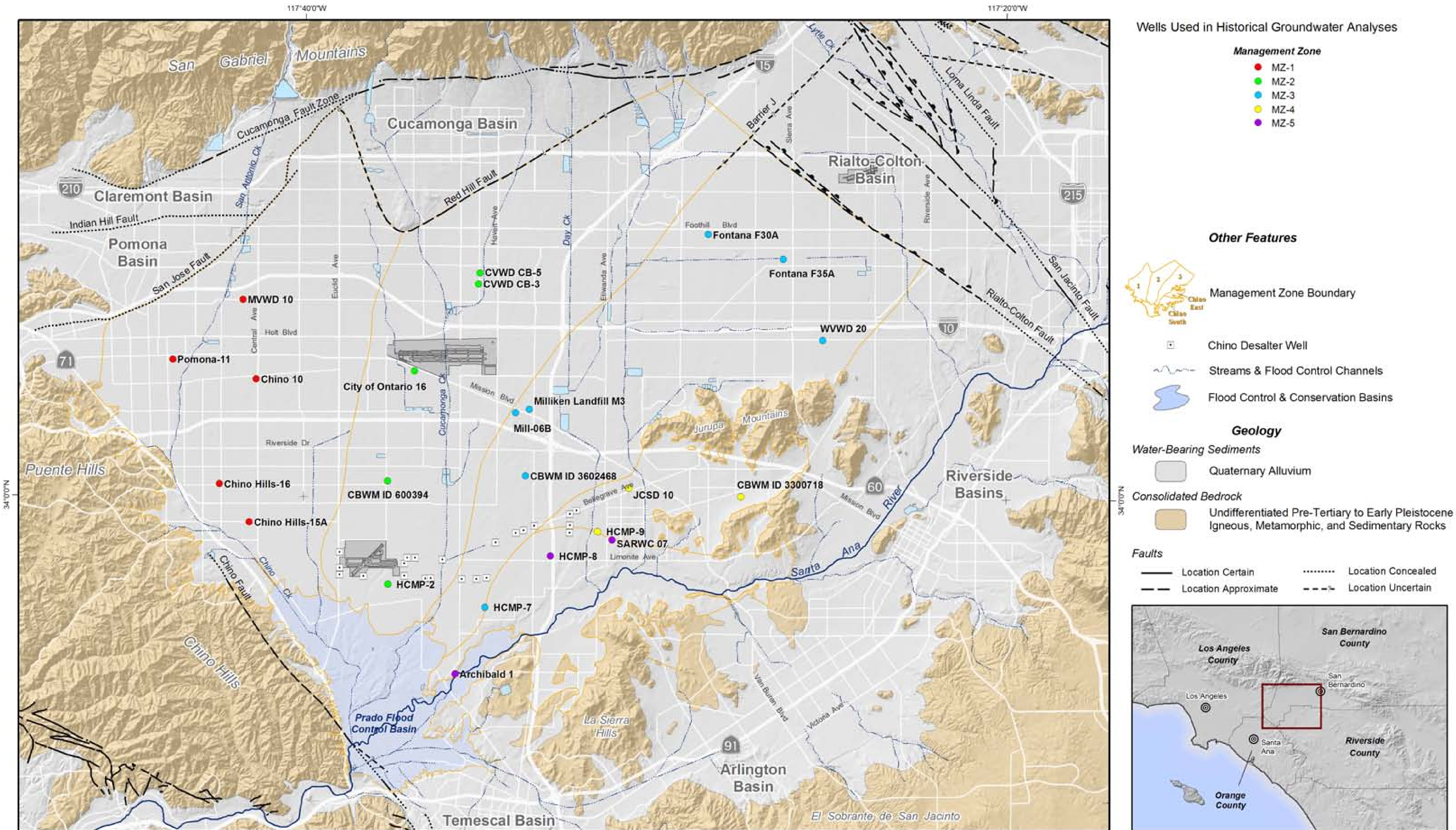
2008 State of the Basin Report

Groundwater Pumping

Groundwater Production by Well

Fiscal Year 2007-2008

Figure 3-9



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2008 State of the Basin Report
Groundwater Levels

Historical Groundwater Level Trends Well Location Map
Wells Used in Historical Groundwater Level Analyses

Figure 3-10

Figure 3-11 - Time History of Production, Recharge, and Groundwater Levels in MZ1

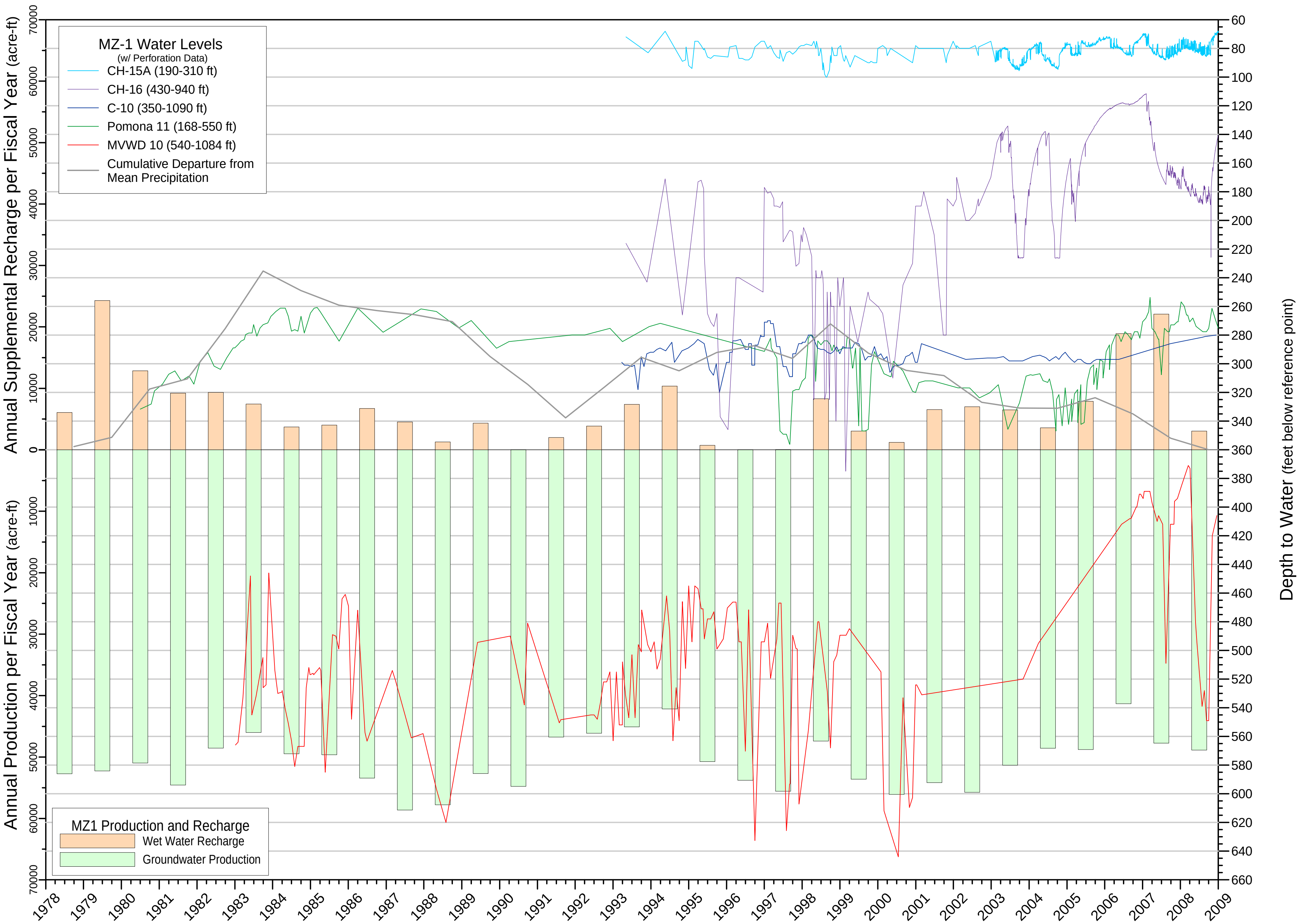

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Figure 3-12 - Time History of Production, Recharge, and Groundwater Levels in MZ2

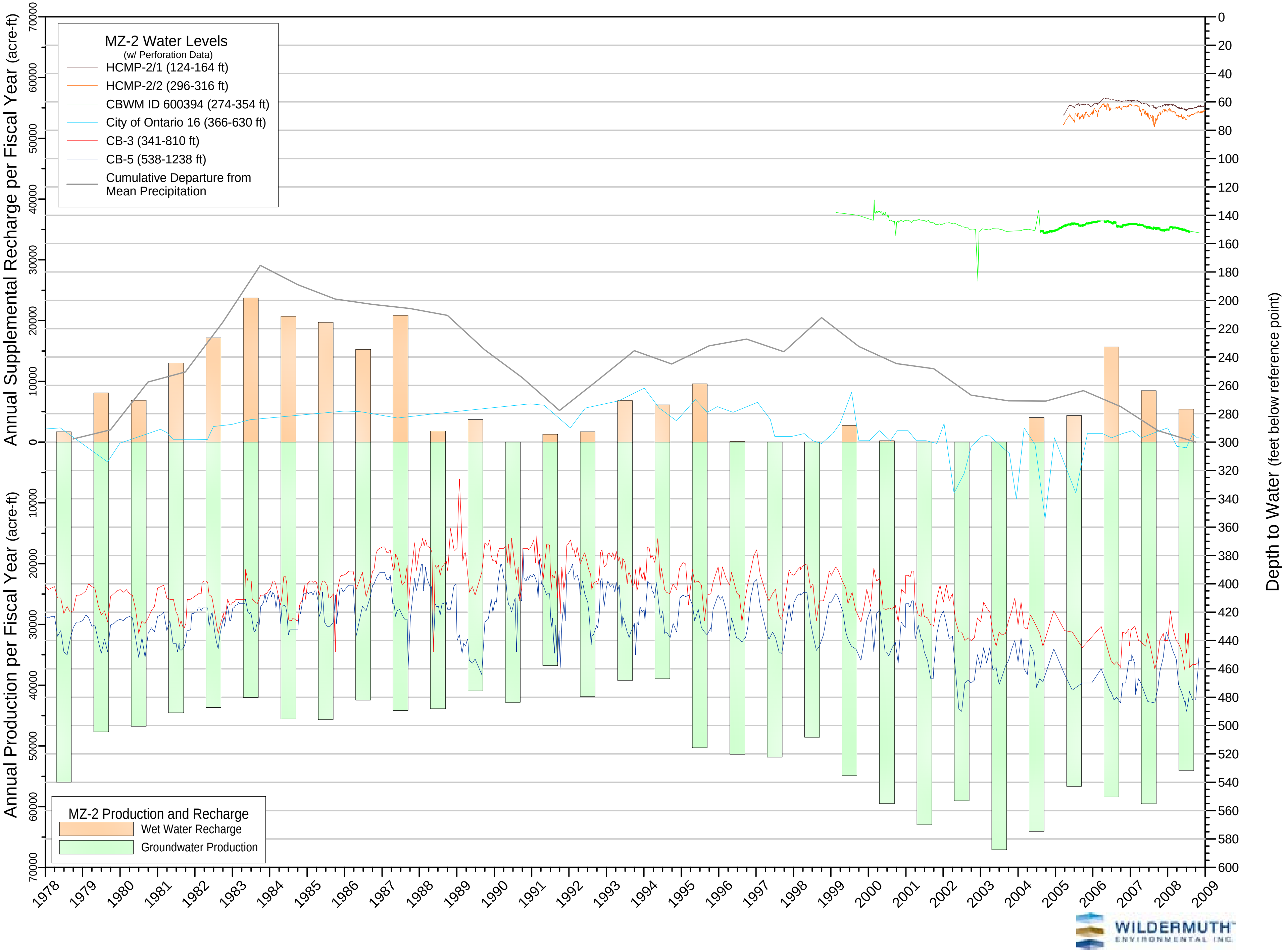


Figure 3-13 - Time History of Production, Recharge, and Groundwater Levels in MZ3

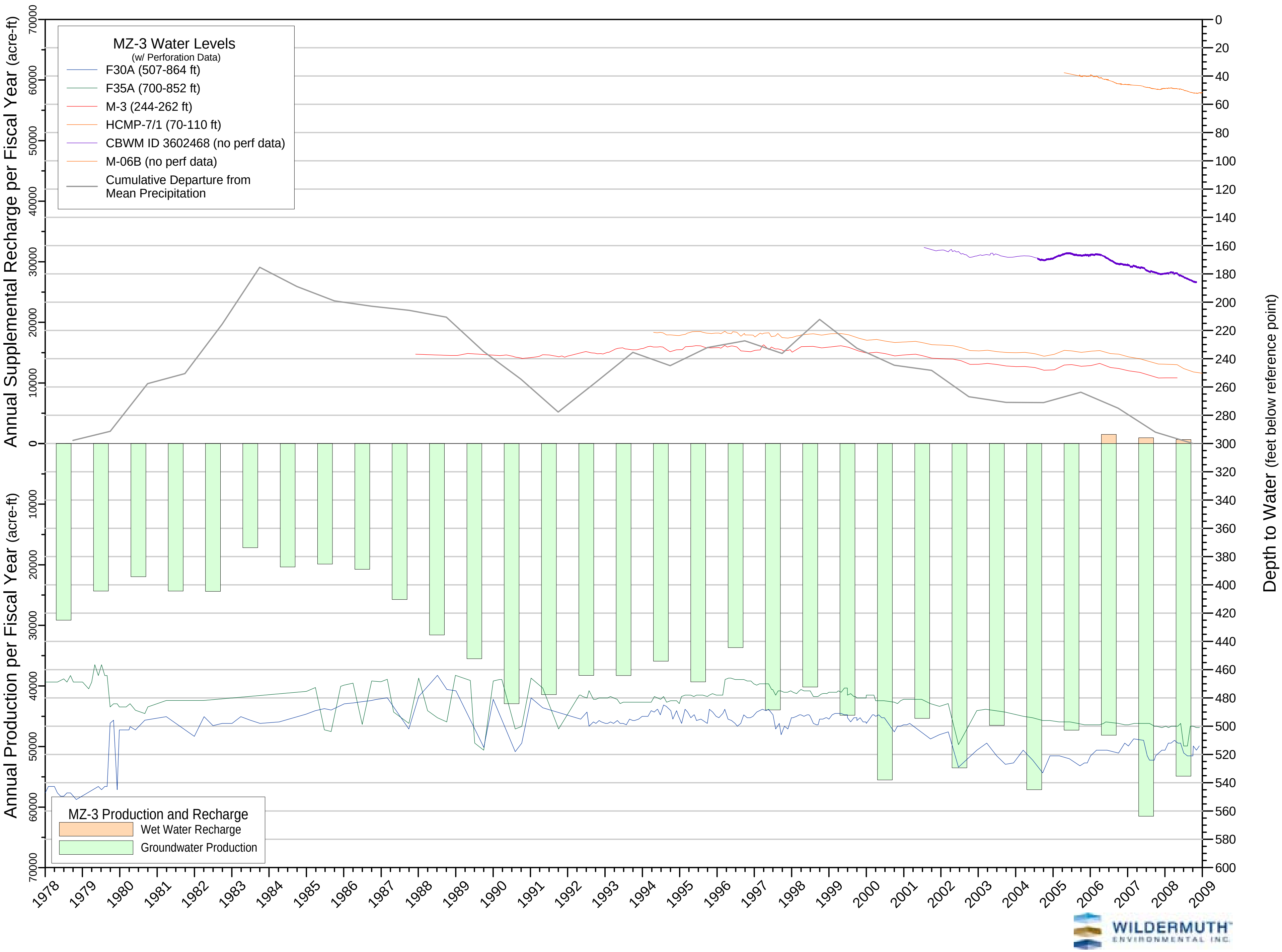


Figure 3-14 - Time History of Production, Recharge, and Groundwater Levels in Chino-East MZ

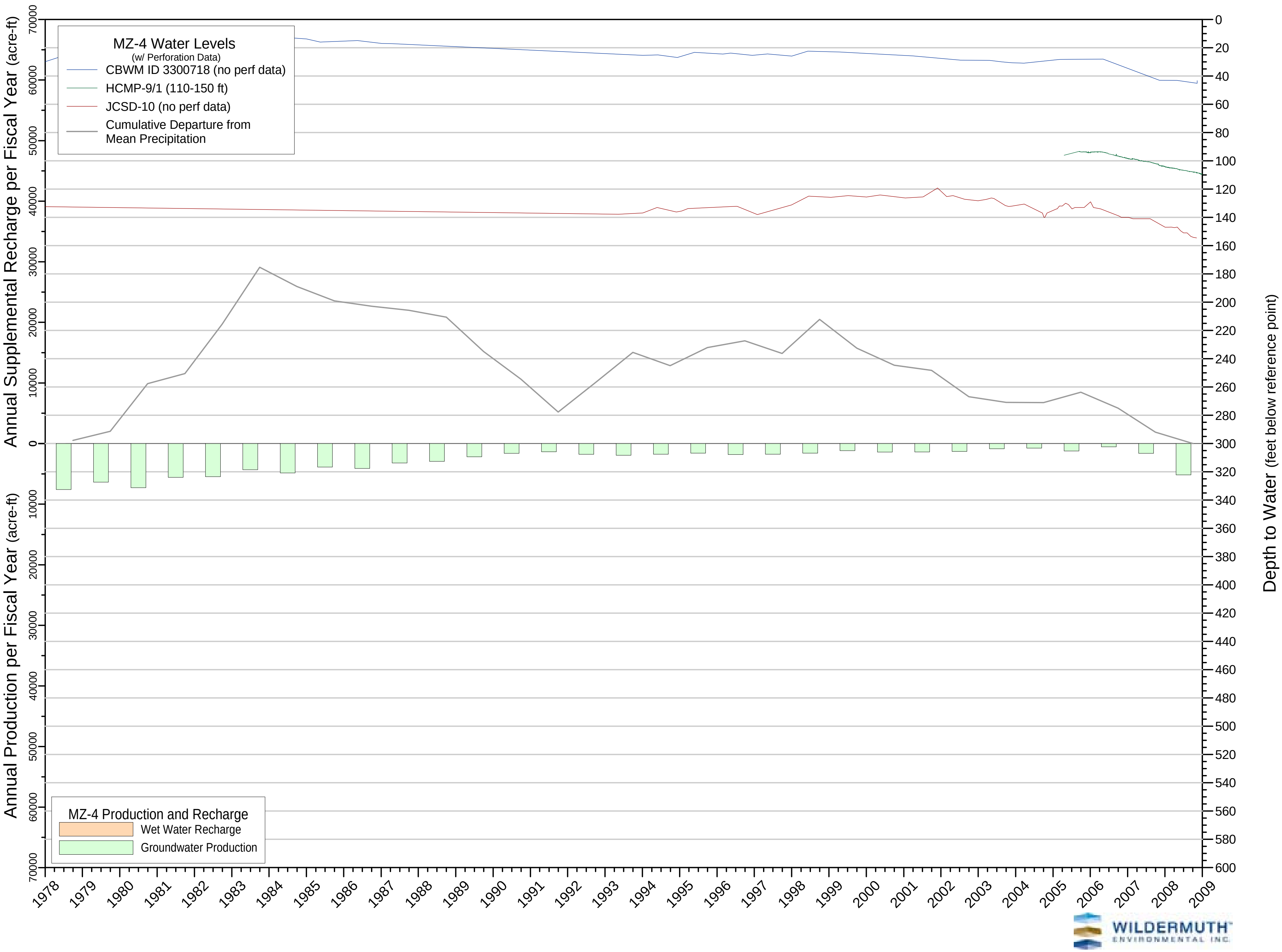
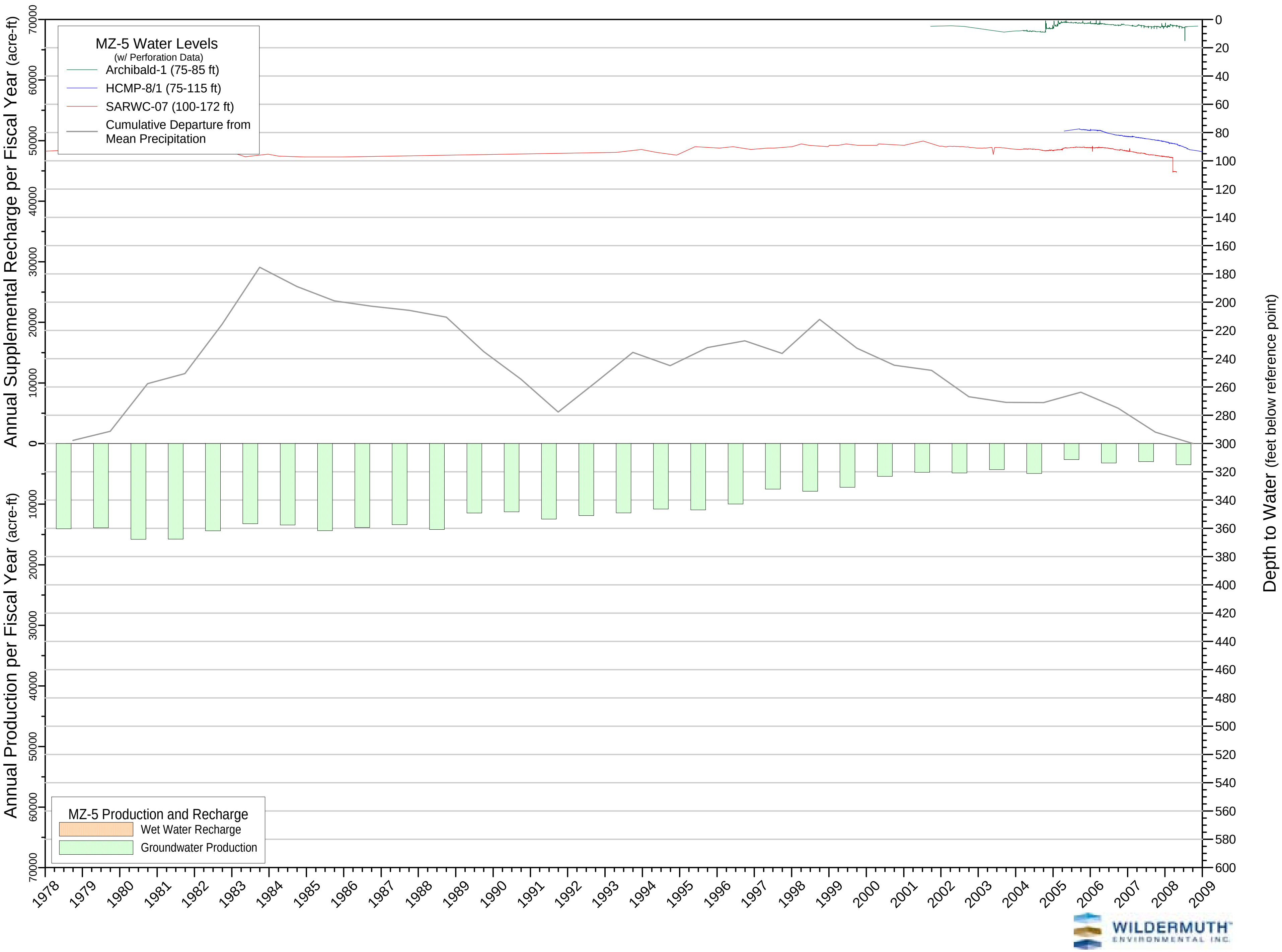
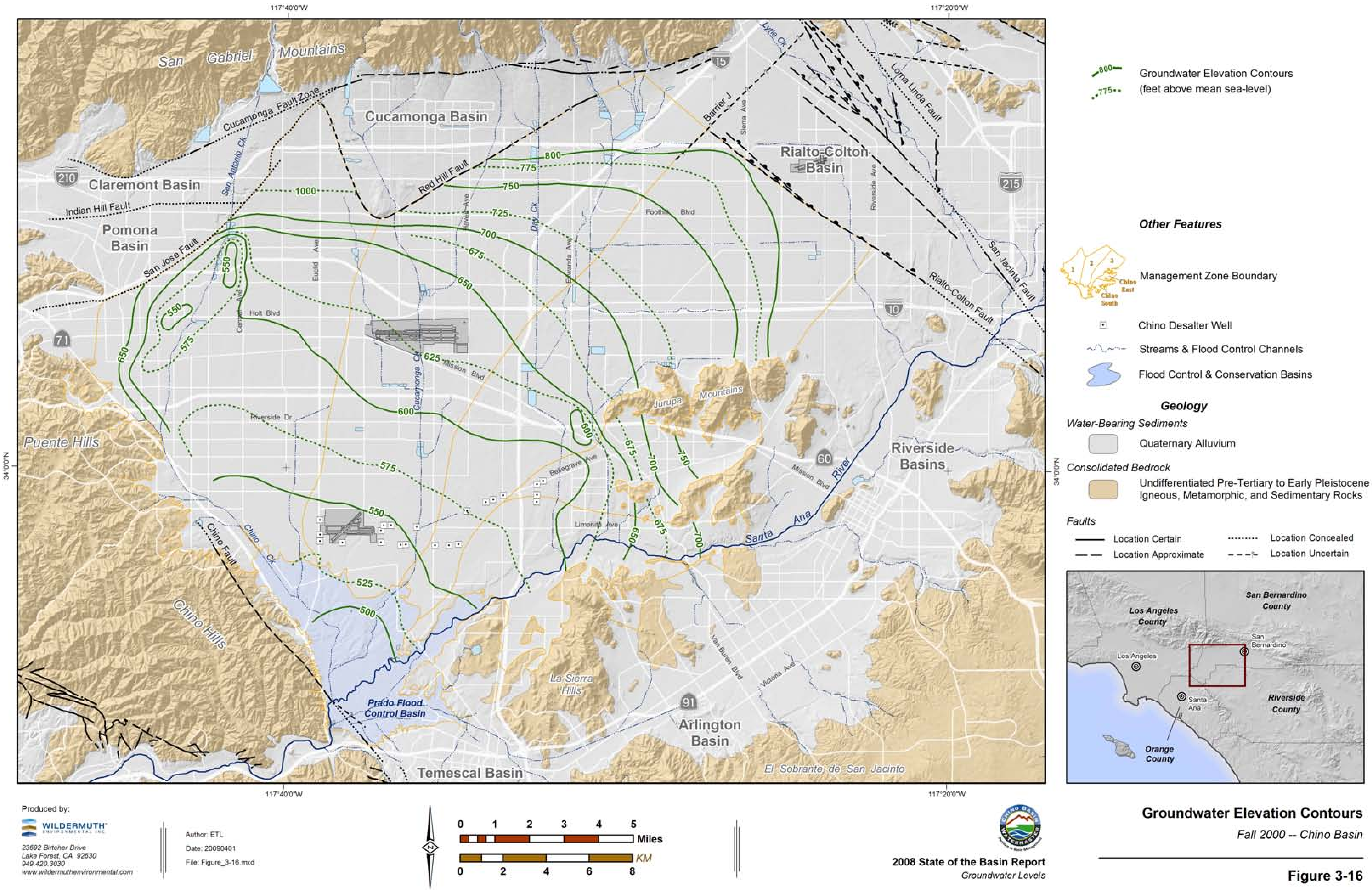


Figure 3-15 - Time History of Production, Recharge, and Groundwater Levels in Chino-South MZ





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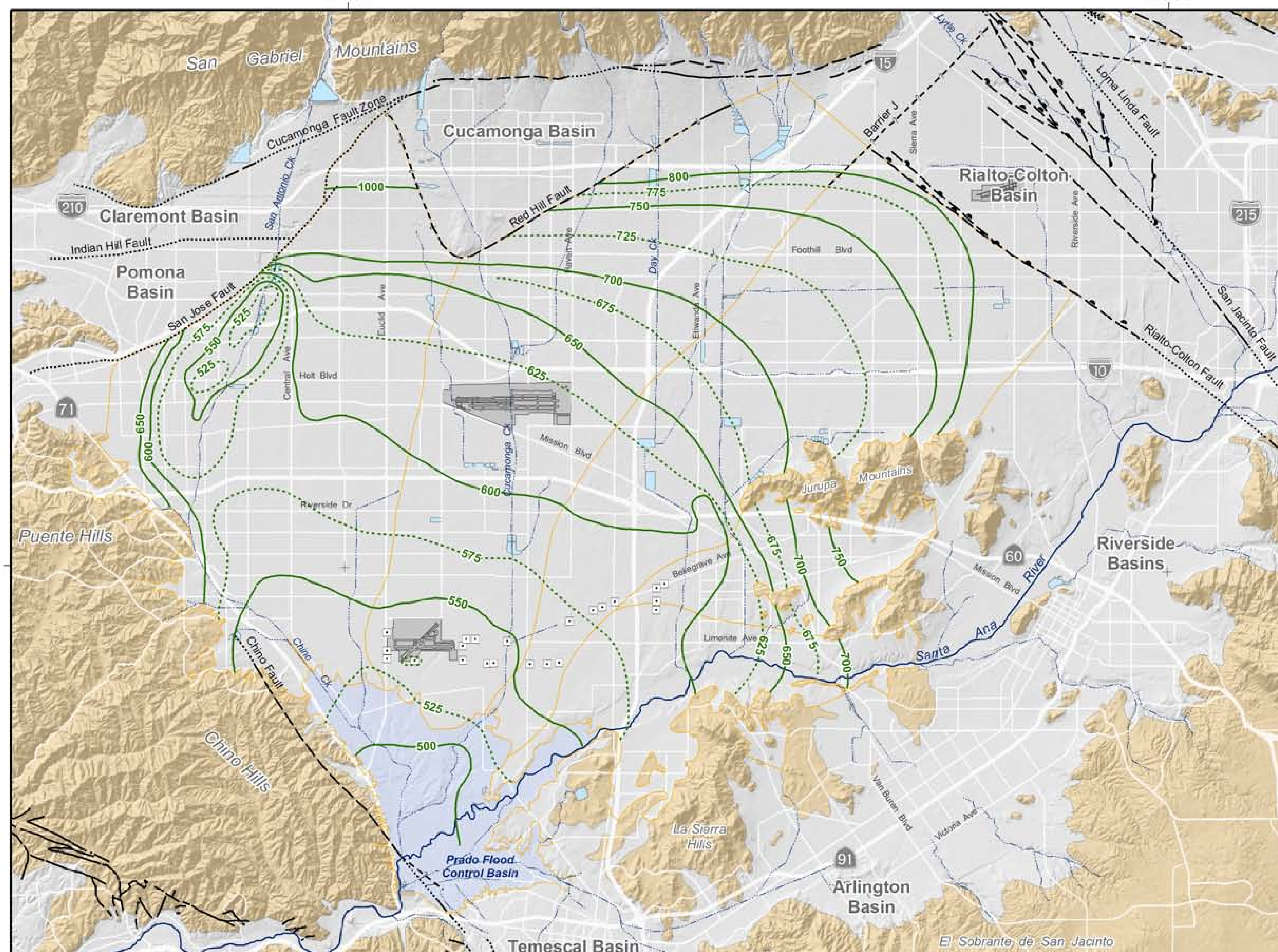
2008 State of the Basin Report
Groundwater Levels

Groundwater Elevation Contours
Fall 2000 -- Chino Basin

Figure 3-16



Groundwater Elevation Contours (feet above mean sea-level)

Other Features

Management Zone Boundary

Chino Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Approximate

Location Concealed

Location Uncertain

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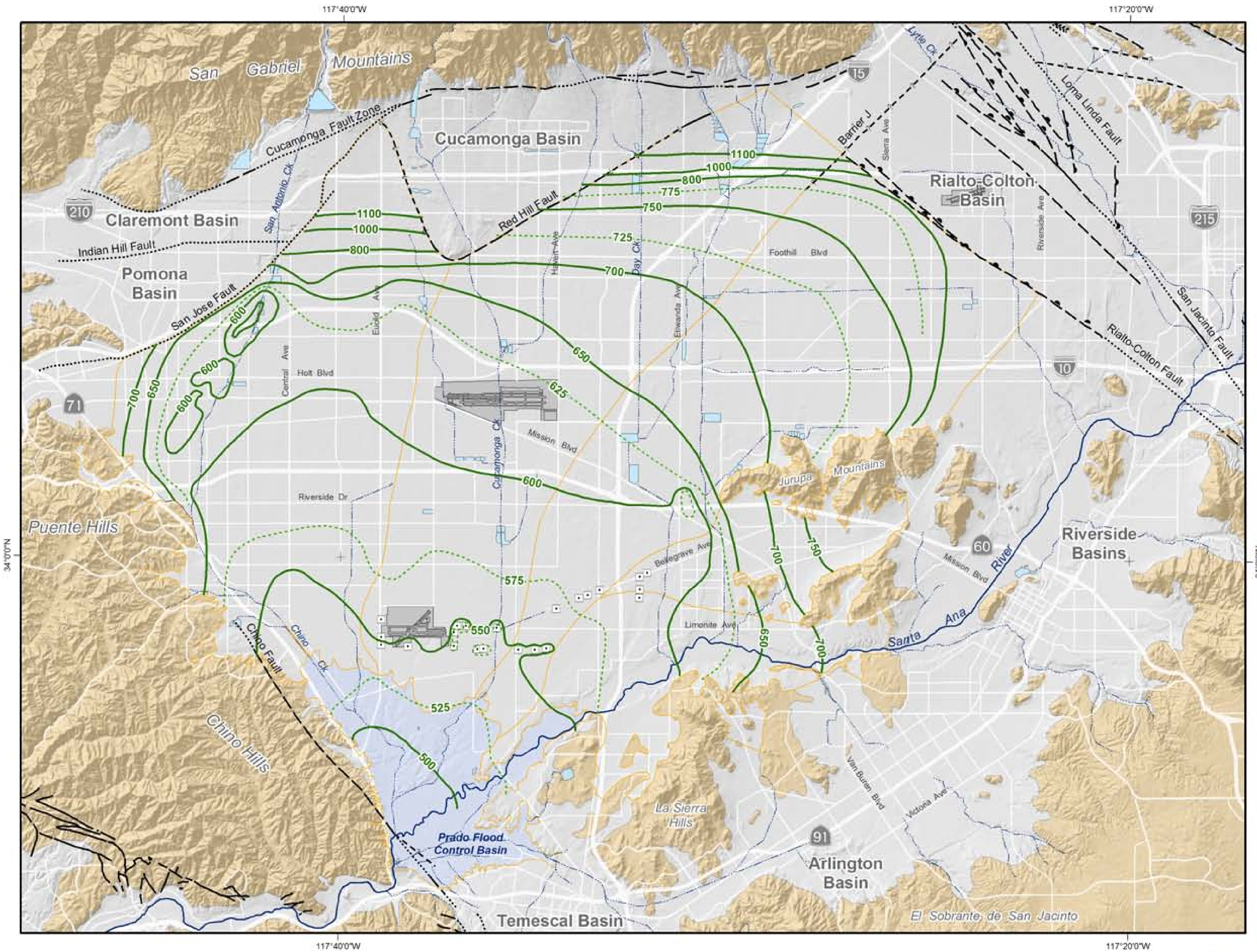
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Levels

Groundwater Elevation Contours
Fall 2003 -- Chino Basin

Figure 3-17



Groundwater Elevation Contours (feet above mean sea-level)

Other Features

Management Zone Boundary

Chino Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Approximate

Location Concealed

Location Uncertain

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0 1 2 3 4 5 Miles

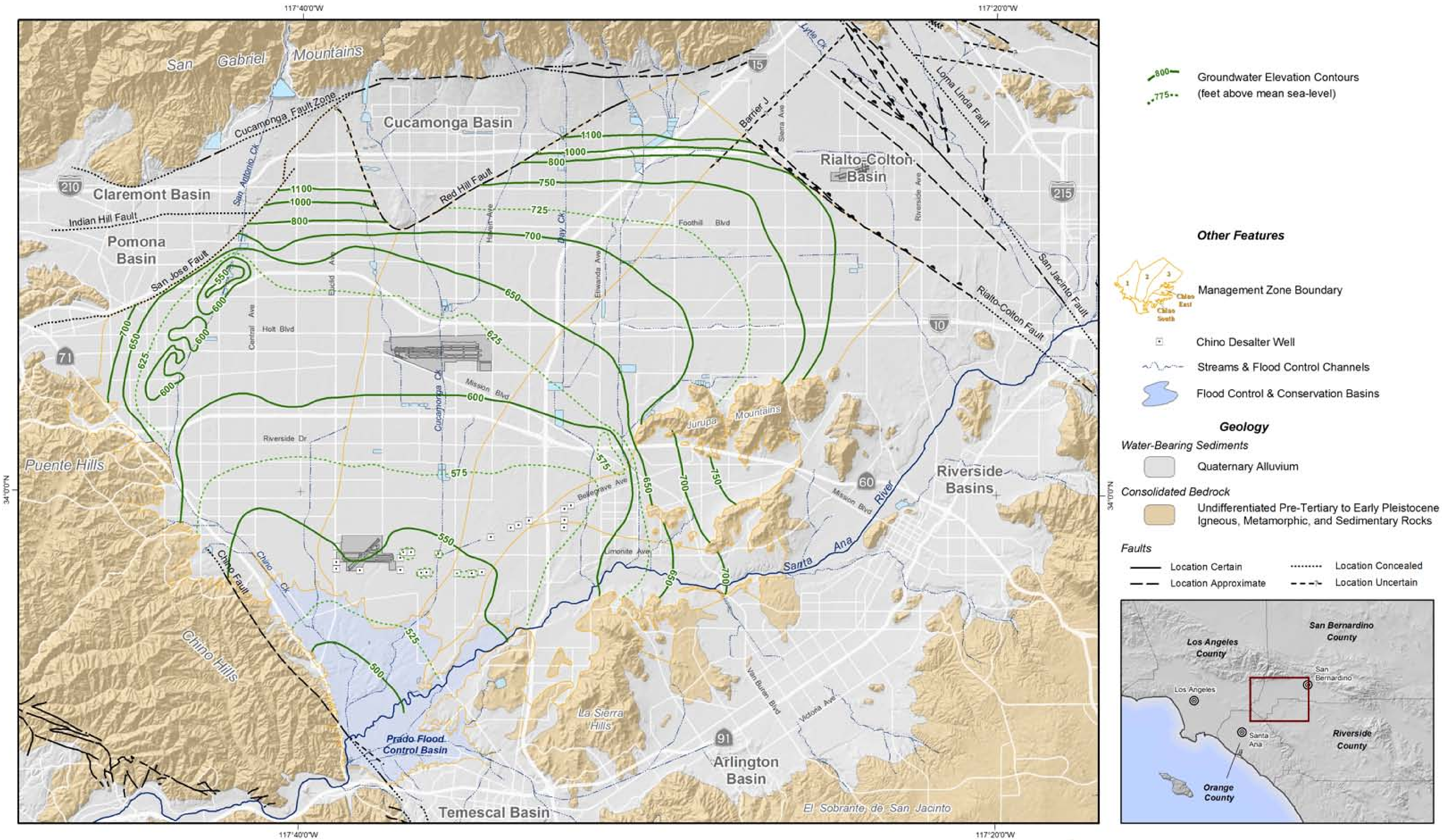
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Levels

Groundwater Elevation Contours

Fall 2006 -- Chino Basin

Figure 3-18



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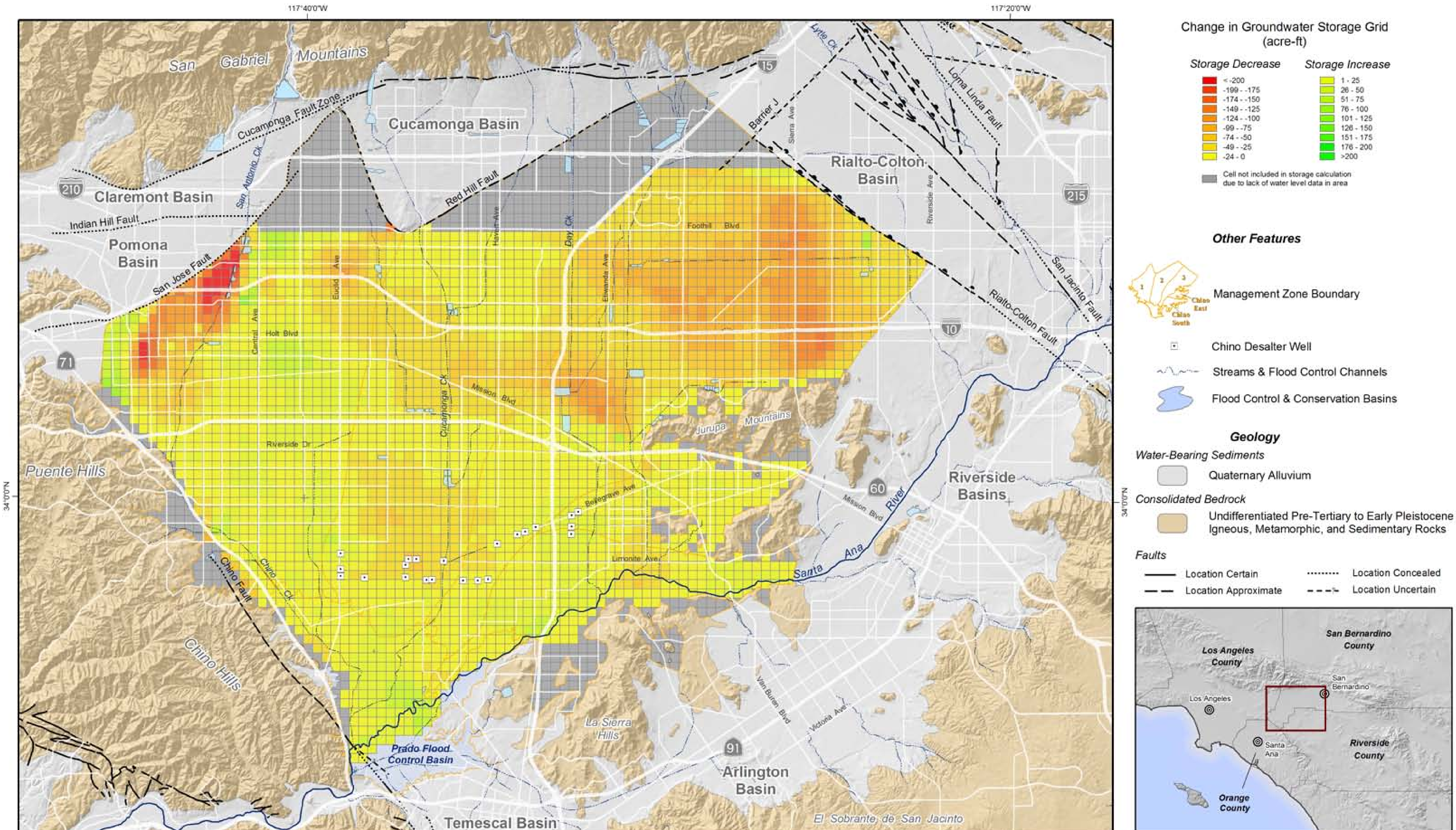
2008 State of the Basin Report
Groundwater Levels

Groundwater Elevation Contours

Fall 2008 -- Chino Basin

Figure 3-19



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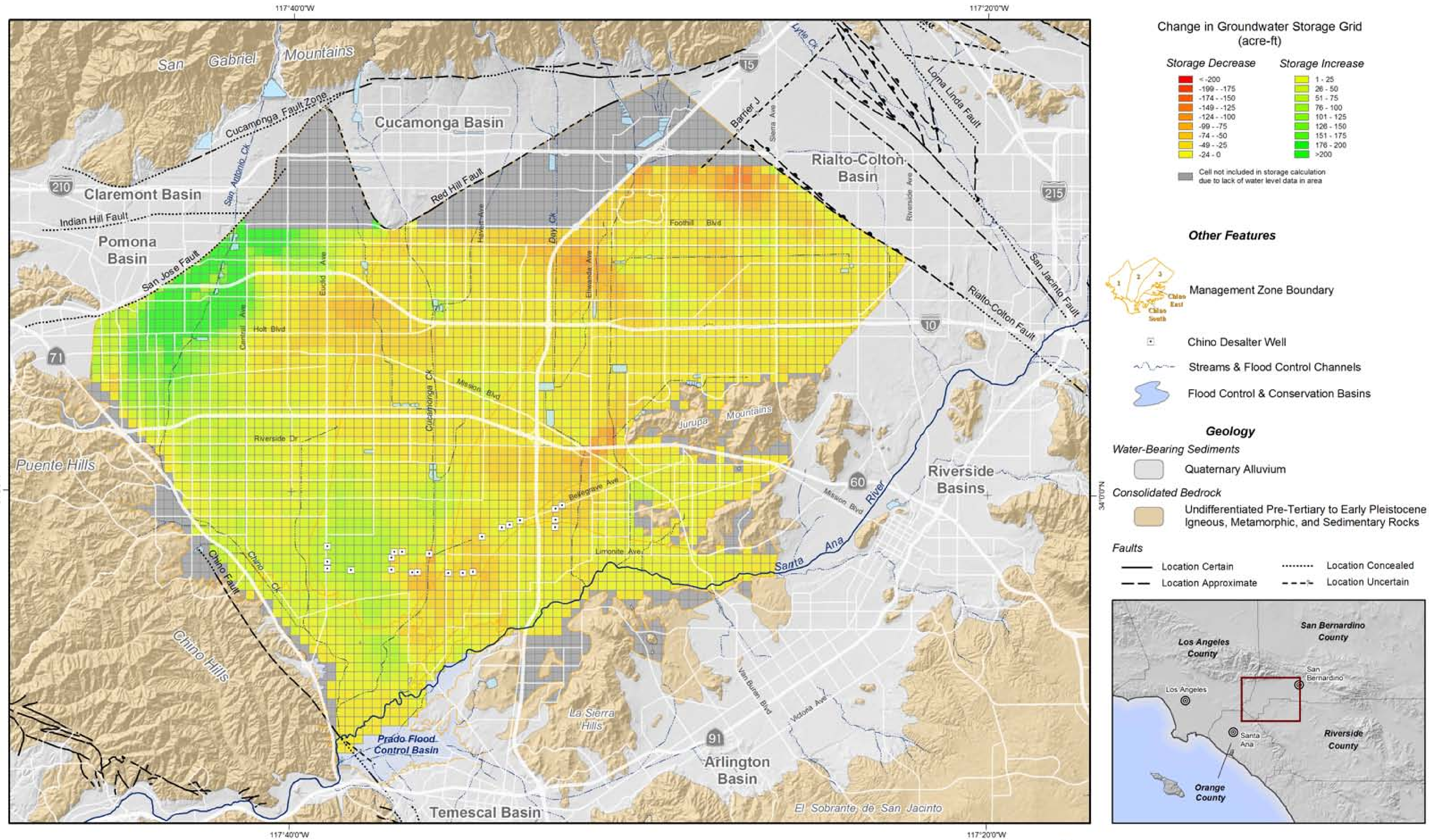
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Changes in Groundwater Storage

Change in Groundwater Storage
Fall 2000 to Fall 2003

Figure 3-20



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File: Figure_3-21.mxd

0 1 2 3 4 5 Miles

0 2 4 6 8 KM

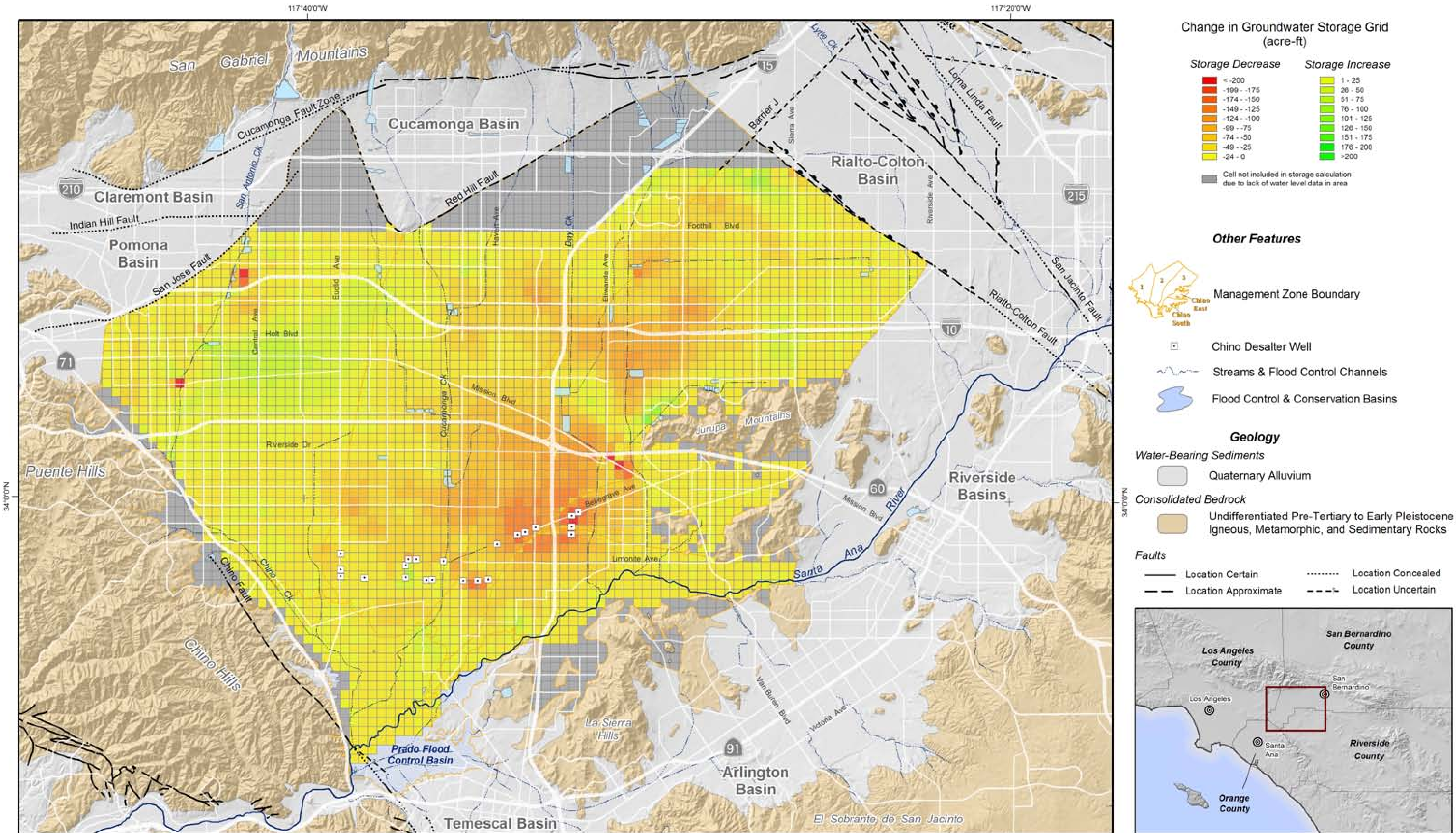
2008 State of the Basin Report

Changes in Groundwater Storage

Change in Groundwater Storage

Fall 2003 to Fall 2006

Figure 3-21



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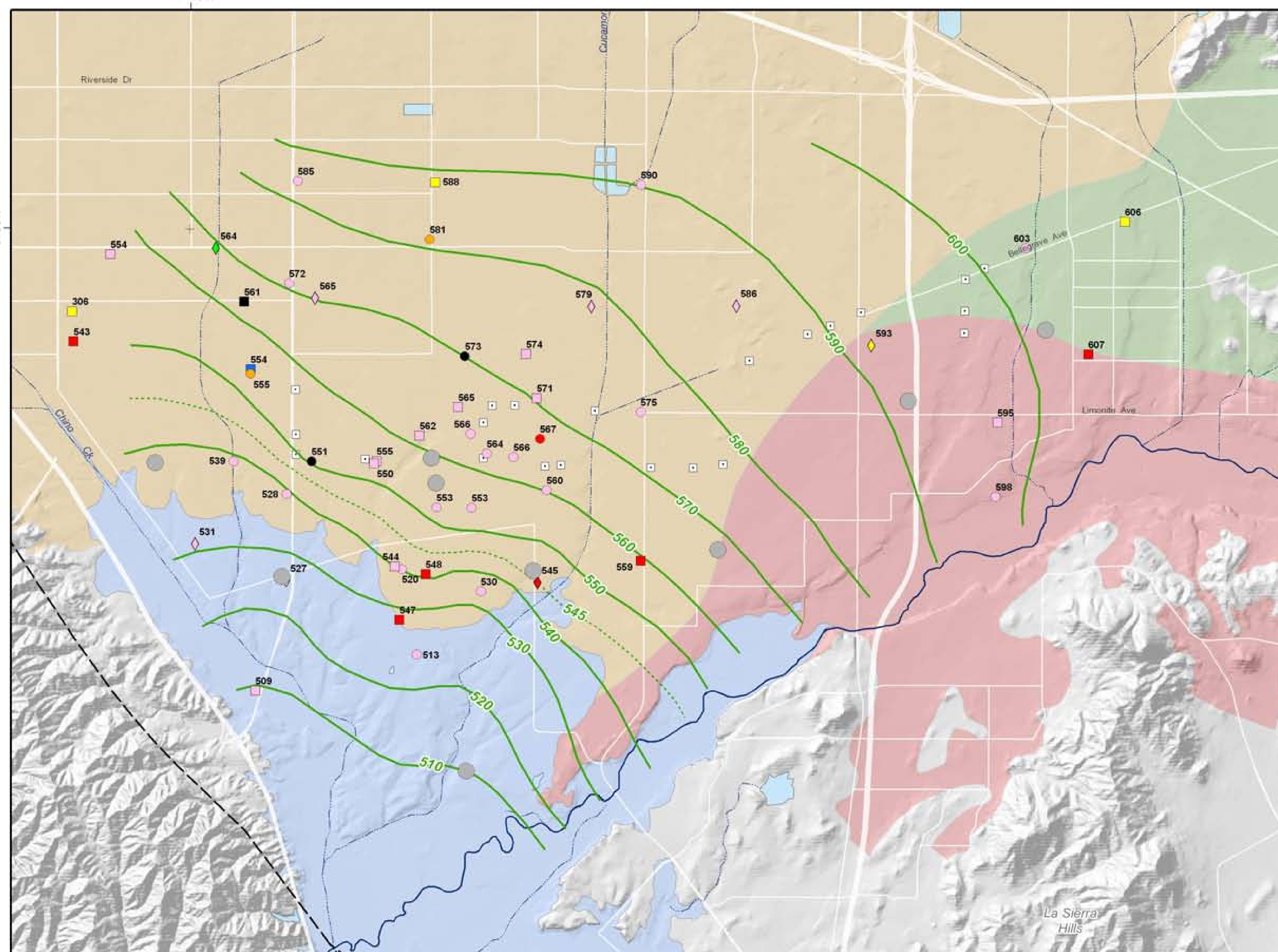
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Changes in Groundwater Storage

Change in Groundwater Storage
Fall 2006 to Fall 2008

Figure 3-22



Groundwater Elevation Contours (feet above mean sea-level)

800 / 775

Other Features

Chino Desalter Well

HCMP Piezometric Monitoring Well

Flood Control and Conservation Basins

Maximum Benefit Management Zones

Chino-North

Chino-East

Chino-South

PBMZ

Faults

Location Certain

Location Approximate

Location Concealed

Location Uncertain

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0 1 2 Miles

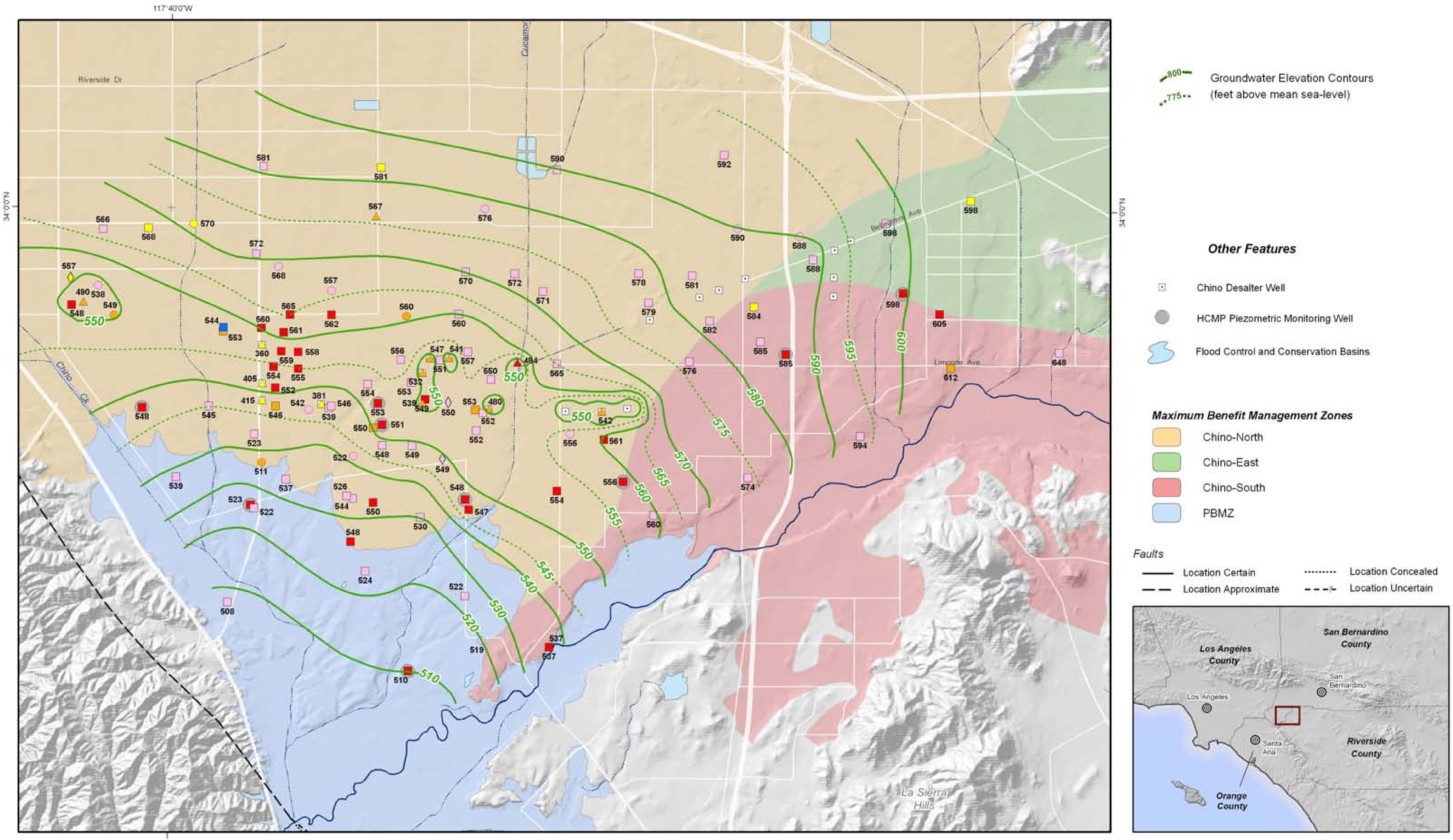
0 1 2 3 KM

2008 State of the Basin Report
Assessment of Hydraulic Control

State of Hydraulic Control -- Spring 2000

Groundwater Contours -- South Chino Basin Shallow Aquifer System

Figure 3-23



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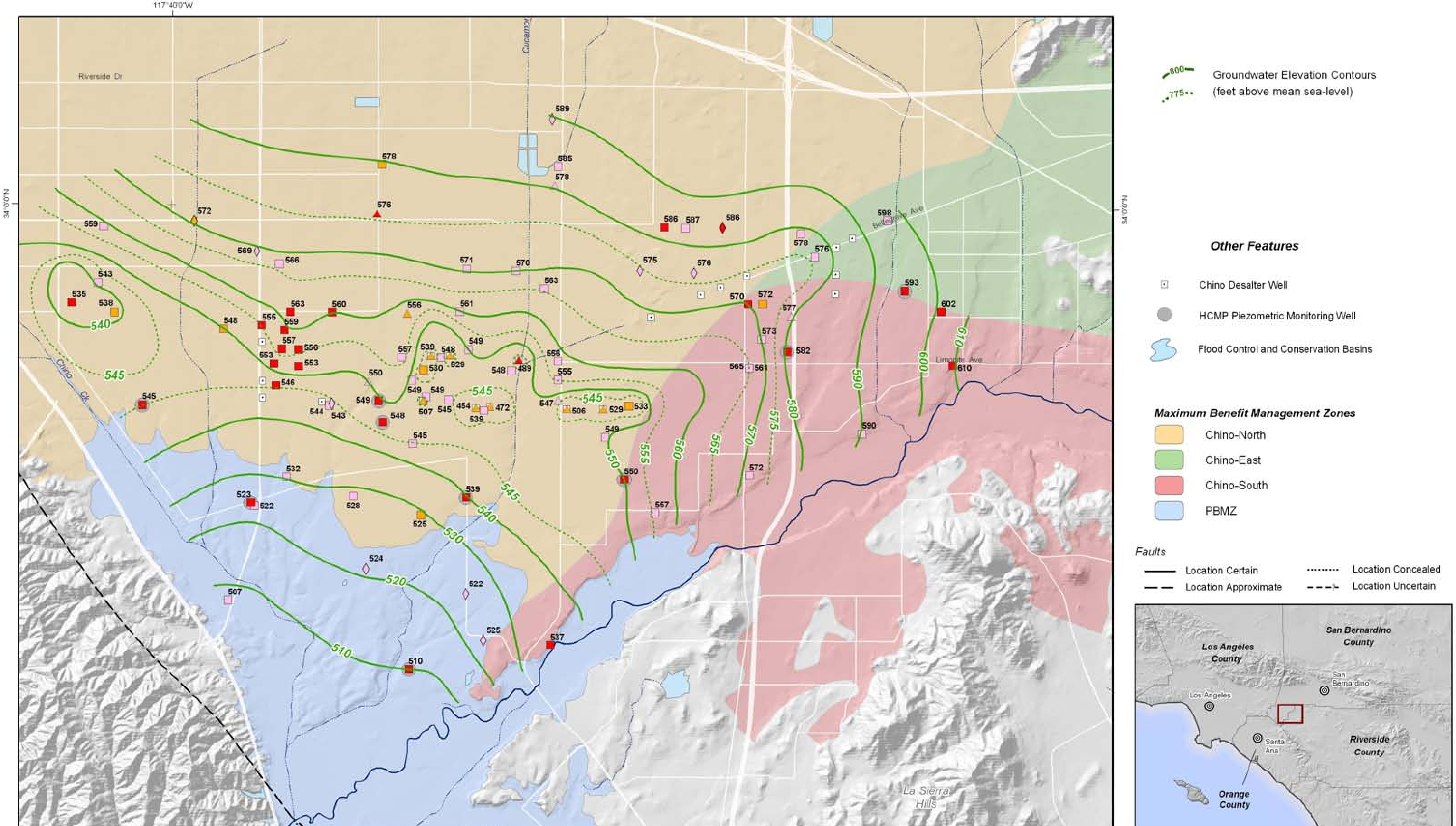
0 1 2 Miles
0 1 2 3 KM

2008 State of the Basin Report
Assessment of Hydraulic Control

State of Hydraulic Control -- Spring 2006
Groundwater Contours -- South Chino Basin Shallow Aquifer System

Figure 3-24



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0 1 2 Miles

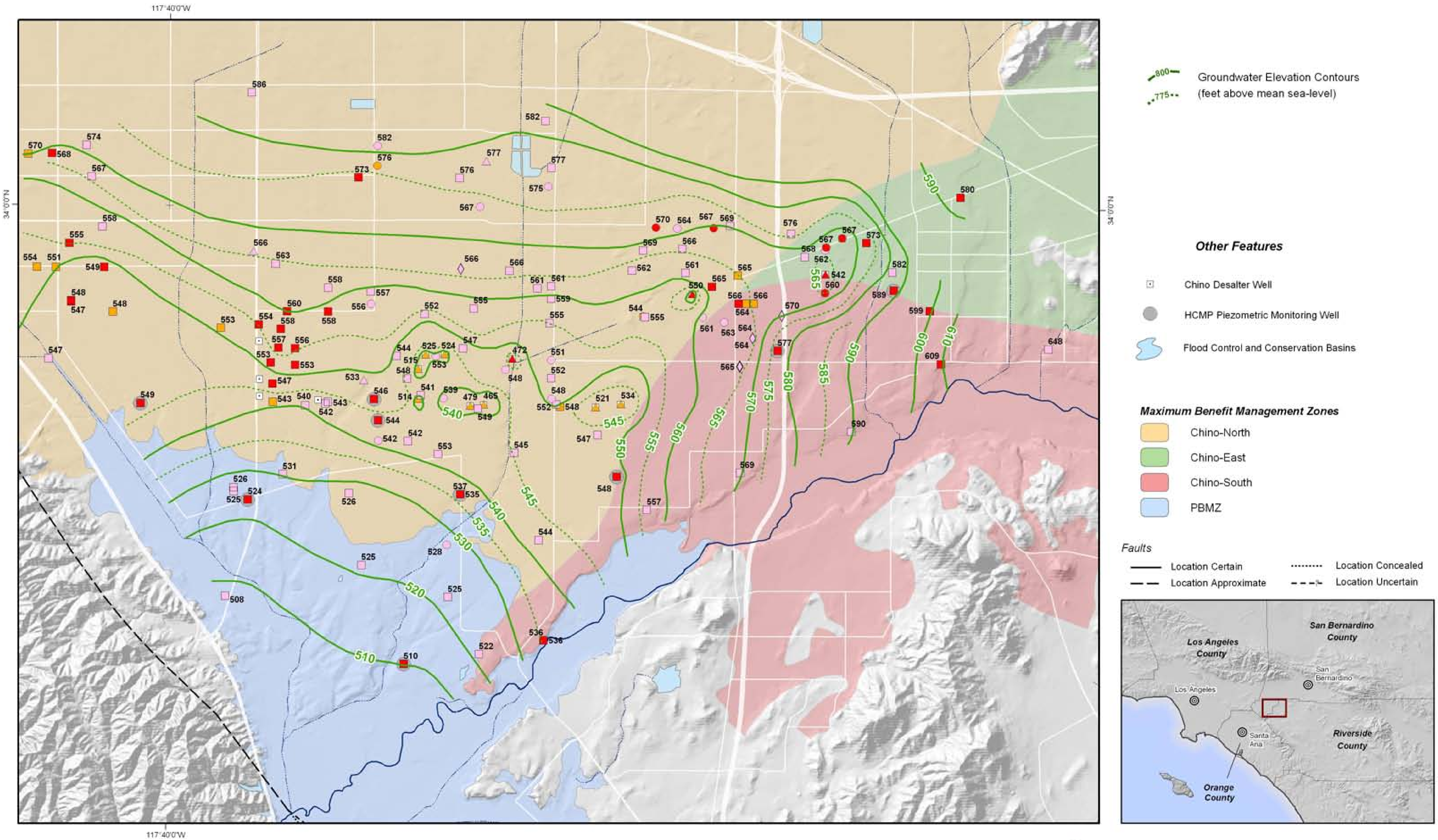
0 1 2 3 KM

2008 State of the Basin Report
Assessment of Hydraulic Control

State of Hydraulic Control -- Spring 2007

Groundwater Contours -- South Chino Basin Shallow Aquifer System

Figure 3-25



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0 1 2 Miles
0 1 2 3 KM

2008 State of the Basin Report
Assessment of Hydraulic Control

State of Hydraulic Control -- Spring 2008
Groundwater Contours -- South Chino Basin Shallow Aquifer System

Figure 3-26

4.1 Background

Chino Basin groundwater is not only a critical resource to overlying water producers; it is a critical resource to the entire Santa Ana Watershed. From a regulatory perspective, the use of Chino Basin groundwater to serve potable demands is limited by drinking water standards, groundwater basin water quality objectives, and Santa Ana River water quality objectives. In August 1999, Phase 1 of the OBMP established that groundwater monitoring must be conducted in order to obtain current water quality and water level data in Chino Basin (WEI, 1999). These data are necessary for defining and evaluating specific strategies and locations for the mitigation of nitrate, TDS, and other Constituents of Potential Concern (COPCs); new recharge sites; and pumping patterns that result from the implementation of the OBMP.

In the past, various entities have collected groundwater quality data. Municipal and agricultural water supply entities have collected groundwater quality data to comply with the Department of Health Services' requirements in the California Code of Regulations, Title 22, or for programs that range from irregular study-oriented measurements to long-term periodic measurements. Groundwater quality observations have been made by the DWR, by participants in the 1969 Judgment on the Santa Ana River (Orange County Water District vs. City of Chino et al.), by dischargers under orders from the RWQCB, and by the County of San Bernardino. The DWR and the San Bernardino County Flood Control District were very active in collecting groundwater quality data in the Chino Basin prior to the adjudication of the Chino Basin. After the Judgment was entered in 1978, monitoring south of State Route 60 stopped almost completely with the exception of that conducted by the Cities of Chino, Chino Hills, and Norco; the Jurupa Community Services District (JCSD); and the Santa Ana River Water Company. Most of the pre-1978 measurements were digitized by the DWR. In 1986, the MWDSC conducted the first comprehensive survey of groundwater quality, covering all constituents regulated under Title 22.

Watermaster initiated a regular monitoring program for Chino Basin in 1989. Groundwater quality data has been obtained periodically since 1990.

4.2 Water Quality Monitoring Programs

Watermaster began conducting a more robust monitoring program as part of the initial OBMP implementation. Watermaster's program relies on municipal producers, government agencies, and private consultants to supply their groundwater quality data on a cooperative basis. Watermaster supplements these data with data obtained through its own sampling and analysis program of private wells in the area generally south of State Route 60. Water quality data are also obtained from special studies and monitoring programs that take place under the orders of the RWQCB, the California Department of Toxic Substances Control (DTSC), and others. Watermaster has combined previously digitized groundwater quality data from all known sources into a comprehensive database.

4.2.1 Water Quality Monitoring Programs for Wells Owned by Municipal Water Suppliers

Water quality samples are collected from Appropriative Pool wells and some overlying Non-Agricultural Pool wells as part of formalized monitoring programs. Constituents include (i) those regulated for drinking water purposes in the California Code of Regulations, Title 22; (ii) those regulated in the 1995 Water Quality Control Plan for the Santa Ana River Basin (Basin Plan); or (iii) those that are of special interest to the pumper.

4.2.2 Water Quality Monitoring Programs for Private Water Supply Wells

Historically, private wells were sampled less methodically and less frequently than wells owned by members of the Appropriative Pool. As a result, there is little historical (pre-1999) groundwater quality information for most of the 600 private wells in the southern part of the Chino Basin. As mentioned above, the MWDSC conducted an assessment of water quality and water levels in the private wells south of State Route 60 in 1986. This assessment was a component of the Chino Basin groundwater storage program Environmental Impact Report (MWDSC et al., 1988). Nevertheless, the historical quality of groundwater produced at the majority of the wells in the southern Chino Basin is unknown.

In 1999, the Comprehensive Monitoring Program initiated the systematic sampling of private wells south of State Route 60 in the Chino Basin. Over a three-year period, Watermaster sampled all available wells at least twice to develop a robust baseline data set. This program has since been reduced to approximately 110 private key wells, and about half of these wells are sampled every other year. Groundwater quality samples are analyzed for general minerals, physical properties, and for regional COPCs (e.g. perchlorate, and volatile organic chemicals [VOCs] in the vicinity of known VOC plumes). This key well monitoring program provides a good representation of the areal groundwater quality in this portion of the basin.

4.2.3 Water Quality Monitoring Programs Conducted Pursuant to Regulatory Orders

Groundwater monitoring is conducted by private and public entities as part of regulatory orders and voluntary cleanups. These programs consist of networks of monitoring wells designed specifically to delineate and characterize the extent of the responsible party's contamination. These monitoring programs may include monthly, quarterly, and/or annual sampling frequencies. The following is a summary of all the regulatory and voluntary contamination monitoring in Chino Basin:

- **Plume:** Alumax Aluminum Recycling Facility
  Constituent of Concern: TDS, sulfate, nitrate, chloride
  Order: RWQCB Cleanup and Abatement Order 99-38
- **Plume:** Chino Airport
  Constituent of Concern: VOCs
  Order: RWQCB Cleanup and Abatement Order 90-134

- **Plume:** California Institute for Men
  Constituent of Concern: VOCs
  Order: Voluntary Cleanup Monitoring
- **Plume:** Crown Coach International Facility
  Constituent of Concern: VOCs and Solvents
  Order: Voluntary Cleanup Monitoring
- **Plume:** General Electric Flatiron Facility
  Constituent of Concern: VOCs
  Order: Voluntary Cleanup Monitoring
- **Plume:** General Electric Test Cell Facility
  Constituent of Concern: VOCs
  Order: Voluntary Cleanup Monitoring
- **Plume:** Kaiser Steel Fontana Site
  Constituent of Concern: TDS/total organic carbon (TOC)
  Order: See discussion in Section 4.36.7.
- **Plume:** Milliken Sanitary Landfill
  Constituent of Concern: VOCs
  Order: RWQCB Order No. 81-003
- **Plume:** Upland Sanitary Landfill
  Constituent of Concern: VOCs
  Order RWQCB Order No 98-99-07
- **Plume:** Ontario International Airport (VOC Plume – South of Ontario Airport)
  Constituent of Concern: VOC
  Order: This plume is currently being voluntarily investigated by a group of potentially responsible parties.
- **Plume:** Stringfellow National Priorities List (NPL) Site
  Constituent of Concern: VOCs, perchlorate, N-nitrosodimethylamine (NDMA), heavy metals
  Order: The Stringfellow Site is the subject of US Environmental Protection Agency (EPA) Records of Decision (RODs): EPA/ROD/R09-84/007, EPA/ROD/R09-83/005, EPA/ROD/R09-87/016, and EPA/ROD/R09-90/048.

4.2.4 Other Water Quality Monitoring Programs

In a letter dated July 13, 2000, the RWQCB expressed their concern to the IEUA that the historical recharge of recycled water at IEUA Regional Plant No. 3 (RP3) may have caused groundwater contamination at down-gradient wells. Other sources of groundwater contamination in the area include the Kaiser Steel Mill, Alumax, other industries, and historical agricultural activities, including citrus groves and hog feed lots. Several municipal wells have been shut down in MZ3 due to perchlorate and nitrate in groundwater. MZ3 includes areas that underlie all or part of the Fontana Water Company, the Marygold Mutual Water Company, the CVWD, and the City of Ontario. MZ3 groundwater is tributary to wells owned by the JCSD.

To characterize groundwater levels and quality in MZ3, Watermaster and the IEUA performed an investigation. The objectives of this investigation were to develop a groundwater sampling program, install two sentry wells at the distal end of the Kaiser plume, and perform further characterization of groundwater quality. Sampling was conducted at twenty-two selected key wells from late 2005 to 2007. Where possible, four quarterly samples and one annual sample were collected. In 2007, two triple-nested wells (MZ3-1 and MZ3-2) were installed down gradient of the Kaiser plume. These wells were sampled quarterly for one year. The sampling results provided data to further characterize the water quality patterns for contaminants of concern in the study area, including TDS, nitrate, sulfate, chloride, and perchlorate. And, the results from well MZ3-1/3 redefined the extent of the Kaiser plume.

4.2.5 Information Management

As with groundwater level and production data, Watermaster manages groundwater quality data in order to perform the requisite scientific and engineering analyses required to ensure that the goals of the OBMP are being met. Watermaster's relational database contains well location, construction, lithology, specific capacity, groundwater level, and water quality data. Historical water quality data for the period prior to the mid-1980s were obtained from the DWR and supplemented with data from producers in the Appropriative and Overlying Non-Agricultural Pools and others. For the period from the mid-1980s forward, Watermaster has QA/QC'd and uploaded water quality data from its own sampling programs, the State of California Department of Public Health (CDPH, formerly the Department of Health Services) database, and other cooperating parties to its relational database. Occasionally, problems have been found with CDPH data, usually occurring in the form of incorrect constituent identification. In 2003, Watermaster launched the Chino Basin Relational Database effort to collect water quality data directly from each member agency and thereby circumvent past data problems. Cooperating parties provide all data (including geologic, geophysical, water levels, water quality, production, and recharge) to Watermaster on a routine basis. These data are delivered in electronic format directly from the laboratory or from the cooperating party.

4.3 Groundwater Quality in Chino Basin

Figure 4-1 shows all wells with groundwater quality monitoring results for the 5-year period of July 2003 to June 2008.

Inorganic and organic constituents detected in groundwater samples from wells in the Chino Basin through June 2008 were analyzed synoptically. This analysis included all available data from production and monitoring wells. Hence, the data do not represent a programmatic investigation of potential sources nor do they represent a randomized study that was designed to ascertain the water quality status of the Chino Basin. These data do, however, represent the most comprehensive information available to date.

Monitoring wells targeted at potential sources tend to have greater concentrations than municipal or agricultural production wells. Wells with constituent concentrations greater than one-half of the MCL represent areas that warrant concern and inclusion in a long-term monitoring program. In addition, groundwater in the vicinity of wells with samples greater than the MCL may be impaired from a beneficial use standpoint.

Numerous water quality standards have been put in place by federal and state agencies. Primary MCLs are enforceable criteria that are set due to health effects. Secondary standards are related to the aesthetic qualities of the water, such as taste and odor. For some chemicals, there are "Notification Level" criteria that are set by the CDPH. When notification levels are exceeded, the CDPH recommends that the utility inform its customers and consumers about the presence of the contaminant and any health concerns associated with exposure. The level at which the CDPH recommends the drinking water system remove the affected drinking water source from service is the "Response Level." These levels range from 10 to 100 times the notification level, depending on the chemical. The following constituents exceeded at least one water quality criteria in more than 10 wells within the Chino Basin for the period of July 2003 through June 2008:

Analyte Group/Constituent		Wells with Exceedance
Inorganic Constituents		
	Total Dissolved Solids	221
	Nitrate-Nitrogen	395
	Aluminum	153
	Arsenic	24
	Chloride	25
	Chromium	30
	Iron	185
	Manganese	58
	Perchlorate	188
	Sulfate	41
	Vanadium	25
General Physical		
	Color	21
	Odor	28
	pH	14
	Specific Conductance	121
	Turbidity	78
Chlorinated VOCs		
	1,1-Dichloroethane	11
	1,1-Dichloroethene	31
	1,2,3-Trichloropropane	23
	1,2-Dichloroethane	17
	cis-1,2-Dichloroethene	10
	Tetrachloroethene (PCE)	37
	Trichloroethene (TCE)	115

For all figures (Section 4 and Appendix B) that depict water quality distributions in the Chino Basin, the following convention is typically followed in setting class intervals in the legend (where WQS is the applicable water quality standard [see table below]). Variations of this convention may be employed to highlight certain aspects of the data.

Symbol	Class Interval
○	Not Detected
●	<0.5x WQS, but detected
●	0.5x WQS to WQS
●	WQS to 2x WQS
●	2x WQS to 4x WQS
●	> 4x WQS

4.3.1 Total Dissolved Solids

In Title 22, TDS is regulated as a secondary contaminant. The California secondary drinking water MCL for TDS is 500 mg/L. Figure 4-2 shows the distribution of the maximum TDS concentrations in Chino Basin from July 2003 through June 2008. During this period, maximum TDS concentrations ranged from 48 mg/L to 4,790 mg/L with average and median concentrations of approximately 550 mg/L and 380 mg/L, respectively. The highest concentrations are located south of State Route 60 where the impacts from agriculture are greatest, which is consistent with the data reported in the 2006 State of the Basin Report.

The impacts of agriculture on TDS in groundwater are primarily caused by dairy waste disposal, consumptive use, and fertilizer use on crops. As irrigation efficiency increases, the impact of consumptive use on TDS in groundwater also increases. For example, if source water has a TDS concentration of 250 mg/L and the irrigation efficiency is about fifty percent (flood irrigation), the resulting TDS concentration in returns to groundwater would be 500 mg/L, which is exclusive of the mineral increments from fertilizer. If irrigation efficiency is increased to seventy-five percent, the resulting TDS concentration in the returns to groundwater would be 1,000 mg/L, which is also exclusive of the mineral increments from fertilizer. For modern irrigated agriculture, the TDS impacts of consumptive use are more significant than mineral increments from fertilizers.

Wells with low TDS concentrations in close proximity to wells with higher TDS concentrations suggests a vertical stratification of water quality. However, there is a paucity of information concerning well construction/perforation intervals; Thus, the vertical differences in water quality are currently unverifiable.

4.3.2 Nitrate-Nitrogen

In Title 22, the primary MCL for nitrate as nitrogen (NO3-N) in drinking water is 10 mg/L. By convention, all nitrate values are expressed in this report as NO3-N. Figure 4-3 displays the distribution of maximum NO3-N concentrations in the Chino Basin from July 2003 through June 2008.

Areas with significant irrigated land use or dairy waste disposal histories overlie groundwater with elevated nitrate concentrations. The primary areas of nitrate degradation were formerly or are currently overlain by:

- Citrus (the northern parts of the Chino-North MZ)
- Dairy and irrigated agriculture (the southern parts of the Chino-North MZ, the Chino-South MZ, the Chino-East MZ, and the Prado Basin MZ [PBMZ])

Nitrate concentrations in groundwater have increased slightly or remained relatively constant in the northern parts of the Chino-North MZ from 1960 to present. These areas were formerly occupied by citrus groves and vineyards. The nitrate concentrations underlying these areas rarely exceed 10 mg/L (as nitrogen). Over the same period, nitrate concentrations increased significantly in the southern parts of the Chino-North MZ, the Chino-South MZ, the Chino-East MZ, and the PBMZ. In these areas, land use was progressively converted from irrigated/non-irrigated agricultural land to dairies, and nitrate concentrations typically exceed the 10 mg/L MCL and frequently exceed 40 mg/L.

4.3.3 Other Constituents of Potential Concern

Section 4.3.3 discusses the constituents with water quality standards that were exceeded in ten or more wells in Chino Basin with the exception of nitrate and TDS. The details of these exceedances are displayed graphically in Figures 4-4 through 4-17, and in Appendix B.

A query was developed to analyze water quality data in the Chino Basin from July 2003 through June 2008 that is in exceedance of any water quality standard. The results of this query are provided in a summary table in Appendix C, including:

- Chemical Constituents (listed alphabetically)
- Reporting Units
- Water Quality Standards (detailed explanations are provided in the table's footnote):
  - EPA Primary MCL
  - EPA Secondary MCL
  - California Primary MCL
  - California Secondary MCL
  - California Notification Level
- Minimum – the minimum concentration of the given constituent for the given time period. Non-detect values were assigned a value of zero.
- Lower or First Quartile – the first value that divides the items of a frequency distribution or ordered data set into four classes with each containing one fourth of the total population.
- Median or Second Quartile – the second value that divides the items of a frequency distribution or ordered data set into four classes with each containing one fourth of the total population.
- Upper or Third Quartile – the third value that divides the items of a frequency distribution or ordered data set into four classes with each containing one fourth of the total population.

- Maximum – the maximum concentration of the given constituent for the given time period. Non-detect values were assigned a value of zero.
- Average – the average concentration of the given constituent for the given time period. Non-detect values were assigned a value of zero.
- Number of Samples – the total number of samples for the given constituent for the given time period.
- Number of Wells Sampled – the number of wells sampled in the given time period, not the number of samples collected.
- Number of Wells with Detects – the number of wells in the period wherein the constituent was detected at any concentration.
- Number of Wells with Exceedances – the number of wells in the given time period with any value that exceeded any of the five water quality standards.

4.3.3.1 VOCs

The following seven VOCs were detected at or above their MCL in more than 10 wells in the Chino Basin:

- 1,1-dichloroethane (1,1-DCA)
- 1,1-dichloroethene (1,1-DCE)
- 1,2,3-trichloropropane (1,2,3-TCP)
- 1,2-dichloroethane (1,2-DCA)
- *cis*-1,2-dichloroethene (cis-1,2-DCE)
- tetrachloroethene (PCE)
- trichloroethene (TCE)

4.3.3.1.1 Trichloroethene and Tetrachloroethene

Trichloroethene (TCE) and tetrachloroethene (PCE) were/are widely used industrial solvents. Both PCE and TCE are used as metal degreasers in the automotive and other metal working industries. PCE is commonly used in the dry-cleaning industry. TCE was commonly used as a food extractant. The areal distributions of TCE and PCE are shown in Figures 4-4 and 4-5, respectively. In general, PCE is below the detection limit for wells in the Chino Basin. Wells with detectable levels tend to occur in clusters, such as those around the Milliken Landfill, south and west of the Ontario Airport, and along the margins of the Chino Hills. The spatial distribution of TCE resembles that of PCE. TCE was not detectable in most of the wells in the basin, and similar clusters of wells occur around the Milliken Landfill, south and west of Ontario International Airport (OIA), south of Chino Airport, and in the Stringfellow plume.

Figure 4-19 shows the ratio of TCE, PCE, and their breakdown products in monitoring wells associated with the VOC plumes in the southern Chino Basin. The unique characteristics of these plumes can be seen by comparing TCE and PCE concentrations and dispersion. For example, the Milliken Landfill plume and the GE plumes near Ontario Airport have significant concentrations of both TCE and PCE while the Chino Airport and Stingfellow plumes have significant concentrations of TCE and only minor detections of PCE, and the OIA plume is characterized solely by TCE. These unique characteristics allow for differentiation between the plumes and determining the intermingling of plumes.

4.3.3.1.2 1,1-Dichloroethene, 1,2-Dichloroethane, and cis-1,2-Dichloroethene

1,1-Dichloroethene (1,1-DCE), 1,2-Dichloroethane (1,2-DCA), and cis-1,2-Dichloroethene (cis-1,2-DCE) are degradation by-products of PCE and TCE (Dragun, 1988) that are formed by reductive dehalogenation. The areal distributions of 1,1-DCE, 1,2-DCA, and cis-1,2-DCE are shown in Figures 4-6 through 4-8, respectively. 1,1-DCE, 1,2-DCA, and cis-1,2-DCE have not been detected in the majority of wells in the Chino Basin. 1,1-DCE is found near the Milliken Landfill, south and west of OIA, at the former Crown Coach Facility, and at the head of the Stringfellow plume. 1,2-DCA and cis-1,2-DCE are found in the same general locations.

4.3.3.1.3 1,1-Dichloroethane

1,1,-Dichloroethane (1,1-DCA) is a colorless oily liquid that is used as a solvent for plastics, as a degreaser, as a halon in fire extinguishers, and in the cementing of rubber, and is a degradation by-product of 1,1,1-TCA. Figure 4-9 shows the areal distribution of 1,1-DCA in the Chino Basin. Eleven wells were in exceedance of the primary CA MCL of 5 μg/L for 1,1-DCA for the period of July 2003 through June 2008. The majority of these wells are monitoring wells at the former Crown Coach Facility.

4.3.3.1.4 1,2,3-Trichloropropane

1,2,3-TCP is a colorless liquid that is used primarily as a chemical intermediate in the production of polysulfone liquid polymers and dichloropropene, and in the synthesis of hexafluoropropylene and as a cross linking agent in the synthesis of polysulfides. It has been used as a solvent, an extractive agent, a paint and varnish remover, and a cleaning and degreasing agent, and it has been formulated with dichloropropene in the manufacturing of soil fumigants, such as D-D.

The current California State Notification Level for 1,2,3-TCP is 0.005 μg/L. The adoption of the Unregulated Chemicals Monitoring Requirements regulations occurred before a method capable of achieving the required detection limit for reporting (DLR) was available. According to the CDPH, some utilities moved ahead with monitoring, and samples were analyzed using higher DLRs. Unfortunately, findings of non-detect with a DLR higher than 0.005 μg/L do not provide the CDPH with the information needed for setting a standard. New methodologies with a DLR of 0.005 μg/L have since been developed, and the CDPH has requested that any utility with 1,2,3-TCP findings of non-detect with reporting levels of 0.01 μg/L or higher do follow-up sampling using a DLR of 0.005 μg/L. Because 1,2,3-TCP may be a basin-wide water quality issue, private and public wells are continuing to be retested at the lower detection limit (0.005 μg/L).

Figure 4-10 shows the distribution of 1,2,3-TCP in Chino Basin, based on the data limitations discussed above. High 1,2,3-TCP values are associated with the Chino Airport Plume. Of particular note, there is a cluster of wells with 1,2,3-TCP concentrations greater than the Notification Level in the Jurupa region and a scattering of wells that exceed the Notification

Level on the western margins of the basin. Watermaster will continue to monitor and investigate this constituent.

4.3.3.2 Iron, Arsenic, and Vanadium

Iron, arsenic, and vanadium concentrations depend on mineral solubility, ion exchange reactions, surface complexations, and soluble ligands. These speciation and mineralization reactions, in turn, depend on pH, oxidation-reduction potential, and temperature.

4.3.3.2.1 Iron

In general, iron is not detected across the Chino Basin, but there are some scattered detectable concentrations that are above regulatory limits (see Appendix B). Iron concentrations are elevated in the vicinity of the Stringfellow Plume. Outside of the Stringfellow Plume, there were 85 wells with iron concentrations that exceed the MCL. Nevertheless, these exceedances may be an artifact of sampling methodology; relatively high concentrations of iron and trace metals are often the result of the dissolution of aluminosilicate particulate matter and colloids, which is caused by the acid preservative in unfiltered samples.

4.3.3.2.2 Arsenic

The US EPA implemented a new primary MCL for arsenic in 2006, decreasing the MCL from 50 μg/L to 10 μg/L. In November 2008, the Primary CA MCL was also changed from 50 μg/L to 10 μg/L. Figure 4-11 shows the distribution of arsenic in the Chino Basin. Eleven wells in the basin had arsenic concentrations that exceeded the MCL. Of these wells, three are associated with the Stringfellow Plume, and three are associated with Chino Airport Plume. Higher concentrations of arsenic are found in the Chino/Chino Hills area in the lower aquifer at depths greater than about 350 ft-bgs.

4.3.3.2.3 Vanadium

In the Chino Basin, vanadium has been detected above regulatory limits in some scattered wells. In groundwater, vanadium can result from mining and industrial activities or be of natural occurrence. While elemental vanadium does not occur in nature, vanadium compounds are found in fossil fuels and exist in over 60 different mineral ores. The primary industrial use of vanadium is in the steel industry where it is used to strengthen steel. Figure 4-12 shows the areal distribution of vanadium in the Chino Basin. The majority of the 25 wells in exceedance of the California Notification Level (0.05 mg/L) are associated with the Stringfellow Plume. Other exceedances are found near the Milliken Landfill, in deep wells in the Chino/Chino Hills area, and in one well near the Jurupa Mountains.

4.3.3.3 Perchlorate

Perchlorate has recently been detected in several wells in the Chino Basin (Figure 4-13), in other basins in California, and in other states in the west. The most probable reason why perchlorate was not detected in groundwater until recently is that analytical methodologies that could attain a low enough detection limit did not previously exist. Prior to 1996, the method detection limit for perchlorate was 400 μg/L. In March 1997, an ion chromatographic method was developed with a detection limit of 1 μg/L and a reporting limit of 4 μg/L.

As an environmental contaminant, perchlorate (ClO4-) originates from the solid salts of ammonium perchlorate (NH4ClO4), potassium perchlorate (KClO4), or sodium perchlorate (NaClO4). Perchlorate salts are quite soluble in water. The perchlorate anion (ClO4-) is exceedingly mobile in soil and groundwater environments. Because of its resistance to react with other available constituents, it can persist for many decades under typical groundwater and surface water conditions. Perchlorate is a kinetically stable ion, which means that reduction of the chlorine atom from a +7 oxidation state in perchlorate to a -1 oxidation state as a chloride ion requires activation energy or the presence of a catalyst to facilitate the reaction. Since perchlorate is chemically stable in the environment, natural chemical reduction is not expected to be significant.

Possible sources of perchlorate contamination are synthetic (ammonium perchlorate used in the manufacturing of solid propellant used for rockets, missiles, and fireworks) and natural (perchlorate derived from Chilean caliche that was used for fertilizer).

Fertilizers derived from Chilean caliche are currently used in small quantities on specialized crops, including tobacco, cotton, fruits, and vegetables (Renner, 1999). However, evidence suggests that usage may have been widespread for citrus crops in Southern California from the late 1800s through the 1930s.

The current CDPH Notification Level for perchlorate is 6 μg/L, which was established on March 11, 2004.

Perchlorate has been detected in 188 wells in the Chino Basin at levels greater than 6 μg/L. Perchlorate Notification Level exceedances occur in the following areas of the Chino Basin (Figure 4-13):

- Rialto-Colton Basin (There is a significant perchlorate plume in the Rialto-Colton Basin. The RWQCB is investigating the source of this plume, which appears to be near the Mid-Valley Sanitary Landfill. According to the RWQCB, several companies—including B.F. Goodrich, Kwikset Locks, American Promotional Events, and Denova Environmental—operated nearby and used or produced perchlorate. These companies were located on a 160-acre parcel at T1N R5W S21 SW1/4. Denova Environmental also operated on a 10-acre lot at T1N R5W S20 S1/2 (along the boundary between Sections 20 and 29). Perchlorate in the Fontana area of Chino Basin may be the result of (i) the Rialto-Colton perchlorate plume migrating across the Rialto-Colton fault, (ii) other point sources in Chino Basin, and/or (iii) the non-point application of Chilean nitrate fertilizer in citrus groves.)
- Downgradient of the Stringfellow Superfund Site (Concentrations have exceeded 600,000 μg/L at onsite observation wells. The plume has likely reached the Pedley Hills and may extend as far as Limonite Avenue.)
- City of Pomona well field (source[s] unknown)
- Wells in the City of Ontario water service area, south of OIA (source[s] unknown)
- Scattered wells in the Monte Vista water service area (source[s] unknown)

- Scattered wells in the City of Chino water service area (source[s] unknown)

A forensic isotope study was conducted to determine the source of perchlorate in Chino Basin groundwater. This forensic technique was developed using comprehensive stable isotope analyses (37Cl/35Cl and 18O/17O/16O) of perchlorate to determine the origin of the perchlorate (synthetic vs. naturally occurring). Stable isotope analyses of perchlorate from known man-made (e.g. samples derived from electrochemically synthesized ammonium- and potassium-perchlorate salts) and natural (e.g. samples from the nitrate salt deposits of the Atacama Desert in Chile) sources reveal systematic differences in isotopic characteristics that are related to the formation mechanisms (Bao & Gu, 2004; Böhlke et al., 2005; Sturchio et al., 2006). There is considerable anecdotal evidence that large quantities of Chilean nitrate fertilizer were imported into the Chino Basin in the early 1900s for the citrus industry, which covered the north, west and central portions of the basin.

The perchlorate isotope study consisted of 10 groundwater samples that were collected throughout the Chino Basin. The sampling points included private wells and municipal production wells. Samples were collected using a flow-through column with a highly perchlorate-selective anion-exchange resin. The exchange resin concentrates low levels of perchlorate in groundwater such that a sufficient amount can be acquired and for isotopic analysis. Results confirmed that most of the perchlorate in the west and central portions of the Chino Basin was derived from Chilean nitrate fertilizer. One sample collected south of the OIA is a potential mixture of natural and synthetic sources.

4.3.3.4 Total Chromium and Hexavalent Chromium

Figure 4-14 shows the areal distribution of total chromium in the Chino Basin. Thirty wells were found to be in exceedance of the CA MCL of 50 μg/L. The majority of these wells are associated with the Milliken Sanitary Landfill, the Stringfellow Plume, and the GE Test Cell Plume. The remaining wells include isolated wells near the Jurupa Mountains and in the southern Chino Basin and City of Pomona wells. Chromium in groundwater results from natural and anthropogenic sources.

Hexavalent chromium is currently regulated under the MCL for total chromium. In 1999, the CDPH identified that hexavalent chromium needed an individual MCL, and concerns over its carcinogenicity grew. Subsequently, the CDPH included it on the list of unregulated chemicals that require monitoring. California Health and Safety Codes (§116365.5 and §1163659a) compelled the adoption of a hexavalent chromium MCL by January 1, 2004, and required it to be close to the public health goals (PHG) established by the Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA). At present, the PHG has not been established, and the CDPH cannot proceed with the MCL process. Figure 4-15 shows the areal distribution of hexavalent chromium in the Chino Basin. Only three wells in the Chino Basin were in exceedence of the CA MCL for total chromium. In the near future hexavalent chromium may become a more significant contaminant of concern in the Chino Basin when a lower MCL is determined by CDPH, and more wells are sampled for hexavalent chromium.

4.3.3.5 Chloride and Sulfate

Chloride and sulfate both exceeded secondary MCLs. As discussed previously, secondary MCLs apply to chemicals in drinking water that adversely affect its aesthetic qualities and are not based on the direct health effects associated with the chemical. Chloride and sulfate are major anions associated with TDS. All wells in the basin had detectable levels of sulfate (Figure 4-16), but most had concentrations that were less then 125 mg/L (one-half the water quality standard). A total of 41 wells had concentrations at or above the sulfate secondary MCL. In general, these wells are distributed in the southern portion of the basin, in the Stringfellow plume, and along the margins of the Chino Hills. All wells had detectable levels of chloride (Figure 4-17), but most had concentrations that were less 125 mg/L (one-half the MCL). The secondary MCL for chloride was exceeded in 25 wells; almost all of which are located in the southern portion of the basin.

4.3.3.6 Color, Odor, and Turbidity

In the last 5 years, color, odor, and turbidity have been detected above their secondary MCLs in more than 10 wells within the Chino Basin (see Appendix B). These parameters are monitored purely for aesthetic reasons and should not substantially impair water quality in the Chino Basin.

4.3.4 Point Sources of Concern

The water quality discussion above described water quality conditions across the entire basin. The discussion below describes the water quality plumes associated with known point source discharges to groundwater. Figure 4-18 shows the locations of various point sources and associated areas of water quality degradation. Figure 4-19 shows the VOC plumes and features pie charts that display the relative percent of TCE, PCE, and other VOCs detected at groundwater wells within plume impacted areas. The pie charts demonstrate the chemical differentiation between the VOC plumes in the southern portion of Chino Basin.

4.3.4.1 Alumax Aluminum Recycling Facility

Between 1957 and 1982, an 18-acre aluminum recovery facility was operated in the City of Fontana. The byproducts of aluminum recycling are aluminum oxide wastes and brine water. During this 25-year period, solid wastes were stockpiled onsite. Process water containing sodium and potassium chloride salts was discharged onsite and allowed to percolate into native soil and groundwater. Discharge ceased in 1982, and the solid wastes were removed in 1992. Onsite groundwater monitoring was initiated in 1993 by then owner Alumax, Inc. The site was subsequently capped to prevent the future mobilization of salts offsite. Alcoa Davenport Works (Alcoa) purchased Alumax in 1998.

Currently, there are two onsite monitoring wells: MW-1 is located in the northeast corner of the property, and MW-2 is located in the southwest corner. These wells have steel casings and have experienced chloride corrosion and extensive accumulation of iron hydroxide scale. Rehabilitation efforts in 2001 failed to adequately clear the well screens. Both wells subsequently experienced partial casing constrictions or screen collapses. In 2007, it was discovered that over ten feet of iron oxide scale and sediment had accumulated in the bottom of MW-1. MW-2 was abandoned and replaced in 2008 as it could no longer be sampled.

Offsite monitoring began with the construction of four monitoring wells (AOS-1, AOS-2, AOS-3, and AOS-4) between 1999 and 2000. These wells are all located downgradient of the site and were constructed of PVC in an effort to avoid the scale and corrosion experienced at the onsite wells. In April 2008, the RWQCB stated that Alcoa would no longer be required to monitor offsite monitoring wells AOS-1, AOS-2, and AOS-3 unless elevated levels of salts were detected at upgradient well AOS-4 (RWQCB, 2008). Alcoa is currently evaluating the ownership transfer of wells AOS-1, AOS-2, and AOS-3 to Watermaster to allow for continued monitoring.

The plume emanating from the Alumax site is characterized by elevated concentrations of sulfate, nitrate, chloride, potassium, and sodium. Consequently, the TDS concentrations at the onsite wells are high, ranging from about 500 mg/L to over 2,000 mg/L. Offsite monitoring has yielded observed TDS concentrations that range from about 100 mg/L to 700 mg/L. Note that these TDS values are higher than those observed at up-gradient wells, which typically range from 200 to 300 mg/L.

4.3.4.2 Chino Airport

The Chino Airport is located approximately four miles east of the City of Chino and six miles south of the OIA and occupies about 895 acres. From the early 1940s until 1948, the airport was owned by the federal government and used for flight training and aircraft storage. The County of San Bernardino acquired the airport in 1948 and has operated and/or leased portions of the facility ever since. Since 1948, businesses and activities at the airport have included: the modification of military aircraft; crop-dusting; aircraft-engine repair; aircraft painting, stripping, and washing; dispensing of fire-retardant chemicals to fight forest fires; and general aircraft maintenance. The use of organic solvents for various manufacturing and industrial purposes has been widespread throughout the airport's history. From 1986 to 1988, a number of groundwater quality investigations were performed in the vicinity of the Chino Airport. Analytical results from groundwater sampling revealed the presence of VOCs above MCLs in six wells downgradient of the Chino Airport. The most common VOC detected above its MCL is TCE, as shown in Figure 4-19. TCE concentrations in the contaminated wells ranged from 6 to 75 μg/L.

In 1990, Cleanup and Abatement Order (CAO) No. 90-134 was issued to address groundwater contamination emanating from the Chino Airport. During 2003, five groundwater monitoring wells were installed onsite; and in 2005, an additional four groundwater monitoring wells were installed onsite for further characterization. During June and July of 2006, Watermaster conducted a focused sampling event of 25 wells within the vicinity of the Chino Airport plume. In 2007, the San Bernardino County Department of Airports began to focus their investigation on offsite characterization of the plume. In 2008, the RWQCB issued a CAO (No. R-8 2008-0064) to the San Bernardino County Department of Airports in order to define the lateral and vertical extent of the VOCs in groundwater and to prepare a remedial action plan. In late 2008, nine offsite monitoring wells were completed in three locations. Initial sampling of these wells was done in August 2009.

Figure 4-18 shows the approximate areal extent of TCE in groundwater at concentrations in exceedance of the MCL in the vicinity of the Chino Airport as of 2008. The plume is elongate in shape, up to 3,600 feet wide, and extends approximately 12,100 feet from the airport's northern boundary in a south to southwestern direction. From July 2003 to June 2008, the maximum TCE concentration detected at an individual well within the Chino Airport plume was 910 μg/L.

4.3.4.3 California Institute for Men

The California Institution for Men (CIM) is a state correctional facility located in the City of Chino and has been in existence since 1939. The property occupies approximately 1,500 acres, and is bounded by Eucalyptus Avenue to the north, Euclid Avenue to the east, Kimball Avenue to the south, and Central Avenue to the west. Site use includes agricultural operations, inmate housing, and correctional facilities. The Heman G. Stark Youth Correctional Facility occupies the eastern portion of the property (Geomatrix Consultants, 2005).

In 1990, PCE was detected at a concentration of 26 μg/L at CIM drinking water supply Well 1. Analytical results have indicated that the most common VOCs detected in groundwater underlying CIM are PCE and TCE. The maximum PCE concentration in groundwater detected at an individual monitoring well (MW-7) was 1990 μg/L, and the maximum TCE concentration in groundwater detected at an individual monitoring well (MW-6) was 160 μg/L (Geomatrix Consultants, 2007). Other detected VOCs include 1,2-DCE, bromodichloromethane, 1,1,1-TCA, carbon tetrachloride, chloroform, and toluene.

In 1992, construction began on a groundwater monitoring network of approximately 40 wells. These wells were sampled intermittently through 2007. An Interim Remedial Measure (IRM) was implemented to resume production at Well 1, treat extracted water to reduce VOC concentrations, and use that water as part of the CIM potable water distribution system. Since the implementation of the IRM, the concentrations of PCE and TCE in groundwater have decreased considerably. Of the 39 wells sampled in 2007, 6 wells in the shallow aquifer had PCE concentrations in exceedance of the MCL, and TCE was detected at one shallow monitoring well (Geomatrix Consultants, 2007). CIM submitted a Request for No Further Action (NFA) for groundwater PCE remediation to the RWQCB.

Figure 4-18 shows the approximate areal extent of VOCs in groundwater at concentrations exceeding their MCLs as of 2008. The plume is up to 2,900 feet wide and extends about 5,800 feet from north to south. As Figure 4-19 illustrates, the CIM plume is primarily characterized by PCE. From July 2003 to June 2008, the maximum PCE and TCE concentrations in groundwater detected at an individual well within the CIM plume were 57 μg/L and 26 μg/L, respectively.

4.3.4.4 Crown Coach

The former Crown Coach site, located at 13799 Monte Vista Ave in the City of Chino, was used by the General Electric Corporation (GE) for the manufacturing and maintenance of semi-tractors and buses from the early 1970s onward. In 1987, it was discovered that twelve underground storage tanks were leaking lube oils, diesel, antifreeze, waste oil, and waste solvents. All 12 tanks were removed by 1988, and the release of spent solvents in the underlying soil and groundwater was reported (Rosengarten Smith & Associates, 1992). Since 1988, sampling at 22 monitoring wells has determined the concentration and areal extent of the VOC plume. Contaminated soil and groundwater are contained onsite. The most common VOCs detected are TCE, PCE, and 1,1-DCE, as shown in Figure 4-19.

Concurrent with groundwater monitoring, a series of remediation activities have occurred on the property. Starting in June 1990, extracted groundwater was discharged to an onsite sewer connection, operating under an industrial wastewater discharge permit. A soil-vapor extraction system was brought onsite in 1992 to address vadose zone contamination. Starting in 2005, a Dual Phase Extraction Treatment System (DPETS) was used to remediate groundwater and soil. In May 2008, Duke Reality began redevelopment activities on the property. During construction, DPETS operations ceased, and Edible Oil Solution (EOS) was injected into ten monitoring and extraction wells as a remediation replacement.

Figure 4-18 shows the approximate areal extent of VOCs in groundwater at concentrations exceeding their MCLs near the Crown Coach Facility as of 2008. The plume is approximately 500 feet in length and 250 feet wide. The last monitoring event in 2008 indicated that the lateral boundaries of the plume are decreasing, and PCE, TCE, and 1,1 DCE were not detected in deep aquifer wells (Rosengarten Smith & Associates, 2008). From July 2003 to June 2008, the maximum PCE and TCE concentrations detected at an individual well within the Crown Coach VOC plume were 182 μg/L and 125 μg/L, respectively.

In June 2009, GE submitted a report to the Regional Board evaluating the effectiveness of the EOS injections and the need for additional remedial measures. In this report GE concluded that the hydrogeologic conditions beneath the site are sufficient to protect the beneficial uses of groundwater in the regional aquifer and that no further monitoring and remediation activity is warranted at this site. A response from the Regional Board on this report is pending.

4.3.4.5 General Electric Flatiron Facility

The General Electric Flatiron Facility (Flatiron Facility) occupied the site at 234 East Main Street, Ontario, California from the early 1900s to 1982. Its operations primarily consisted of manufacturing clothes irons. Currently, the site is occupied by an industrial park. The RWQCB issued an investigative order to GE in 1987 after an inactive well in the City of Ontario was found to contain TCE and chromium above drinking water standards. Analytical results from groundwater sampling have indicated that VOCs and total chromium are the major groundwater contaminants. The most common VOC detected at levels significantly above its MCL is TCE, as shown in Figure 4-19. TCE has reached a measured maximum concentration of 5,620 μg/L. Other VOCs—including PCE, toluene, and total xylenes—are periodically detected but commonly below their MCLs (Geomatrix Consultants, 1997).

The facility's eighteen monitoring wells are part of a quarterly monitoring program that began in 1991. Remediation activities began in 1995 with RWQCB Waster Discharge Requirement Order No. 95-62 for the pump and treat of groundwater at two extraction wells, EW-01 and EW-02. The operation of the extraction wells and remediation system is also referred to as the Final Remediation Measures (FRM). Groundwater from EW-01 is treated for VOCs, and groundwater from EW-02 is treated for VOCs and chromium. The two sources of treated water join, are pipelined to the West Cucamonga Channel and ultimately to the Ely Basins, where it percolates into the Chino Basin Aquifer. In late 2009 or early 2010, an injection well and pipeline will be completed, and treated groundwater will be injected into the Chino Basin. In addition to the remediation measures discussed above, a Soil Vapor Extraction (SVE) system has been in operation since 2003 to remove VOCs from impacted soil.

Figure 4-18 shows the approximate areal extent of TCE in groundwater at concentrations exceeding the MCL as of 2008. The plume is up to 3,400 feet wide and extends about 9,000 feet south-southwest (hydraulically downgradient) from the southern border of the site. From July 2003 to June 2008, the maximum TCE concentration detected at an individual well within the Flatiron Facility plume was 5,620 μg/L, and the maximum total chromium concentration detected at an individual well was 485 μg/L.

4.3.4.6 General Electric Test Cell Facility

The GE Engine Maintenance Center Test Cell Facility (Test Cell Facility) is located at 1923 East Avion, Ontario, California. From 1956 to present, primary operations at the Test Cell Facility have included the testing and maintenance of commercial and military aircraft engines. Historically, hazardous waste was disposed of in dry wells. In 1987, results of a preliminary investigation indicated the presence of VOCs in soils near the dry wells. In 1991, a soil and groundwater investigation and subsequent quarterly groundwater quality monitoring showed the presence of VOCs in the soil and groundwater beneath the Test Cell Facility and that the VOCs had migrated offsite (Dames & Moore, 1996). Subsequent investigations indicated that the most common and abundant VOC detected in groundwater beneath the site was TCE. The historical maximum TCE concentration measured at an onsite monitoring well (directly beneath the Test Cell Facility) was 1,240 μg/L. The historical maximum TCE concentration measured at an offsite monitoring well (downgradient) was 190 μg/L (BDM International, 1997). Other detected VOCs include PCE, cis-1,2-DCE, 1,2-dicholoropropane, 1,1-DCE, 1,1-DCA, and chloroform, among others.

A Consent Order between General Electric and CDPH was signed September 28, 1988 for groundwater and soil remediation (Docket No. 88/89-009CO). The groundwater investigation and cleanup is under the oversight of the RWQCB. Vapor extraction treatment system operations began in 1996 (Docket No. HAS 97/98-014). Quarterly monitoring and operations status reports have been submitted to the DTSC and the RWQCB since remediation commenced. Recently a study was conducted to evaluate the effectiveness of the soil remediation program. The results of this study were submitted to the DTSC in October 2008 (Geosyntec Consultants, 2008). In some regions of the facility, shallow soils have reached acceptable closure levels; however, remediation activities will continue until sufficient data can be evaluated.

Figure 4-18 shows the approximate areal extent of VOCs in groundwater at concentrations exceeding federal MCLs as of 2008. The plume is elongate in shape, up to 2,400 feet wide, and extends approximately 10,300 feet from the Test Cell Facility in a southwesterly direction. As Figure 4-19 illustrates, the GE Test Cell Facility plume is characterized primarily by TCE, PCE, cis-1,2-DCE, and 1,1-DCE. From July 2003 to June 2008, the maximum TCE and PCE concentrations in groundwater detected at an individual well within the Test Cell Facility plume were 900 μg/L and 16 μg/L, respectively.

4.3.4.7 Kaiser Steel Fontana Steel Site

Between 1943 and 1983, the Kaiser Steel Corporation (Kaiser) operated an integrated steel manufacturing facility in Fontana. During the first 30 years of operations (1945-1974), a portion of the Kaiser brine wastewater was discharged to surface impoundments and allowed to percolate into the soil. In the early 1970s, the surface impoundments were lined to eliminate percolation to groundwater (Wildermuth, 1991). In July of 1983, Kaiser initiated a groundwater investigation that revealed the presence of a plume of degraded groundwater beneath the facility. In August 1987, the RWQCB issued CAO Number 87-121, requiring additional groundwater investigations and remediation activities. The results of those investigations showed that the major constituents of release to groundwater were inorganic dissolved solids and low molecular weight organic compounds. The wells sampled during the groundwater investigations had TDS concentrations ranging from 500 to 1,200 mg/L and TOC concentrations ranging from 1 to 70 mg/L. By November 1991, the plume had migrated almost entirely off the Kaiser site.

In 1993, Kaiser and the RWQCB entered into a settlement agreement; Kaiser was required to mitigate any adverse impacts caused by its plume at existing and otherwise useable municipal wells. Pursuant to the settlement, the RWQCB rescinded its earlier order 91-40, and Kaiser was granted capacity in the Chino II Desalter to intercept and remediate the Kaiser plume within the Chino Basin. In an effort to further characterize the plume, during 2005, a network of 22 public and private supply wells were selected for quarterly groundwater sampling for one year and annual sampling thereafter. In addition, two triple nested monitoring wells, MZ3-1 and MZ3-2, were installed between the distal edge of the plume and municipal supply wells in 2007. Well MZ3-1/3 was found to have elevated concentrations of TDS, sulfate, and TOC. Based on this finding, the Kaiser plume was extended to include this well.

Figure 4-18 shows the approximate areal extent of the TDS/TOC groundwater plume as of 2008. Based on a limited number of wells, including Kaiser monitoring wells MP-2 and KOSF, City of Ontario Wells 27 and 30, and monitoring wells MZ3-1 and MZ3-2, the plume is up to 7,000 feet wide and extends about 18,500 feet from the northeast to the southwest.

4.3.4.8 Milliken Sanitary Landfill

The Milliken Sanitary Landfill (MSL) is an inactive Class III Municipal Solid Waste Management Unit, located near the intersections of Milliken Avenue and Mission Boulevard in the City of Ontario. This facility is owned by the County of San Bernardino and managed by the County's Waste System Division. The facility operated from 1958 to 1999. Groundwater monitoring at the MSL began in 1987 with five monitoring wells as part of a Solid Waste Assessment Test (SWAT) investigation (IT, 1989). The results of this investigation indicated that the MSL had released organic and inorganic compounds to underlying groundwater. Based on this finding, the MSL conducted an Evaluation Monitoring Program (EMP) investigation. At the completion of the EMP, a total of 29 monitoring wells were drilled to evaluate the nature and extent of the groundwater impacts identified in the vicinity of the MSL (GeoLogic Associates, 1998). Analytical results have indicated that VOCs are the major constituents of release. The most commonly detected VOCs are TCE, PCE, and dichlorodifluoromethane. Other VOCs that have been detected above MCLs include vinyl chloride, benzene, 1,1-dichloroethane, and 1,2-dichloropropane. Historically, the maximum total VOC concentration in an individual monitoring well was 159.6 μg/L (GeoLogic Associates, 1998).

Figure 4-18 shows the approximate areal extent of VOCs in groundwater at concentrations exceeding MCLs as of 2008. The plume is up to 1,800 feet wide and extends about 2,100 feet south of the MSL's southern border. As Figure 4-19 illustrates, the MSL plume is characterized by a mixture of PCE, TCE, and their degradation products. From July 2003 to June 2008, the maximum TCE and PCE concentrations detected at an individual well within the MSL plume were 12 μg/L and 8.4 μg/L, respectively.

4.3.4.9 Municipal Wastewater Disposal Ponds

Historically, treated municipal wastewater was disposed of in ponds located near the current IEUA Regional Plant 1 (RP1), located in south Ontario, and the former Regional Plant 3 (RP3) disposal ponds, located in south Fontana. The ponds located just east of RP1, commonly referred to as the Cucamonga ponds, were used to dispose of untreated effluent collected by the Cucamonga County Water District (now the CVWD) and the IEUA. The RP3 disposal ponds are located on the southwest corner of Beech and Jurupa Avenues in the City of Fontana. The discharge of treated wastewater to the Cucamonga ponds and the RP3 ponds ceased between the early 1970s and the mid-1980s. The contaminant plumes emanating from these ponds have never been characterized.

4.3.4.10 Upland Sanitary Landfill

The Upland Sanitary Landfill (USL) is located on the site of a former gravel quarry at the southeastern corner of 15th Street and Campus Avenue in the City of Upland. The facility operated from 1950 to 1979 as an unlined Class II and Class III municipal solid waste disposal site. In 1982, the entire USL disposal site was covered with a 10-inch thick, low permeability layer of sandy silt (GeoLogic Associates, 1997). Groundwater monitoring began at the USL in 1988, and there are now three onsite monitoring wells: an upgradient well, a cross-gradient well, and a downgradient well (City of Upland, 1998). Monitoring results indicate that the USL has released organic and inorganic compounds to underlying groundwater (GeoLogic Associates, 1997). Groundwater samples from the downgradient monitoring well consistently contain higher concentrations of organic and inorganic compounds than samples from the upgradient and cross-gradient wells. Historical groundwater samples have indicated that VOCs are the major constituents of release, and all three monitoring wells have shown detectable levels of VOCs. The most common VOCs detected above MCLs are dichlorodifluoromethane, PCE, TCE, and vinyl chloride. Other VOCs that have been periodically detected above MCLs include methylene chloride, cis-1,2-DCE, 1,1-DCA, and benzene. For the 1990 to 1995 period, the average total VOC concentration at the downgradient monitoring well was 125 μg/L (GeoLogic Associates, 1997). And, for the July 2003 to June 2008 period, the maximum TCE and PCE concentrations detected at USL monitoring wells were 0.6 μg/L and 3.5 μg/L, respectively.

Figure 4-18 shows the approximate areal extent of VOCs at concentrations exceeding MCLs as of 2008. Please note that this plume is only defined by three onsite monitoring wells. The extent of the plume may be greater than currently depicted in Figure 4-18.

4.3.4.11 VOC Plume – South of the OIA

A VOC plume, containing TCE, exists south of the OIA. This plume extends approximately from State Route 60 on the north and Haven Avenue on the east to Cloverdale Road on the south and South Grove Avenue on the west. It is up to 11,300 feet wide and 20,500 feet long. By the late 1980s, the RWQCB determined TCE was present in numerous private wells in the area south of the OIA, and identified past activities at the airport as a likely source of TCE (RWQCB, 2005b). By 2005, TCE in exceedance of the CA MCL (5µg/L) was detected in 92 of the 167 private wells in the area. In July 2005, Draft CAOs were issued by the RWQCB to six parties identified as former TCE dischargers on the OIA property: Aerojet, the Boeing Company (Boeing), the Department of Defense, the Lockheed Martin Corporation (Lockheed), and the Northrop Grumman Corporation (Northrop). On a voluntary basis, Lockheed, GE, Boeing, and Aerojet are funding current investigative work on the extent and source of the TCE plume. Three triple nested monitoring wells were constructed in 2008 between the OIA and the VOC plume. A fourth well will be completed in 2009.

Final CAOs will likely be issued in the future. Watermaster has been working closely with the RWQCB and the identified parties, providing any available information to assist in the investigation. Remediation of the plume will likely be achieved using the CDA's Chino Basin Desalter I facilities . Watermaster is currently seeking a settlement with the companies to recover treatment costs associated with the VOC plume.

Figure 4-18 shows the approximate areal extent of the plume as of 2008. As Figure 4-19 illustrates, the OIA plume is characterized solely by TCE. During the July 2003 to June 2008 period, the maximum TCE concentration detected at an individual well within this plume was 38 µg/L.

4.3.4.12 Stringfellow NPL Site

One facility in the Chino Basin, the Stringfellow site, is on the current NPL of Superfund Sites. This site is located in Pyrite Canyon north of Highway 60 near the community of Glen Avon in Riverside County (see Figure 4-18). From 1956 until 1972, this 17-acre site was operated as a hazardous waste disposal facility. More than 34-million gallons of industrial waste—primarily from metal finishing, electroplating, and pesticide production—were deposited at the site (US EPA, 2001). A groundwater plume of site-related contaminants exists underneath portions of the Glen Avon area. Groundwater at the site contains various VOCs, perchlorate, NDMA, and trace metals, such as cadmium, nickel, chromium, and manganese. In the original disposal area, soil is contaminated with pesticides, polychlorinated biphenyls (PCBs), sulfates, perchlorate, and trace metals. The original disposal area is covered by a clay cap, fenced, and guarded by security services.

Contamination at the Stringfellow site has been addressed by cleanup remedies described in four EPA RODs. Since 1986, cleanup actions have focused on controlling the source of contamination, installing an onsite pretreatment plant, the cleanup of the lower part of Pyrite Canyon, and the cleanup of the community groundwater area below Highway 60. In 1996, the DTSC assumed responsibility for the maintenance of the Stringfellow Superfund Site through a Cooperative Agreement with the USEPA. In December 2007, the DTSC submitted the Draft Final Supplemental Feasibility Study (SFS), which identified and evaluated the final remedial alternatives for cleanup. The 2007 Draft SFS is a revised version of an earlier 2000 draft; reconsideration was required after perchlorate and other new contaminates were discovered in 2001. Once finalized, the SFS will be used by the US EPA to select a final remedial strategy and prepare a draft ROD. The draft ROD is anticipated in December 2009.

Figure 4-18 shows the approximate areal extent of the Stringfellow VOC plume as of 2008. The VOC plume is elongate in shape, up to 1,500 feet wide, and extends approximately 14,500 feet from the original disposal area in a southwesterly direction. The most common VOC detected at levels above the MCL is TCE. There are approximately 70 extraction wells throughout the length of the plume, which have been effective in stopping plume migration and removing TCE contamination. South of Highway 60, there are only a few isolated areas where TCE exceeds 5 μg/L (DTSC, 2008). During the 2003 to 2008 period, the maximum TCE concentration detected in the Stringfellow plume was 170 μg/L.

High levels of perchlorate associated with the Stringfellow site were detected in community groundwater south of Highway 60 in 2001. Residents connected to the JCSD water service were provided bottled water, and the DTSC contracted to install water mains and hook ups at each residence. Concurrent with the SFS, the DTSC is conducting a Remedial Investigation and Feasibility Study of remedial alternatives for perchlorate in the downgradient community area. As with TCE, the operation of the groundwater treatment system has resulted in a reduction of perchlorate. Since the discovery in 2001, perchlorate concentrations have been reduced by 30% to 50% throughout the monitored area (DTSC, 2008). Figure 4-18 shows the approximate areal extent of perchlorate concentrations exceeding the Notification Level (6 μg/L) as of 2008. The perchlorate plume is elongated in shape, up to 2,000 feet wide, and extends approximately 25,000 feet to the southwest from the original disposal area. During the 2003 to 2008 period, the maximum perchlorate concentration detected in the Stringfellow plume was 870 μg/L.

4.3.5 Water Quality by Management Zone

Figure 4-20 shows the locations of wells with groundwater quality time histories discussed herein and the five Chino Basin management zone boundaries. Wells were selected based on length of record, completeness of record, quality of data, and geographical distribution. Wells are identified by their local name (usually owner abbreviation and well number) or their X Reference ID (X Ref ID) if privately owned. The HCMP wells were selected because they are sampled at multiple depths and have a consistent water quality record for the past four years. Figures 4-21 through 4-28 are TDS and NO3-N time histories for the wells shown in Figure 4-20 from 1970 to 2008. These time histories illustrate water quality variation and trends within each management zone and the current state of water quality compared to historical trends.

4.3.5.1 Management Zone 1

MZ1 is an elongate region in the westernmost part of the Chino Basin. Figures 4-21 and 4-22 show TDS and NO3-N time histories for three wells representative of the northern portion of MZ1 (City of Upland well 8 [Upland 08], Monte Vista Water District well 5 [MVWD 05], and City of Upland well 20 [Upland 20]), two wells representative of the central region (City of Chino 5 [Chino 05] and City of Pomona well 23 [Pomona 23]), and two wells representative of the southern portion (Chino Institution for Men well 13 [CIM 13] and HCMP 3). In the northern portion of MZ1, NO3-N and TDS values have remained steady or decreased slightly over the time period depicted. Upland 08 exhibits NO3-N concentrations above the MCL (10 mg/L); however, slightly towards the west, near the Upland, Montclair, and College Heights Recharge Basins, NO3-N values drop below the MCL, as demonstrated by MVWD 05. TDS levels also decrease near the recharge basins. In the central region of MZ1, TDS and NO3-N concentrations have increased slightly over the last 30 years, but they are still below the MCLs. In the southern portion, NO3-N and TDS concentrations have increased significantly since 1990 and are above the MCLs, which is the trend seen in the majority of wells south of Highway 60. Quarterly sampling at HCMP 3 shows that TDS and NO3-N concentrations have remained stable over the past four years. HCMP 3 also shows the variation of water quality from the shallow to deeper aquifers. Overall, NO3-N and TDS concentrations in MZ1 escalate from north to south but have not increased over the last five years.

4.3.5.2 Management Zone 2

MZ2 is an elongate region in the center part of the Chino Basin. Figures 4-23 and 4-24 show TDS and NO3-N time histories for two wells representative of the northern portion of MZ2 (CVWD Well 5 [CVWD 05] and City of Ontario well 24 [ONT 24]), one well representative of the central region (City of Ontario well 17 [ONT 17]), and three wells representative of the southern portion (X Ref 29, HCMP 1, and X Ref 5333). Similar to MZ1, NO3-N and TDS values increase from north to south. Over the time period depicted, NO3-N and TDS concentrations have remained stable in the northern portion of MZ2, increased slightly in the central region, and increased considerably in the southern portion. At X Ref 5333 and HCMP 1, in the southern portion of MZ2, TDS concentrations are currently greater than twice the MCL (500 mg/L), and NO3-N concentrations are twice the MCL (10mg/L) or greater. In addition, HCMP 1 exemplifies the variation of high TDS and NO3-N levels in the shallow aquifer and low levels in the deeper aquifer. Overall, NO3-N and TDS concentrations have not increased over the last five years with the exception well X Ref 5333.

4.3.5.3 Management Zone 3

MZ3 is an elongate region that borders the majority of the Chino Basin's eastern boundary. Figures 4-25 and 4-26 show TDS and NO3-N time histories for one well representative of the northern portion (City of Fontana 37A [F37A]), one well representative of the central region (City of Ontario well 31 [ONT 31]), and two wells representative of the southern portion (Jurupa Community Service District well 16 [JCSD 16], and X Ref 5736). Similar to MZ1 and

MZ2, NO3-N and TDS values increase from north to south. In the northern and central areas of MZ3, TDS values have slightly increased since 1980 but still remain below the MCL (500 mg/L). Over the time period depicted, NO3-N concentrations increase in all regions of MZ3. Well F37A, in the northern region, exhibits NO3-N concentrations slightly above the MCL (10 mg/L). In the southern portion of MZ3, current TDS and NO3-N concentrations are near double the MCLs. At JCSD 16, NO3-N and TDS concentrations have increased significantly since 1990. In general, NO3-N and TDS concentrations have not increased over the last five years.

4.3.5.4 Management Zone 4

MZ4 – also known as Chino-East – is a wedge shaped region, bounded by the Jurupa Hills to the northeast, the Pedley Hills to the southeast, Management Zone 5 to the south, and Management Zone 3 to the west. Figures 4-27 and 4-28 show TDS and NO3-N time-histories for one well representative of the western region (HCMP-9), one well representative of the northern region (Jurupa Community Service District Well 24 [JCSD 24]), and one well representative of the eastern region (CDPH Stringfellow monitoring well [CTP-TW1]). In the western portion of MZ4, at HCMP-9, TDS and NO3-N concentrations are above the MCLs in the shallow aquifer but quite low in the deeper aquifer. The TDS and NO3 concentrations at JCSD 24 are slightly lower than those in the western portion, but they are slightly below or equal to the MCLs. In the eastern portion, at CTP-TW1, TDS and NO3-N concentrations are significantly above the MCLs. High TDS and NO3-N concentrations in the eastern portion of MZ4 are predominantly associated with the Stringfellow plume. Pre-1990 water quality data was not available for wells in this region. Since 1990, MZ4 TDS and NO3-N levels have remained relatively stable and decreased slightly over the last few years.

4.3.5.5 Management Zone 5

MZ5 – also known as Chino-South – is a small region towards the southeastern boundary of the Chino Basin. It is bordered by MZ4 to the north and MZ3 to the east. Figures 4-27 and 4-28 show TDS and NO3-N time histories for three wells representative of the northern portion of MZ5 (San Ana River Water Company Well 1A [SARWC 01A], JCSD 01, and HCMP-8). None of the wells in the southern region of MZ5 have sampling records that are complete enough to be considered representative. At JCSD 01 and SARWC 01A, TDS concentrations have historically been above the MCL (500 mg/L) and began to notably increase in 1990. Starting in 1995, NO3-N concentrations at JCSD 01 and SARWC 01A began to increase slightly above the MCL. Water quality sampling at these two wells ceased around 2005; however, HCMP-8 shows that TDS and NO3-N concentrations have decreased significantly since then.

4.3.6 Current State of Groundwater Quality in Chino Basin

The groundwater quality in Chino Basin is generally very good with better groundwater quality found in the north where recharge occurs. In the southern portion of the basin, TDS and NO3-N concentrations increase. Between July 2003 and June 2008, 32 percent of the wells sampled south of Highway 60 had TDS concentrations below the secondary MCL, an improvement from the 20 percent reported in the 2006 State of the Basin Report (period of July 2001 through June 2006). In some places, wells with low TDS concentrations are proximate to wells with higher TDS concentrations, suggesting a vertical stratification of water quality. Between July 2003 and June 2008, about 69 percent of the wells sampled south of Highway 60 had NO3-N concentrations greater than the MCL, an improvement from the 80 percent reported in the 2006 State of the Basin Report (period of July 2001 through June 2006). However, please note that these statistical improvements may be an artifact of sampling occurrence and frequency.

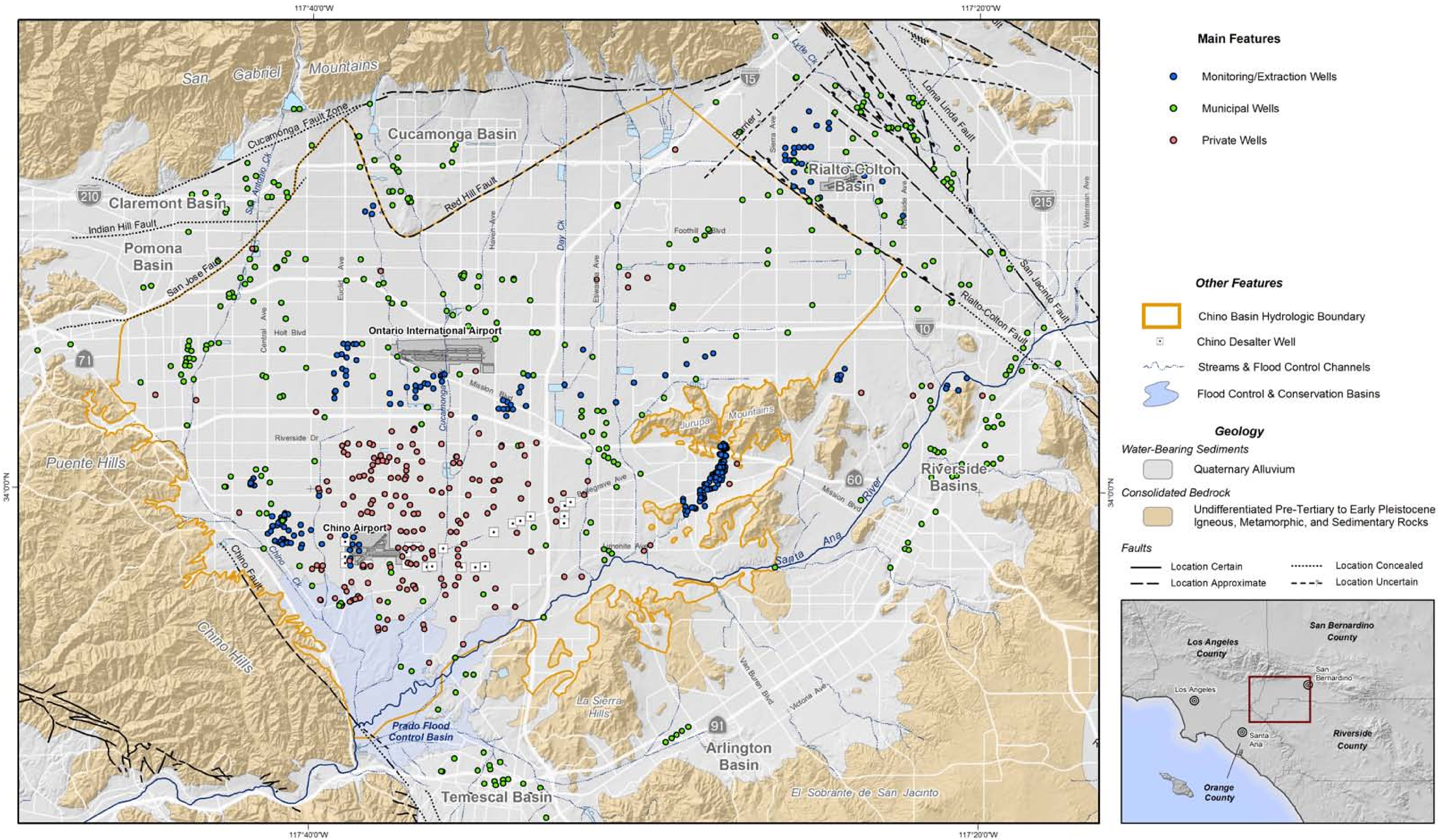
Other constituents that impact groundwater quality from a regulatory or Basin Plan standpoint include certain VOCs, arsenic, and perchlorate. As discussed in Section 4.3.4, there are a number of point source releases of VOCs in the Chino Basin that are in various stages of investigation or cleanup. There are also known point source releases of perchlorate (MVSL area, Stringfellow, etc.), and non-point source related perchlorate contamination appears to have resulted from natural and anthropogenic sources. Arsenic at levels above the WQS appears to be limited to the deeper aquifer zone near the City of Chino Hills. Hexavalent chromium, while not currently a groundwater quality issue in the Chino Basin, may become so, depending on the promulgation of future standards.

4.4 Conclusions and Recommendations

The Initial State of the Basin, and the 2004 and 2006 State of the Basin Reports discussed the need for future, long-term monitoring. Due to commercial and residential development in the Chino Basin area; many of the private agricultural wells that have been used for monitoring activities are destroyed as land is developed.

In response to the loss of historically utilized wells, Watermaster developed a water quality key well program. This program designates a series of wells across a wide areal distribution for long-term monitoring activities. To establish the well network, a grid was overlain the basin, and, where possible, at least one well was chosen per grid cell. Wells that are part of the water level monitoring program and/or on property that is not likely to be developed were preferentially chosen. Details of the Key Well Groundwater Quality Monitoring Program are available in the 2008 Chino Basin Maximum Benefit Annual Report and in Section 4.2.2 of this report. Key well sampling began in fall 2005 and runs in two-year cycles. Sampling results are added to the Watermaster database.

Point sources of concern are critical to the overall quality of Chino Basin groundwater. To ensure that Chino Basin groundwater remains a sustainable resource, it is of the utmost importance that Watermaster closely monitor point sources and emerging contaminates. It is recommended that Watermaster continue to work closely with the RWQCB and potentially responsible parties within the Chino Basin. This will allow for up-to-date understanding of groundwater quality, investigations, remediation activities, and potential mutually beneficial remedial options through Chino Basin desalting facilities.



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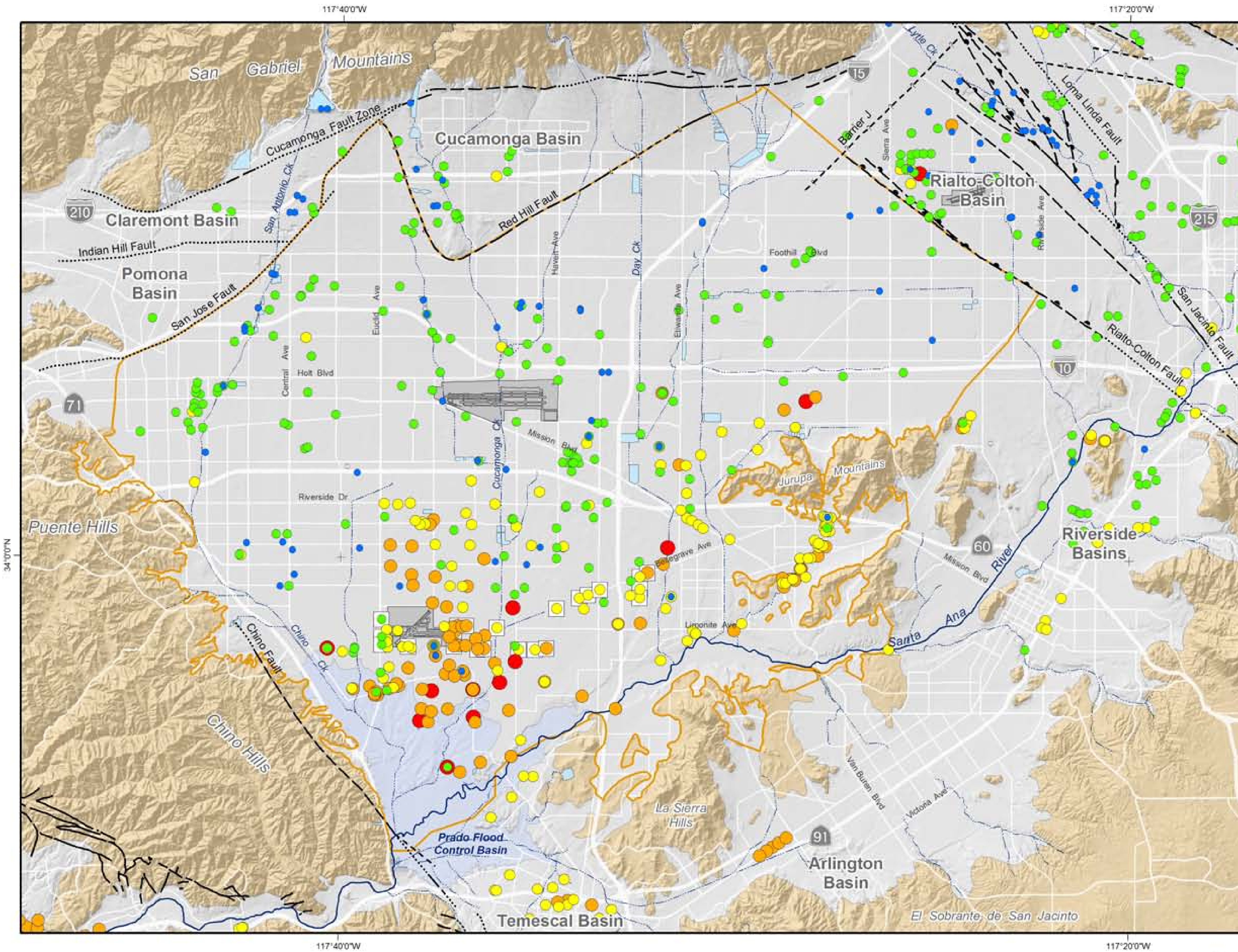
Date: 20090422
File: Figure_4-1.mxd

2008 State of the Basin Report
Groundwater Quality

Groundwater Wells with Water Quality Data

July 2003 - June 2008

Figure 4-1



Main Features

Total Dissolved Solids Concentration (mg/L)

- < 125
- 125 - 250
- 250 - 500
- 500 - 1,000
- 1,000 - 2,000
- > 2,000

Secondary US EPA MCL = 500 mg/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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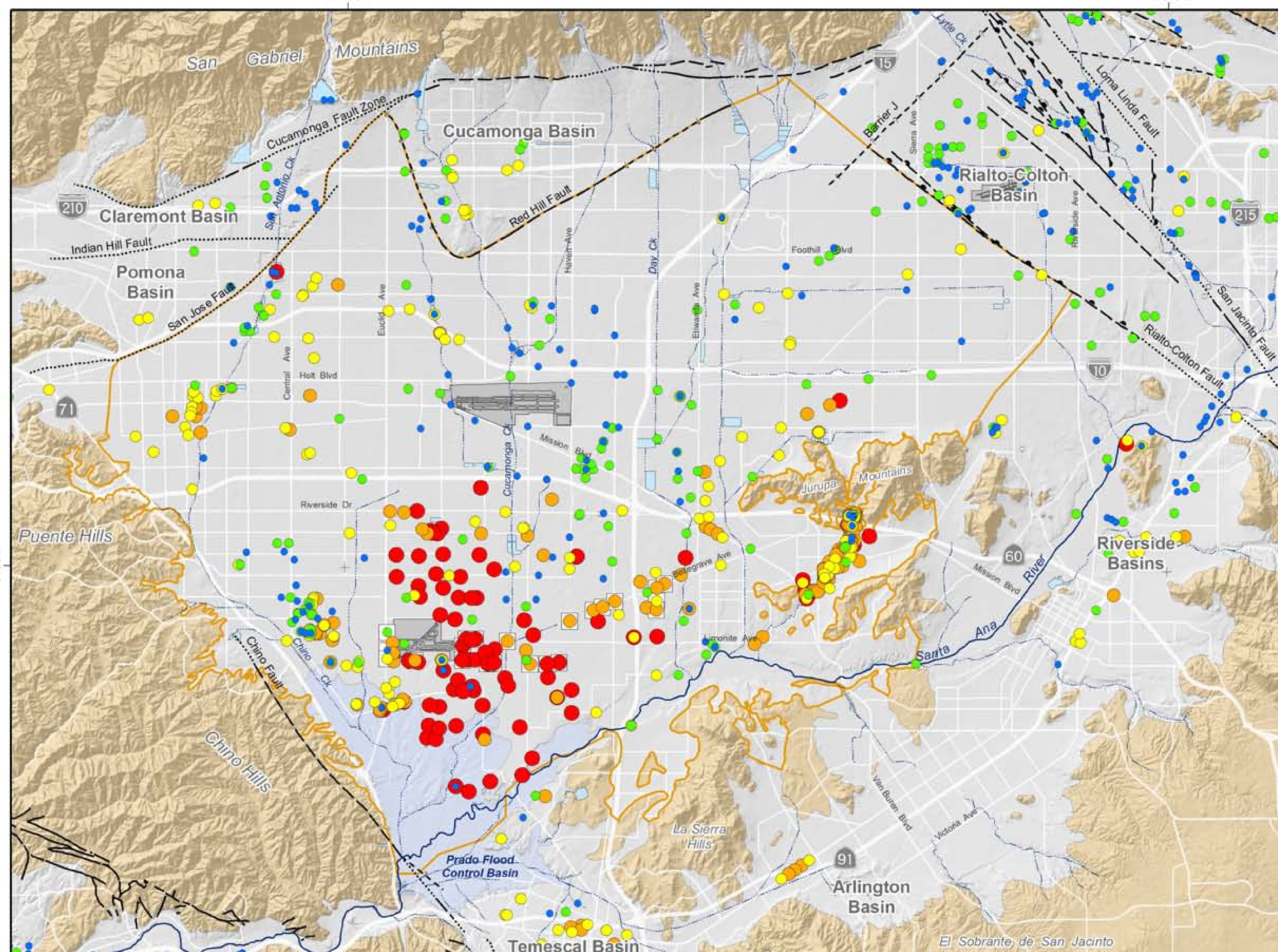
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Total Dissolved Solids in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-2



Main Features

Nitrate-Nitrogen (mg/L)

- ND
- < 5
- 5 - 10
- 10 - 20
- 20 - 40
- > 40

Primary US EPA MCL = 10 mg/L
Primary CA MCL = 10 mg/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

0 1 2 3 4 5 Miles
0 2 4 6 8 KM

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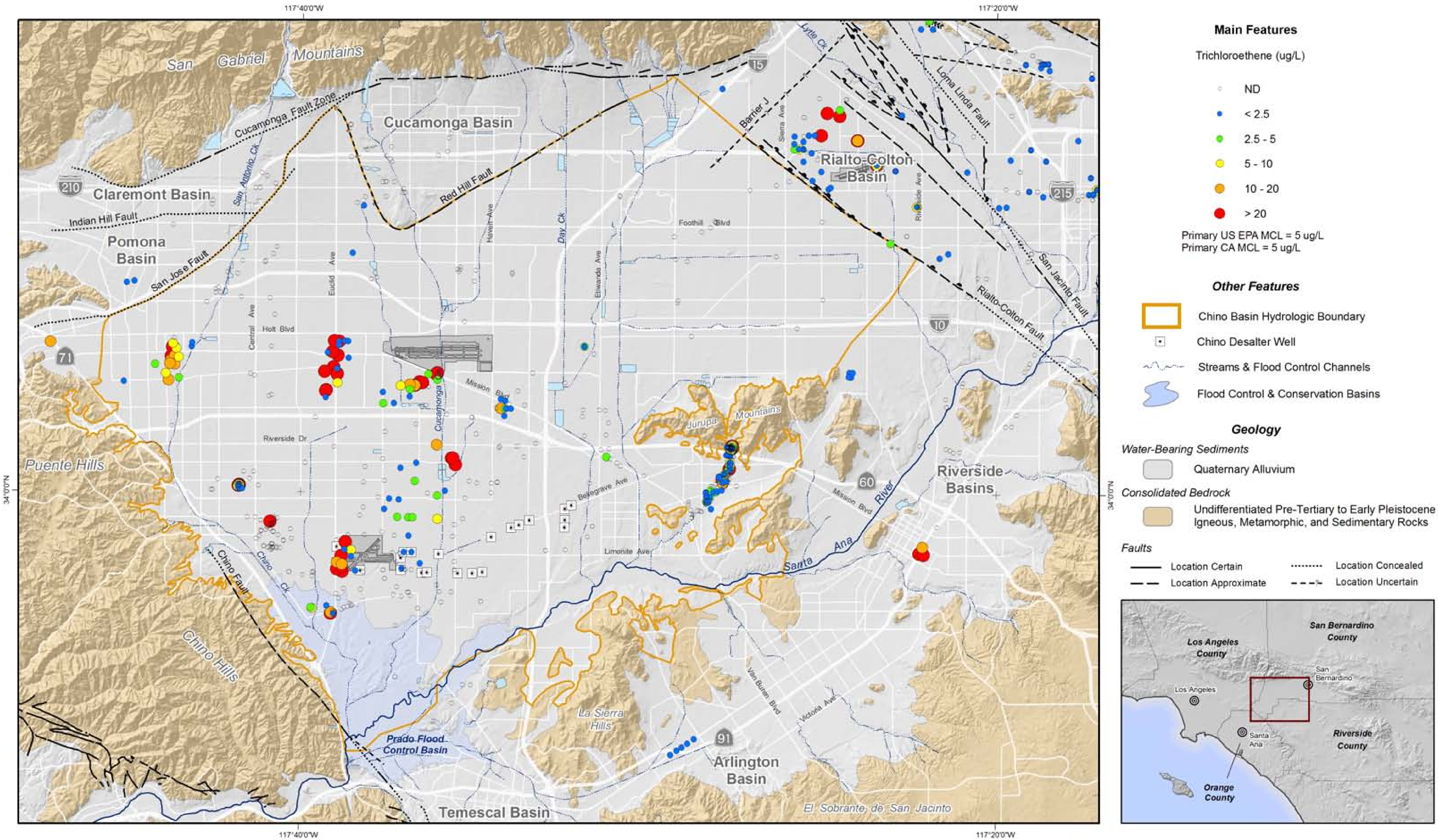
File: Figure_4-3.mxd

2008 State of the Basin Report
Groundwater Quality

Nitrate as Nitrogen in Groundwater
Maximum Concentration (July 2003 - June 2008)

Figure 4-3



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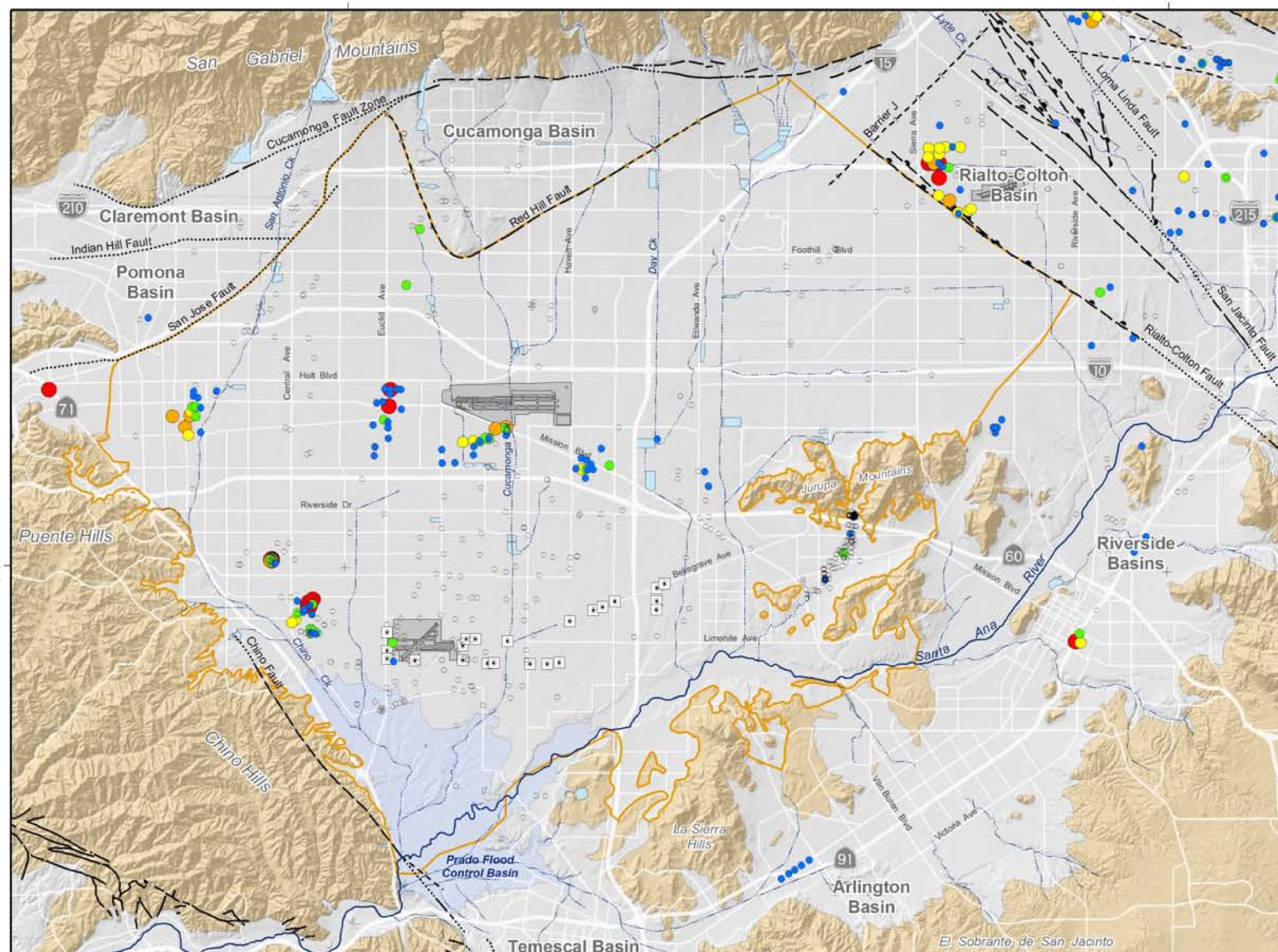
Date: 20090420
File: Figure_4-4.mxd

2008 State of the Basin Report
Groundwater Quality

Trichloroethene in Groundwater
Maximum Concentration (July 2003 - June 2008)

Figure 4-4



Main Features

Tetrachloroethene (ug/L)

- ND
- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- > 20

Primary US EPA MCL = 5 ug/L
Primary Ca MCL = 5 ug/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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Author: VME
Date: 20090420
File: Figure_4-5.mxd

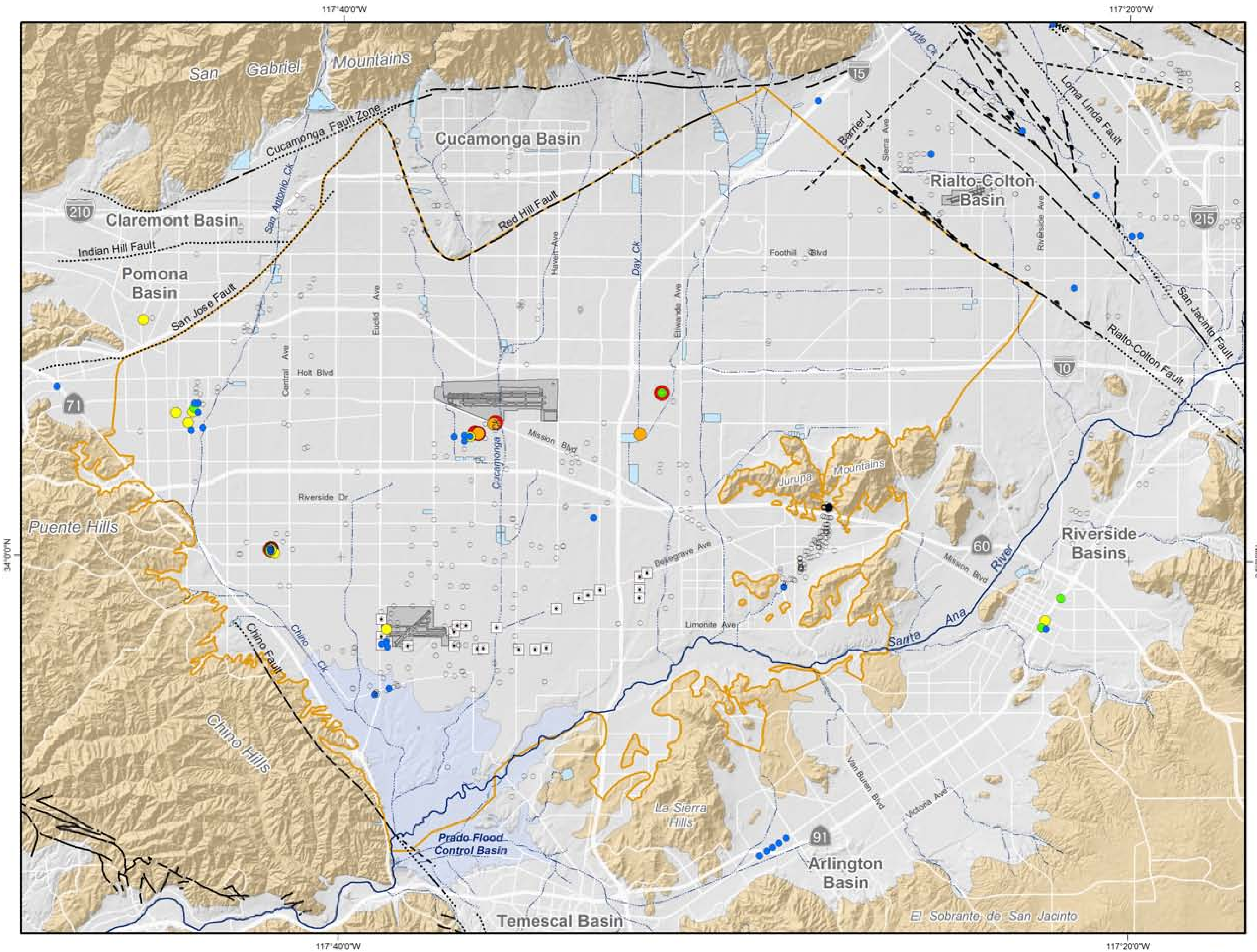
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Tetrachloroethene in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-5



Main Features

1,1-Dichloroethene (ug/L)

- ND
- < 3
- 3 - 6
- 6 - 12
- 12 - 24
- > 24

Primary EPA MCL = 7 ug/L
Primary CA MCL = 6 ug/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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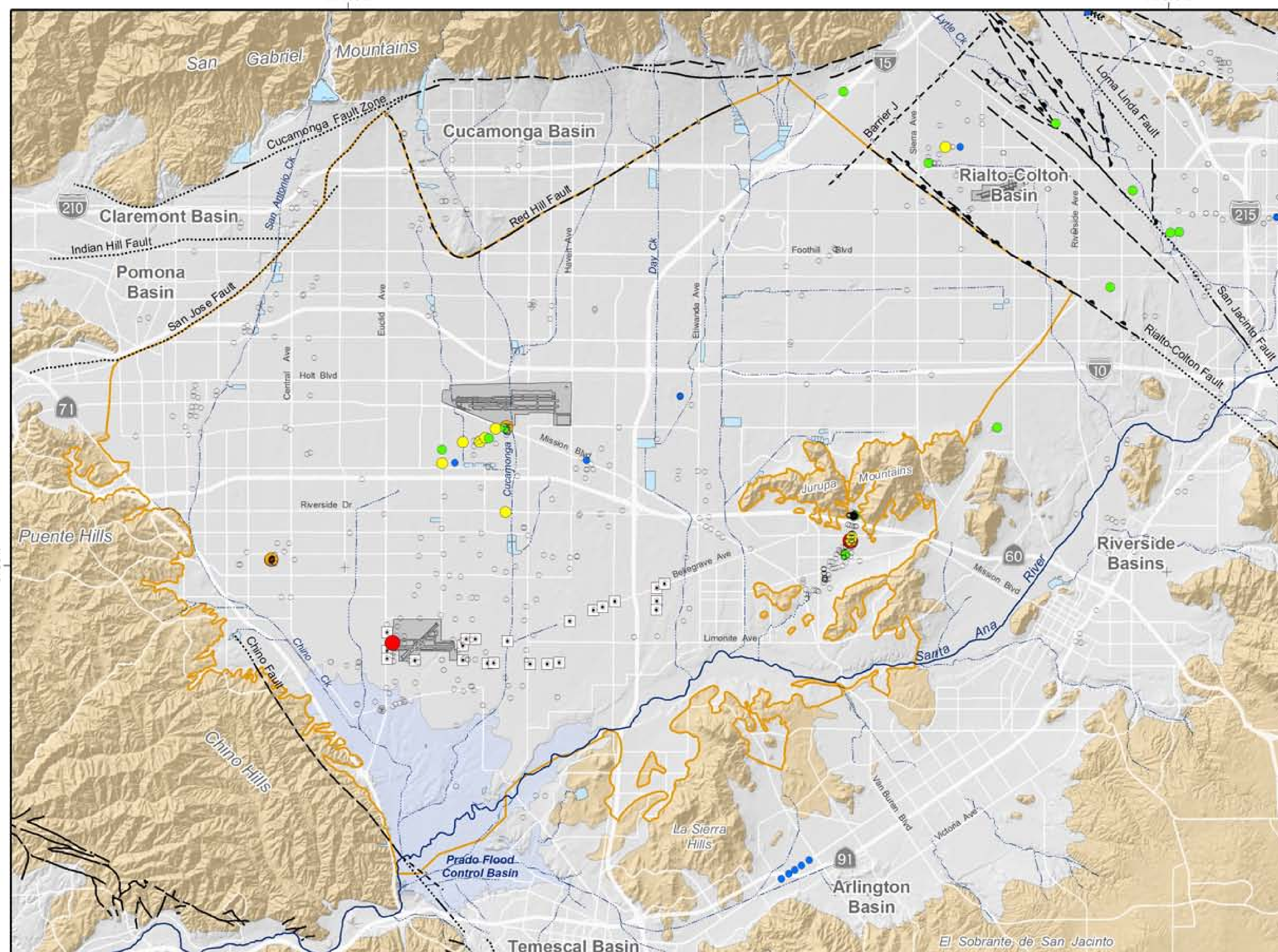
Date: 20090420
File: Figure_4-6.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

1,1-Dichloroethene in Groundwater
Maximum Concentration (July 2003 - June 2008)

Figure 4-6



Main Features

1,2-Dichloroethane (ug/L)

- ND
- < 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

Primary EPA MCL = 5 ug/L
Primary CA MCL = 0.5 ug/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

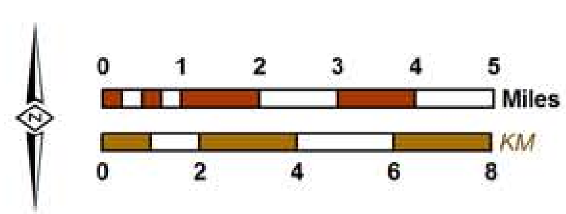
- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain



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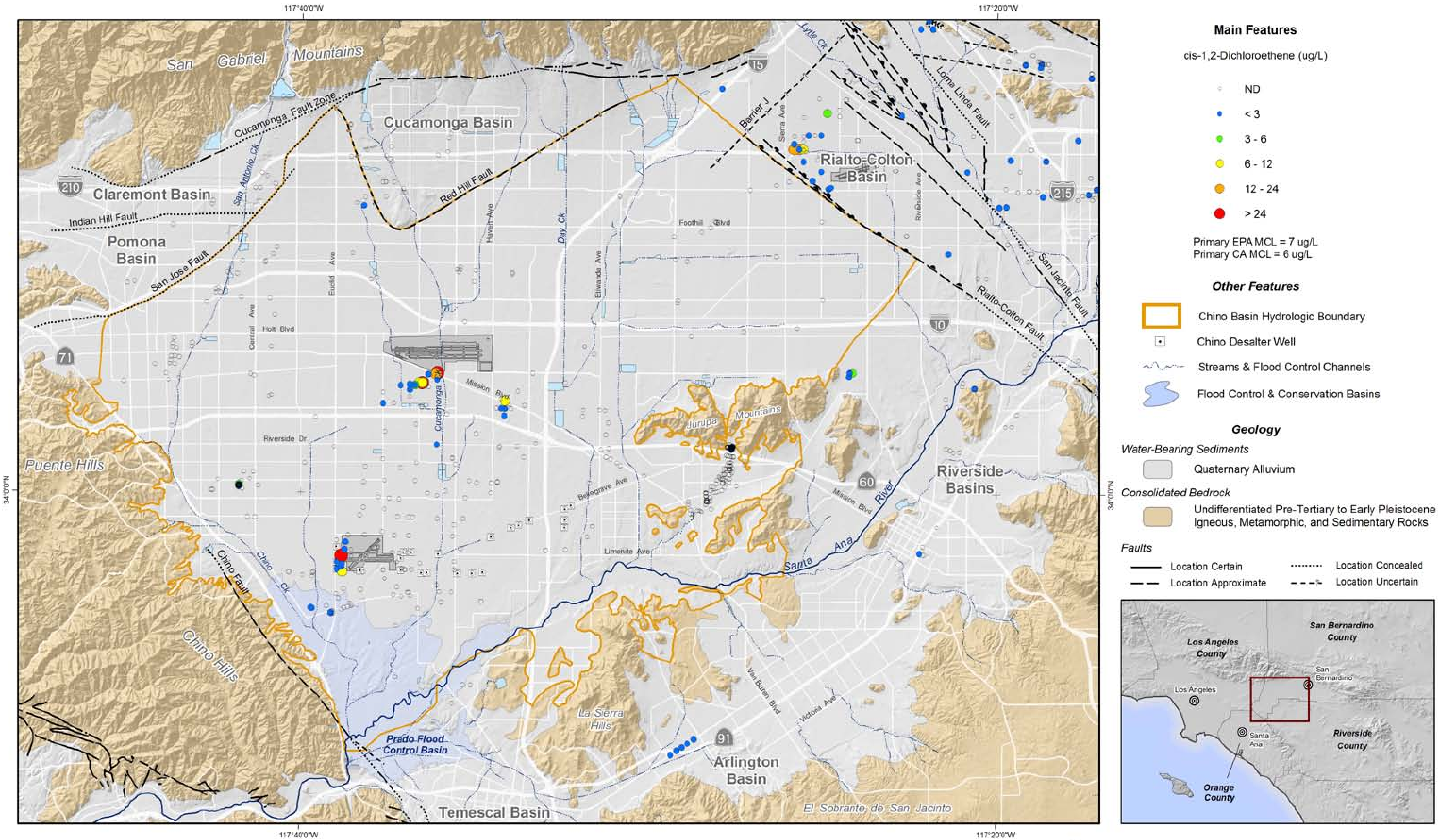
2008 State of the Basin Report
Groundwater Quality

1,2-Dichloroethane in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-7



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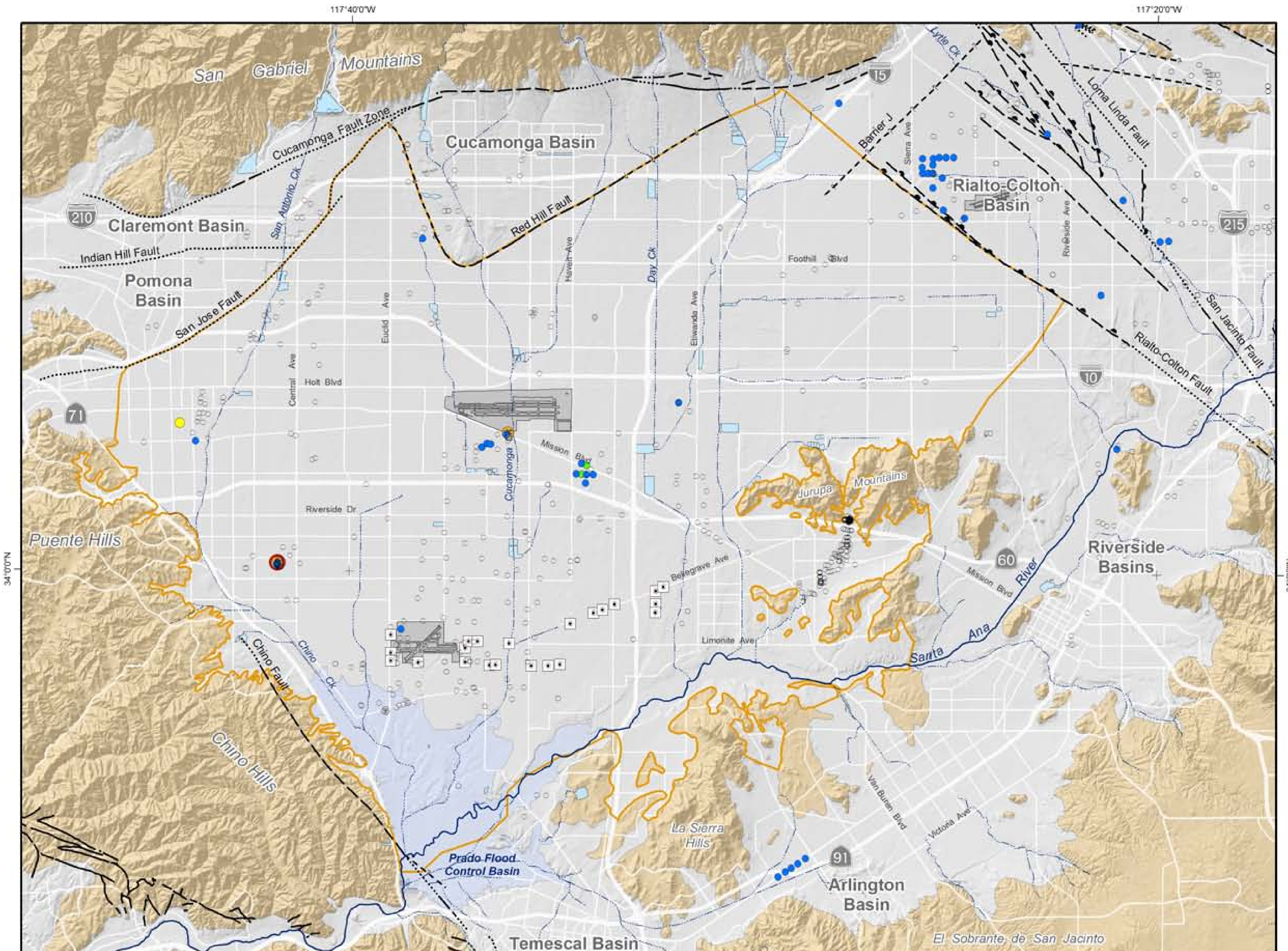
File: Figure_4-8.mxd

2008 State of the Basin Report
Groundwater Quality

cis-1,2-Dichloroethene in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-8



Main Features

1,1-Dichloroethane (ug/L)

- ND
- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- > 20

Primary CA MCL = 5 ug/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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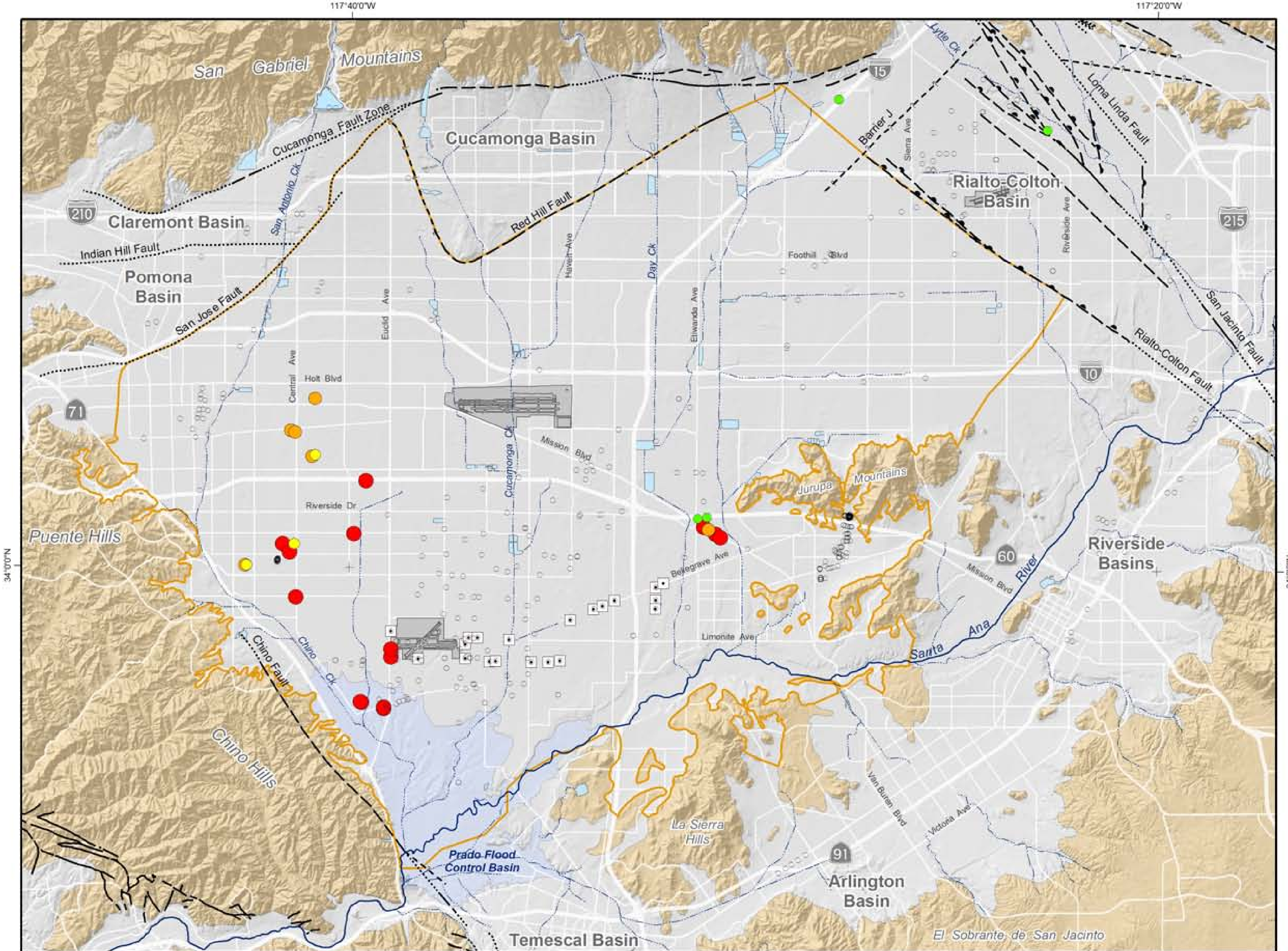
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

1,1-Dichloroethane in Groundwater
Maximum Concentration (July 2003 - June 2008)

Figure 4-9



Main Features

1,2,3-Trichloropropane (ug/L)

- ND
- < 0.0025
- 0.0025 - 0.005
- 0.005 - 0.01
- 0.01 - 0.02
- > 0.02

CA Notification Level = 0.005 ug/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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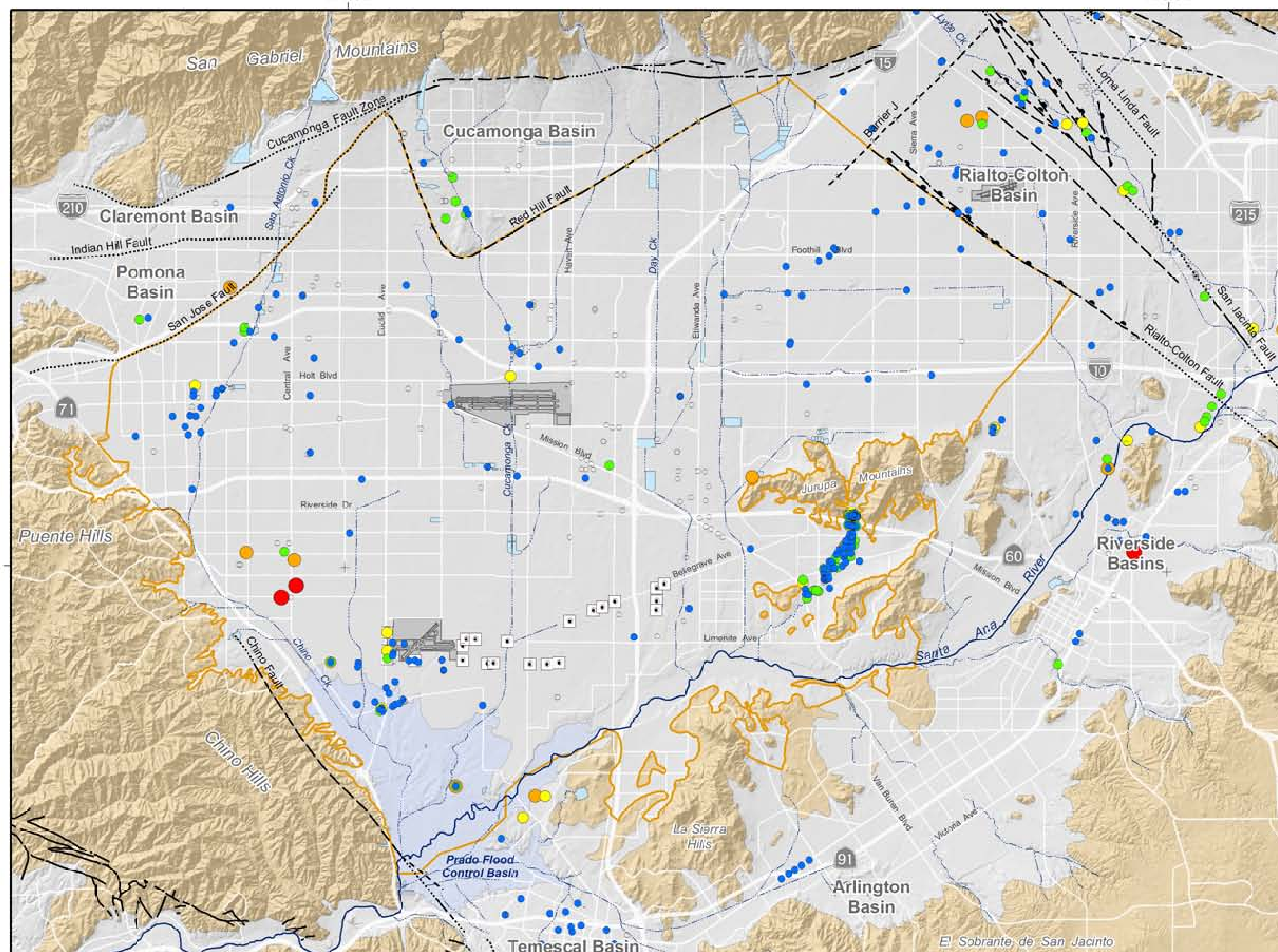
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

1,2,3-Trichloropropane in Groundwater
Maximum Concentration (July 2003 - June 2008)

Figure 4-10



Main Features

Arsenic (ug/L)

- ND
- < 5
- 5 - 10
- 10 - 20
- 20 - 40
- > 40

Primary EPA MCL = 10 ug/L
Primary CA MCL = 10 ug/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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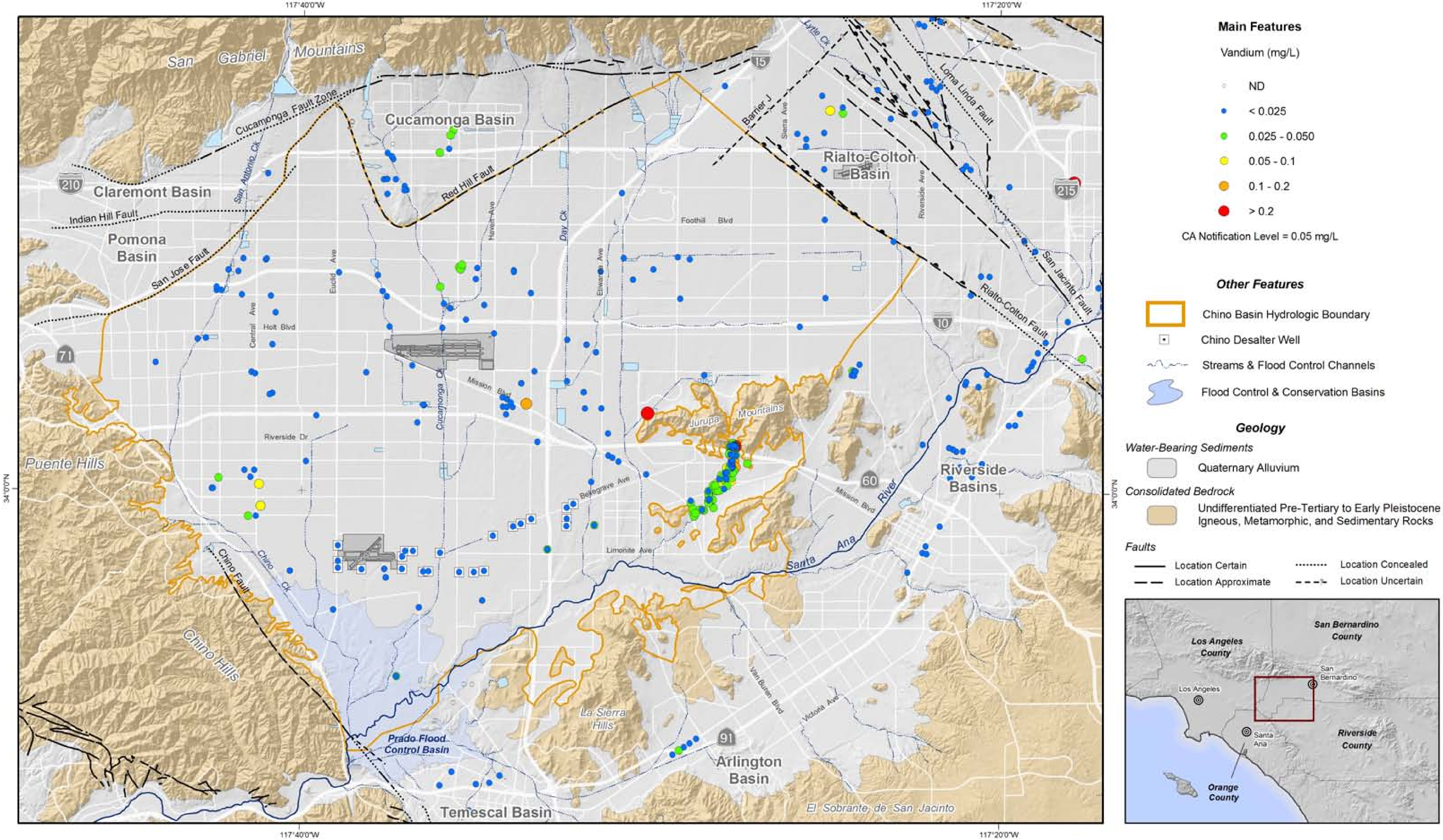
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Arsenic in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-11



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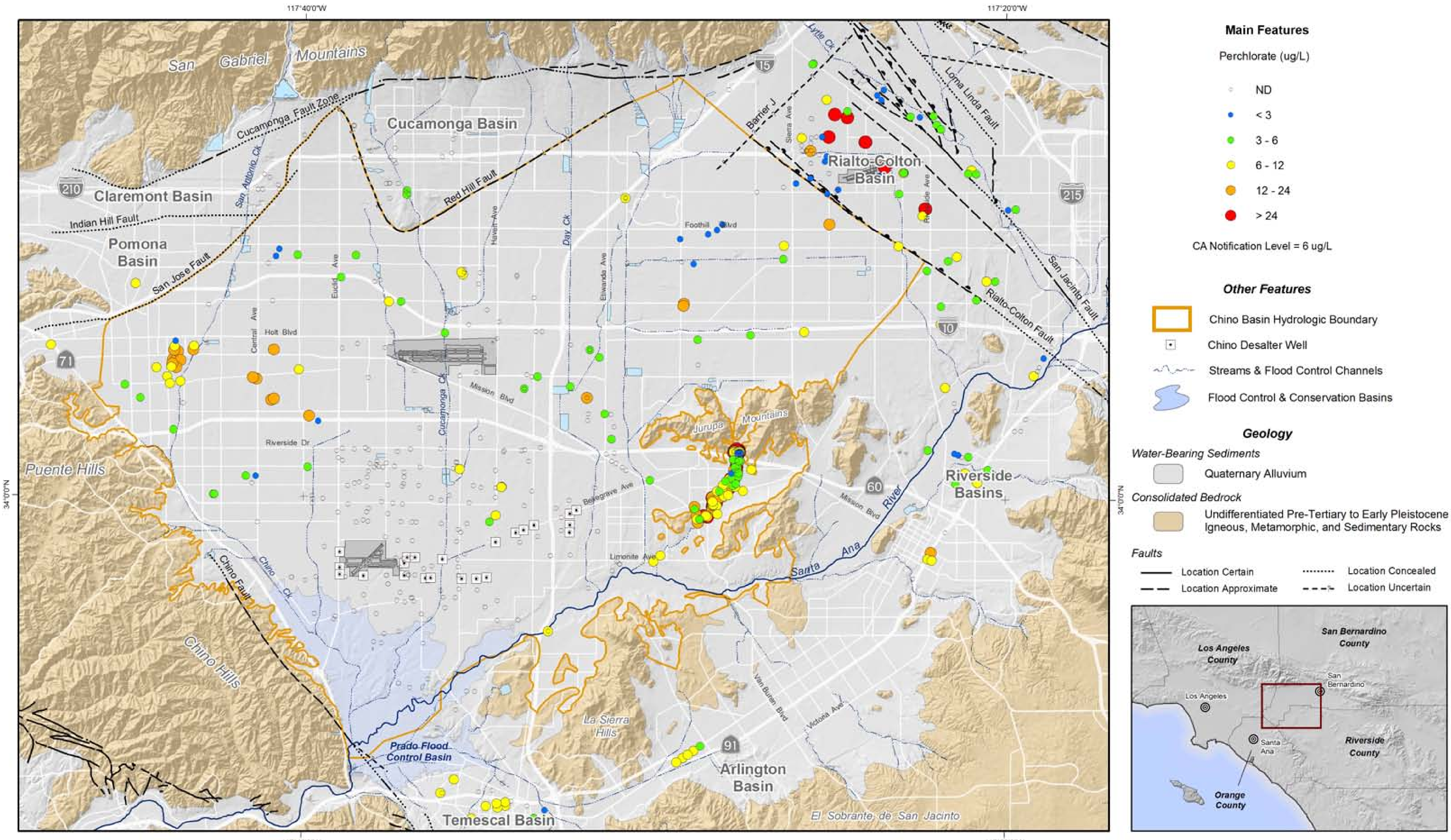
2008 State of the Basin Report
Groundwater Quality

Vanadium in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-12



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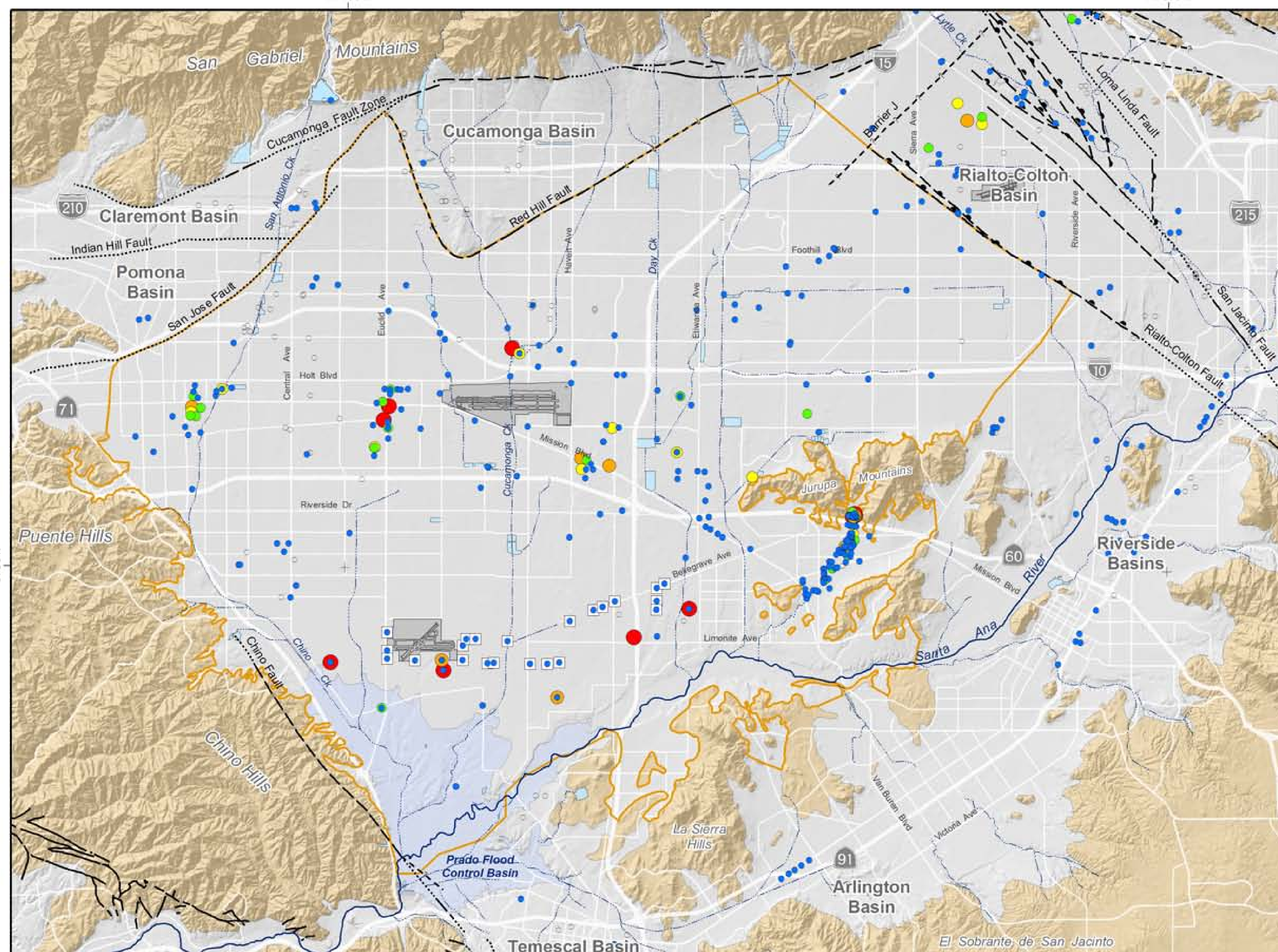
2008 State of the Basin Report
Groundwater Quality

Perchlorate in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-13



Main Features

Total Chromium (ug/L)

- ND
- < 25
- 25 - 50
- 50 - 100
- 100 - 200
- > 200

Primary EPA MCL = 100 ug/L
Primary CA MCL = 50 ug/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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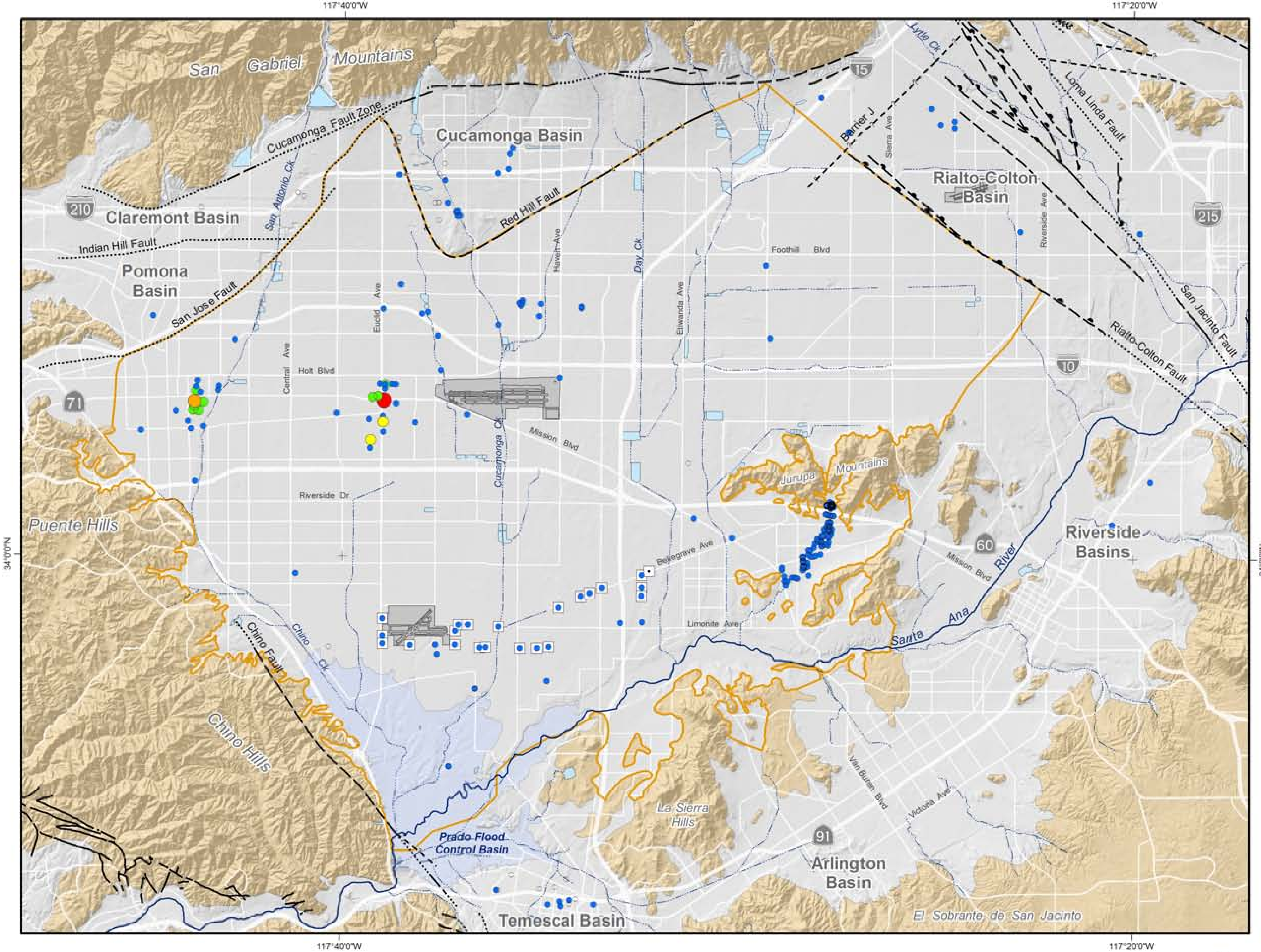
File: Figure_4-14.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Total Chromium in Groundwater
Maximum Concentration (July 2003 - June 2008)

Figure 4-14



Main Features

Hexavalent Chromium (ug/L)

- ND
- < 25
- 25 - 50
- 50 - 100
- 100 - 200
- > 200

Currently no US EPA or CA EPA MCL

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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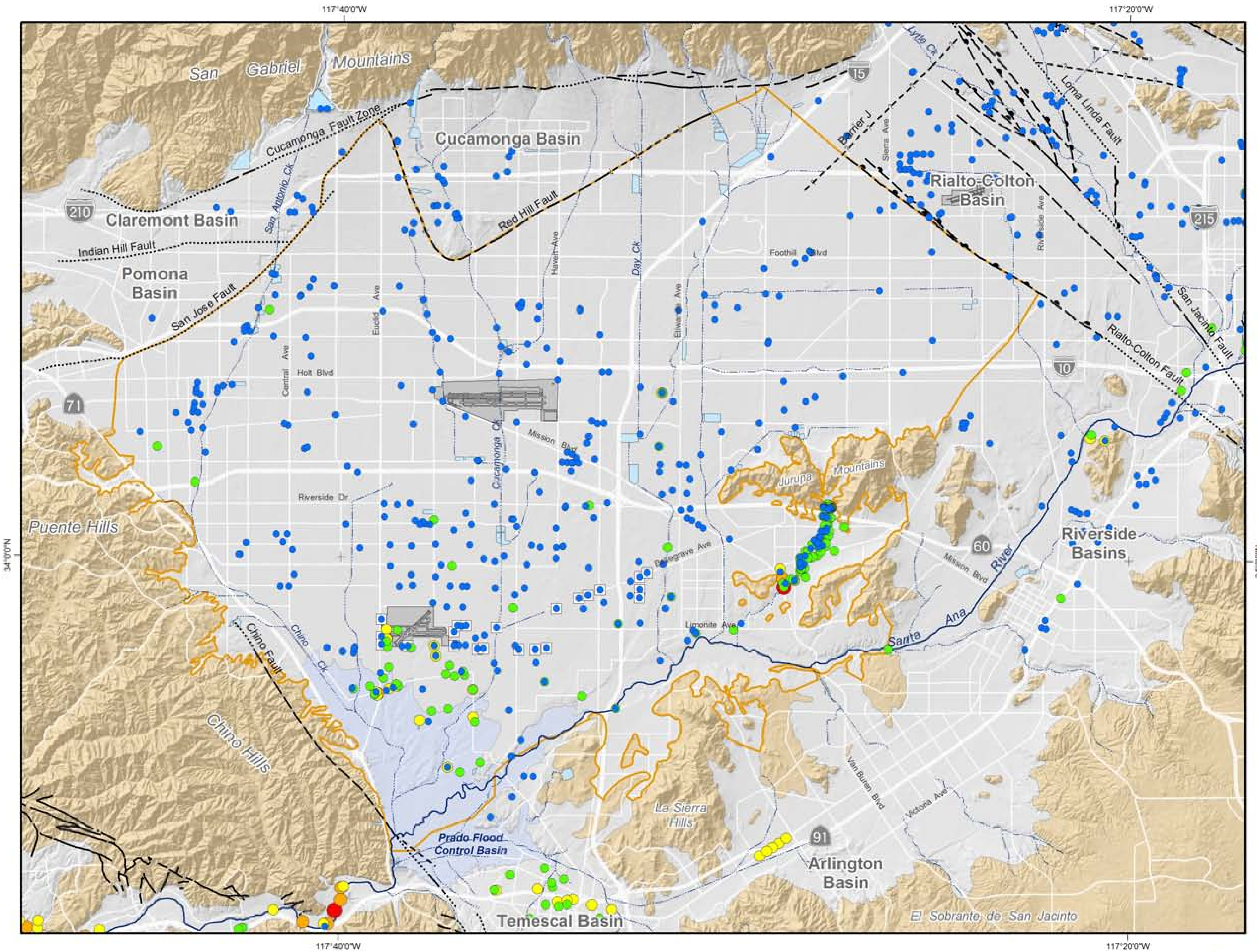
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Hexavalent Chromium in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-15



Main Features

Sulfate (mg/L)

- ND
- < 125
- 125 - 250
- 250 - 500
- 500 - 1,000
- > 1,000

Secondary EPA MCL = 250 mg/L
Secondary CA MCL = 250 mg/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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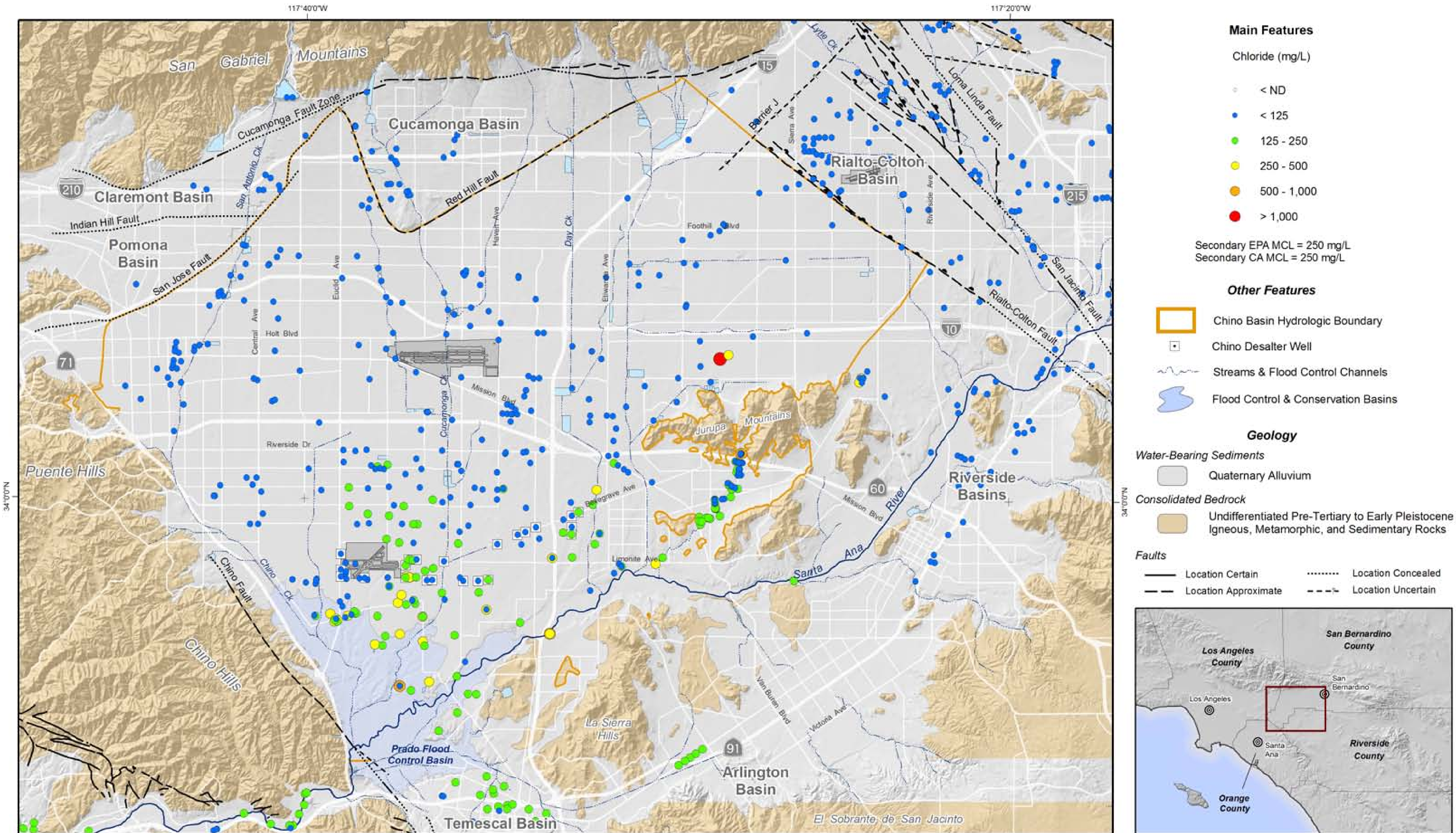
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Sulfate in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-16



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File: Figure_4-17.mxd

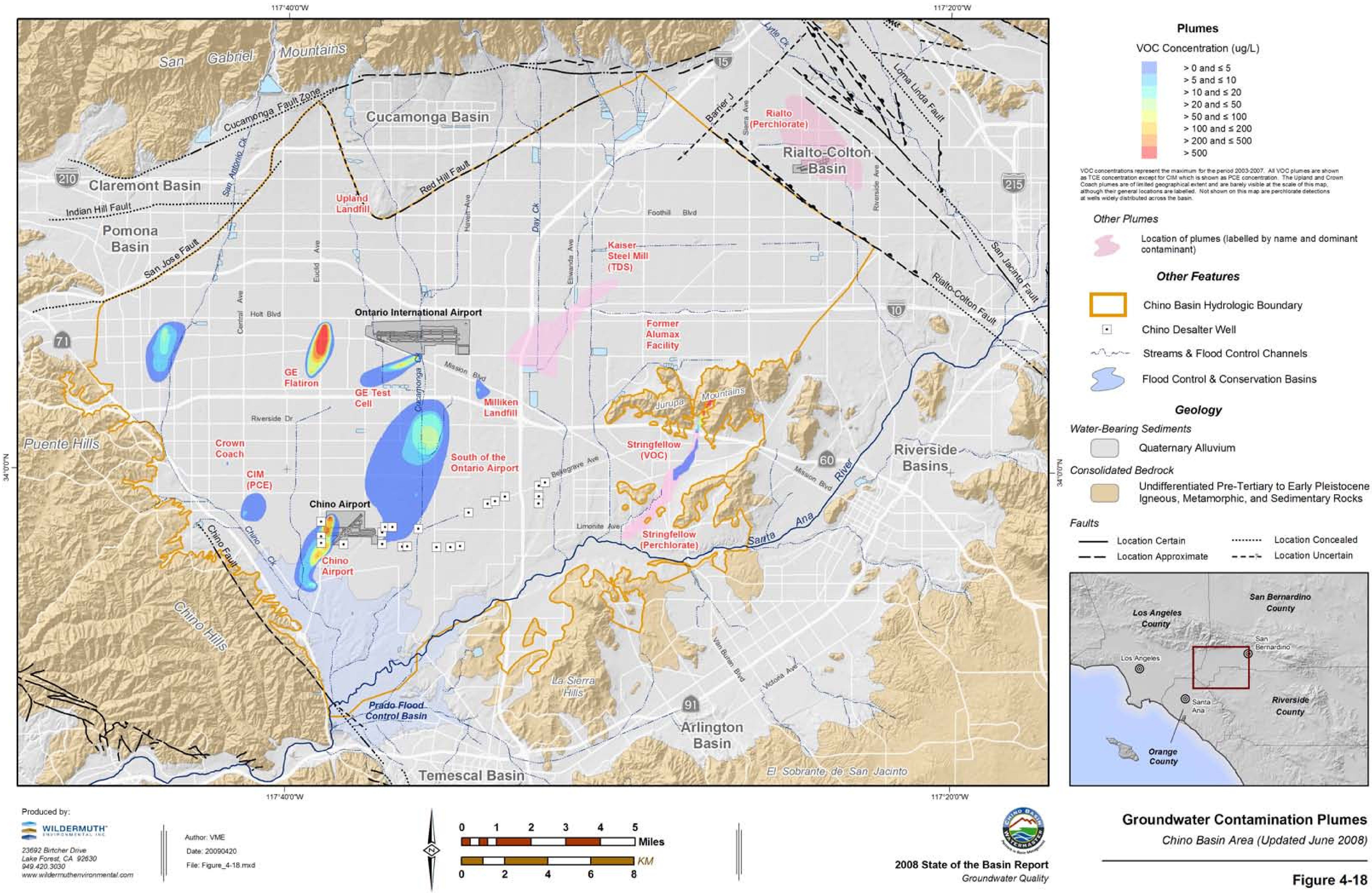
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Chloride in Groundwater

Maximum Concentration (July 2003 - June 2008)

Figure 4-17



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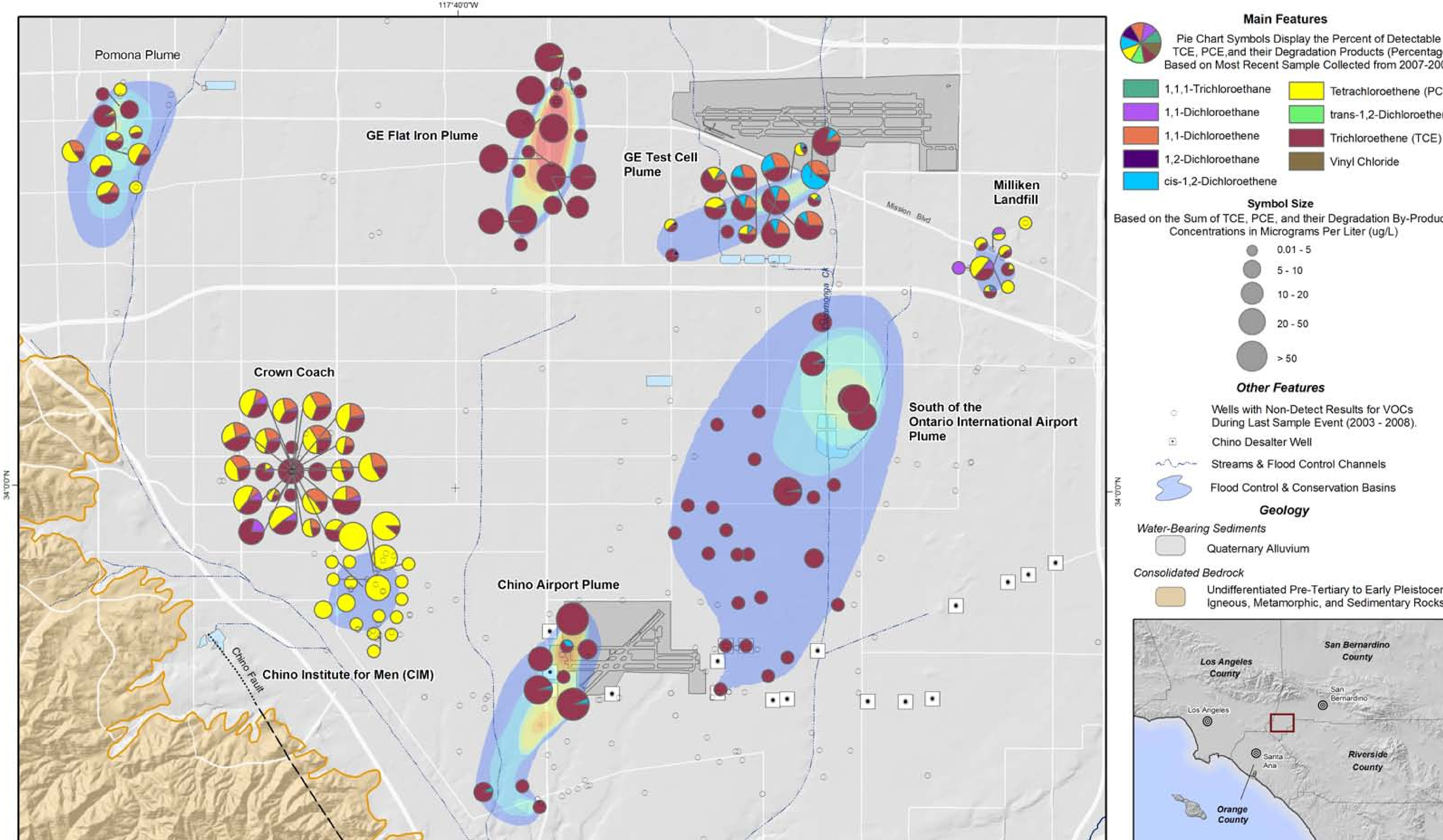
2008 State of the Basin Report
Groundwater Quality

Groundwater Contamination Plumes
Chino Basin Area (Updated June 2008)

Figure 4-18



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117°40'0"W

0 0.9 1.8 2.7 Miles

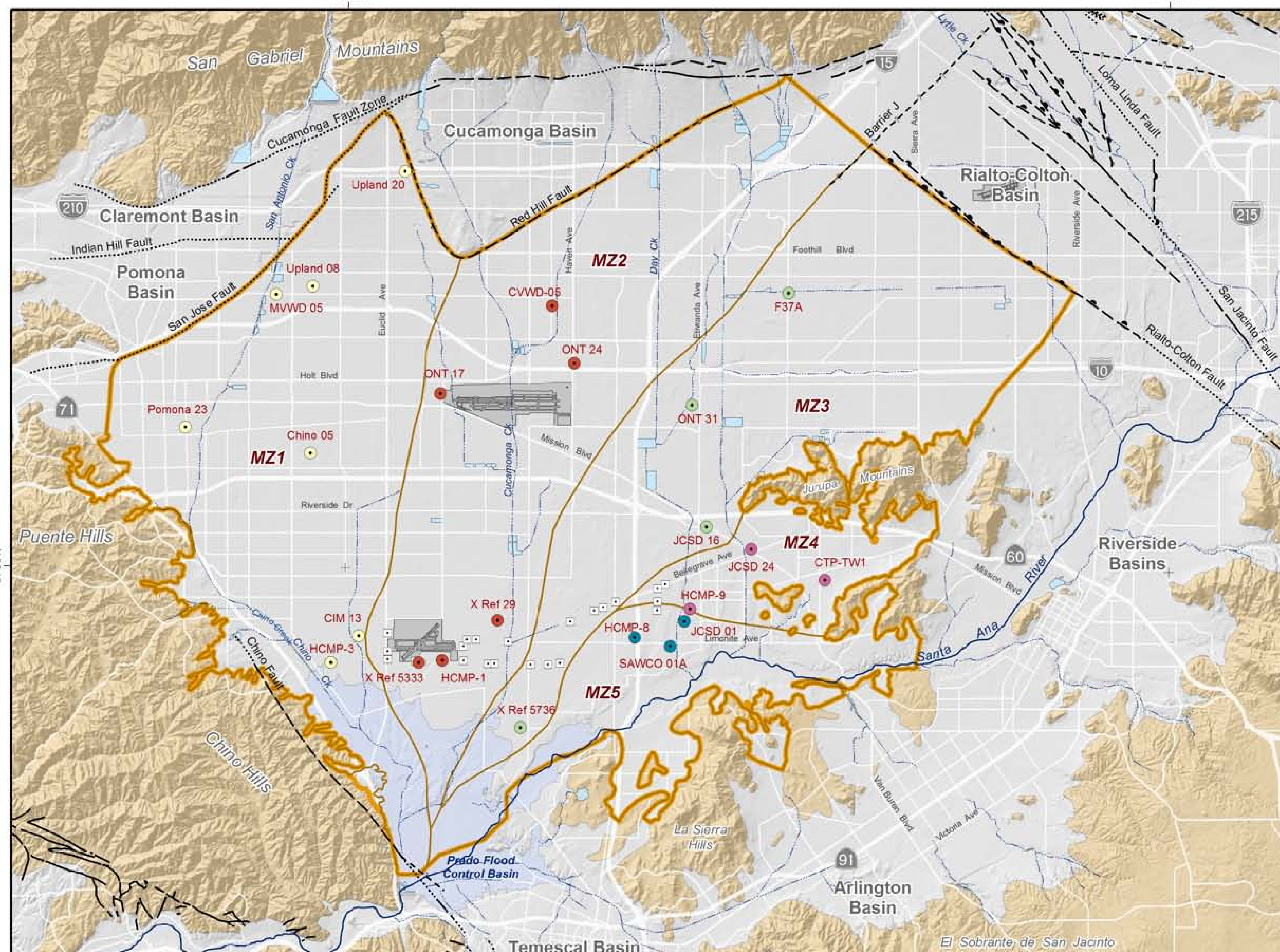
0 0.9 1.8 2.7 3.6 Kilometers

2008 State of the Basin Report
Groundwater Quality

VOC Pie Chart Comparisons

Wells Within and Adjacent to Groundwater Contamination Plumes

Figure 4-19



Main Features

- Chino Basin Hydrologic Boundary
- Chino Basin Management Zone Boundaries
- MZ1 Wells
- MZ2 Wells
- MZ3 Wells
- MZ4 Wells
- MZ5 Wells

Other Features

- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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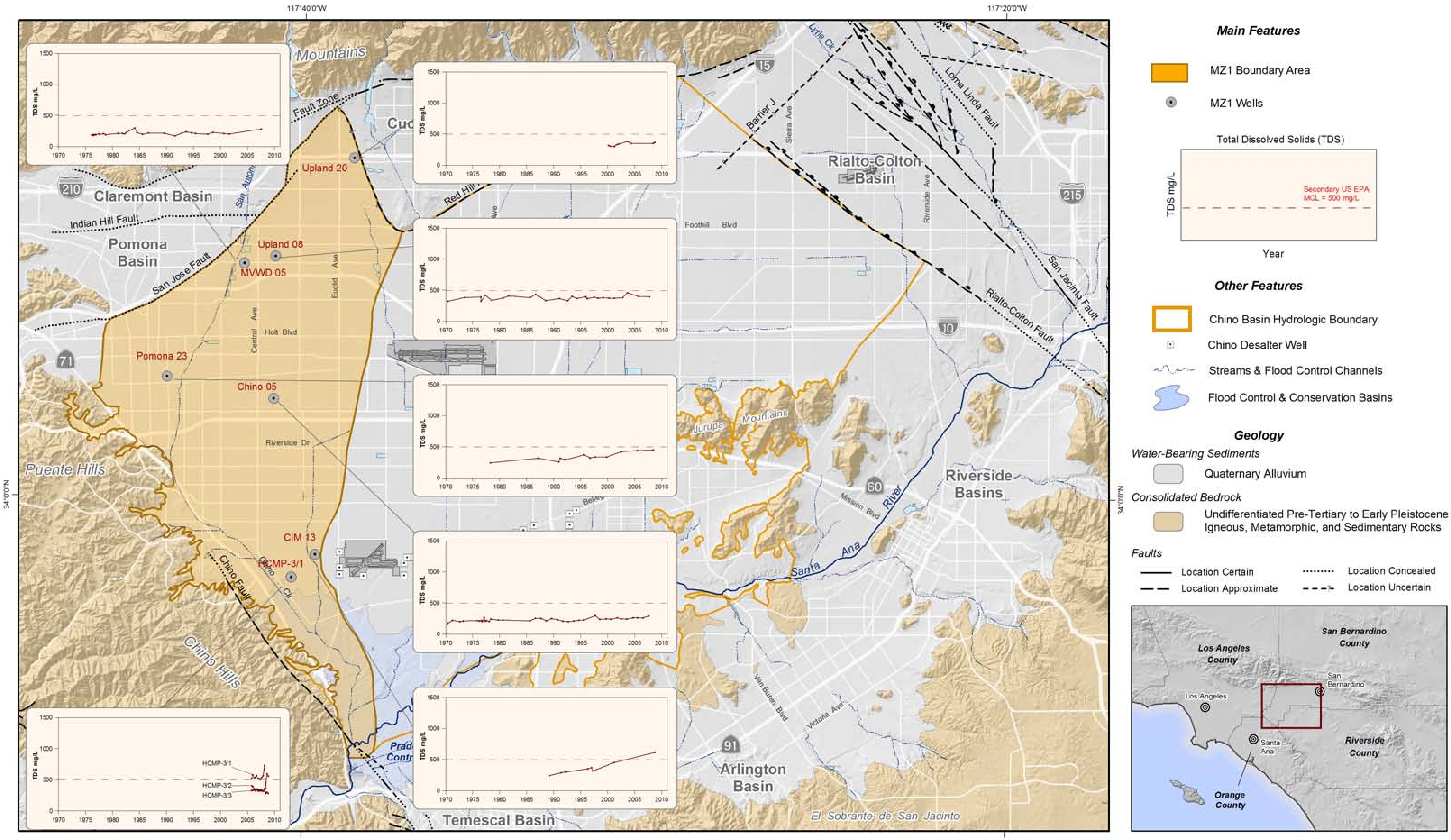
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Well Locations

Wells Used in Management Zone Water Quality Analyses

Figure 4-20



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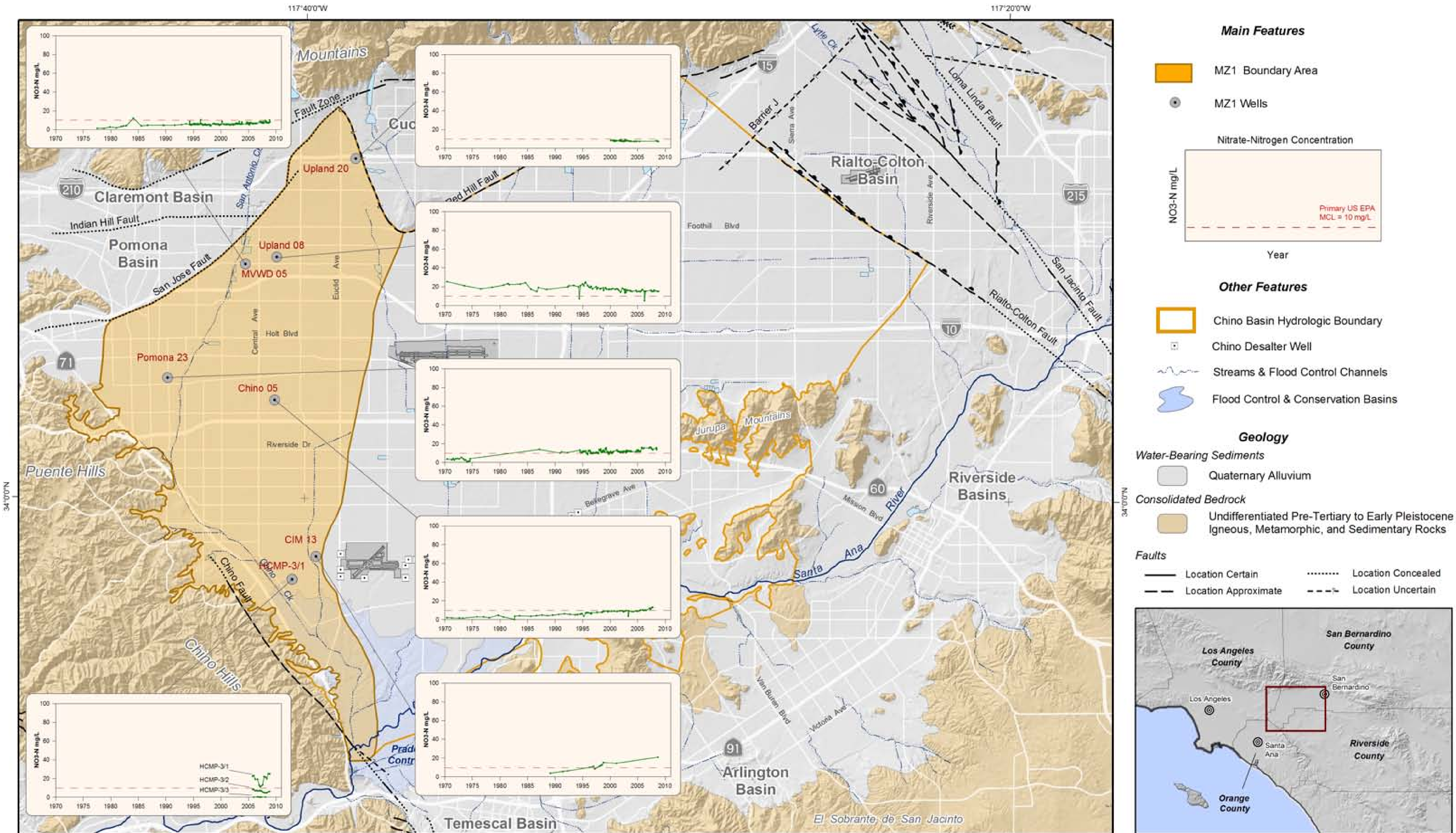
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 1
Historical and Current Total Dissolved Solids Concentration

Figure 4-21



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File: Figure_4-22.mxd

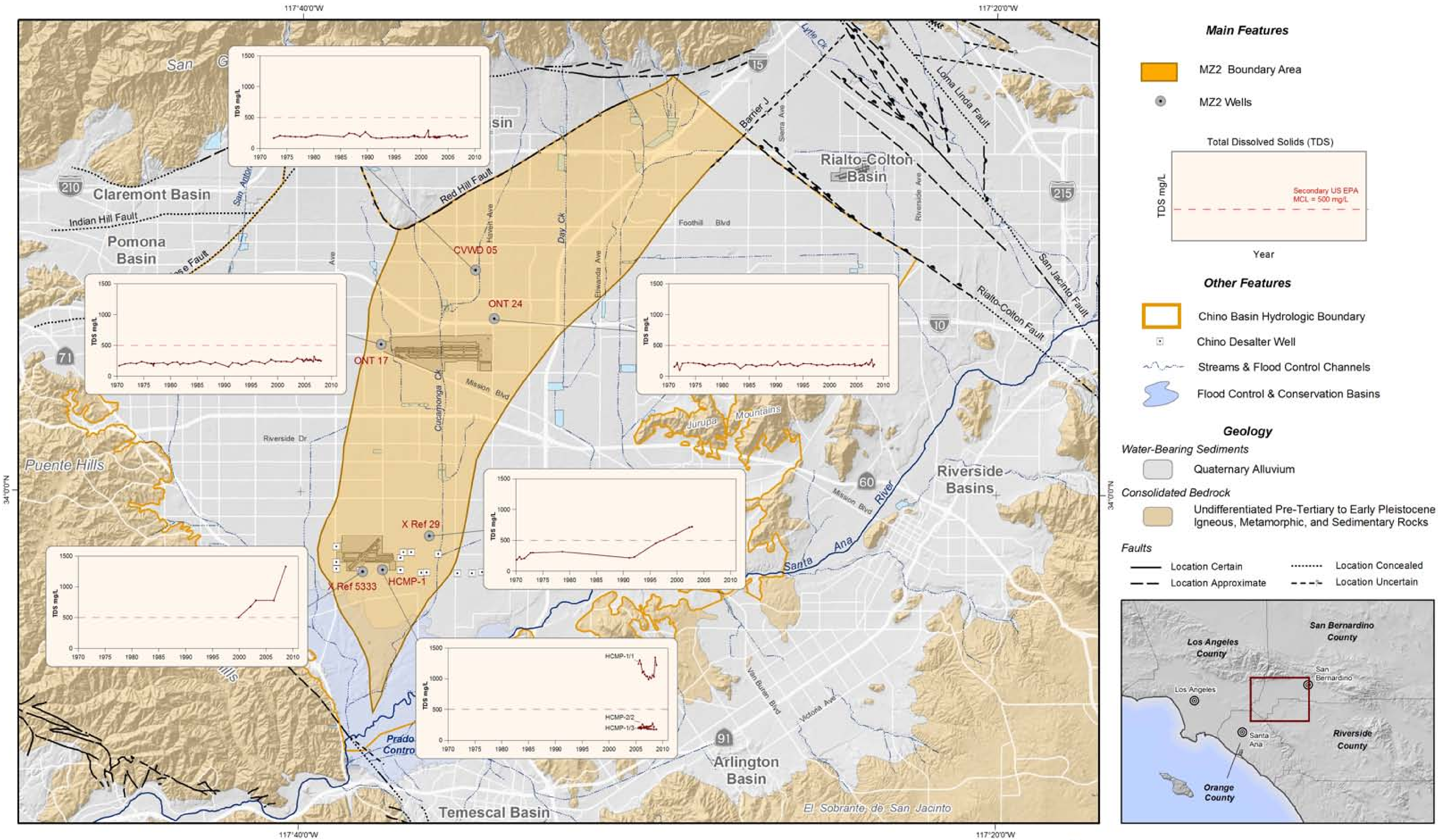
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 1

Historical and Current Nitrate-Nitrogen Concentrations

Figure 4-22



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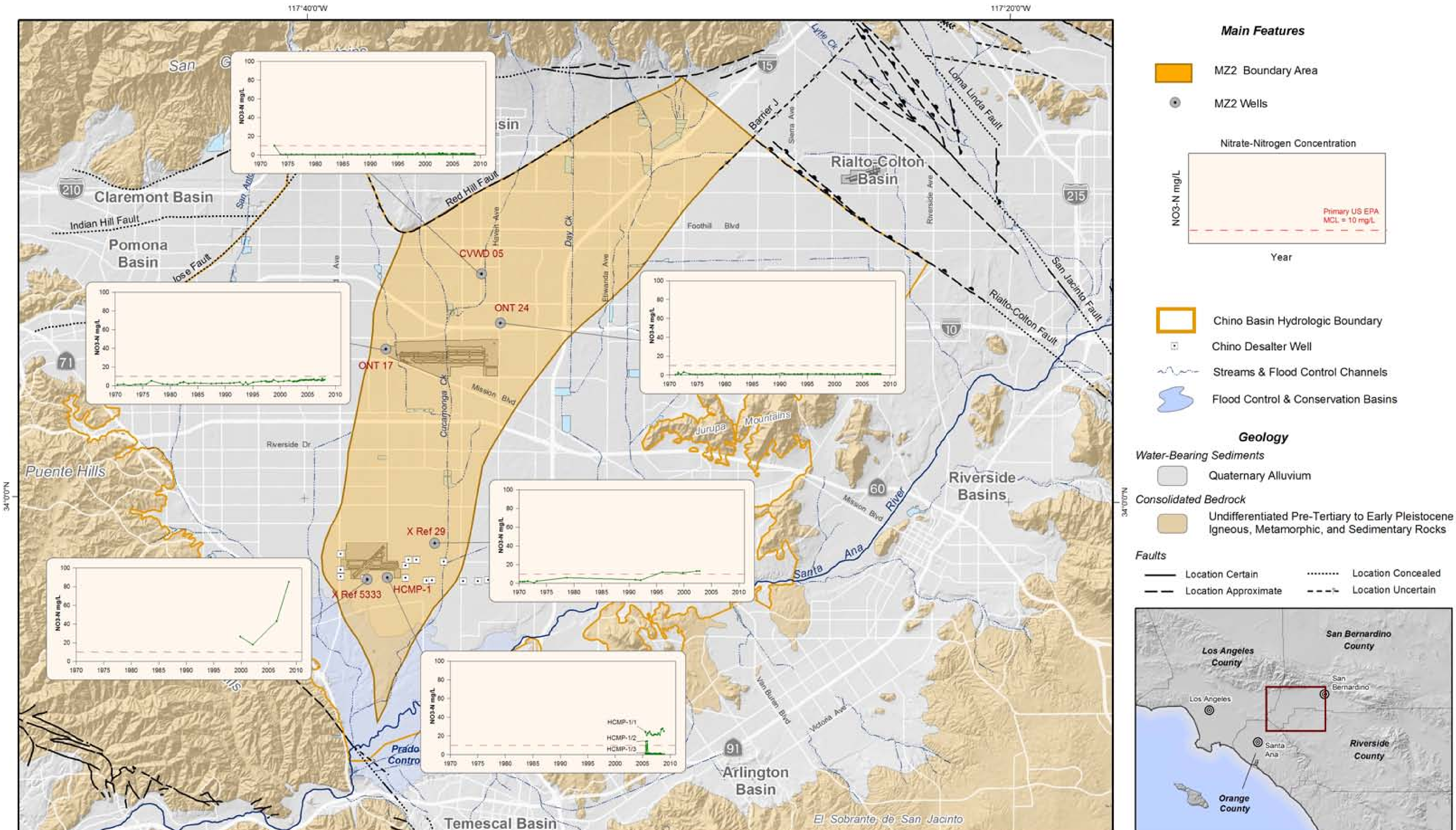
File: Figure_4-23.mxd

2008 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 2

Historical and Current Total Dissolved Solids Concentration

Figure 4-23



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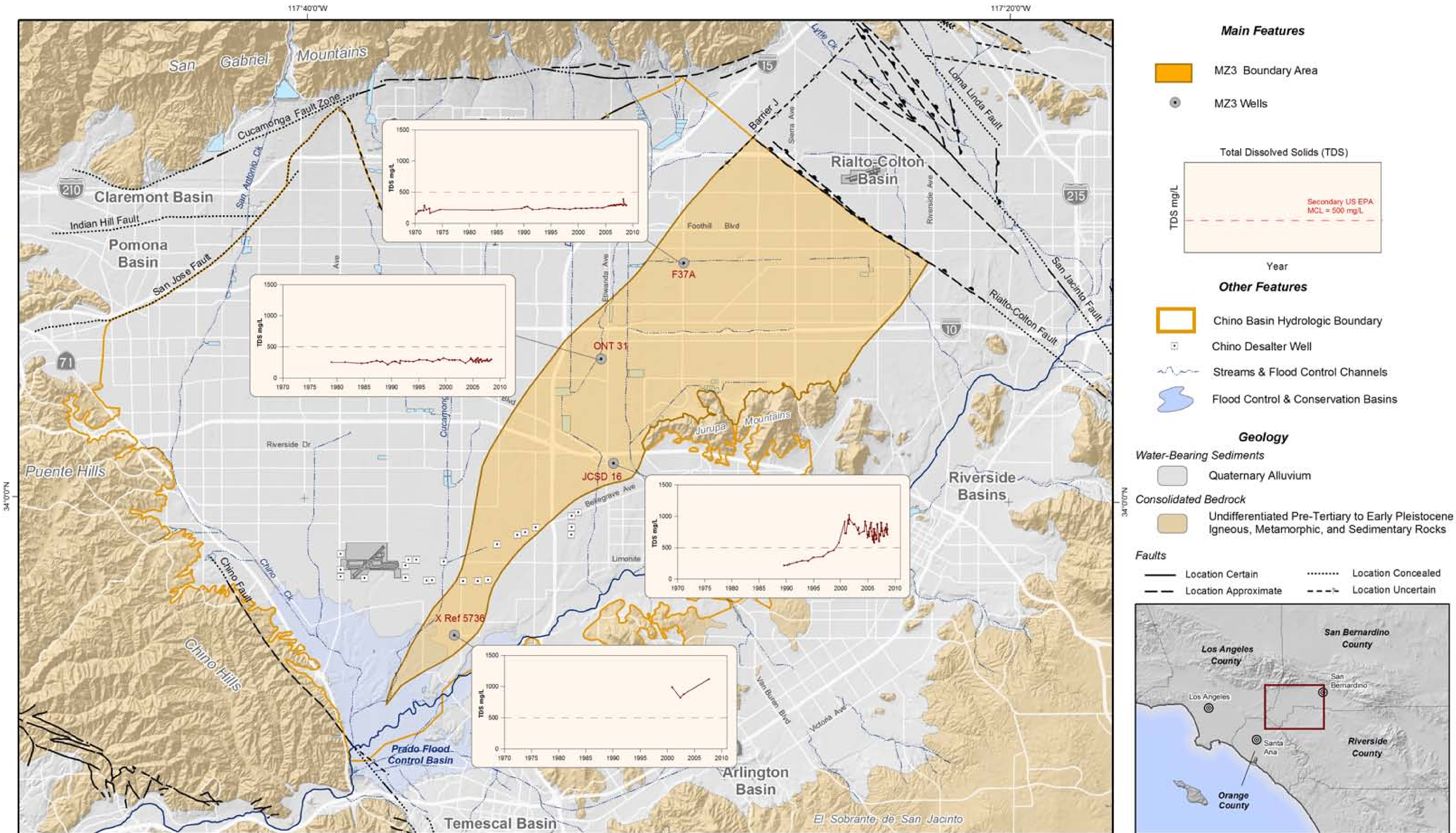
File: Figure_4-24.mxd

2008 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 2

Historical and Current Nitrate-Nitrogen Concentration

Figure 4-24



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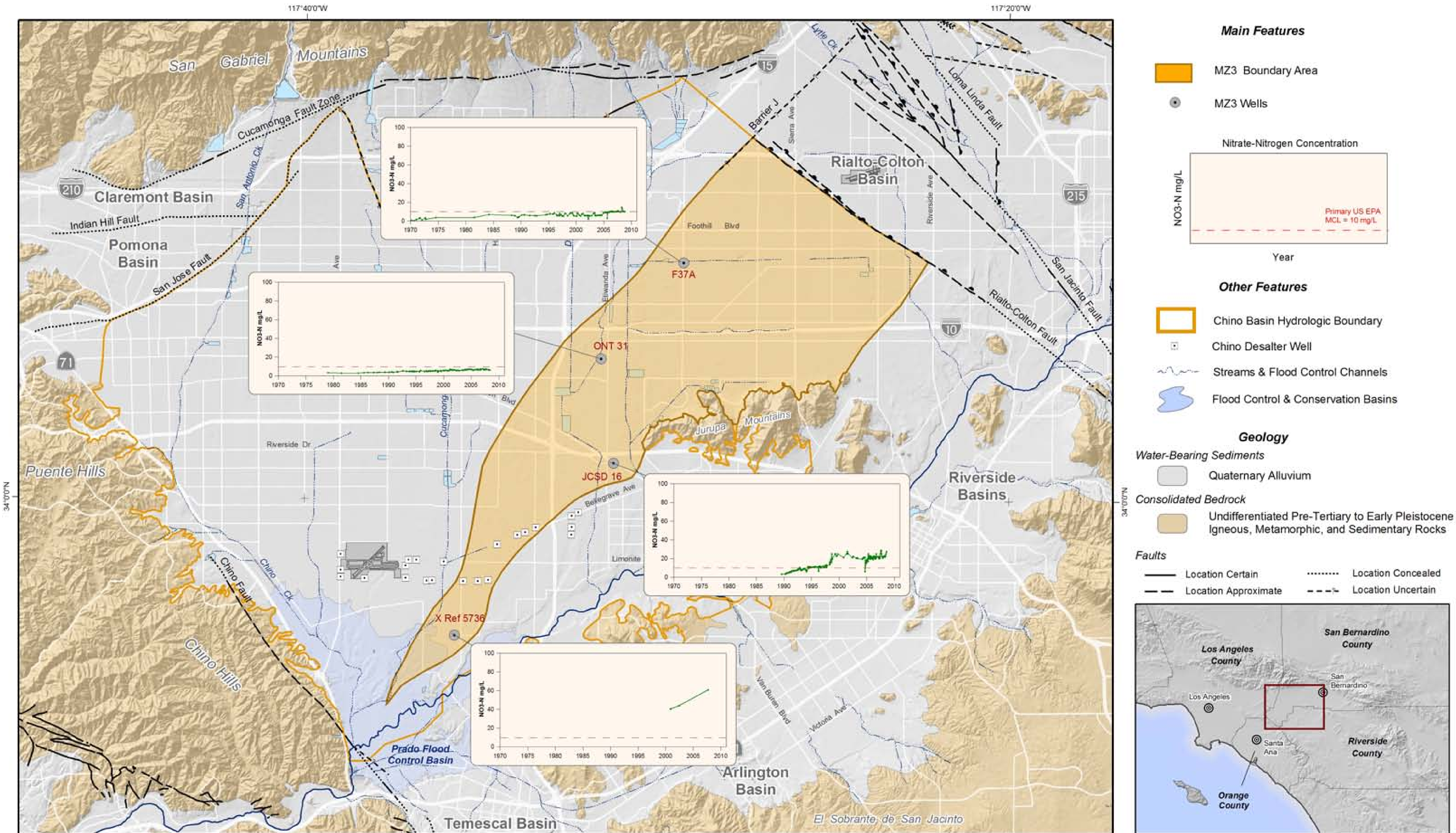
File: Figure_4-25.mxd

2008 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 3

Historical and Current Total Dissolved Solids Concentration

Figure 4-25



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Author: VME
Date: 20090515
File: Figure_4-26.mxd

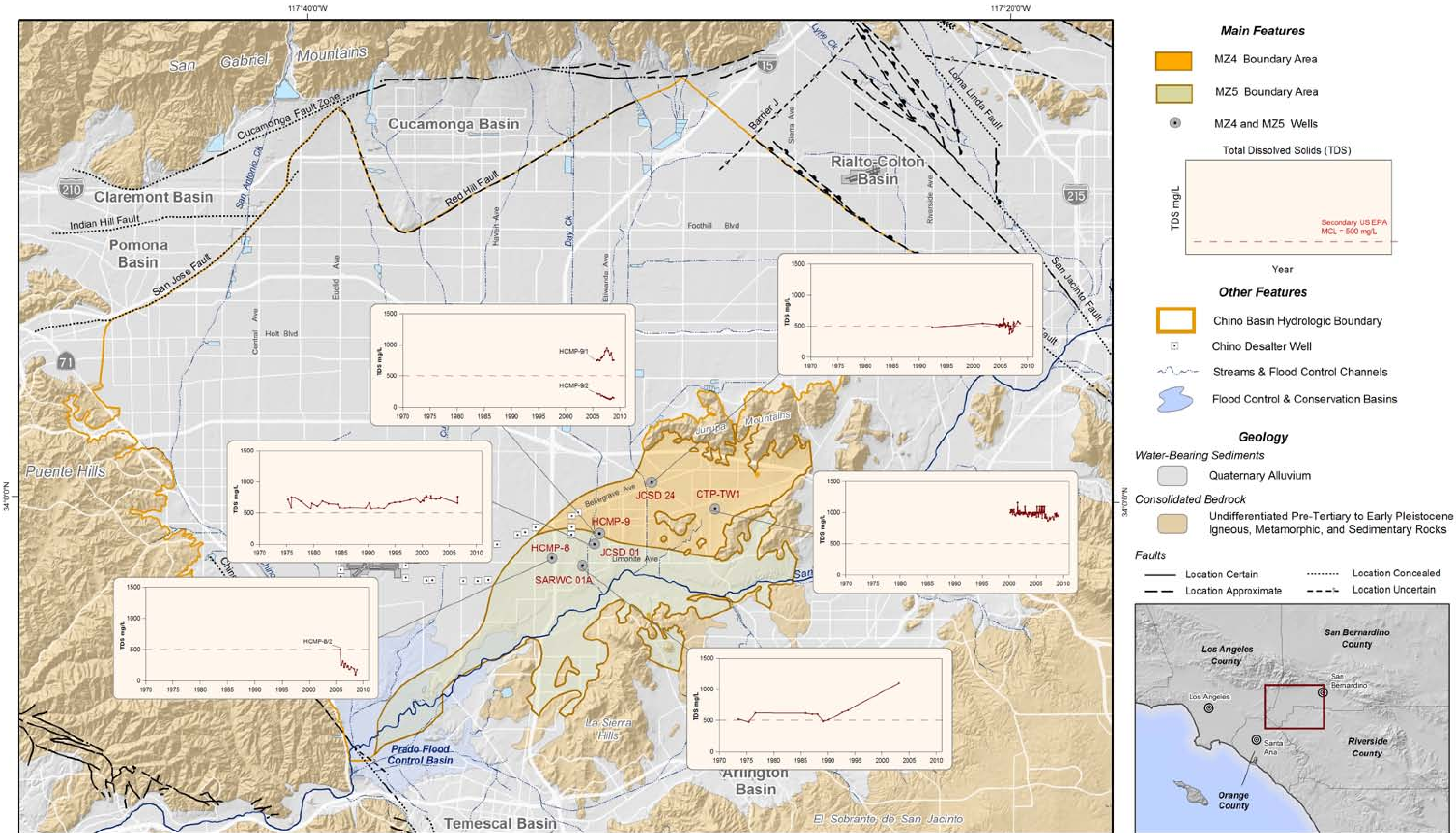
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 3

Historical and Current Nitrate-Nitrogen Concentration

Figure 4-26



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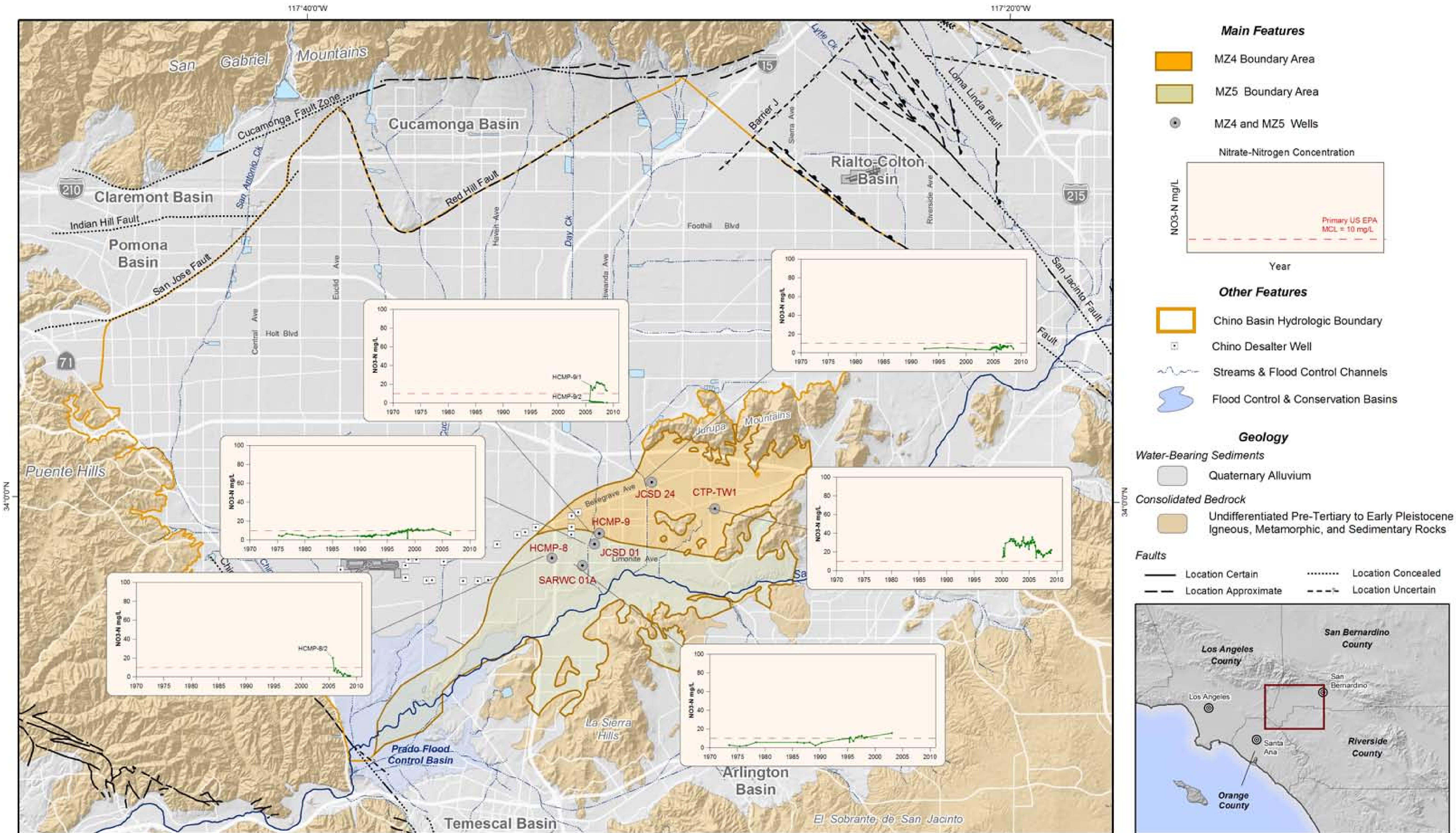
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 4 and Zone 5

Historical and Current Total Dissolved Solids Concentration

Figure 4-27



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0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 4 and Zone 5

Historical and Current Nitrate-Nitrogen Concentration

Figure 4-28

5.1 Background

One of the earliest indications of land subsidence in Chino Basin was the appearance of ground fissures in the City of Chino. These fissures appeared as early as 1973, but an accelerated occurrence of ground fissuring ensued after 1991 and resulted in damage to existing infrastructure (see Figure 5-1). The scientific studies that followed attributed the fissuring phenomenon to differential land subsidence caused by pumping of the underlying aquifer system and the consequent drainage and compaction of aquitard sediments.

5.1.1 OBMP Program Element 4

In 1999, the OBMP Phase I Report (WEI, 1999) identified pumping-induced drawdown and subsequent aquifer-system compaction as the most likely cause of land subsidence and ground fissuring observed in MZ1. Program Element 4 of the OBMP, *Develop and Implement a Comprehensive Groundwater Management Plan for Management Zone 1*, called for the development and implementation of an interim management plan for MZ1 that would:

- Minimize subsidence and fissuring in the short-term.
- Collect the information necessary to understand the extent, rate, and mechanisms of subsidence and fissuring.
- Formulate a management plan to abate future subsidence and fissuring or reduce it to tolerable levels.

In 2000, the Implementation Plan in the Peace Agreement called for an aquifer-system and land subsidence investigation in the southwestern region of MZ1 to support the development of a management plan for MZ1 (second and third bullets above). This investigation was titled the MZ1 Interim Monitoring Program (IMP). From 2001-2005, Watermaster developed, coordinated, and conducted the IMP under the guidance of the MZ1 Technical Committee, which is composed of representatives from all major MZ1 producers and their technical consultants. Specifically, the producers represented on the MZ1 Technical Committee include: the Agricultural Pool, the Cities of Chino, Chino Hills, Ontario, Pomona, and Upland; the Monte Vista Water District; the Southern California Water Company; and the State of California (CIM).

The main conclusions derived from the IMP were:

1. Groundwater production from the deep confined aquifer system in this area causes the greatest stress to the aquifer system. In other words, pumping of the deep aquifer system causes water level drawdowns that are much greater in magnitude and lateral extent than drawdowns caused by pumping of the shallow aquifer system.
2. Water level drawdowns due to pumping of the deep aquifer system can cause inelastic (permanent) compaction of the aquifer-system sediments, which results in permanent land subsidence. The initiation of inelastic compaction within the aquifer system was identified during this investigation when water levels fell below

a depth of about 250 feet in the PA-7 piezometer at Ayala Park.

3. The current state of aquifer-system deformation in south MZ1 (in the vicinity of Ayala Park) is essentially elastic. Very little inelastic (permanent) compaction is now occurring in this area, which is in contrast to the recent past when about 2.2 feet of land subsidence, accompanied by ground fissuring, occurred from about 1987 to 1995.
4. During this study, a previously undetected barrier to groundwater flow was identified. This barrier is located within the deep aquifer system and is aligned with the historical zone of ground fissuring. Pumping from the deep aquifer system is limited to the area west of the barrier, and the resulting drawdowns do not propagate eastward across the barrier. Thus, compaction occurs within the deep system on the west side of the barrier but not on the east side, which causes concentrated differential subsidence across the barrier and creates the potential for ground fissuring.
5. InSAR and ground level survey data indicate that permanent subsidence in the central region of MZ1 (north of Ayala Park) has occurred in the past and continues to occur today. The InSAR data also suggest that the groundwater barrier extends northward into central MZ1. These observations suggest that the conditions that very likely caused ground fissuring near Ayala Park in the 1990s are also present in central MZ1 and should be studied in more detail.

The investigation methods, results, and conclusions (listed above) are described in detail in the MZ1 Summary Report (WEI, 2006b). The investigation provided enough information for Watermaster to develop Guidance Criteria for the MZ1 producers in the investigation area that, if followed, would minimize the potential for subsidence and fissuring during the completion of the MZ1 Subsidence Management Plan (MZ1 Plan). The Guidance Criteria formed the basis for the MZ1 Plan, which was developed by the MZ1 Technical Committee and approved by Watermaster in October 2007. In November 2007, the California Superior Court, which retains continuing jurisdiction over the Chino Basin Adjudication, approved the MZ1 Plan and ordered its implementation.

The MZ1 Plan includes a listing of Managed Wells subject to the plan, a map of the so-called Managed Area in southern MZ1, an initial threshold water level (Guidance Level) at an index well in the Managed Area (245 feet below the top of the PA-7 well casing at Ayala Park in Chino [ft-brp]), and a plan for ongoing monitoring and annual reporting.

5.1.2 OBMP Program Element 1

The OBMP Phase I Report also noted that land subsidence was occurring in other parts of the basin besides Chino. Program Element 1 (PE1) of the OBMP and the Implementation Plan, *Develop and Implement a Comprehensive Monitoring Program*, called for basin-wide analysis of land subsidence via ground-level surveys and InSAR and ongoing monitoring based on the analysis of the subsidence data. Through 2008, basin-wide monitoring has been based on the ground-level survey data and InSAR data collected as part of the IMP and the MZ1 Plan implementation.

5.2 Ground-Level Monitoring Program

Implementation of the MZ1 Plan began in 2008. The MZ1 Plan calls for (1) the continued scope and frequency of monitoring implemented during the IMP within the MZ1 Managed Area and (2) expanded monitoring of the aquifer system and land subsidence in other areas of the Chino Basin where the IMP indicated concern for future subsidence and ground fissuring. The expanded monitoring efforts outside of the MZ1 Managed Area are consistent with the requirements PE1.

Watermaster's current ground-level monitoring program includes:

- *Piezometric Levels*. Piezometric levels are an important part of the ground-level monitoring program because piezometric changes are the mechanism for aquifer-system deformation and land subsidence. Watermaster monitors piezometric levels at about 33 wells in MZ1. Currently, a pressure-transducer/data-logger is installed at each of these wells and records one water level reading every 15 minutes. And, Watermaster records depth-specific water levels at the piezometers located at the Ayala Park Extensometer facility every 15 minutes.
- *Aquifer-System Deformation*. Watermaster records aquifer-system deformation at the Ayala Park Extensometer facility (see Figure 5-1). At this facility, two extensometers, completed at 550 ft-bgs and 1,400 ft-bgs, record the vertical component of aquifer-system compression and/or expansion once every 15 minutes (synchronized with the piezometric measurements).
- *Vertical Ground-Surface Deformation*. Watermaster monitors vertical ground-surface deformation via the ground-level surveying and remote sensing (InSAR) techniques established during the IMP. Currently, ground-level surveys are being conducted in the MZ1 Managed Area once per year. InSAR is the only monitoring technique being employed outside the MZ1 Managed Area, and InSAR data is analyzed once per year.
- *Horizontal Ground-Surface Deformation*. Watermaster monitors horizontal ground-surface displacement across the eastern side of the subsidence trough and the adjacent area east of the barrier/fissure zone. These data, obtained by electronic distance measurements (EDMs), are used to characterize the horizontal component of land surface displacement caused by groundwater production on either side of the fissure zone. Currently, Watermaster is collecting EDMs at a semiannual frequency (Spring/Fall) between east/west aligned benchmarks on Eucalyptus, Edison, Schaefer, and Philadelphia Avenues.

5.3 Results of Ground-Level Monitoring Program

At the conclusion of each fiscal year, the MZ1 Plan requires that Watermaster produce an MZ1 Annual Report that includes the results of the past year's monitoring. The 2008 MZ1 Annual Report (currently in preparation) will be the first such report published by Watermaster and will focus primarily on the intensive monitoring being conducted in the MZ1 Managed Area.

The ground-level monitoring results described below will focus primarily on the ground-level survey and InSAR monitoring being conducted across the entire Chino Basin (PE1).

5.3.1 InSAR

Figure 5-2 is a map of the Chino Basin that shows InSAR results for 2005-2008. The InSAR data are generally coherent and useful in the northern urbanized areas of the basin but are generally incoherent and not as useful in the southern agricultural areas (light brown areas in Figure 5-2). This pattern of "coherence" relative to land use is typical of InSAR data.

Figure 5-2 shows that ground motion during 2005-2008 was relatively minor (less than about -0.02 ft of subsidence) in the northeastern parts of the basin, such as Fontana and Rancho Cucamonga. However, in northwestern parts of the basin, land subsidence of over -0.14 ft and -0.12 ft have been measured by InSAR in Pomona and Ontario, respectively.

Figure 5-2 also shows that ground motion is influenced by geologic faults that cut through the aquifer system and act as barriers to groundwater flow. For instance, the land surface elevation has increased (uplift) in the southern portion of the Cucamonga Basin—just north of the Red Hill Fault. The San Jose Fault is clearly influencing the pattern of ground motion in the Claremont, Pomona, and Chino Basins. Of most concern, with respect to the potential for ground fissuring, is the differential ground motion across the San Jose Fault between the Pomona and Chino Basins.

Historically, the City of Chino has experienced the most land subsidence (e.g. over -2.0 ft of subsidence within the MZ1 Managed Area during 1987-1999), but for 2005-2008, the InSAR data indicate that land subsidence was relatively minor in this area (less than about -0.04 ft).

5.3.2 Ground-Level Surveys

Figure 5-3 is a map of the western half of Chino Basin that shows both the InSAR and ground-level survey results for 2005-2008. The ground-level survey data generally corroborate the patterns and magnitude of ground motion shown in the InSAR data with a few exceptions:

- The ground-level survey data indicate a greater magnitude of land subsidence in the MZ1 Managed Area (maximum subsidence = -0.10 ft) than the InSAR data (maximum subsidence = -0.05 ft).
- In some areas, the ground-level survey data indicate minor subsidence while the InSAR data indicate minor uplift. In these instances, the difference between the ground-level survey and InSAR data is generally less than about 0.05 ft.

One advantage of the ground-level survey data is that it can provide information on ground motion in areas where InSAR data is absent. See, for example, the area shown on Figure 5-3 near at the intersection of Euclid Avenue and Kimball Avenue where the Chino I Desalter wells pump groundwater from the deep aquifer system. The survey data indicated maximum land subsidence of -0.24 ft in this area during 2005-2008.

5.4 Analysis of Ground Surface Displacement

Historical ground motion data (shown in Figure 5-1) and recent ground motion data (shown in Figures 5-2 and 5-3) indicate that land subsidence concerns in the Chino Basin are confined to certain portions of MZ1 and MZ2. These "areas of subsidence concern" are delineated and labeled in Figures 5-2 and 5-3. Besides the MZ1 Managed Area, Watermaster has designated four additional areas of subsidence concern: the Central MZ1 Area, the Pomona Area, the Ontario Area, and the Southeast Area.

The recent land subsidence that has been occurring in each of these areas is mainly controlled by recent and/or historical changes in groundwater levels, which, in turn, are mainly controlled by pumping and recharge.

Below, the relationships between groundwater pumping, aquifer recharge, groundwater levels, and ground motion, which help to reveal cause and effect; the current state of ground motion; and the nature of current land subsidence (i.e. elastic and/or inelastic, differential, etc.), are discussed by area of concern.

5.4.1 MZ1 Managed Area

Within the MZ1 Managed Area, pumping of the deep confined aquifer system causes water level drawdowns that are much greater in magnitude and lateral extent than drawdowns caused by pumping of the shallow aquifer system. Artificial recharge in the northern portions of MZ1 appears to have no immediate impact on groundwater levels in the deep aquifer system in the MZ1 Managed Area. These conclusions were established during the IMP (WEI, 2006b) and are shown graphically in Figure 5-4.

Figures 5-4 and 5-5 also show vertical ground motion at the Deep Extensometer at Ayala Park and at a benchmark monument (137/53) at the corner of Schaefer Avenue and Central Avenue. About -2.5 ft of subsidence occurred in portions of the MZ1 Managed Area from 1987-2000, but very little inelastic subsidence has occurred since 2000, and no additional ground fissuring has been observed.

Another conclusion of the IMP was that groundwater-level drawdowns due to pumping of the deep aquifer system can cause inelastic (permanent) compaction of the aquifer-system sediments, which results in permanent land subsidence. The initiation of inelastic compaction within the aquifer system was identified during the IMP when water levels fell below a depth of about 250 feet in the PA-7 piezometer at Ayala Park. From 2005 to 2008, water levels at PA-7 did not decline below 250 ft-brp , and very little, if any, inelastic compaction was recorded in the MZ1 Managed Area. Data from the MZ1 Managed Area are further analyzed in the 2008 MZ1 Annual Report (in preparation).

The IMP also identified a previously undetected barrier to groundwater flow on the east side of the MZ1 Managed Area. This barrier is located within the deep aquifer system and is aligned with the historical zone of ground fissuring (see Figure 5-3). Pumping from the deep aquifer system has been limited to the area west of the barrier, and the resulting drawdowns have not propagated eastward across the barrier. Thus, historical compaction occurred within the deep system on the west side of the barrier but not on the east side. Concentrated differential subsidence across the barrier is the most likely cause of the ground fissuring observed in the early 1990s. The rate of land subsidence decreased to almost zero in the MZ1 Managed Area in the mid-1990s, and no additional ground fissuring has been observed.

5.4.2 Central MZ1 Area

The Central MZ1 Area is located directly north of the MZ1 Managed Area (see Figure 5-3). Figures 5-6 and 5-7 display time histories of groundwater pumping, aquifer recharge, groundwater levels, and ground motion in the Central MZ1 Area.

The ground motion time histories for Central MZ1 is similar to that of the MZ1 Managed Area—as much as -2.2 ft of inelastic subsidence occurred at the corner of Philadelphia and Monte Vista Avenue from 1987-2000, but very little inelastic subsidence has occurred since 2000. This similarity suggests a relationship to the causes of land subsidence in the MZ1 Managed Area; however, there is very little historical groundwater level data in this area to confirm this relationship.

Most of the wells with historical groundwater level records are in the northern part of Central MZ1 (see Figure 5-3) where historical subsidence was not as pronounced. From about 1935 to 1978, groundwater levels in these wells declined by about 150 ft. Groundwater levels increase by about 50 ft during the 1980s and remained relatively stable until 2005. Since 2005, groundwater levels have increased by about 25 ft, which is likely due to decreased pumping and increased recharge in MZ1.

5.4.3 Pomona Area

The Pomona Area is located directly north of the Central MZ1 Area (see Figure 5-3). Figures 5-8 and 5-9 display time histories of groundwater pumping, aquifer recharge, groundwater levels, and ground motion in the Pomona Area.

The ground motion time histories of the Pomona Area is based solely on InSAR data from 1992 to 1995, 1995 to 2000, and 2005 to 2008. These data indicate that land subsidence has occurred continuously in this area, generally at a rate of about 0.07 ft/yr. The rate of subsidence appears to be decreasing gradually with time.

From about 1935 to 1978, groundwater levels in the Pomona Area declined by about 175 ft or more. Groundwater levels increased by about 50 to 100 ft during the 1980s. From about 1990 to 2004, groundwater levels declined again by about 25 to 50 ft. And from 2004 to 2008, groundwater levels increased by about 25 to 50 ft. The groundwater level changes from 1990 to 2008 appear to be closely related to pumping and recharge in MZ1.

The observed, continuous land subsidence cannot be explained entirely by the corresponding changes in groundwater levels during this time (1992-2008). A plausible explanation for the subsidence is that thick, slowly-draining aquitards are compacting in response to the historical drawdowns that occurred from 1935 to 1978 (see Figure 5-9).

Lastly, the InSAR data in Figure 5-3 shows a steep gradient of subsidence across the San Jose Fault, indicating the potential for the accumulation of horizontal strain in the shallow sediments and the possibility of ground fissuring. Ground fissuring is the main subsidence-related threat to infrastructure.

5.4.4 Ontario Area

The Ontario Area is located east of the Central MZ1 and the Pomona Areas (see Figure 5-3). Figures 5-10 and 5-11 display time histories of groundwater pumping, aquifer recharge, groundwater levels, and ground motion in the Ontario Area.

The ground motion time histories of the Ontario Area is based solely on InSAR data from 1992 to 1995, 1995 to 2000, and 2005 to 2008. These data indicate that land subsidence has occurred continuously in this area, generally at a rate of about 0.06 ft/yr. The rate of subsidence appears to be decreasing gradually with time.

From about 1935 to 1978, groundwater levels in the Ontario Area declined by about 125 ft. Groundwater levels increased by about 10 to 20 ft during the early 1980s and have remained relatively stable since then.

The observed continuous land subsidence from 1992 to 2008 is not explained by the relatively stable groundwater levels. A plausible explanation for the subsidence is that thick, slowly-draining aquitards are compacting in response to the historical drawdowns that occurred from 1935 to 1978 (see Figure 5-11).

5.4.5 Southeast Area

The Southeast Area is located east of the MZ1 Managed Area (see Figure 5-3). Figures 5-12 and 5-13 display time histories of groundwater pumping, aquifer recharge, groundwater levels, and ground motion in the Southeast Area.

The ground motion time histories of the Southeast Area is based solely on ground-level surveys performed from 1987to 2008. These data indicate that land subsidence has occurred continuously and slowly in this area, generally at a rate of about 0.02 ft/yr. However, the data also indicate that from 2005 to 2008 about -0.24 ft of subsidence occurred near the western portion of the Chino I Desalter well field where these wells are pumping from and causing drawdown within the deep confined aquifer system.

There is very little historical groundwater level data for this area prior to about 1990. The data since 1990 indicate relatively stable groundwater levels.

The observed slow but continuous land subsidence from 1987 to 2008 is not explained by the relatively stable groundwater levels. A plausible explanation for the subsidence is that thick, slowly-draining aquitards are compacting in response to the historical drawdowns that likely occurred prior to 1990.

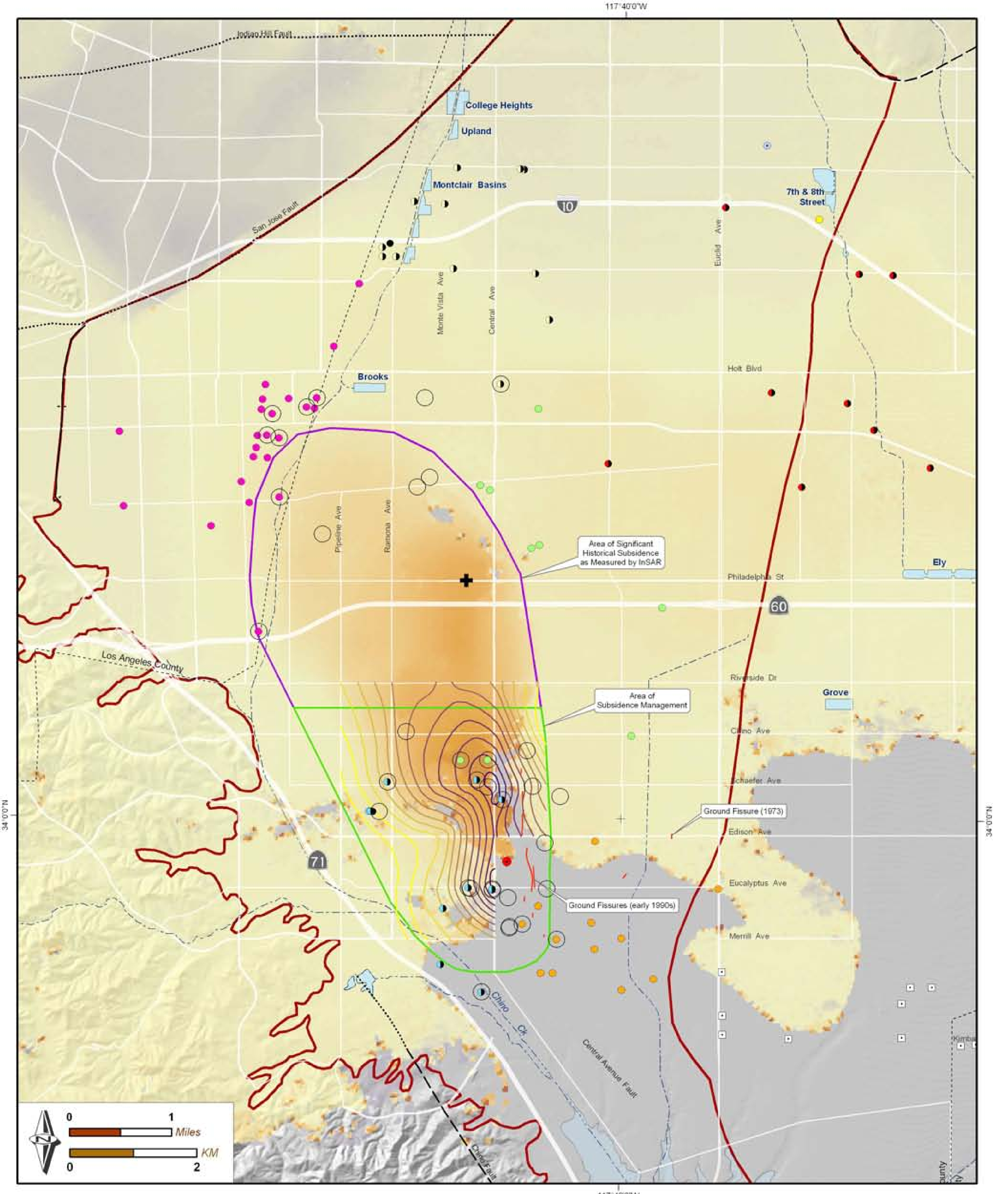
Lastly, the first ground fissures ever documented in the Chino Basin occurred in the Southeast Area in the early 1970s, but ground fissuring has not been observed in the Southeast Area since then.

5.5 Conclusions and Recommendations

The conclusions and recommendations for Watermaster's basin-wide ground-level monitoring program are provided below.

- Land subsidence does not appear to be a concern in the eastern and northernmost portions of Chino Basin. In these areas, the underlying aquifer system is composed primarily of coarse-grained sediments that are not prone to compaction.
- Land subsidence and the potential for ground fissuring are major concerns in the western and southern portions of the Chino Basin. In these areas, the underlying aquifer system consists of interbedded, fine-grained sediment layers (aquitards) that can drain and compact when groundwater levels decline in the adjacent coarse-grained aquifers. Ground fissuring has occurred in the past where land subsidence was differential (i.e. steep gradient of subsidence). Ground fissuring is the main subsidence-related threat to infrastructure.
- Land subsidence has been persistent across most of the western and southern portions of the Chino Basin since, at least, 1987 when land subsidence monitoring began. In many of these areas, land subsidence continues even during periods of groundwater level recovery, indicating that thick, slowly-draining aquitards are compacting in response to the large historical drawdowns of 1935 to 1978.
- Pumping-induced drawdown has caused accelerated occurrences of land subsidence in the recent past, including subsidence in the City of Chino during the early 1990s and, currently, in the vicinity of the Chino I Desalter well field. Watermaster should anticipate similar occurrences of land subsidence in areas (1) that are prone to subsidence and (2) where drawdown will occur in the future.
- Watermaster will continue its basin-wide ground-level monitoring program, using InSAR and ground-level surveys. Watermaster will consider expanding the ground-level surveys to cover the area of the proposed Chino Creek Desalter Well Field. This is an area that is prone to subsidence, where drawdown may occur near where ground fissuring has occurred in the past, and where InSAR data is not currently available. Watermaster will also consider expanding the ground-level surveys to cover the Pomona and Ontario Areas. In general, InSAR data coverage is continuous and of high quality throughout both areas, so ground-level surveys would primarily provide supporting and confirmation data for the InSAR and would occur at a frequency of once every three to five years.
- Watermaster will consider installing low-cost piezometer/extensometer facilities at appropriate locations in all Areas of Subsidence Concern. This type of facility has been successfully constructed and tested at Ayala Park in Chino. Such facilities record the requisite data (1) to monitor land subsidence and groundwater levels at high resolution and accuracy, (2) to provide the information necessary to characterize the elastic and/or inelastic nature of any land subsidence occurring in an area, (3) to provide the information necessary to develop criteria to manage subsidence, and (4) to provide the information necessary to characterize aquifer and aquitard properties that could be used in a predictive computer-simulation model of subsidence.

- Watermaster will consider building and calibrating predictive computer-simulation models of subsidence across all Areas of Subsidence Concern in the Chino Basin. These models would provide information on the rates and ultimate magnitude of land subsidence that could be associated with various basin management planning scenarios (i.e. pumping and recharge patterns). This information would be valuable to affected Watermaster parties.
- Because ground fissuring caused by differential land subsidence is the main threat to infrastructure, Watermaster will periodically inspect for signs of ground fissuring in areas that are experiencing differential land subsidence. In addition, Watermaster will consider monitoring the horizontal strain across these zones of potential ground fissuring in an effort to better understand and manage ground fissuring.



Subsidence Features

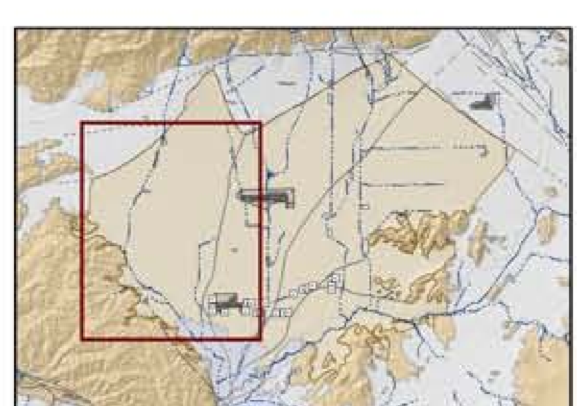
- 0.0 to -2.2: Contours of Relative Change in Land Surface Altitude as Measured by Leveling Surveys 1987 - 1999 (feet)
- + 1.0 / 0.0 / - 1.0: Relative Change in Land Surface Altitude as Measured by InSAR Oct 1993 - Dec 1995 (feet)
- No InSAR Data

Active Production Wells in MZ-1 by Owner

- Ontario
- Pomona
- SAWC
- Upland
- SCWC
- CIM
- Chino Hills
- Chino
- MVWD

Other Features

- Well Used in MZ-1 Monitoring Program
- Ayala Park Extensometer Facility
- Proposed Central MZ-1 Piezometer
- Chino Basin Desalter Well (Existing)
- Management Zone 1 Boundary



Historical Land Surface Deformation in Management Zone 1

Leveling Surveys (1987-99) and InSAR (1993-95)

Figure 5-1

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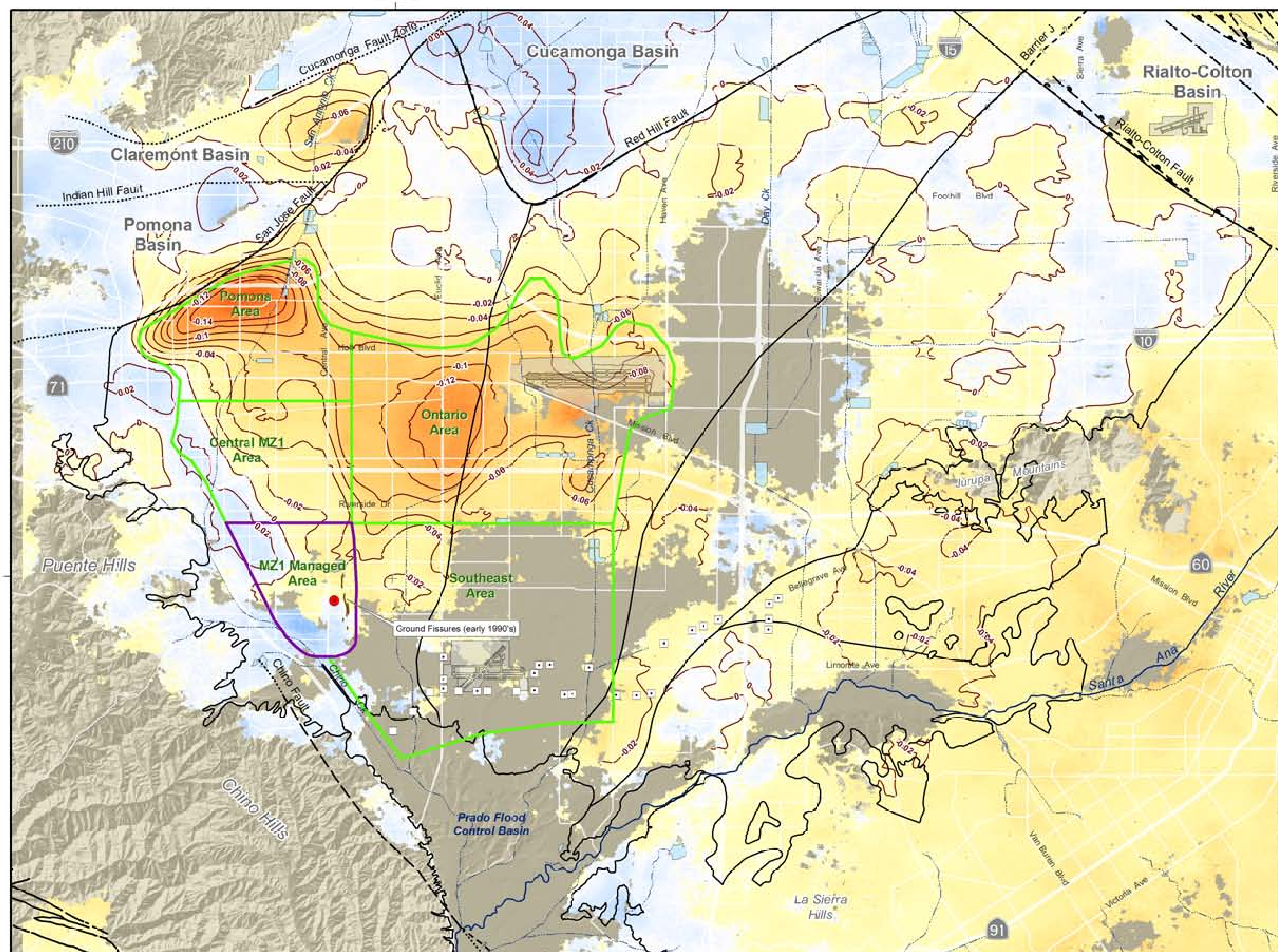

Relative Change in Land Surface Altitude as Measured by InSAR (feet)
June 2005 to October 2008

+ 0.2 ft
0
-0.1
- 0.2

Brown areas represent regions where InSAR data is absent (incoherent)

- Ayala Park Extensometer
- Ground Fissures (early 1990's)
- Proposed Chino Creek Desalter Well
- Existing Chino Desalter Well
- Chino Basin Management Zones
- Areas of Subsidence Concern
- MZ1 Managed Area
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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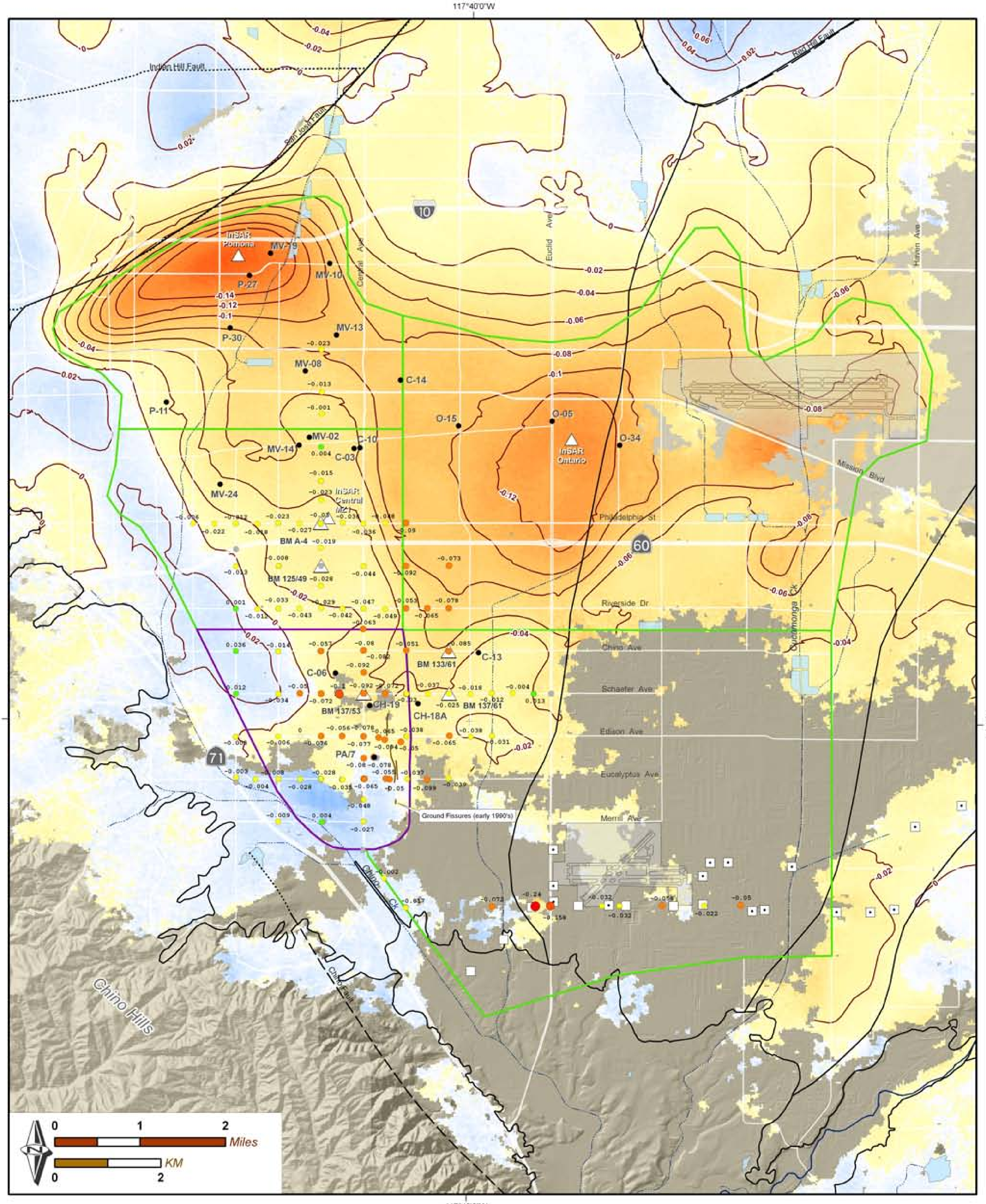
File: Figure_5-2.mxd

0 1 2 3 4 5 Miles
0 1 2 3 4 5 6 7 KM

2008 State of the Basin Report
Ground-Level Monitoring

Vertical Ground Motion (2005-2008)
as Measured by InSAR in the Chino Basin Area

Figure 5-2



Insufficient Data
> 0.20
0.10 - 0.20
0.05 - 0.10
0.01 - 0.05
0.00
-0.01 - -0.05
-0.05 - -0.10
-0.10 - -0.20
< -0.20

Relative Change in Land Surface Altitude as Measured by Leveling Surveys Oct 2005 - Oct 2008 *(feet)*

+0.2 ft
0
-0.1
-0.2

Relative Change in Land Surface Altitude as Measured by InSAR June 2005 - Oct 2008 *(feet)*

Brown areas represent regions where InSAR data is absent (incoherent)

Water Level Wells (in Figures 5-4 to 5-13)

Chino Basin Desalter Well (Existing)

Proposed Chino Creek Desalter Well

Survey and InSAR Measurement Points (in Figures 5-4 to 5-13)

Chino Basin Management Zones

Subsidence Areas of Interest

MZ1 Managed Area

Vertical Ground Motion (2005-2008)

Leveling Surveys and InSAR in Western Chino Basin

Figure 5-3

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2008 State of the Basin Report
Ground-Level Monitoring

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Figure 5-4
Groundwater Levels versus Ground Levels in the MZ1 Managed Area - 1993 to 2009

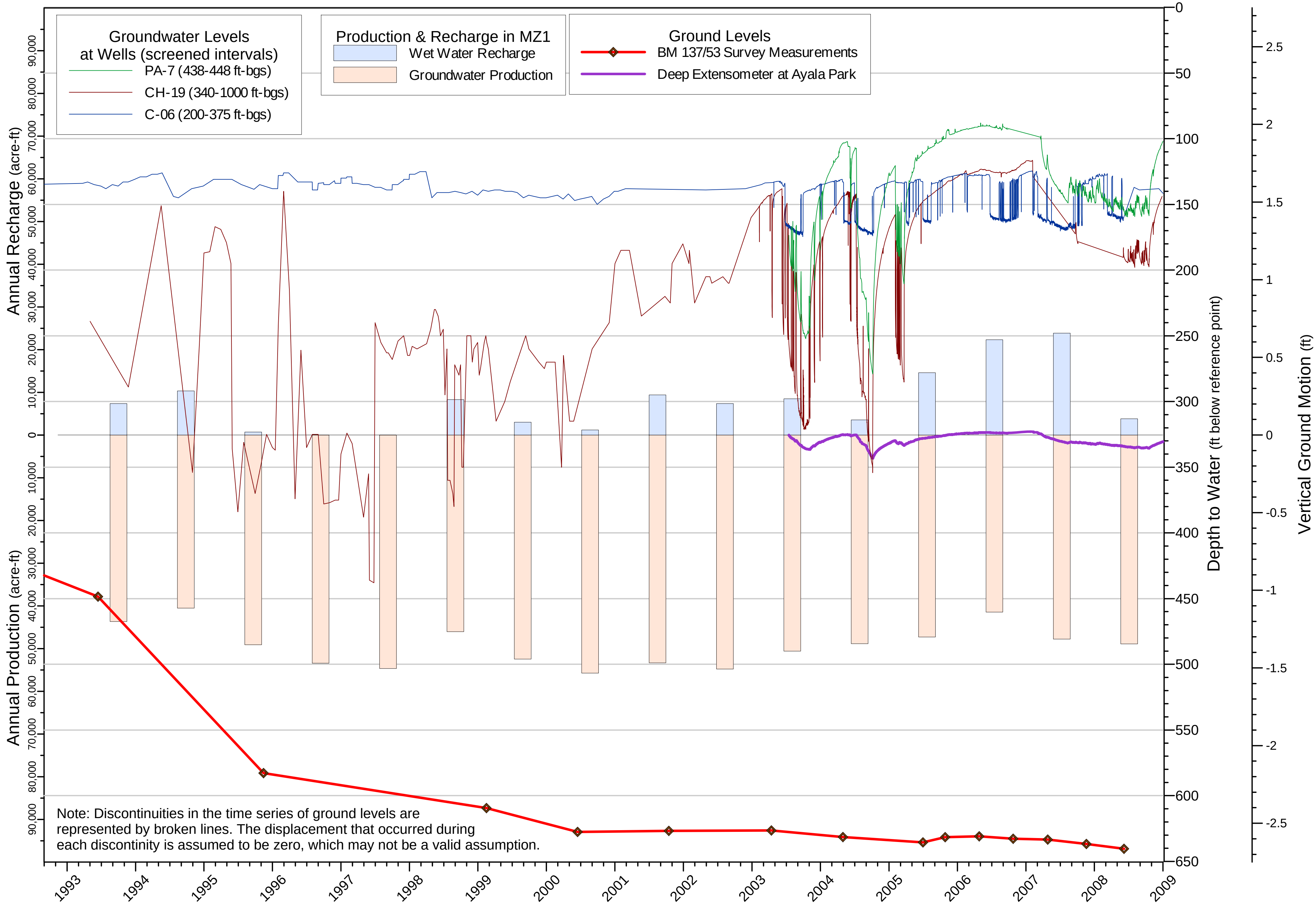


Figure 5-5
Groundwater Levels versus Ground Levels in the MZ1 Managed Area - 1935 to 2009

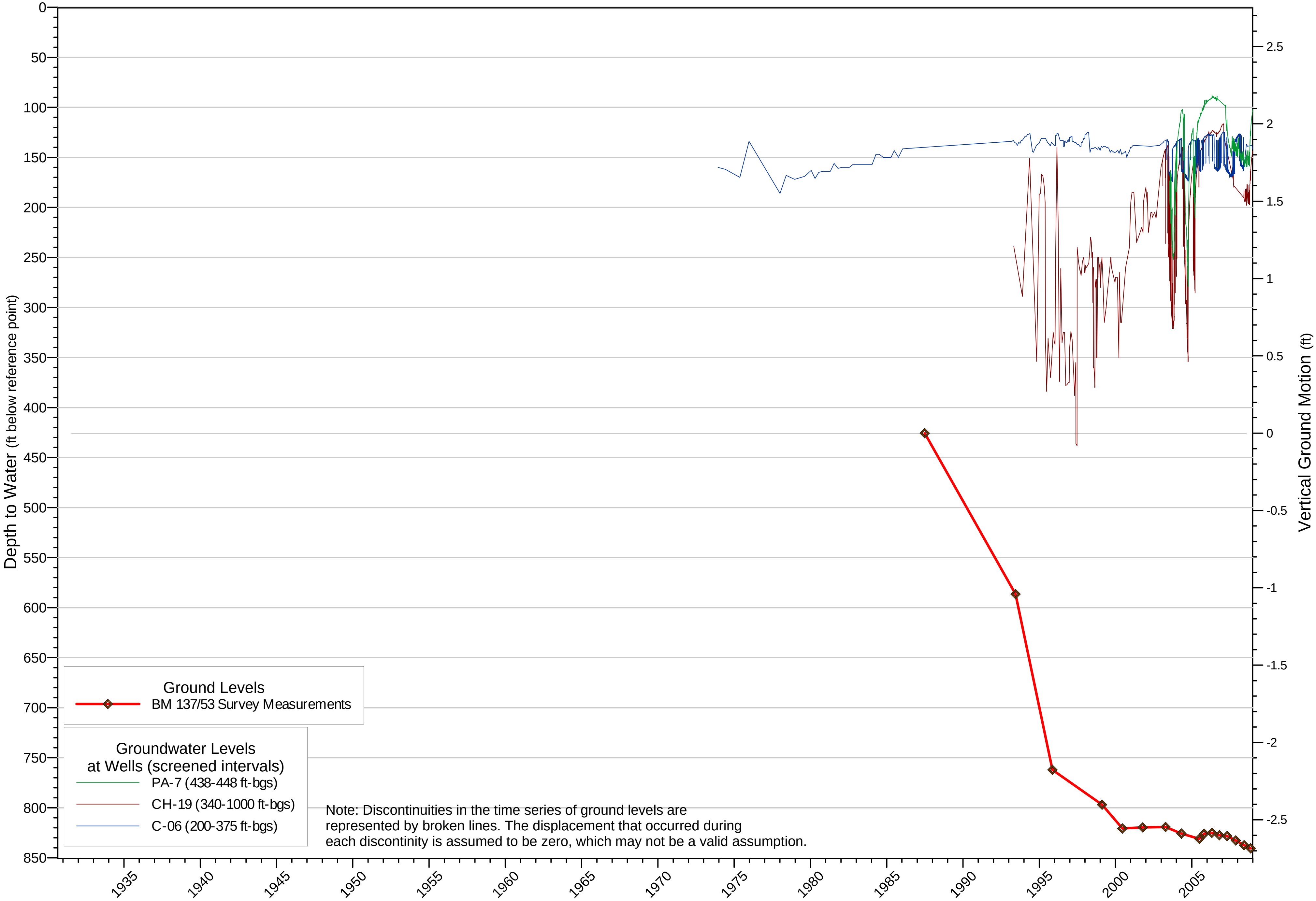


Figure 5-6
Groundwater Levels versus Ground Levels in the Central MZ1 Area - 1993 to 2009

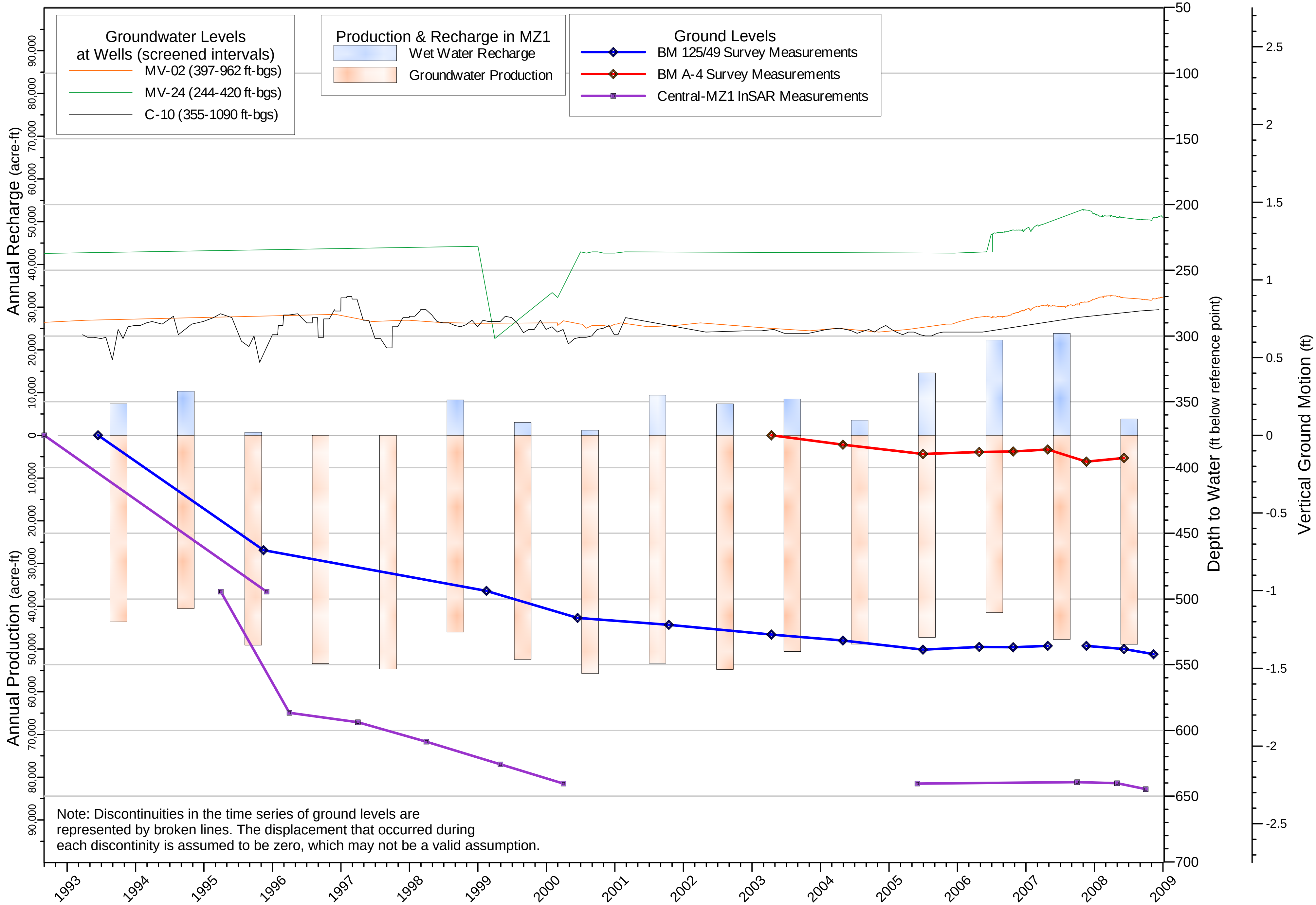


Figure 5-7
Groundwater Levels versus Ground Levels in the Central MZ1 Area - 1935 to 2009

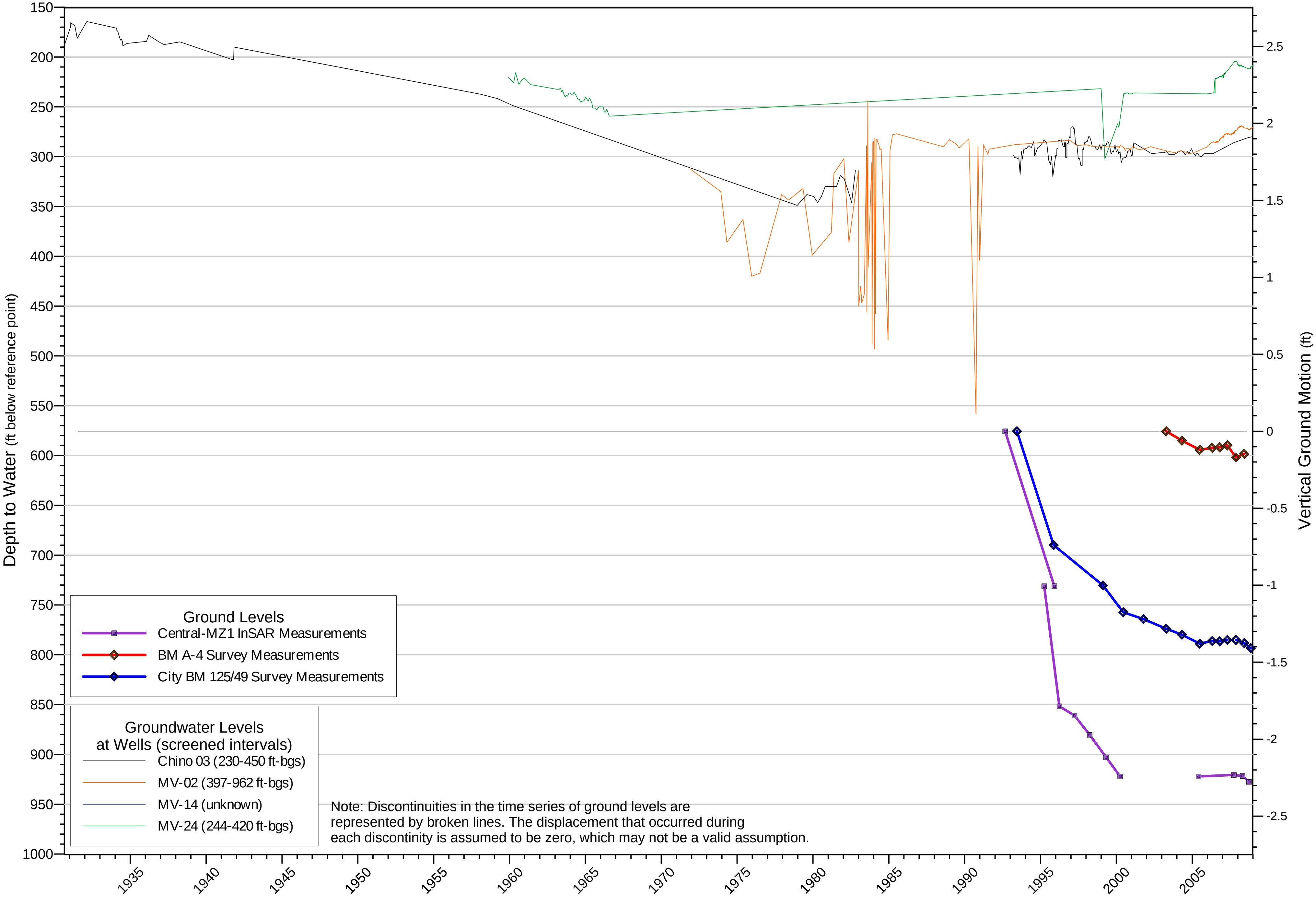


Figure 5-8
Groundwater Levels versus Ground Levels in the Pomona Area - 1993 to 2009

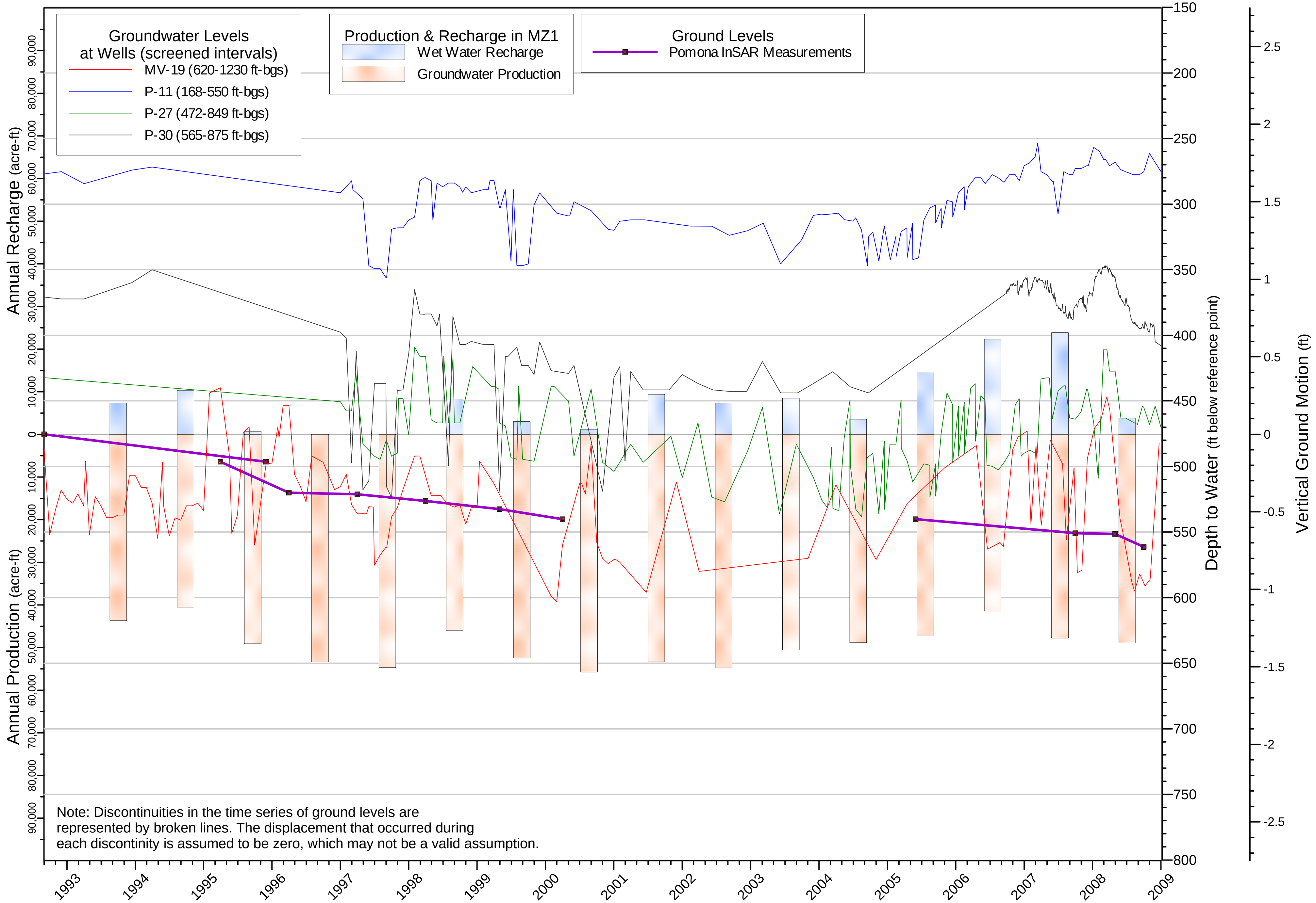
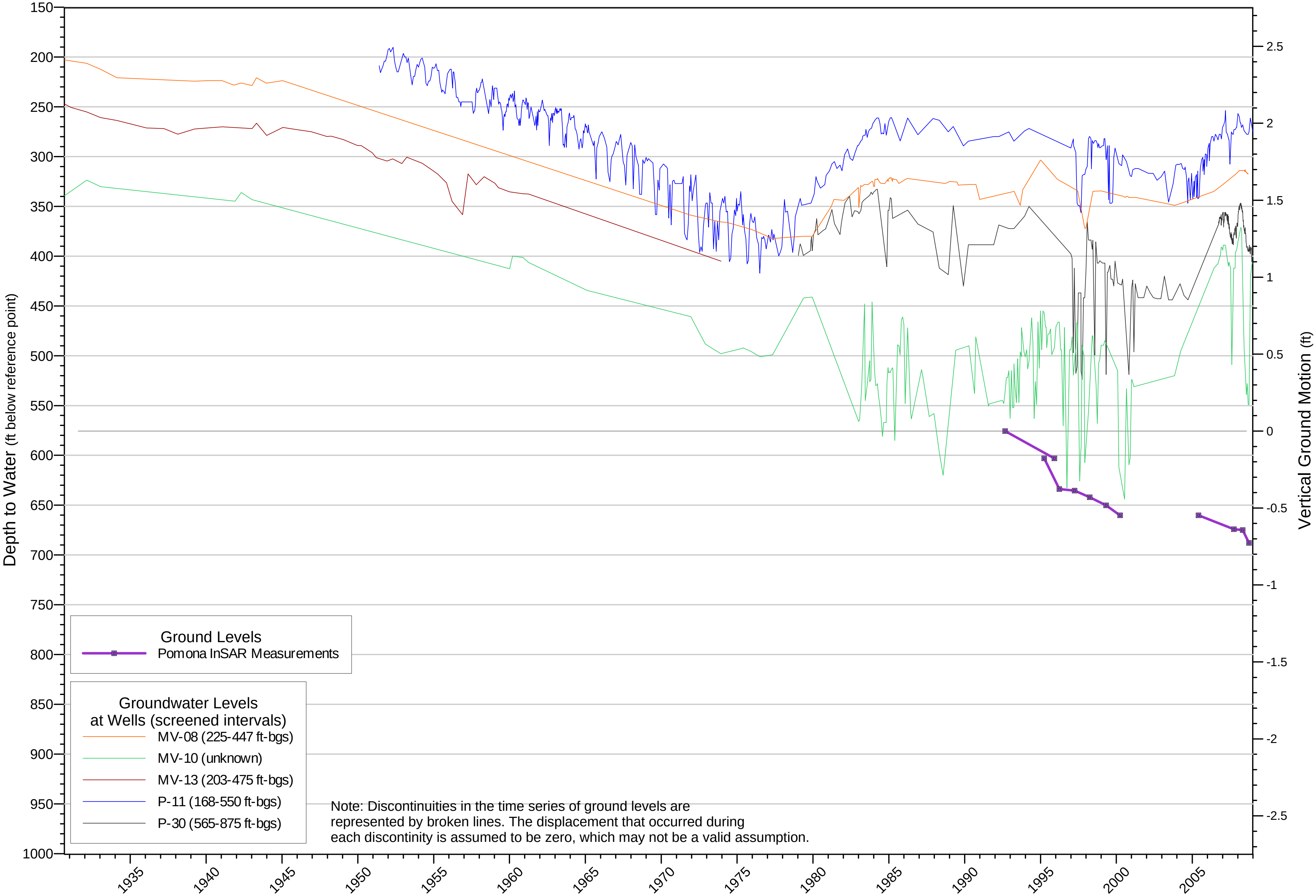


Figure 5-9
Groundwater Levels versus Ground Levels in the Pomona Area - 1935 to 2009



Note: Discontinuities in the time series of ground levels are represented by broken lines. The displacement that occurred during each discontinuity is assumed to be zero, which may not be a valid assumption.

Figure 5-10
Groundwater Levels versus Ground Levels in the Ontario Area - 1993 to 2009

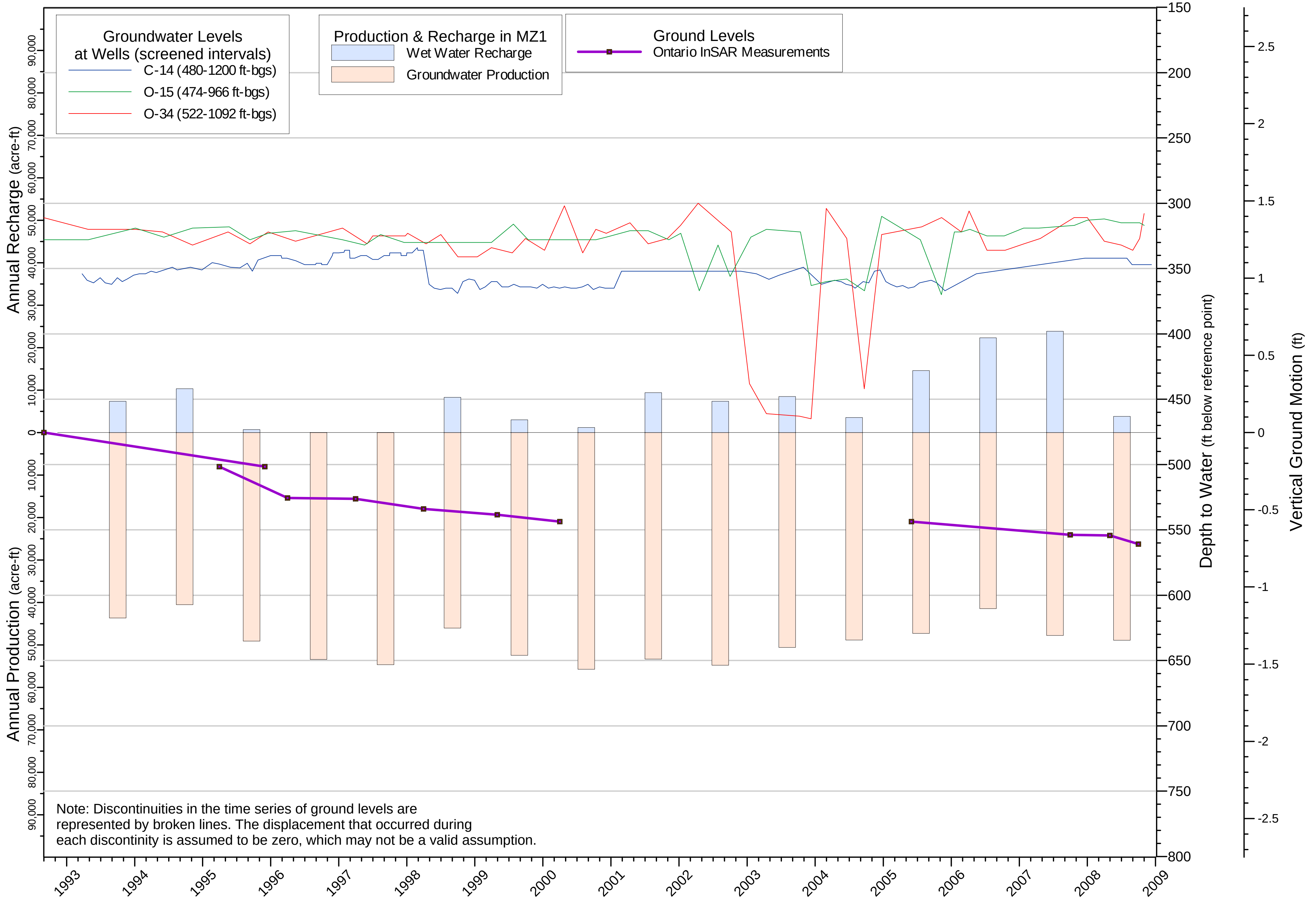


Figure 5-11
Groundwater Levels versus Ground Levels in the Ontario Area - 1930 to 2009

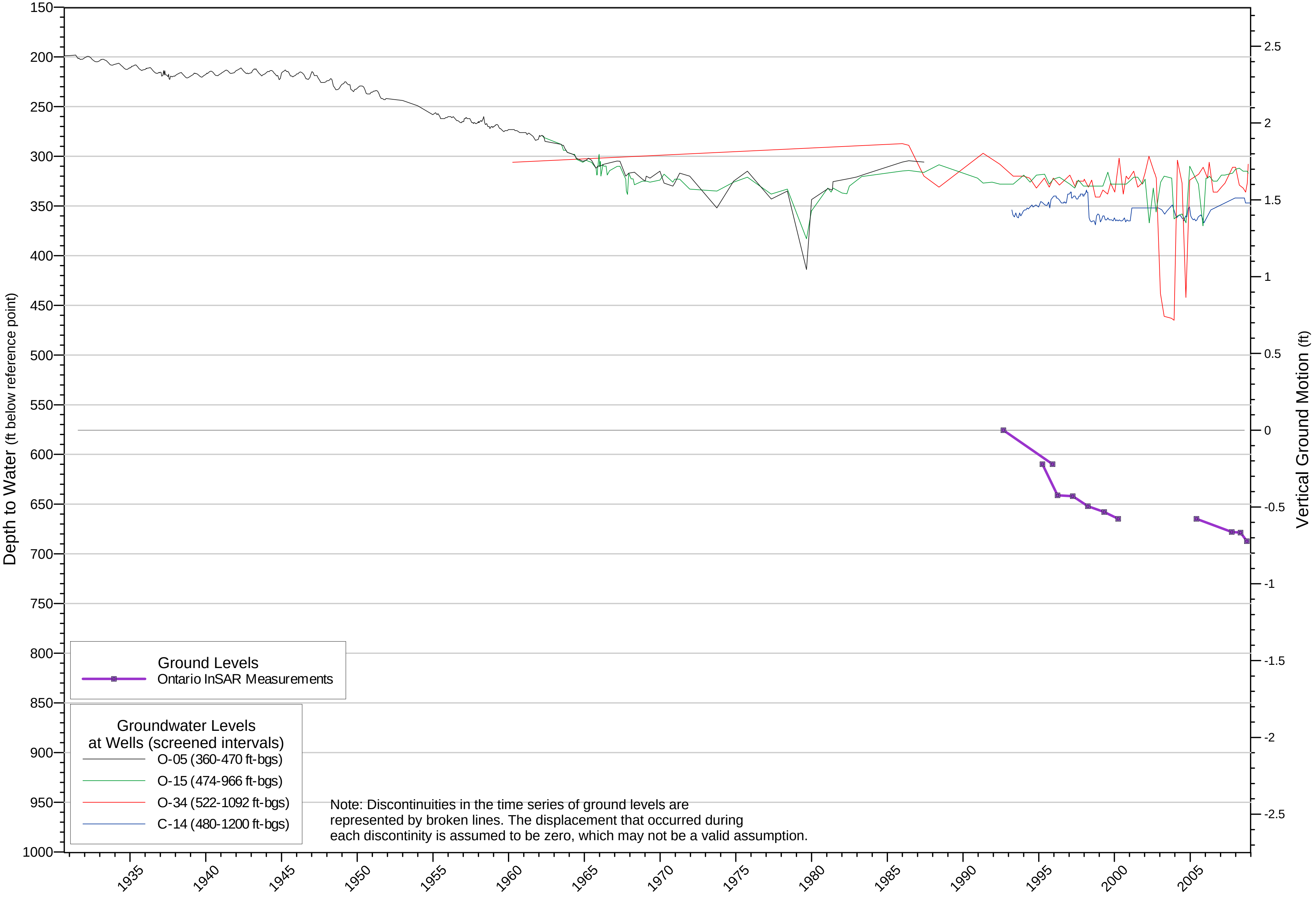


Figure 5-12
Groundwater Levels versus Ground Levels in the Southeast Area - 1993 to 2009

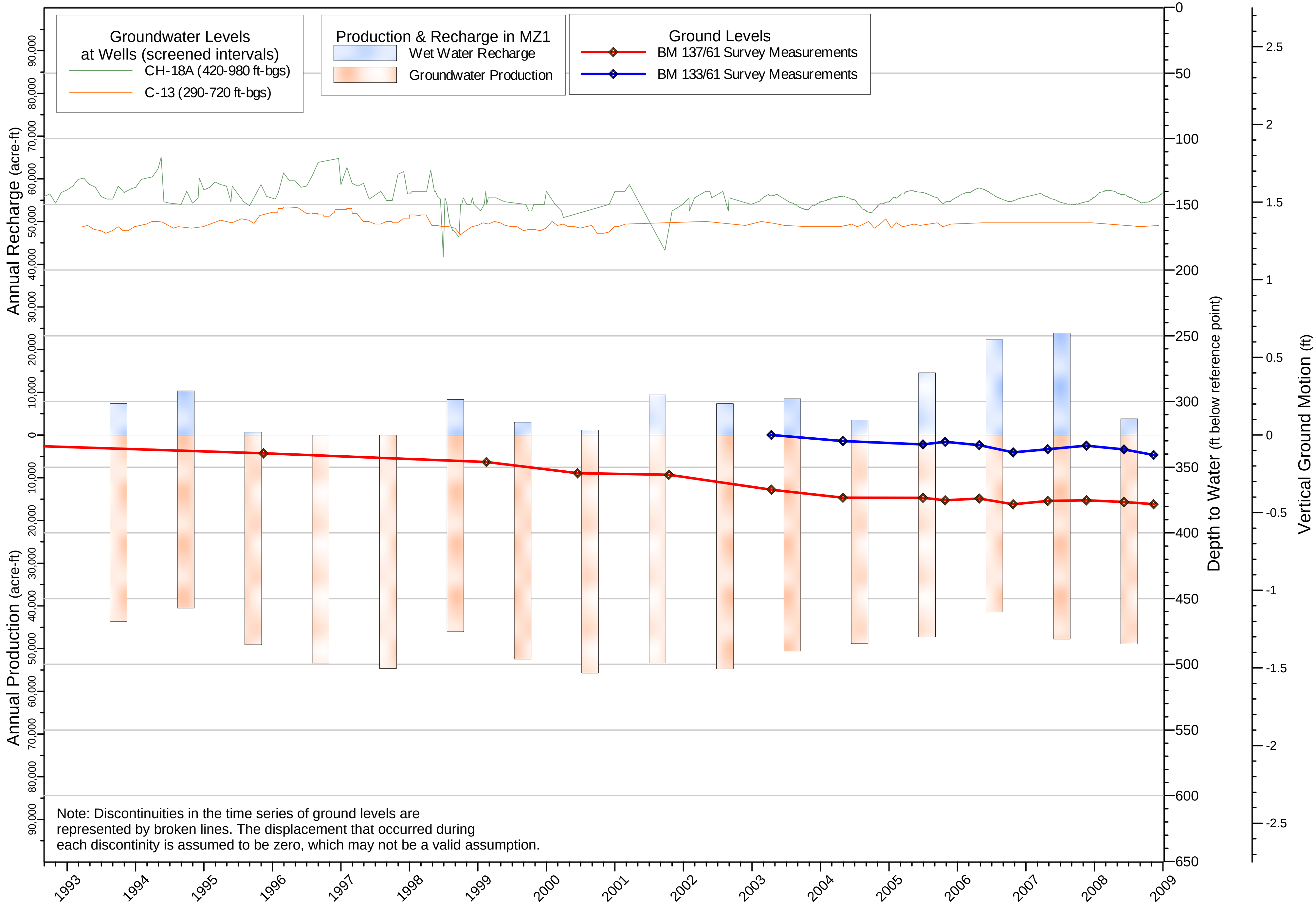
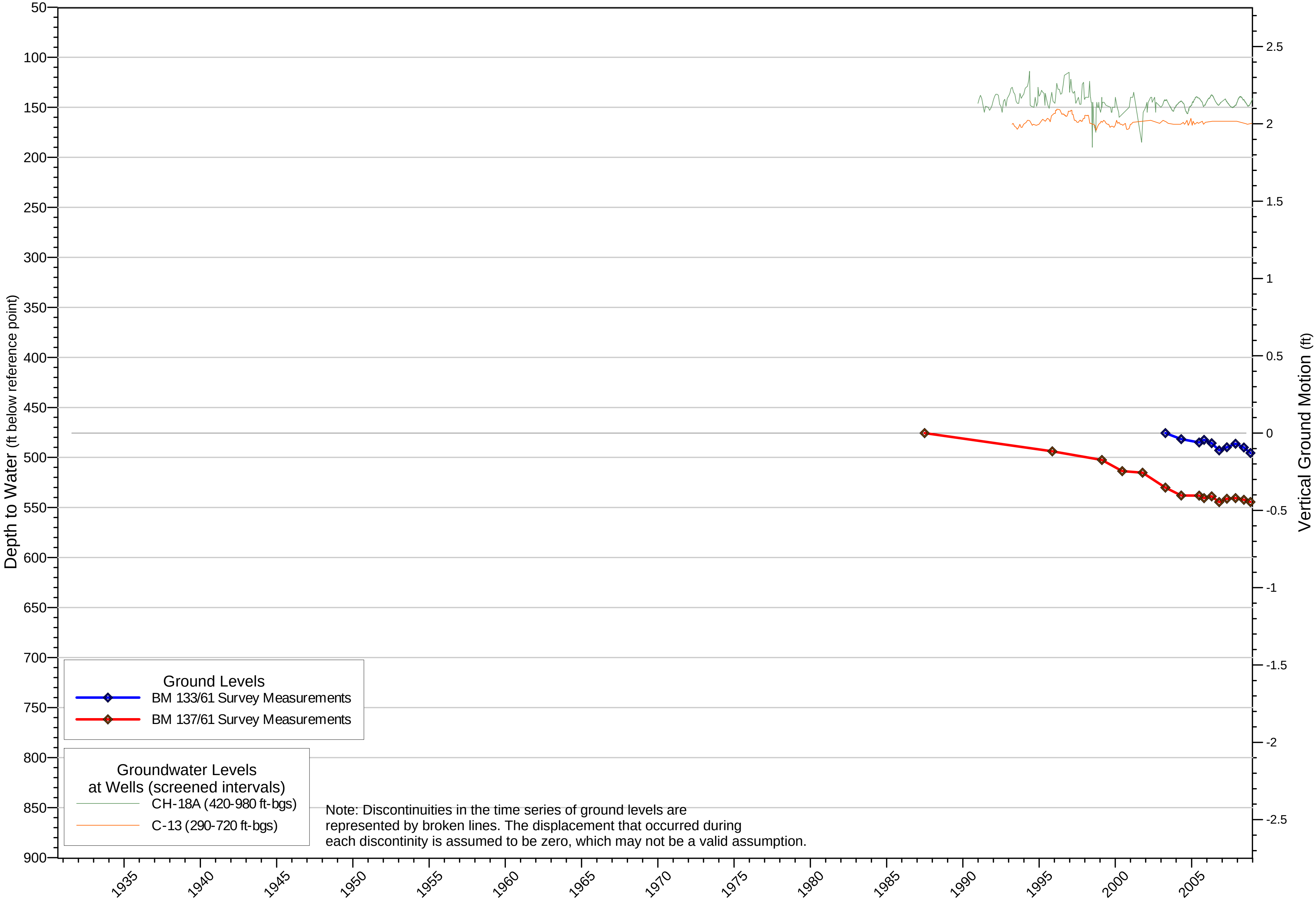


Figure 5-13
Groundwater Levels versus Ground Levels in the Southeast Area - 1930 to 2009



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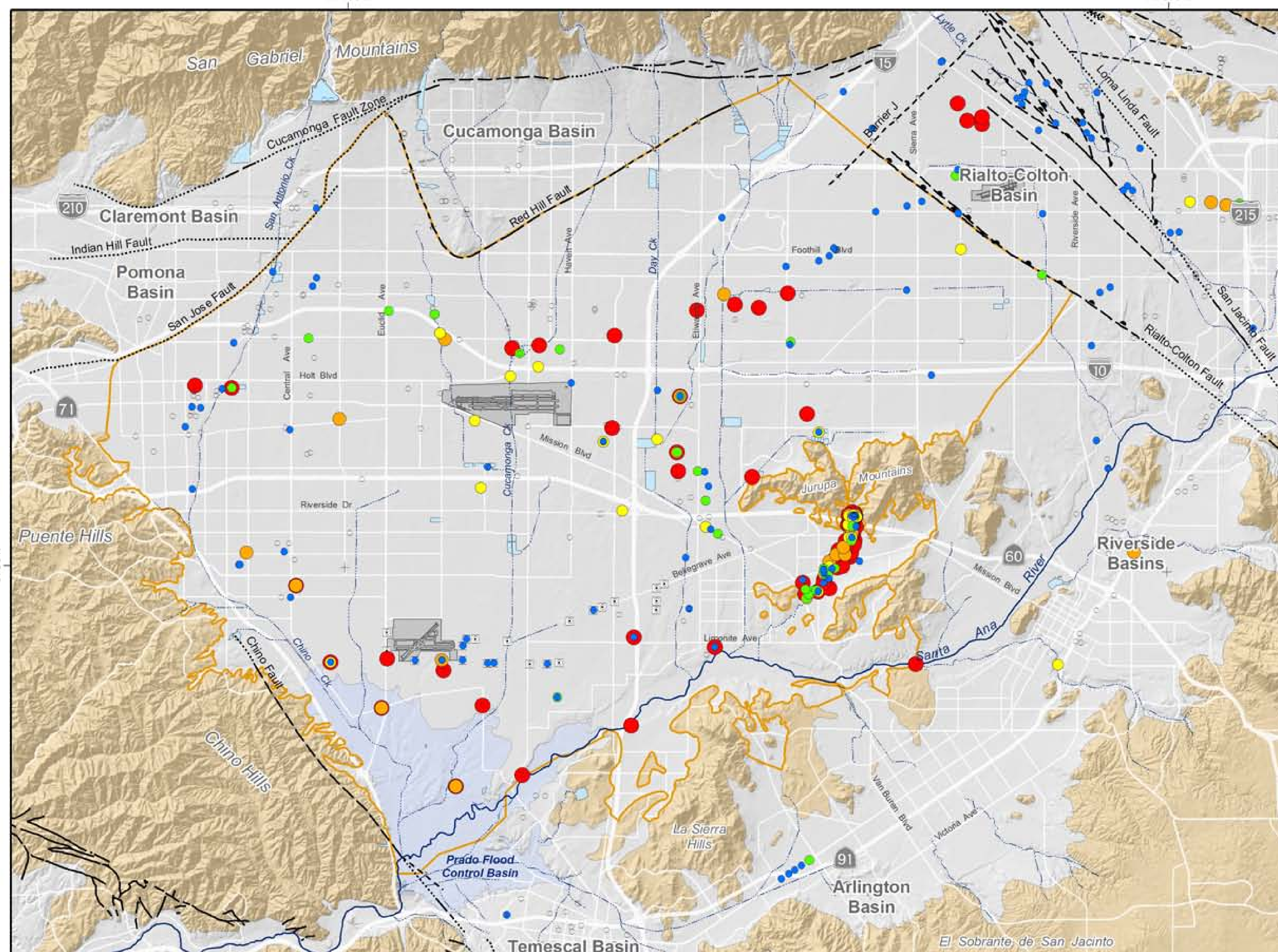
Appendix A

Groundwater Level Map

Appendix B

Groundwater Quality Maps



Main Features

Aluminum (mg/L)

- ND
- < 0.10
- 0.10 - 0.20
- 0.20 - 0.40
- 0.40 - 0.80
- > 0.80

Secondary EPA MCL = 2 mg/L
Primary CA MCL = 1 mg/L
Secondary CA MCL = 0.2 mg/L

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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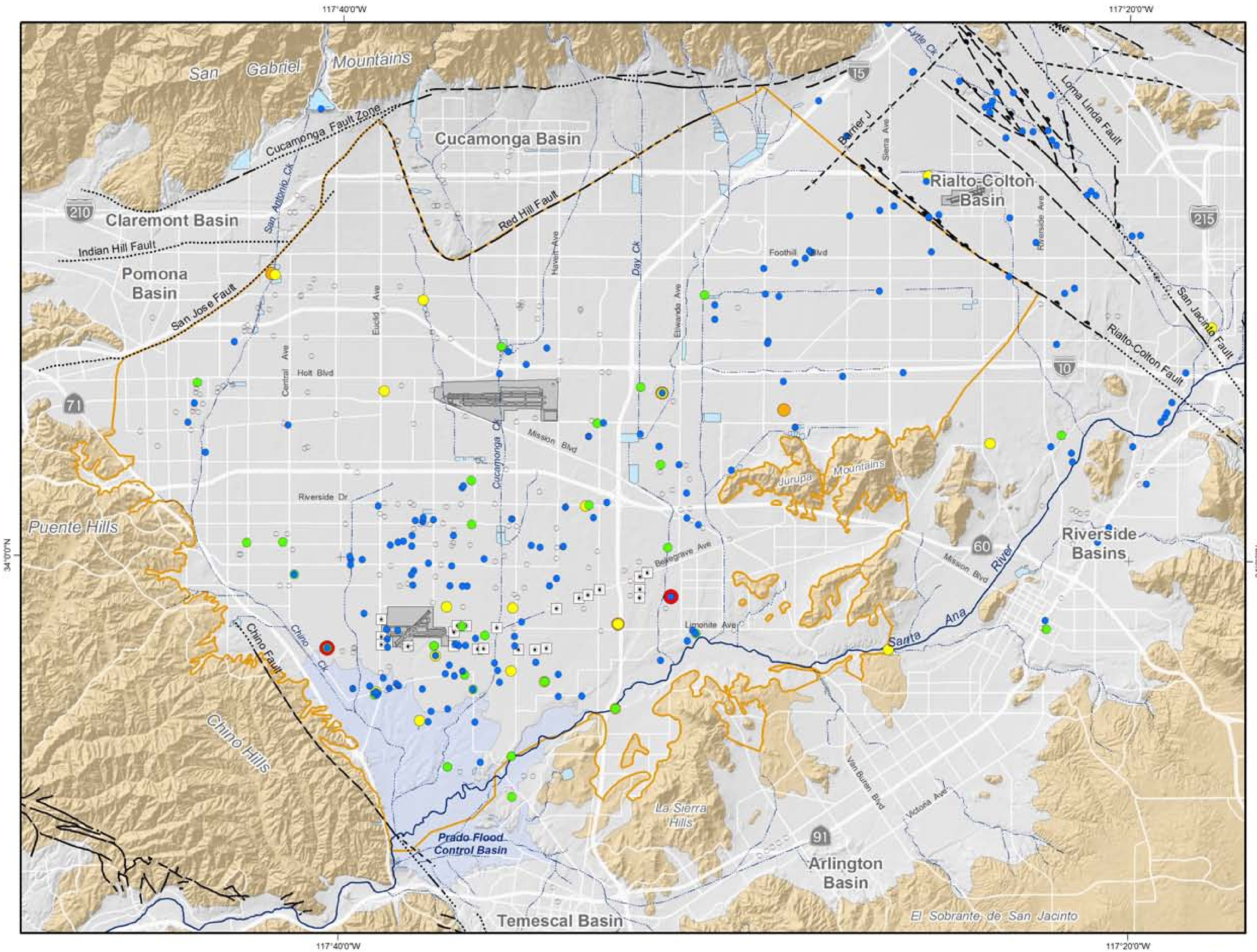
File: Appendix_B_Aluminum.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Appendix B

Aluminum in Groundwater
Maximum Concentration (July 2003 - June 2008)

Appendix B



Main Features

Color (Color Units)

- ND
- < 7.5
- 7.5 - 15
- 15 - 30
- 30 - 60
- > 60

Secondary EPA MCL = 15 Color Units
Secondary CA MCL = 15 Color Units

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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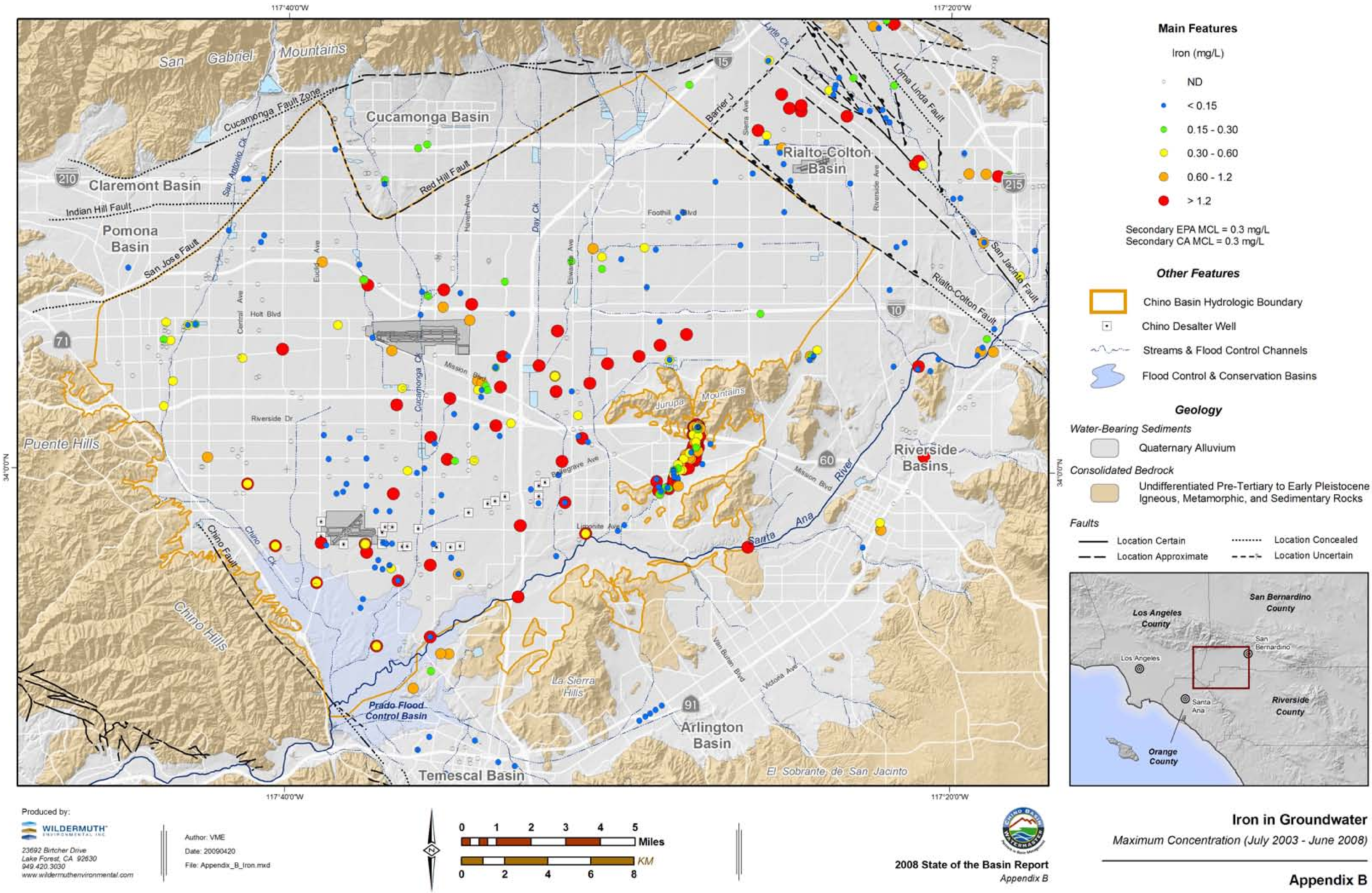
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Appendix B

Color in Groundwater
Maximum Concentration (July 2003 - June 2008)

Appendix B



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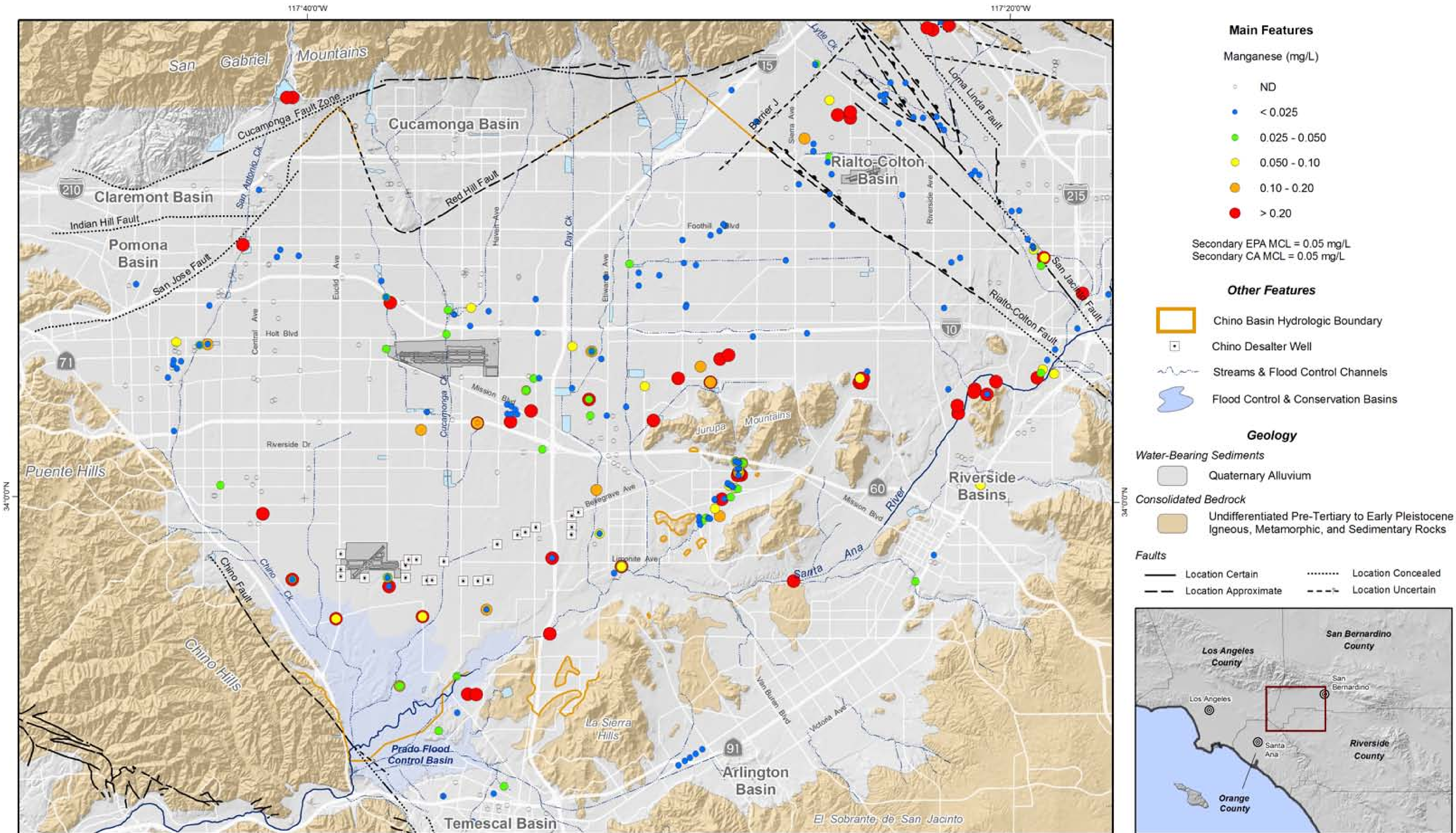
2008 State of the Basin Report
Appendix B

Iron in Groundwater

Maximum Concentration (July 2003 - June 2008)

Appendix B



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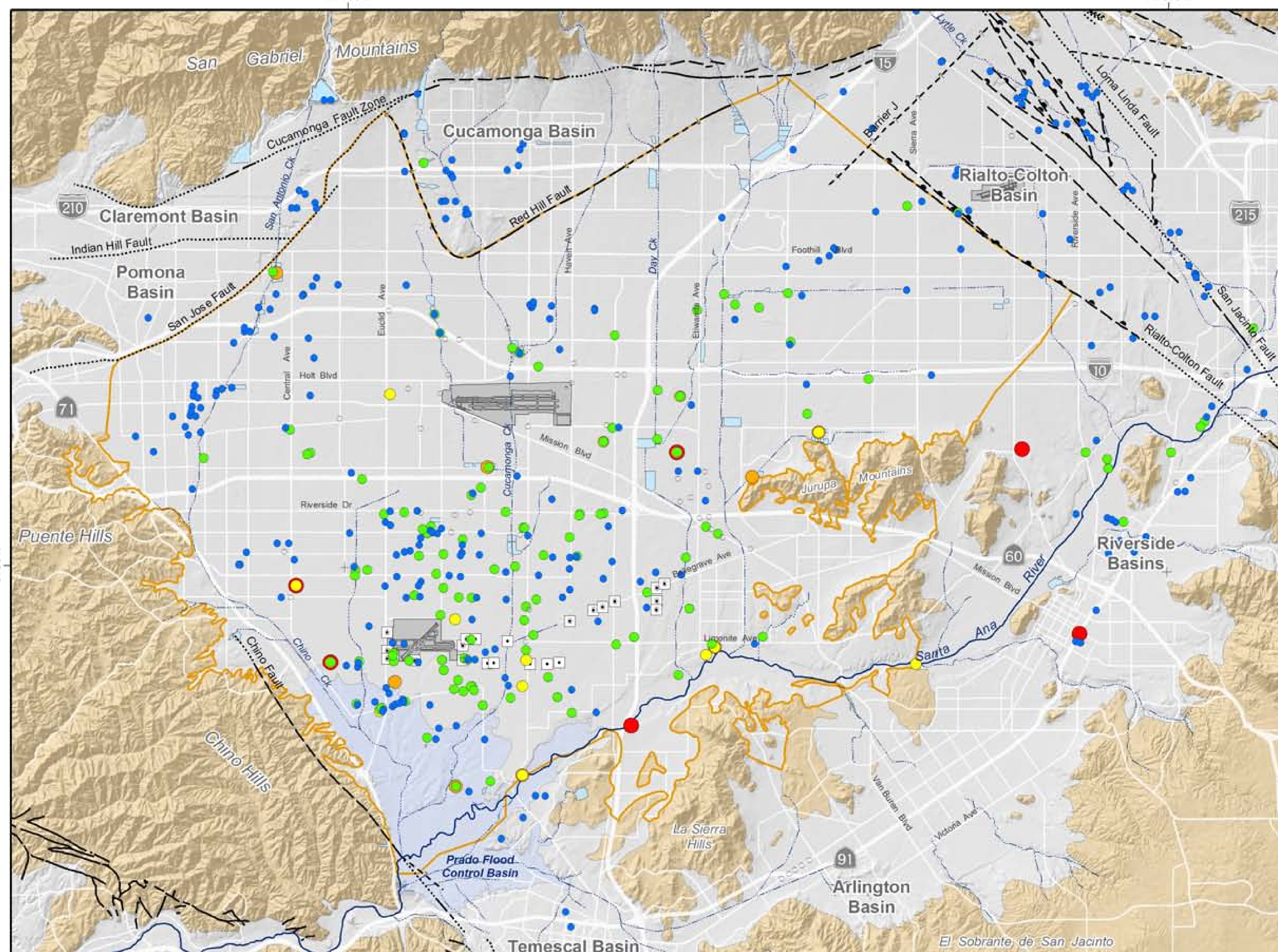
2008 State of the Basin Report
Appendix B

Manganese in Groundwater

Maximum Concentration (July 2003 - June 2008)

Appendix B



Main Features

Odor (TON)

- ND
- < 1.5
- 1.5 - 3
- 3 - 6
- 6 - 12
- > 12

Secondary EPA MCL = 3 TON
Secondary CA MCL = 3 TON

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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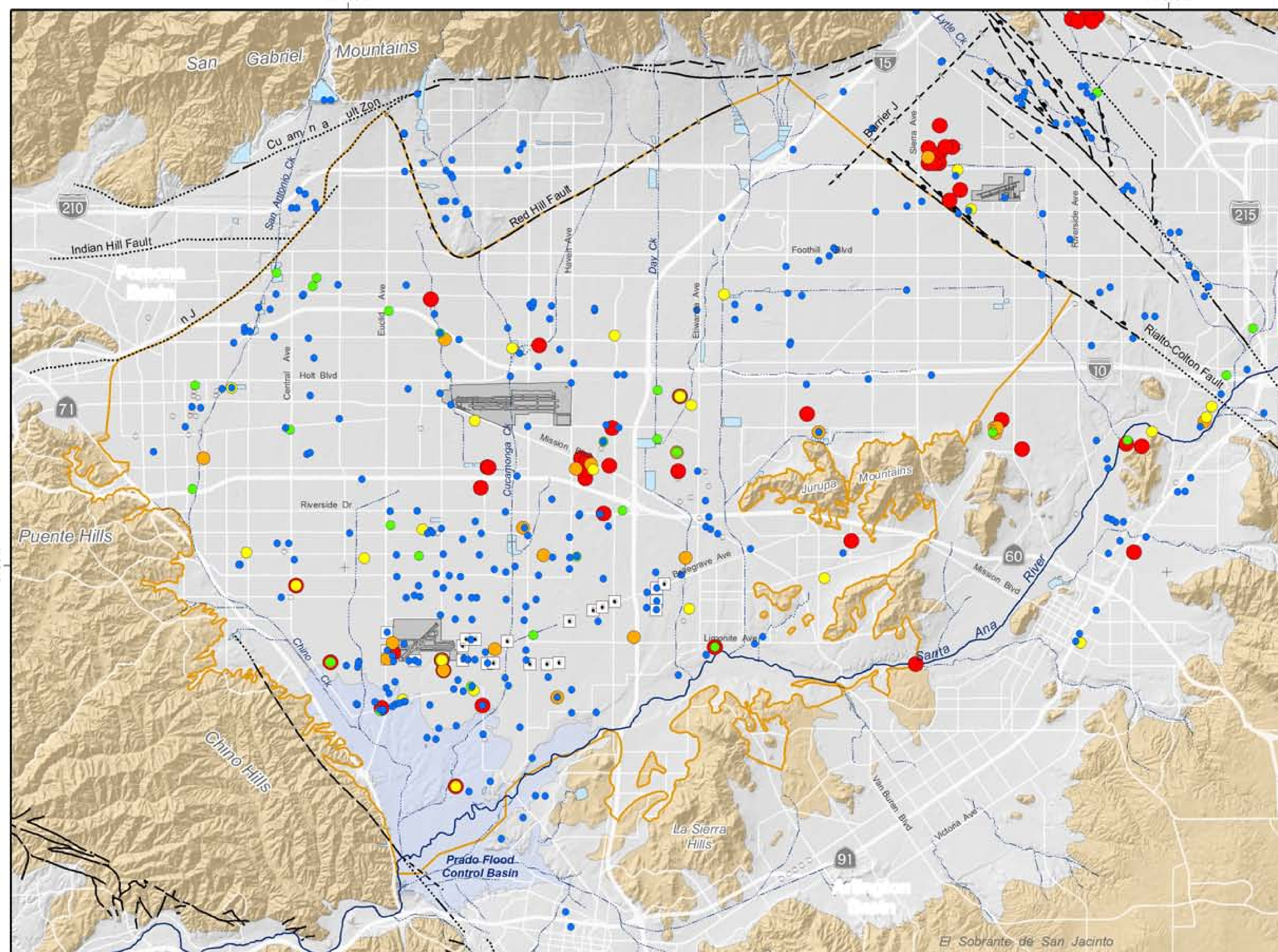
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2008 State of the Basin Report
Appendix B

Odor in Groundwater

Maximum Concentration (July 2003 - June 2008)

Appendix B



Main Features

Turbidity (NTU)

- ND
- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- > 20

Secondary EPA MCL = 5 NTU
Secondary CA MCL = 5 NTU

Other Features

- Chino Basin Hydrologic Boundary
- Chino Desalter Well
- Streams & Flood Control Channels
- Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain

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0 1 2 3 4 5 Miles
0 2 4 6 8 KM

Turbidity in Groundwater

Maximum Concentration (July 2003 - June 2008)

Appendix C

Groundwater Quality Exceedance Report

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
1,1,1-Trichloroethane			**ug/L**	**200**		**n/a**	**200**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.46	0.7	1.02	1.36	4.46	1.446	2641	499	5	0
1,1,2,2-Tetrachloroethane			**ug/L**	**n/a**		**n/a**	**1**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						2313	477	0	0
1,1,2-Trichloro-1,2,2-trifluoroethane			**ug/L**	**n/a**		**n/a**	**1200**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.5	0.63	1.1	6.5	185	32.488	1694	396	6	0
1,1,2-Trichloroethane			**ug/L**	**5**		**n/a**	**5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.11	0.45	0.81	2.3	3.8	1.293	2625	499	5	0
1,1-Dichloroethane			**ug/L**	**n/a**		**n/a**	**5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.1	0.56	1.3	3.4	6013	23.667	2730	509	39	11
1,1-Dichloroethene			**ug/L**	**7**		**n/a**	**6**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.19	1.94	5.4	11.8	190	13.667	2709	507	56	31
1,2,3-Trichloropropane			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**0.005**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0.012	0.13	0.94	3.1	0.491	1192	375	25	23
1,2,4-Trichlorobenzene			**ug/L**	**70**		**n/a**	**5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.5	0.5	0.5		0.5	0.5	1008	285	1	0
1,2,4-Trimethylbenzene			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**330**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						2062	440	0	0
1,2-Dibromo-3-chloropropane			**ug/L**	**0.2**		**n/a**	**0.2**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.01	0.11	0.16	0.24	0.639	0.185	880	301	16	4

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
1,2-Dichlorobenzene			**ug/L**	**600**		**n/a**	**600**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						1200	292	0	0
1,2-Dichloroethane			**ug/L**	**5**		**n/a**	**0.5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.1	0.34	0.45	0.6	3.1	0.611	2714	508	27	17
1,2-Dichloropropane			**ug/L**	**5**		**n/a**	**5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.12	0.36	0.5	1.1	3.6	0.933	2607	502	25	0
1,3,5-Trimethylbenzene			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**330**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						1538	373	0	0
1,3-Dichloropropene			**ug/L**	**n/a**		**n/a**	**0.5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
94	94	94		96.5	95.25	790	238	2	2
1,4-Dichlorobenzene			**ug/L**	**75**		**n/a**	**5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.13	0.15	0.17	0.21	0.57	0.215	1271	295	1	0
1,4-Dioxane			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**3**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.1	0.29	0.5	0.99	46	1.289	577	63	10	3
2,3,7,8-Tetrachlorodibenzo-p-dioxin			**ug/L**	**3E-05**		**n/a**	**3E-05**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0	0		0	0	192	98	1	0
2,4-Dichlorophenoxyacetic acid			**ug/L**	**70**		**n/a**	**70**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						227	118	0	0
2-Chlorotoluene			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**140**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						1531	364	0	0

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical	Unit	Primary EPA MCL	Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
4-Chlorotoluene	**ug/L**	**n/a**	**n/a**	**n/a**	**n/a**	**140**
Alachlor	**ug/L**	**2**	**n/a**	**2**	**n/a**	**n/a**
Aluminum	**mg/L**	**n/a**	**2**	**1**	**0.2**	**n/a**
Antimony	**ug/L**	**6**	**n/a**	**6**	**n/a**	**n/a**
Arsenic	**mg/L**	**0.01**	**n/a**	**0.05**	**n/a**	**n/a**
Asbestos	**MFL**	**7**	**n/a**	**7**	**n/a**	**n/a**
Atrazine	**ug/L**	**3**	**n/a**	**1**	**n/a**	**n/a**
Barium	**mg/L**	**2**	**n/a**	**1**	**n/a**	**n/a**
Bentazon	**ug/L**	**n/a**	**n/a**	**18**	**n/a**	**n/a**
Benzene	**ug/L**	**5**	**n/a**	**1**	**n/a**	**n/a**

Chemical	*Min*	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
4-Chlorotoluene							1532	365	0	0
Alachlor							262	129	0	0
Aluminum	0.005	0.058	0.2	1.1	240	3.145	1437	355	250	153
Antimony	0.159	0.6	0.8	1.1	8.3	1.066	1341	350	46	1
Arsenic	0	0.002	0.003	0.005	0.14	0.005	1565	381	247	24
Asbestos	0.26	0.26	0.26		0.26	0.26	153	100	1	0
Atrazine	0.06	0.06	0.08	0.1	1.04	0.32	303	142	3	1
Barium	0	0.042	0.07	0.13	160	0.629	1396	354	291	10
Bentazon							221	112	0	0
Benzene	0.11	0.14	0.16	0.52	1.5	0.4	2674	508	6	1

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
Benzo(a)pyrene			**ug/L**	**0.2**		**n/a**	**0.2**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.02	0.02	0.02		0.02	0.02	265	131	1	0
Beryllium			**mg/L**	**0.004**		**n/a**	**0.004**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0	0	0.001	0.008	0.001	1346	350	52	2
Boron			**mg/L**	**n/a**		**n/a**	**n/a**	**n/a**	**1**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
-0.004	0.1	0.161	0.3	2.5	0.228	1260	299	105	3
Bromate			**mg/L**	**0.01**		**n/a**	**0.01**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						2	1	0	0
Cadmium			**mg/L**	**0.005**		**n/a**	**0.005**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0	0	0	0.009	0	1355	351	140	1
Carbofuran			**ug/L**	**40**		**n/a**	**18**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						210	116	0	0
Carbon Disulfide			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**160**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.28	0.3	0.54	6.6	15.7	3.862	1102	272	8	0
Carbon Tetrachloride			**ug/L**	**5**		**n/a**	**0.5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.16	0.16	0.9	1.2	1.2	0.753	2323	477	3	2
Chlorate			**mg/L**	**n/a**		**n/a**	**n/a**	**n/a**	**0.8**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.021	0.021	0.061	0.063	0.063	0.048	3	2	2	0
Chlordane			**ug/L**	**2**		**n/a**	**0.1**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						227	118	0	0

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
Chloride			**mg/L**	**n/a**		**250**	**n/a**	**250**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
2.3	12	30	95	2700	68.323	2361	428	428	25
Chlorine			**mg/L**	**4**		**n/a**	**4**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
4.1	50	73	130	486	97.758	110	96	95	95
Chlorine Dioxide			**mg/L**	**0.8**		**n/a**	**0.8**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						1	1	0	0
Chlorite			**mg/L**	**1**		**n/a**	**1**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						4	3	0	0
Chlorobenzene			**ug/L**	**100**		**n/a**	**70**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.28	0.6	0.79	1.4	1.7	0.962	2337	478	4	0
Chromium			**ug/L**	**100**		**n/a**	**50**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	3.5	6.5	13	1500	23.765	1762	372	329	30
Cis-1,2-Dichloroethene			**ug/L**	**70**		**n/a**	**6**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.1	0.7	2.4	6.3	71	6.832	2690	509	43	10
Color			**Assessment**	**n/a**		**15**	**n/a**	**15**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
1	3	5	5	100	6.707	1483	377	182	21
Copper			**mg/L**	**1.3**		**1**	**1.3**	**1**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0.001	0.002	0.004	150	0.504	1768	370	277	8
Cyanide			**ug/L**	**200**		**n/a**	**150**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
8.46	8.46	8.46		8.46	8.46	450	173	1	0

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical	Unit	Primary EPA MCL	Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
Dalapon	**ug/L**	**200**	**n/a**	**200**	**n/a**	**n/a**
Di(2-ethylhexyl)adipate	**ug/L**	**400**	**n/a**	**400**	**n/a**	**n/a**
Di(2-ethylhexyl)phthalate	**ug/L**	**6**	**n/a**	**4**	**n/a**	**n/a**
Dichlorodifluoromethane	**ug/L**	**n/a**	**n/a**	**n/a**	**n/a**	**1000**
Dichloromethane	**ug/L**	**5**	**n/a**	**5**	**n/a**	**n/a**
Dinoseb	**ug/L**	**7**	**n/a**	**7**	**n/a**	**n/a**
Diquat	**ug/L**	**20**	**n/a**	**20**	**n/a**	**n/a**
Endothall	**ug/L**	**100**	**n/a**	**100**	**n/a**	**n/a**
Endrin	**ug/L**	**2**	**n/a**	**2**	**n/a**	**n/a**
Ethylbenzene	**ug/L**	**700**	**n/a**	**300**	**n/a**	**n/a**

Chemical	*Min*	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
Dalapon							227	118	0	0
Di(2-ethylhexyl)adipate							260	128	0	0
Di(2-ethylhexyl)phthalate	0.77	1.3	3.3	8.3	440	36.405	261	124	9	4
Dichlorodifluoromethane	0.17	0.5	0.8	2.5	29	3.07	2323	476	17	0
Dichloromethane	0.15	0.17	0.25	0.9	3	0.589	2468	482	53	0
Dinoseb							227	118	0	0
Diquat							198	108	0	0
Endothall							215	109	0	0
Endrin							231	122	0	0
Ethylbenzene	0.5	0.6	0.8	1.3	1.7	1.025	2380	481	8	0

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical	Unit	Primary EPA MCL	Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
Ethylene Dibromide	**ug/L**	**0.05**	**n/a**	**0.05**	**n/a**	**n/a**
Fluoride	**mg/L**	**4**	**2**	**2**	**n/a**	**n/a**
Foaming Agents	**mg/L**	**n/a**	**0.5**	**n/a**	**0.5**	**n/a**
Glyphosate	**ug/L**	**700**	**n/a**	**700**	**n/a**	**n/a**
Gross Alpha	**pci/L**	**15**	**n/a**	**15**	**n/a**	**n/a**
Haloacetic Acids 5 (HAA5)	**ug/L**	**60**	**n/a**	**60**	**n/a**	**n/a**
Heptachlor	**ug/L**	**0.4**	**n/a**	**0.01**	**n/a**	**n/a**
Heptachlor Epoxide	**ug/L**	**0.2**	**n/a**	**0.01**	**n/a**	**n/a**
Hexachlorobenzene	**ug/L**	**1**	**n/a**	**1**	**n/a**	**n/a**
Hexachlorocyclopentadiene	**ug/L**	**50**	**n/a**	**50**	**n/a**	**n/a**

Chemical	*Min*	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
Ethylene Dibromide	0.02	0.02	0.02	0.02	0.02	0.02	1227	360	1	0
Fluoride	0.05	0.2	0.3	0.7	7.6	0.538	1553	271	265	4
Foaming Agents	0.005	0.06	0.08	0.14	18	0.237	1140	226	76	2
Glyphosate							196	109	0	0
Gross Alpha	0	1.6	2.91	4.94	42	4.283	440	127	93	7
Haloacetic Acids 5 (HAA5)	1.5	8.9	11.8	13.6	90	14.747	24	7	4	1
Heptachlor							232	122	0	0
Heptachlor Epoxide							231	122	0	0
Hexachlorobenzene							271	137	0	0
Hexachlorocyclopentadiene							265	131	0	0

Water Quality Exceedance Report

WILDERMUTH ENVIRONMENTAL INC.

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
Iron			**mg/L**	**n/a**		**0.3**	**n/a**	**0.3**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.001	0.063	0.231	1.19	1714	7.298	2174	451	299	185
Isopropylbenzene			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**770**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						2015	438	0	0
Lead			**mg/L**	**0.015**		**n/a**	**0.015**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0	0.001	0.002	0.087	0.002	1365	353	189	7
Lindane			**ug/L**	**0.2**		**n/a**	**0.2**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						231	122	0	0
Manganese			**mg/L**	**n/a**		**0.05**	**n/a**	**0.05**	**0.5**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0.006	0.022	0.065	140	0.499	1752	281	167	58
Mercury			**mg/L**	**0.002**		**n/a**	**0.002**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0	0	0	0.002	0	1067	327	55	0
Methoxychlor			**ug/L**	**40**		**n/a**	**30**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						227	120	0	0
Methyl Isobutyl Ketone			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**120**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
5.3	5.3	5.3		5.3	5.3	2233	440	1	0
Methyl Tert-Butyl Ether			**ug/L**	**n/a**		**n/a**	**13**	**5**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.3	11	41	93	5800	136.23	2364	488	11	3
Molinate			**ug/L**	**n/a**		**n/a**	**20**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						298	133	0	0

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
n-Butylbenzene			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**260**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						1531	364	0	0
N-Nitrosodimethylamine			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**0.01**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.006	0.006	0.006		0.006	0.006	68	34	1	0
N-Nitrosodipropylamine			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**0.01**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						3	1	0	0
n-Propylbenzene			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**260**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						1532	365	0	0
Naphthalene			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**17**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.6	0.6	0.6	0.7	0.7	0.633	987	259	3	0
Nickel			**mg/L**	**n/a**		**n/a**	**0.1**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0.002	0.003	0.007	0.66	0.013	1340	349	253	7
Nitrate-Nitrogen			**mg/L**	**10**		**n/a**	**10**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.009	3.388	7.677	15.806	200	12.759	8891	594	588	395
Nitrite-Nitrogen			**mg/L**	**1**		**n/a**	**1**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0.05	0.1	0.15	35	1.759	1827	402	124	6
Odor			**TON**	**n/a**		**3**	**n/a**	**3**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
1	1	1	2	40	1.69	1371	366	315	28
Oxamyl			**ug/L**	**200**		**n/a**	**50**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						210	116	0	0

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
Pentachlorophenol			**ug/L**	**1**		**n/a**	**1**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						234	123	0	0
Perchlorate			**ug/L**	**n/a**		**n/a**	**6**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.81	6	11	20	870	21.406	2260	513	252	188
pH			**pH**	**n/a**		**8.5**	**n/a**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	7.3	7.64	7.9	770	7.921	2319	394	394	14
Picloram			**ug/L**	**500**		**n/a**	**500**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						227	118	0	0
Polychlorinated Biphenyls			**ug/L**	**0.5**		**n/a**	**0.5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						225	117	0	0
Propachlor			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**90**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						183	85	0	0
Ra 226 + Ra 228			**pci/L**	**5**		**n/a**	**5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.16	0.5	0.5	0.57	0.8	0.513	20	15	6	0
Sec-Butylbenzene			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**260**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						1518	364	0	0
Selenium			**mg/L**	**0.05**		**n/a**	**0.05**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0.002	0.004	0.006	0.045	0.005	1333	350	196	0
Silver			**mg/L**	**n/a**		**0.1**	**n/a**	**0.1**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0	0	0	0.014	0	1369	350	80	0

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
Silvex			**ug/L**	**50**		**n/a**	**50**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						227	118	0	0
Simazine			**ug/L**	**4**		**n/a**	**4**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.05	0.05	0.2	0.4	0.92	0.274	311	148	6	0
Specific Conductance (lab)			**umhos/cm**	**n/a**		**n/a**	**n/a**	**900**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
60	375	540	1100	1600000	3016.663	2124	335	335	121
Strontium-90			**pci/L**	**n/a**		**n/a**	**8**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
-0.35	0	0.103	0.3	1.2	0.217	63	19	18	0
Styrene			**ug/L**	**100**		**n/a**	**100**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						2291	478	0	0
Sulfate			**mg/L**	**n/a**		**250**	**n/a**	**250**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
2.4	17	50	120	1200	82.22	2913	527	527	41
TDS			**mg/L**	**n/a**		**500**	**n/a**	**500**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
48	260	380	760	4790	553.745	3945	425	425	221
Tert-Butyl Alcohol			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**12**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
2	2.1	9.7	22	150	37.16	968	232	3	1
Tert-Butylbenzene			**ug/L**	**n/a**		**n/a**	**n/a**	**n/a**	**260**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						1530	365	0	0
Tetrachloroethene			**ug/L**	**5**		**n/a**	**5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.14	1	1.8	5.7	182	7.975	3357	568	114	37

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
Thallium			**ug/L**	**2**		**n/a**	**2**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
-2.406	0.14	0.19	0.38	30.72	1.933	1260	349	41	6
Thiobencarb			**ug/L**	**n/a**		**n/a**	**70**	**1**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						407	159	0	0
Toluene			**ug/L**	**1000**		**n/a**	**150**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.11	0.5	0.71	2	9.8	1.694	2591	490	31	0
Total Xylene			**ug/L**	**10000**		**n/a**	**1750**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						1543	392	0	0
Toxaphene			**ug/L**	**3**		**n/a**	**3**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						227	118	0	0
Trans-1,2-Dichloroethene			**ug/L**	**100**		**n/a**	**10**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.2	0.28	0.72	1.7	7.73	1.313	2703	509	12	0
Trichloroethene			**ug/L**	**5**		**n/a**	**5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.13	1.8	3.8	18	5620	64.883	3412	569	241	115
Trichlorofluoromethane			**ug/L**	**n/a**		**n/a**	**150**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.07	0.3	0.42	0.62	19	1.663	2042	420	18	0
Trihalomethanes			**ug/L**	**80**		**n/a**	**80**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.5	1.6	4.8	64.5	87.3	28.432	618	215	23	2
Tritium			**pci/L**	**n/a**		**n/a**	**20000**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
-199	-12.6	25.7	287	596	118.69	65	18	18	0

Water Quality Exceedance Report

Sampling Period: 7/1/2003 **to** 6/30/2008

Chemical			Unit	Primary EPA MCL		Secondary EPA MCL	Primary CA MCL	Secondary CA MCL	CA NL
Turbidity			**NTU**	**5**		**n/a**	**n/a**	**5**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0	0.21	0.52	2.6	2880	21.599	1699	360	320	78
Uranium			**pci/L**	**n/a**		**n/a**	**20**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.48	1.58	2.77	5.48	20.5	4.319	175	54	53	1
Vanadium			**mg/L**	**n/a**		**n/a**	**n/a**	**n/a**	**0.05**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.001	0.009	0.013	0.025	0.31	0.02	817	290	286	25
Vinyl Chloride			**ug/L**	**2**		**n/a**	**0.5**	**n/a**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
						2389	483	0	0
Zinc			**mg/L**	**n/a**		**5**	**n/a**	**5**	**n/a**
Min	*1st Quartile*	*Median*	*3rd Quartile*	*Maximum*	*Average*	*# of Samples*	*# of Wells Sampled*	*# of Wells with Detects*	*# of Wells with Exceedances*
0.001	0.003	0.006	0.014	9.853	0.061	1804	369	264	1

Primary EPA MCL	**Primary EPA MCLs are federally enforceable limits for chemicals in drinking water and are set as close as feasible to the corresponding EPA MCLG.**
Secondary EPA	**Secondary EPA MCLs apply to chemicals in drinking water that adversely affect its odor, taste, or appearance Secondary EPA MCLs are not based on direct health effects associated with the chemical. Secondary MCLs are consdered desireable goals and are not federally enforceable**
Primary CA MCL	**Primary CA MCLs are analogous to Primary EPA MCLs and are enforceable at the state level . If the California DHS has adopted a more stringent primary MCL than the EPA MCL, the primary CA MCL sould be enforceable.**
Secondary CA	**Secondary CA MCLs are analogous to Secondary EPA MCLs and are applicable at the state level. If the California DHS has adopted a more stringent secondary MCL than the EPA MCL, the secondary CA MCL would be applied.**
CA NL	**California Notification Levels are health -based criteria similar to US EPA Health Advisories. CA NLs are not enforceable, but are levels at which the California Department of Health Services strongly urges water purveyors to take corrective actions.**

Appendix D

Compact Disk