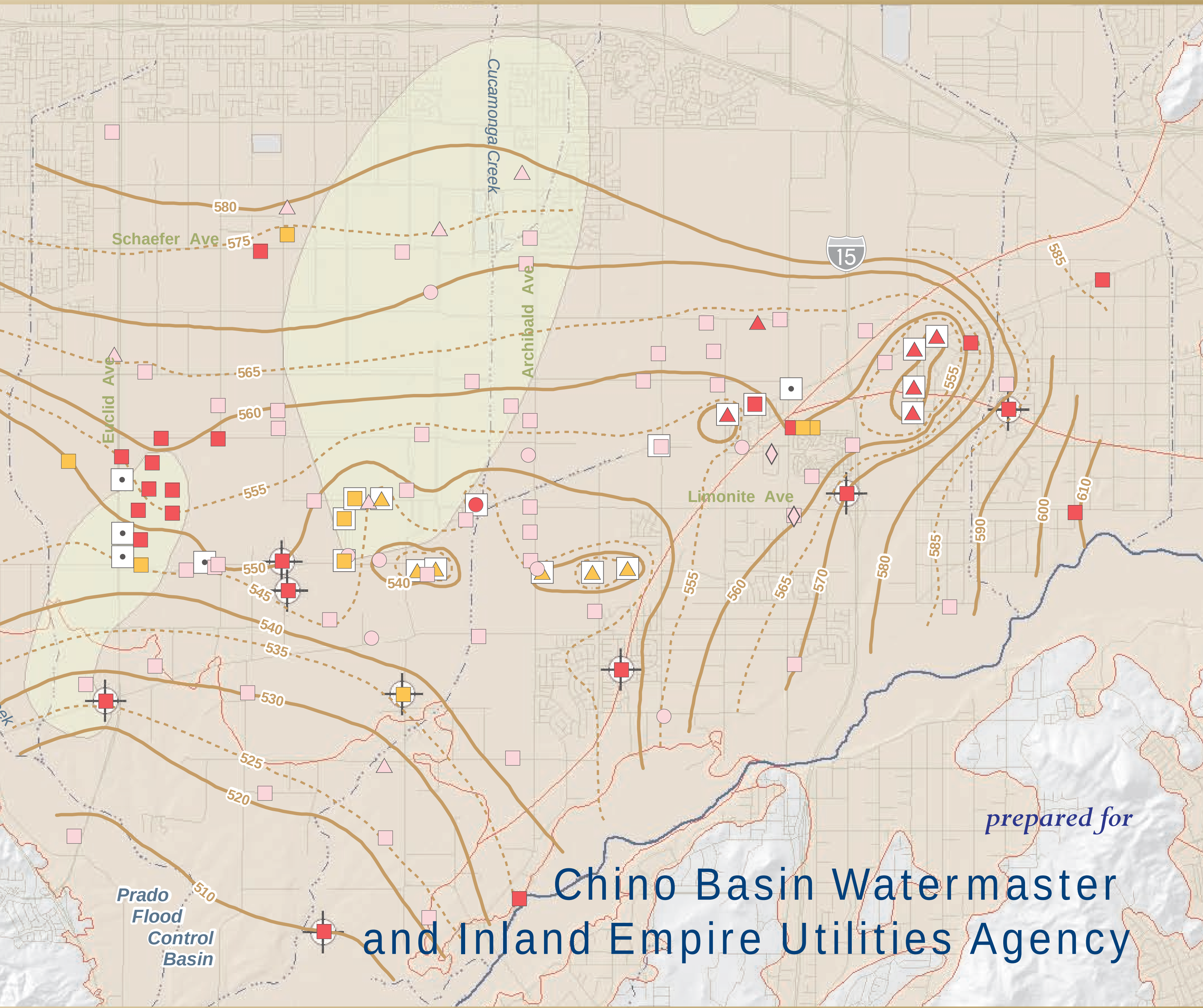
Optimum Basin Management Program
Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report



prepared for

Chino Basin Watermaster and Inland Empire Utilities Agency

April 2010

WILDERMUTH™ ENVIRONMENTAL INC.

CHINO BASIN WATERMASTER

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KENNETH R. MANNING
Chief Executive Officer

April 15, 2010

Regional Water Quality Control Board, Santa Ana Region
Attention: Mr. Gerard Thibeault
3737 Main Street, Suite 500
Riverside, California 92501-3348

Subject: Transmittal of the Chino Basin Maximum Benefit Monitoring Program 2009 Annual Report

Dear Mr. Thibeault,

The Chino Basin Watermaster (Watermaster) hereby submits the Chino Basin Maximum Benefit Monitoring Program 2009 Annual Report. This Annual Report is in partial fulfillment of the maximum benefit commitments made by IEUA and Watermaster as discussed in Resolution No. R8-2004-0001 and its attachment: Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate an Updated Total Dissolved Solids (TDS) and Nitrogen Management Plan for the Santa Ana Region Including Revised Groundwater Subbasin Boundaries, Revised TDS and Nitrate-Nitrogen Quality Objectives for Groundwater, Revised TDS and Nitrogen Wasteload Allocations, and Revised Reach Designations, TDS and Nitrogen Objectives and Beneficial Uses for Specific Surface Waters. Table 5-8a in the Attachment to the Resolution identifies the projects and requirements that must be implemented to demonstrate that water quality consistent with maximum benefit to the people of the state will be maintained. The first two of nine commitments in Table 5-8a are for surface water and groundwater monitoring programs. This Annual Report summarizes the results for 2009 for those two programs.

If you have any questions, please do not hesitate to call.

Sincerely,

<u>**Chino Basin Watermaster**</u>

Kenneth R. Manning
Chief Executive Officer

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Acronyms, Abbreviations, and Initialisms

µg/L	micrograms per liter
acre-ft/yr	acre-feet per year
Basin Plan	Water Quality Control Plan
CBDC	Chino Basin Data Collection
CBFIP	Chino Basin Facilities Improvement Program
CCWF	Chino Creek Well Field
CDA	Chino Desalter Authority
CDFM	cumulative departure from mean precipitation
cfs	cubic feet per second
Chino-North	Chino-North Management Zone
Corona 1B	City of Corona Wastewater Treatment Plant 1B
DTSC	California Department of Toxic Substance Control
ft/ft	feet/feet
ft/yr	feet/year
ft-brp	feet below reference point
ft-msl	feet mean sea level
FY	fiscal year
HCMP	Hydraulic Control Monitoring Program
IEUA	Inland Empire Utilities Agency
KWMP	Key Well Monitoring Program
meq/L	milliequivalents per liter
mgd	million gallons per day
mg/L	milligrams per liter
MWD	Metropolitan Water District of Southern California
MZ	Management Zone
NAWQA	National Water Quality Assessment Program
OIA	Ontario International Airport
OBMP	Optimum Basin Management Program
OCWD	Orange County Water District
POTWs	Publicly Owned Treatment Works
QA/QC	quality assurance/quality control
Regional Board	Regional Water Quality Control Board, Santa Ana Region
RWQCP	Regional Water Quality Control Plant
SAR	Santa Ana River

Acronyms, Abbreviations, and Initialisms

SARWC	Santa Ana River Water Company
SOB	State of the Basin
SWMP	Surface Water Monitoring Program
SWP	State Water Project
Task Force	Nitrogen/TDS Task Force
TCE	trichloroethene
TDS	total dissolved solids
TIN	total inorganic nitrogen
USGS	United States Geological Survey
VOC	volatile organic compound
Watermaster	Chino Basin Watermaster
WCI	water character index
WEI	Wildermuth Environmental, Inc.
WLAM	Wasteload Allocation Model
WRCRWA	Western Riverside County Regional Wastewater Authority
WRCRWTP	Western Riverside County Regional Wastewater Treatment Plant

This Annual Report of the Chino Basin Maximum Benefit Monitoring Program—a requirement of the Water Quality Control Plan for the Santa Ana Basin (Basin Plan), as updated in February 2008 (California Regional Water Quality Control Board, 2008)—presents the work performed during the 2009 calendar year. The California Regional Water Quality Control Board (Regional Board) requires that the Chino Basin Watermaster (Watermaster) and the Inland Empire Utilities Agency (IEUA) conduct the Maximum Benefit Monitoring Program to determine the state of the hydraulic control of rising groundwater outflow in the southern portion of the Chino Basin. Watermaster and the IEUA refer to these monitoring efforts as the Hydraulic Control Monitoring Program (HCMP). The objective of the HCMP is to describe the state of hydraulic control through the collection and analysis of groundwater and surface water data.

The Basin Plan defines hydraulic control as "[…] eliminating groundwater discharge from the Chino Basin to the Santa Ana River, or controlling the discharge to *de minimis* levels […]." Watermaster and the IEUA use a more measurable definition of hydraulic control: eliminating groundwater discharge from the Chino-North Management Zone or controlling the discharge to *de minimis* levels.

The data collected through the HCMP are analyzed to build multiple lines of evidence to demonstrate whether and to what extent hydraulic control is being achieved. In 2009, a total of 768 manual groundwater level measurements, 536 transducer downloads (data loggers that automatically record water levels at wells once every 15 minutes), 170 groundwater quality samples, 570 surface water quality samples, and 110 direct surface water discharge measurements were collected in the field for the HCMP. The conclusions drawn from the analyses of these data are summarized as follows:

- **Piezometric Levels**. The piezometric data collected and analyzed to date, at both local and regional scales, indicate that progress toward complete hydraulic control has occurred since 2000. The shape of the piezometric contours of the shallow aquifer system for spring 2009 suggest that hydraulic control is occurring at the desalter wells in the central and eastern part of the combined well fields (Chino-I Desalter wells 5 through 15 and Chino-II Desalter wells 1 through 9). In the western part of the Chino-I Desalter well field (wells 1 through 4), the shape of the piezometric contours suggests that hydraulic control is not occurring because these wells are perforated primarily within the deep aquifer system. In the area adjacent to the Santa Ana River and east of Archibald Avenue, piezometric levels declined by approximately 10 feet from 2000 to 2009. Agricultural pumping in this area declined over this period, which suggests that the piezometric decline is due to desalter pumping. The piezometric declines in this area are physical evidence that suggests Santa Ana River recharge to the Chino Basin is increasing due to desalter pumping.
- **VOC Contaminant Plume**. The 2009 sampling and analysis of water quality from wells in the vicinity of the Chino-I Desalter well field demonstrated that the OIA VOC contaminant plume has not migrated beyond the well field. This finding

suggests that hydraulic control is continuing to occur in the vicinity of Chino-I Desalter wells 5 through 11.

- **Comparison of Surface Water and Groundwater Quality**. The surface water quality results collected between 2005 and 2009 suggest that there is not a significant amount of discharge to the Santa Ana River from the Chino Basin. Reach by reach comparisons of WCI, piper plots, and TDS demonstrate that changes in Santa Ana River water quality, from the Riverside Narrows to downstream below Prado Dam, are dominated by the discharge of wastewater effluent from POTWs. Furthermore, a comparison of the general water character of the Santa Ana River to that of wells perforated in the shallow aquifer suggests that water from the Santa Ana River is recharging the groundwater basin between Van Buren Avenue and Archibald Avenue. The near-river wells have WCI values that range between 200 and 600, representing a mixture of river water character (200) and native groundwater (700-800).
- **Analysis of Surface Water Discharge Measurements**. An analysis of the discharge data collected from the Riverside Narrows to Hamner Avenue in 2009 suggests that groundwater occasionally rises into the Santa Ana River but that there is an overall net loss of surface water flow in this reach. Total rising water along the Santa Ana River from *MWD Xing* to *Hamner* averaged about -3 cfs in 2009. If the average level of recharge were sustained year long in this reach, it would correspond to an annual net recharge to the Chino Basin of about 2,200 acre-ft. Review of Santa Ana River Watermaster data suggests that the net loss of surface water from the Riverside Narrows to Prado Dam in water year 2008-09 was about 33,500 acre-ft. The volume of rising groundwater in the Santa Ana River cannot be quantified with the surface water discharge data.
- **Comparison with Watermaster's 2007 Groundwater Model**. The measured (2009) and modeled (2010) groundwater flow directions are generally consistent across the entire southern end of the Chino Basin with some variations due to interpretations of groundwater elevations from wells with variable constructions and short-term piezometric responses to localized pumping. The flow vectors at the southern boundary of the OIA plume show that groundwater flows to the desalters from both the south and the north, corroborating the capture of Chino-North groundwater as suggested by the piezometric contours and the non-detect levels of TCE measured to the south of the well field. In addition, the flow vectors along the river corroborate the WCI evidence (values of 200-400), which shows that Santa Ana River water has migrated about a mile away from the river in a north-westerly direction into the Chino Basin. The model results confirm that hydraulic control has yet to be achieved to the west of Chino-I Desalter Well 5.

In summary, the results of the HCMP have demonstrated that hydraulic control has been achieved across the central and eastern portions of the Chino Desalter well fields and that groundwater discharge from Chino-North to the Prado Basin occurs only to the west of Chino-I Desalter Well 5.

Watermaster and the IEUA assert that:

1. The groundwater that currently flows past the west side of the desalter well field and the outflow of rising groundwater in Prado Basin have had, and will continue to have, a *de minimis* impact on the water quality of the Santa Ana River at Prado Dam. This assertion is based on the analysis of historical surface water data and predictive, computer-simulation modeling of surface water.

2. When the Chino Creek Well Field is constructed and in operation, and as the complete capture of groundwater outflow from Chino-North develops around the Chino Desalter well fields, the influence of rising groundwater in the Prado Basin on the flow and quality of the Santa Ana River will be even less. This assertion is based on predictive computer-simulation modeling of groundwater.

3. Based on (1) and (2) above, the elimination of groundwater discharge from the Chino-North Management Zone by the Chino Desalter well fields, or the control of the discharge to *de minimis* levels (measurable definition of hydraulic control), is the same as controlling groundwater discharge from the Chino Basin to the Santa Ana River to *de minimis* levels (Basin Plan definition of hydraulic control). Hence, the measurable definition of hydraulic control is appropriate.

Based on these assertions, Watermaster and the IEUA recommend the following:

1. Future annual reports should focus on the analysis of groundwater data (piezometric levels and groundwater quality) since these are the main data sets used to show the extent of the complete capture of Chino-North groundwater by the Chino Desalter well fields.
2. Future annual reports should deemphasize the analysis of surface water data (flow and water quality) since these data are not necessary to show the extent of the complete capture of Chino-North groundwater by the Chino Desalter well fields. Future annual reports should continue to report on flow and quality at Below Prado as a check on the conclusion that the influence of rising groundwater in the Prado Basin on the flow and quality of the Santa Ana River is *de minimis*.
3. If Watermaster and the IEUA have satisfied all other Chino Basin maximum benefit commitments, the Regional Board should reduce the surface water monitoring commitments in the Chino Basin Maximum Benefit Monitoring Program as they are currently defined in the Basin Plan.

This section provides background information on (1) the interactions between Chino Basin groundwater and the Santa Ana River, (2) the Chino Basin Optimum Basin Management Program (OBMP), (3) the Regional Board's recognition of the OBMP and the establishment of new groundwater quality objectives for the Chino Basin, and (4) the commitments made by the Chino Basin Watermaster (Watermaster) and the Inland Empire Utilities Agency (IEUA) when the Regional Board granted the new groundwater quality objectives. One such commitment is to control the outflow of rising groundwater in the southern portion of the Chino Basin to protect the water quality of the Santa Ana River and its beneficial uses, referred to as "hydraulic control." To assess the state of hydraulic control, the Regional Board requires that Watermaster and the IEUA conduct the Chino Basin Maximum Benefit Monitoring Program.

This Annual Report of the Chino Basin Maximum Benefit Monitoring Program—a requirement of the Water Quality Control Plan for the Santa Ana Basin (Basin Plan), as updated in February 2008 (Regional Board, 2008)—presents the work performed during the 2009 calendar year.

1.1 Investigations of the Relationship between Groundwater Production and Santa Ana River Discharge

Figure 1-1 is a map of the Chino Basin. Groundwater generally flows from the forebay regions in the north and east towards Prado Basin, where rising groundwater can become surface water in the Santa Ana River or its tributaries. Recent and past studies have provided some insight into the influence of groundwater production in the southern end of the Chino Basin on the safe yield of the basin and, hence, the ability to control the outflow of rising groundwater. Three studies, discussed below, quantified the impacts of the groundwater desalters in the southern Chino Basin on groundwater discharge to the Prado Basin and the Santa Ana River.

The proposed desalters were first described in *Nitrogen and TDS Studies, Upper Santa Ana Watershed* (James M. Montgomery, Consulting Engineers, Inc., 1991). This study matched desalter production to meet future potable demands in the lower Chino Basin through the year 2015. Well fields were sited to maximize the interception of rising groundwater and to induce streambed percolation in the Santa Ana River. The decrease in rising groundwater and the increase in streambed percolation were projected to range from 45 to 65 percent of total desalter production.

A design study for the Chino Basin Desalter well fields also provided estimates of the volume of rising groundwater intercepted by Desalter production (Wildermuth, 1993). This study used a detailed model of the lower Chino Basin (a rectangular 400-foot by 400-foot grid covering the southern Chino Basin) to evaluate the hydraulic impacts on rising groundwater and groundwater levels at nearby wells. This study showed the relationship of intercepting rising groundwater to well field locations and capacity. The fraction of total desalter production composed of decreased rising groundwater and increased streambed percolation was estimated to range from 40 to 50 percent.

A subsequent analysis, consistent with the OBMP and the Peace II Agreement, projected the increase in streambed percolation to be closer to 20 percent of desalter production (WEI, 2009d). This projection resulted from evaluating the Peace II project description through 2060 with the updated groundwater flow model, using the existing Chino Desalter wells and the planned Chino Creek Well Field (CCWF).

These three studies suggest that the yield of the Chino Basin could be increased by simply increasing groundwater production near the river. These studies also suggest that an expanded desalter program (as shown in Figure 1-1) and a slight permanent decrease in basin storage will (1) capture all groundwater flowing south from the forebay regions of the Chino Basin and (2) reduce the outflow of high salinity groundwater from the southern Chino Basin to the Santa Ana River, thereby providing greater protection of downstream beneficial uses.

1.2 The OBMP and the 2004 Basin Plan Amendment

The Chino Basin OBMP was developed by Watermaster and the parties to the 1978 Judgment (Chino Basin Municipal Water District *v.* City of Chino, *et al.*). The OBMP maps a strategy that will provide for enhanced yield of the Chino Basin and seeks to provide reliable water supplies for development that is expected to occur within the basin. The goals of the OBMP are: to enhance basin water supplies, to protect and enhance water quality, to enhance the management of the basin, and to equitably finance the OBMP. The OBMP is a comprehensive, long-range water management plan for the Chino Basin and includes the use of recycled water for direct reuse and artificial recharge. It also includes the capture of increased quantities of high quality storm water runoff, the recharge of imported water when total dissolved solids (TDS) concentrations are low, improving the water supply by desalting poor quality groundwater, supporting regulatory efforts to improve water quality in the basin, and the implementation of management activities that will result in reduced outflow of high-TDS/ high-nitrate groundwater to the Santa Ana River and the Orange County Basin, thus ensuring the protection of downstream beneficial uses and water quality (WEI, 1999).

For the Chino Basin, the 1995 Basin Plan contained restrictions on the use of recycled water for irrigation and groundwater recharge. In particular, it contained TDS objectives ranging from 220 to 330 milligrams per liter (mg/L) over most of the Chino Basin. The ambient TDS concentrations in the Chino Basin exceeded these objectives, which meant that no assimilative capacity existed for most of basin. Therefore, the use of IEUA recycled water (~500 mg/L) for irrigation and groundwater recharge, one of the key elements of the OBMP, would require mitigation even though recycled water reuse would not materially impact future TDS concentrations or impair the beneficial uses of Chino Basin groundwater.

In 1995, in part because of these considerations, the Regional Board initiated a collaborative study with 22 water supply and wastewater agencies, including Watermaster and the IEUA, to devise a new TDS and nitrogen management plan for the Santa Ana Watershed. This study culminated in the Regional Board's adoption of a Basin Plan Amendment in January 2004 (Regional Board, 2004). This amendment included revised groundwater subbasin boundaries (termed "management zones"), revised TDS and nitrate-nitrogen objectives for groundwater, revised TDS and nitrogen wasteload allocations, revised reach designations, and revised TDS and nitrogen objectives and beneficial uses for specific surface waters. The technical work supporting the Basin Plan Amendment was directed by the Nitrogen/TDS Task Force (Task Force) and is summarized in *TIN/TDS Phase 2A: Tasks 1 through 5, TIN/TDS Study of the Santa Ana Watershed* (WEI, 2000).

The new TDS and nitrate-nitrogen objectives for the groundwater management zones in the Santa Ana Region were established to ensure that historical quality is maintained, pursuant to the State's antidegradation policy (State Board Resolution No. 68-16). These objectives were termed "antidegradation" objectives. Figure 1-1 shows the antidegradation objectives for the Chino Basin management zones. Note that the antidegradation TDS objectives across most of the Chino Basin are still very low (250-280 mg/L), which would still be restrictive of recycled water reuse and the artificial recharge of imported water.

To address this issue, Watermaster and the IEUA proposed, and the Regional Board accepted, alternative and less stringent "maximum benefit" objectives for a large portion of the Chino Basin. Figure 1-1 also shows the maximum benefit objectives—specifically the 420 mg/L TDS objective—for the Chino-North Management Zone. This maximum benefit TDS objective is higher than the current ambient TDS concentration (340 mg/L in 2006), thus creating assimilative capacity and allowing for recycled water reuse and recharge without mitigation.

The maximum benefit objectives, which allow for the lowering of water quality, were established based on demonstrations by Watermaster and the IEUA that antidegradation requirements were satisfied. First, they demonstrated that beneficial uses would continue to be protected. Second, they showed that water quality consistent with maximum benefit to the people of the State of California would be maintained. Other factors—such as economics, the need to use recycled water, and the need to develop housing in the area—were also taken into account in establishing the maximum benefit objectives.

The Watermaster and IEUA maximum benefit demonstrations are contingent upon the implementation of specific projects and programs. These projects and programs are termed "Chino Basin maximum benefit commitments" and are listed in Table 5-8a of the current Basin Plan and Table 1-1 of this report. These commitments include:

1. The implementation of a surface water monitoring program
2. The implementation of groundwater monitoring program
3. The expansion of Desalter I to 10 million gallons per day (mgd) and the construction of a 10-mgd Desalter II
4. The commitment to additional desalter expansion (20 mgd) pursuant to the OBMP and the Peace Agreement and tied to the IEUA's effluent concentration
5. The completion of the recharge facilities included in the Chino Basin Facilities Improvement Program (CBFIP)

6. The management of recycled water quality to ensure that the 12-month running average agency wastewater effluent quality does not exceed 550 mg/L and 8 mg/L for TDS and TIN, respectively
7. The management of volume-weighted TDS and nitrogen in artificial recharge to less than or equal to the maximum benefit objectives
8. The achievement and maintenance of "hydraulic control" of groundwater outflow from the Chino Basin to protect Santa Ana River water quality
9. The determination of ambient TDS and nitrogen concentrations of Chino Basin groundwater every three years

If these projects and programs are not implemented to the Regional Board's satisfaction, the alternative antidegradation objectives apply for regulatory purposes. In this situation, the Regional Board would require mitigation for TDS and nitrate-nitrogen discharges to these management zones (for both recycled and imported water) that took place in excess of the antidegradation objective limits. The application of the antidegradation objectives would result in a finding that there is no assimilative capacity for TDS in the Chino-1, Chino-2, and Chino-3 Management Zones, thus eliminating the ability to recharge recycled water. This would also restrict the recharge of imported State Water Project (SWP) water when the TDS concentration is in excess of the antidegradation objectives. Figure 1-2 shows the percent of time that the TDS concentration at the Devil Canyon Afterbay will be less than or equal to a specific value based on observed TDS concentrations over the last 30 years. Antidegradation restrictions on the use of SWP water will occur about 30, 48, and 42 percent of the time in Management Zones 1, 2, and 3, respectively. Alternatively, under the maximum benefit objectives, restrictions on SWP water use will only occur one percent of the time in Chino-North.

1.3 Hydraulic Control

The eighth maximum benefit commitment listed above requires Watermaster and the IEUA to achieve and maintain "hydraulic control" of groundwater outflow from the Chino Basin. The Basin Plan defines hydraulic control as "[…] eliminating groundwater discharge from the Chino Basin to the Santa Ana River, or controlling the discharge to *de minimis* levels […]." Watermaster and the IEUA use a more measurable definition of hydraulic control: eliminating groundwater discharge from the Chino-North Management Zone or controlling the discharge to *de minimis* levels. This definition is practical because:

- Chino-North is the only management zone in the Chino Basin with maximum benefit objectives.
- The Chino Desalter well field is located at the downgradient edge of the Chino-North Management Zone and can isolate Chino-North from downgradient groundwater and surface water.
- The groundwater and surface water monitoring programs have demonstrated that rising groundwater from the Chino Basin currently has *de minimis* impacts on the water quality of the Santa Ana River.

- Computer-simulation modeling of groundwater flow in the Chino Basin predicts that future expansion of the Chino Desalters will reduce rising groundwater outflow and, hence, further reduce its impact on the Santa Ana River.
- The elimination of rising groundwater outflow is likely not possible with the current and future configuration of the Chino Desalter well field nor is it desirable given the sensitive flora and fauna in the Prado Basin that are likely dependent on shallow groundwater.

1.4 Hydraulic Control Monitoring Program

The surface water and groundwater monitoring programs listed as the first two maximum benefit commitments in Table 1-1 are, in part, intended to demonstrate whether hydraulic control is being achieved and maintained. Watermaster and the IEUA refer to these monitoring efforts as the Hydraulic Control Monitoring Program (HCMP). HCMP data are analyzed to build multiple lines of evidence. The concept of using multiple lines of evidence was included in the initial design of the HCMP because it was not clear that one line of evidence would be sufficient to demonstrate hydraulic control. The lines of evidence presented in this report are summarized as follows:

- Collect and analyze groundwater elevation data to determine the direction of groundwater flow in the southern part of the basin and whether pumping at the Chino Desalter well field is completely capturing all groundwater flowing south in the Chino-North Management Zone.
- Collect and analyze the chemistry of basin-wide groundwater and the Santa Ana River (a) to track the migration, or lack thereof, of the Ontario International Airport (OIA) volatile organic compound (VOC) plume beyond the Chino Desalter well field, and (b) to identify the source of groundwater in the area between the Santa Ana River and the Chino Desalter well fields.
- Collect and analyze surface water quality data and discharge measurements to determine if groundwater from the Chino Basin is rising as surface water to the Santa Ana River or if the river is percolating and recharging the basin.
- Use Watermaster's computer-simulation groundwater-flow model to corroborate the results and interpretations of the first three lines of evidence.

The remainder of this report describes the HCMP and analyzes and interprets the data to determine whether and to what extent hydraulic control is being achieved and maintained.

1.5 Report Organization

Section 1 – Introduction: This section describes the background and objectives of the HCMP.

Section 2 – Work Performed in 2009: Section 2 describes the data collected in 2009 as part of the HCMP.

Section 3 – Analysis of Monitoring Data to Evaluate Hydraulic Control: Section 3 describes the analyses of the data collected in 2009 and interprets the results for each line of evidence used to demonstrate the extent of hydraulic control.

Section 4 – Conclusions and Recommendations: Section 4 summarizes the overall conclusions drawn in Section 3 and makes recommendations for future modifications to the HCMP.

Section 5 – References: Section 5 provides the references consulted in performing the analyses described herein and those consulted in writing this report.

Table 1-1
Chino Basin Maximum Benefit Commitments

Description of Commitment	Compliance Date – as soon as possible, but no later than
1. Surface Water Monitoring Program a. Submit Draft Monitoring Program to Regional Board b. Implement Monitoring Program c. Quarterly data report submittal d. Annual data report submittal	 a. (**30 days from date of approval of this amendment*)* b. Within 30 days from date of Regional Board approval of monitoring plan c. April 15, July 15, October 15, January 15 d. February 15th
2. Groundwater Monitoring Program a. Submit Draft Monitoring Program to Regional Board b. Implement Monitoring Program c. Annual data report submittal	 a. (**30 days from date of approval of this amendment*)* b. Within 30 days from date of Regional Board approval of monitoring plan c. February 15th
3. Chino Desalters a. Chino I desalter expansion to 10 MGD b. Chino II desalter at 10 MGD design	 a. Prior to recharge of recycled water b. Recharge of recycled water allowed once award of contract and notice to proceed issued for construction of desalter
4. Future desalters plan and schedule submittal	October 1, 2005 Implement plan and schedule upon Regional Board approval
5. Recharge facilities (17) built and in operation	June 30, 2004
6. IEUA wastewater quality improvement plan and schedule submittal	60 days after agency-wide 12 month running average effluent TDS quality equals or exceeds 545 mg/L for 3 consecutive months or agency-wide 12 month running average TIN equals or exceeds 8 mg/L in any month.
7. Recycled water will be blended with other recharge sources so that the 5-year running average TDS and nitrate-nitrogen concentrations of water recharged are equal to or less than the "maximum benefit" water quality objectives for the affected Management Zone (Chino North or Cucamonga). a. Submit baseline report of amount, locations and TDS and nitrogen quality of stormwater recharge b. Submit documentation of amount, TDS and nitrogen quality of all sources of recharge and recharge locations. For stormwater recharge used for blending, submit documentation that the recharge is the result of Watermaster/IEUA enhanced recharge facilities.	Compliance must be achieved by end of 5th year after initiation of recycled water recharge operations. a. Prior to initiation of construction of basins/other facilities to support enhanced stormwater recharge b. Annually, by February 15th, after initiation of construction of basins/other facilities to support enhanced stormwater recharge.
8. Hydraulic Control Failure a. Plan and schedule to correct loss of hydraulic control b. Achievement and maintenance of hydraulic control c. Mitigation plan for temporary failure to achieve/maintain hydraulic control	 a. 60 days from Regional Board finding that hydraulic control is not being maintained b. In accordance with plan and schedule approved by Regional Board. The schedule shall assure that hydraulic control is achieved as soon as possible but no later than 180 days after loss of hydraulic control is identified. c. By (**30 days from effective date of this Basin Plan amendment**). Implement plan upon Regional Board determination that hydraulic control is not being maintained.
9. Ambient water quality determination	July 1, 2005 and every 3 years thereafter

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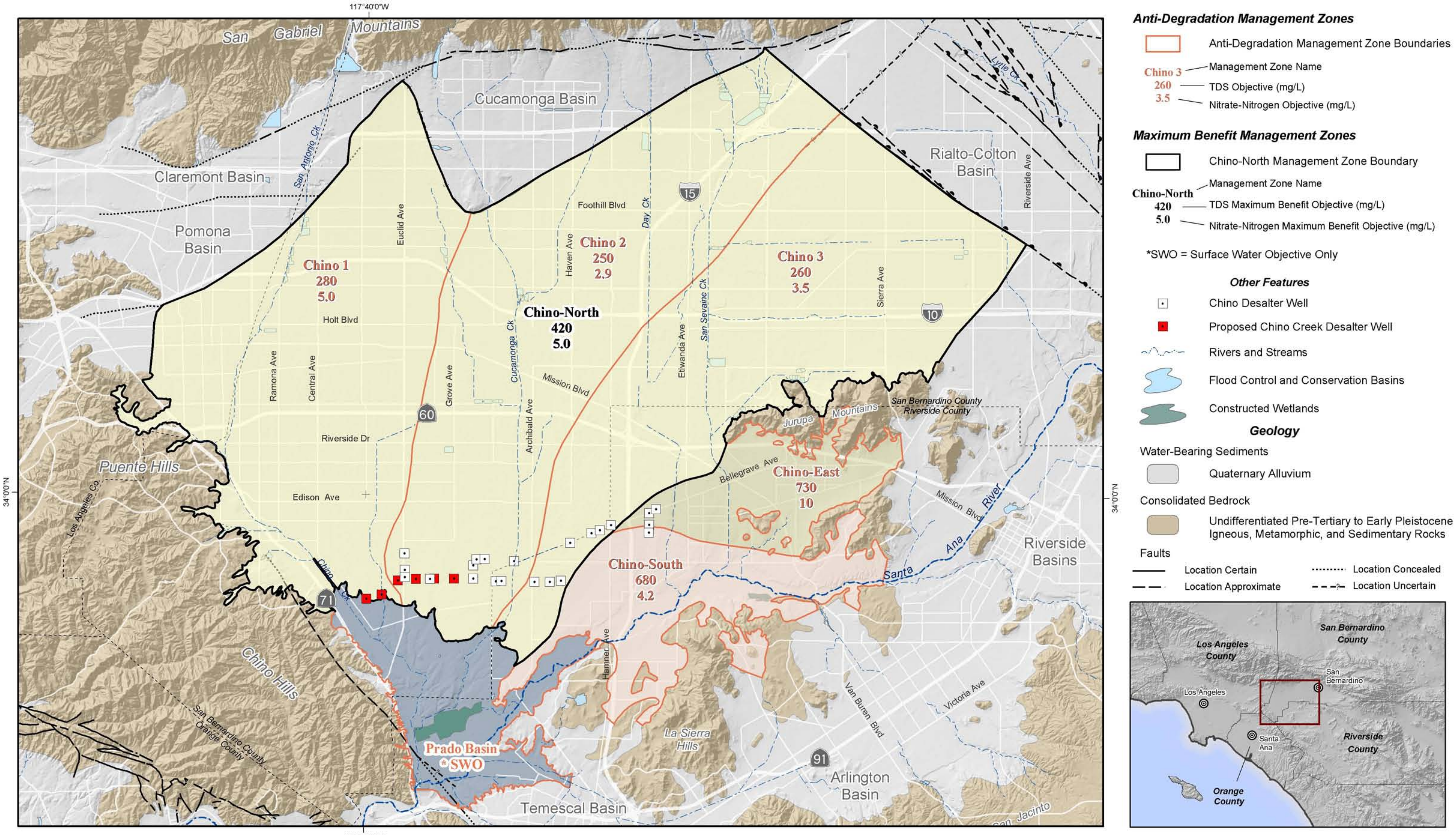

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Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Chino Basin Management Zones

Antidegradation & Maximum Benefit Objectives for TDS and Nitrate-Nitrogen

Figure 1-1

Figure 1- 2
Historical TDS Concentration in State Water Project Water at Devil Canyon

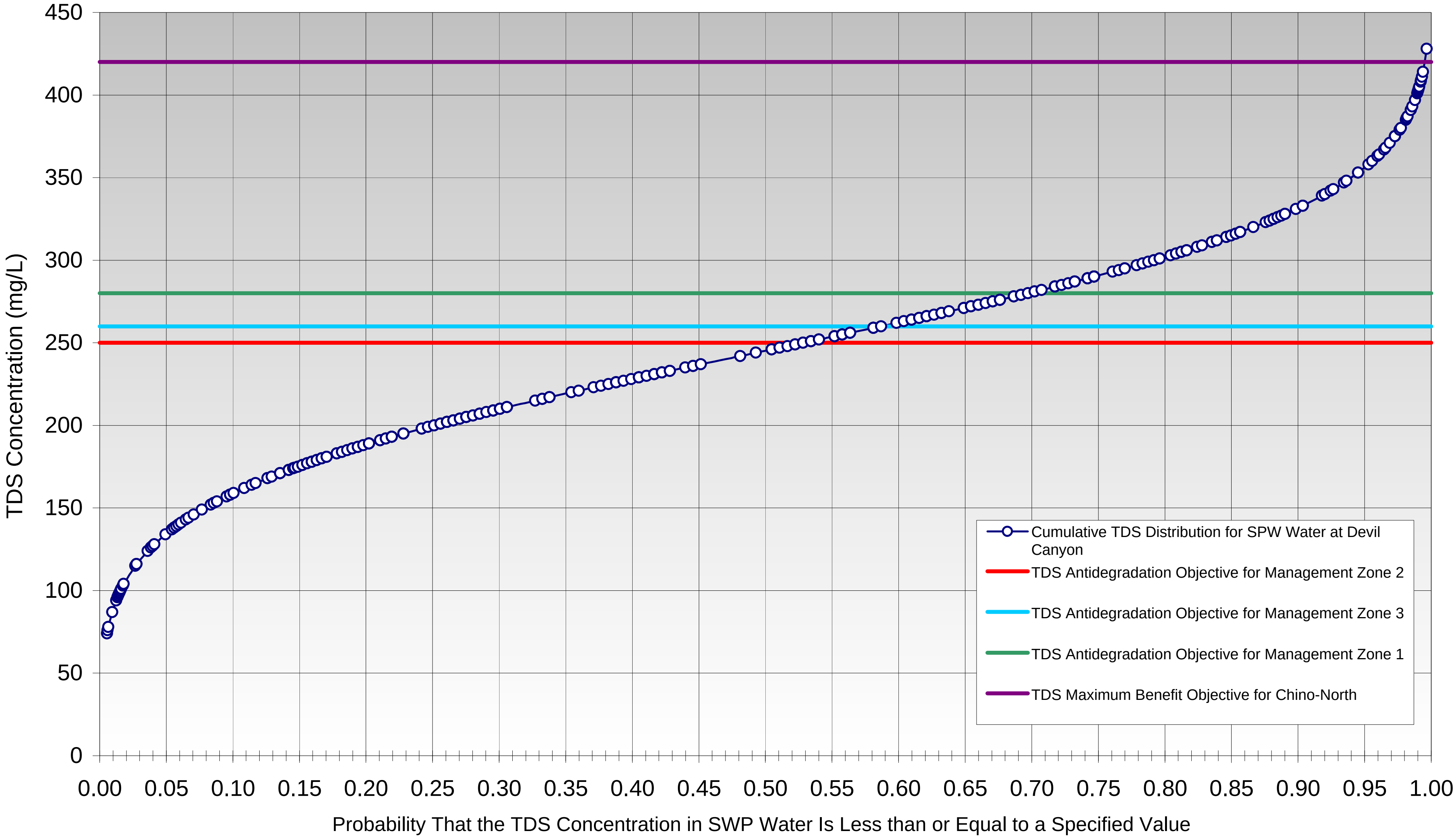

Figure 1-2_v2

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2.1 Groundwater Monitoring Program

Watermaster's Groundwater Monitoring Program consists of two main components: a groundwater level monitoring program and a groundwater quality monitoring program. These monitoring programs were designed and implemented to support the OBMP program elements and the other regulatory requirements of Watermaster and the IEUA. Watermaster's Groundwater Monitoring Program is briefly described below with specific reference to the monitoring requirements of the Watermaster/IEUA maximum benefit commitments.

2.1.1 Groundwater Level Monitoring Program

The primary challenges with historical, pre-OBMP groundwater level monitoring include 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 to support the implementation of OBMP program elements. The program startup occurred in two steps: an initial survey of all wells that could be measured for water levels from 1998 to 2001, followed by long-term monitoring at a set of key wells.

Currently, about 700 wells comprise Watermaster's groundwater level monitoring program. These wells are shown in Figure 2-1, symbolized by their measurement frequency. At about 500 of these wells, water levels are measured by well owners, which include municipal water agencies, the California Department of Toxic Substance Control (DTSC), the County of San Bernardino, and various private consulting firms. The measurement frequency is typically about once per month. Watermaster collects these water level data twice per year. The remaining 200 wells are private wells or dedicated monitoring wells that are mainly located in the southern portion of the Chino Basin. Watermaster staff measures water levels at these wells using manual methods once per month or with pressure transducers that record water levels once every 15 minutes.

The wells in the monitoring program within the southern portion of the basin were preferentially selected to assist in Watermaster's monitoring programs for hydraulic control, land subsidence, and desalter impacts to private well owners. Note that the density of groundwater level monitoring wells near the desalter well fields is greater than in outlying areas, given that hydraulic gradients are expected to be steeper near the desalter well fields.

The water level data are checked by Watermaster staff and uploaded to a centralized relational database.

2.1.2 Groundwater Quality Monitoring Program

Watermaster obtains groundwater quality samples and data for the triennial ambient water quality update mandated by the Basin Plan and for the HCMP, a maximum benefit requirement of the Basin Plan. These data are also used for the Biennial State of the Basin report, for groundwater modeling, to monitor non-point source groundwater contamination and plumes associated with point source discharges, and to assess the overall health of the groundwater basin.

Watermaster obtains the requisite data through several groundwater quality monitoring programs:

- **Key Well Monitoring Program (KWMP)**. Watermaster collects groundwater quality samples from a network of about 120 private wells in the southern portion of the Chino Basin. About twenty of these wells are sampled every year; the remaining wells are sampled every three years. Watermaster is constantly analyzing and revising the KWMP as private wells are abandoned due to urban development.
- **Chino Basin Data Collection (CBDC)**. Watermaster's program routinely and proactively collects groundwater quality data from municipal producers and other government agencies. Water quality data are also obtained from special studies and monitoring that takes place under the orders of the Regional Board (landfills, groundwater quality investigations, etc.), the DTSC (Stringfellow NPL site), the US Geological Survey (USGS), and others.
- **HCMP**. Watermaster collects groundwater quality samples from the nine nested HCMP monitoring wells to demonstrate whether hydraulic control is being achieved. Watermaster is evaluating whether additional monitoring wells will be required to aid in determining the achievement of hydraulic control. In addition, Watermaster collects monthly samples from four near-river wells to characterize the interaction of the Santa Ana River and groundwater. These shallow monitoring wells along the Santa Ana River consist of two former USGS National Water Quality Assessment Program (NAWQA) wells (Archibald 1 and Archibald 2) and two Santa Ana River Water Company (SARWC) wells (well 9 and well 11).
- **Non-Annual Monitoring Programs**. Watermaster develops and executes other groundwater quality monitoring programs on an as-needed basis to assess the health of the groundwater basin and to obtain the information necessary to actively manage the basin such that supply and water quality are optimized. For example, Watermaster conducted a perchlorate isotope study to determine whether the source of widespread, generally low-concentration perchlorate was of synthetic or Chilean fertilizer origin. And, Watermaster recently completed a groundwater quality study of Management Zone 3.

A quality assurance/quality control (QA/QC) program is conducted prior to uploading data into Watermaster's relational database management system. Watermaster has worked closely with Appropriative Pool members and their state-certified laboratories to obtain water quality data as electronic data deliverables directly from the lab.

2.1.2.1 Key Well Water Quality Monitoring Program

Wells for the KWMP were selected through the following process:

- The basin was divided into a grid with each cell being approximately 1 square mile, based on the township/range grid.
- For each grid cell, the average values and time histories for TDS, nitrate-nitrogen, and trichloroethene (TCE) were reviewed, using the last five years of available data.
- If available, well construction information was reviewed to determine the layer(s) in which the well screens were constructed.
- The wells that most closely matched the average constituent concentrations for each respective grid cell and layer were then selected. In total, one to two wells were retained in each grid square for sampling; alternates were selected if the primary well could not be sampled. Preference was given to wells with the following characteristics:
  - Known construction
  - Choice as a groundwater level key well
  - Likelihood of ability to sample in future years

Initially, about 110 key wells were identified through this process. On average, about 50 wells are sampled every year. As key wells are lost to development, nearby wells are evaluated for suitability as replacements.

Some years, the KWMP is modified to address specific concerns. In 2007, for example, Watermaster focused the KWMP in and around the south edge of the OIA VOC plume, as the Primary Responsible Parties were in the process of drilling and installing four nested monitoring wells in the area upgradient of the plume. Similarly, in 2008, the KWMP was focused on the Chino Airport VOC plume in order to characterize its nature and extent while the Chino Desalter Authority's (CDA) consultants were developing a conceptual design for the proposed CCWF. In 2009, the KWMP focused on sampling wells to obtain a third sample of TDS and nitrate-nitrogen for inclusion in the upcoming Ambient Water Quality analysis.

The field activities for this project are in general accordance with the guidelines established by the California EPA (1994) and the US EPA (1998) and are outlined in the *Final Hydraulic Control Monitoring Program Work Plan* (WEI, 2004). These protocols are followed to ensure the collection of high quality and well documented data. Groundwater samples are tested for the analytes listed in Table 2-1. VOCs are sampled at wells within or adjacent to the plumes.

2.1.2.2 Wells Sampled in 2009

In 2009, the KWMP well network was reevaluated and divided into two groups: (1) wells to be sampled annually, and (2) wells to be sampled every three years. The annual well list was instituted for the continued monitoring of the areas of concern associated with the southern edge of the OIA VOC plume, the southern region of the Chino Airport plume near the proposed Chino Creek desalter well field, and the MZ3 area. The triennial list consists of the remaining key wells. During 2009, 45 KWMP wells were sampled, of which, 16 were sampled for VOCs.

Sampling at the nine nested HCMP wells was done during the months of February, June, and September 2009, resulting in 63 samples and approximately 7,000 analytical determinations. Monthly sampling at the near-river wells resulted in 36 samples and approximately 1,200 analytical determinations. During 2009, SARWC well 9 was shut down for repair from January through March and could not be sampled as part of the monthly program. Through the CBDC program, Watermaster obtained water quality data for approximately 370 wells throughout the Chino Basin. Figure 2-2 shows the locations of all wells from which water quality data were analyzed in 2009. All water quality data collected in 2009 as part of the HCMP are contained in an Access database, which has been included with this report as Appendix A.

2.2 Surface Water Monitoring Program

Table 2-2 lists the stations included in the initial Surface Water Monitoring Program (SWMP) and the frequency at which these stations are to be monitored. The stations and monitoring frequencies are based on Table 5-8b of the 2004 Basin Plan Amendment. The locations of these stations are shown in Figure 2-3. These stations were selected, in part, because they have some historical data and were part of existing monitoring programs: data could be collected from the monitoring agencies, including the Orange County Water District (OCWD), USGS, City of Corona, City of Riverside, IEUA, and Western Riverside County Regional Wastewater Authority (WRCRWA). These surface water stations are monitored at varying frequencies for discharge and water quality. Water quality samples are analyzed for general minerals, general physical, and nitrogen components. On October 19, 2005, a list of analytes was formalized by the Regional Board (see Table 2-3).

Since the approval of the SWMP, several changes have occurred. Three stations—*SAR-DIV-PRADOWTLNDS*, *RP2*, and *11073440*—are no longer active. And, the OCWD no longer monitors the 11 surface water stations at the specified biweekly frequencies. In November 2005, Watermaster began monitoring surface water stations *Chino Creek at Pine Ave* and *Mill Creek at Chino-Corona*, which are near the *CK-CHINO* and *CK-MILL* stations, on a biweekly basis to replace the OCWD monitoring sites. The USGS monitoring station *11072100*, which is upstream of *CK-TEMESCAL*, was added to the program to replace the *CK-TEMESCAL* station. Data from the OCWD is provided when available. USGS gaging stations *11073300*, *11073360*, and *11073493* were added to the program as a result of the *Draft Chino Basin Maximum Benefit Implementation Plan for Salt Management and Commitments from the Chino Basin Watermaster and Inland Empire Utilities Agency*, dated February 20, 2004.

Table 2-4 reflects these SWMP surface water station modifications. Note that Table 2-4 does not show the Day Creek monitoring site. This site is not formally part of the HCMP program; however, water quality and discharge measurements are collected when flow is present and are included in the calculation of rising groundwater for the Santa Ana River. The locations of the actively monitored stations are shown in Figure 2-4.

2.2.1 Surface Water Quality Sampling

Table 2-5 shows the weeks in which surface water quality samples were collected at active surface water stations in 2009. Surface water quality samples were not collected at *Chino Creek at Schaefer* and *San Antonio Creek* during weeks 4 and 8 due to weather related access closures nor during weeks 20 and 22 due to locked access to the site. And, water quality samples were not collected at *San Antonio Creek, Chino Creek at Schaefer, Mill Creek*, nor *Santa Ana River below Prado Dam* during week 42 due to heavy rain, which restricted access to the sites. It was not possible to collect water quality samples at *Santa Ana River at River Road* during week 6 due to construction, which blocked access to the site. In 2009, about 500 water quality samples were collected at 21 stations, resulting in approximately 14,000 analytical determinations. All surface water quality data collected in 2009 as part of the HCMP are contained in an Access database, which has been included with this report as Appendix A.

2.2.2 Surface Water Discharge Measurements

Table 2-6 shows the weeks in which discharge measurements were collected at active surface water stations in 2009. Direct discharge measurements were not collected at *Santa Ana River at River Road* from weeks 6 through 52 due to construction activities, which blocked access to site. Direct discharge measurements were not collected at the four Santa Ana River stations, *Chino Creek at Pine Ave.*, nor *Hole Lake Outlet* during weeks 8, 42, week 50, and week 52 as rain events caused high discharge conditions in the River. During high discharge conditions, direct discharge measurements cannot be safely collected. In 2009, approximately 110 direct discharge measurements were made, and 6,200 daily measurements were collected from USGS gaging stations or treatment plant effluent flow meters. All surface water discharge data collected in 2009 as part of the HCMP are contained in an Access database, which has been included with this report as Appendix A.

2.3 Desalter Groundwater Production

Watermaster monitors all groundwater production in the Chino Basin, including that of the wells that supply the Chino Basin Desalters. Desalter pumping is fundamental to achieving hydraulic control, maximizing the yield of the Chino Basin, minimizing the loss of stored water, and protecting Santa Ana River water quality. Watermaster's goal—as articulated in the OBMP Phase 1 Report (WEI, 1999), the Peace Agreement, and the recent Court approved Peace II process—is to expand desalter product water deliveries from the current level of about 25,300 acre-ft/yr to the full capacity of about 34,800 acre-ft/yr. This corresponds to an increase in desalter well production from the current level of 27,700 acre-ft to about 39,400 acre-ft/yr.

Figure 2-5 shows annual desalter groundwater production since the desalters began pumping. During 2009, groundwater production by the Chino-I Desalter was about 14,700 acre-ft, a decrease of 4.6 percent from 2008 pumping. For the Chino-II Desalter, groundwater production was about 13,000 acre-ft, an 11.2 percent decrease from 2008.

Table 2-1
Analyte List for the Key Well Water Quality Monitoring Program

Analyte	Method
Major cations: B, Ca, Fe, Mg, K, Si, Na, Sr	EPA 200.7
Major anions: Cl, SO_4, NO_2, NO_3	EPA 300.0
Major Trace Elements Al, As, Ba, Cr, Mn	EPA 200.8
Total Hardness	SM 2340B
Total Alkalinity	SM 2320B
Carbonate, Bicarbonate, Hydroxide	SM 2330B
Ammonia Nitrogen	EPA 350.1
Fluoride	SM 4500F-C
Gross Alpha/Beta	EPA 900.0
Hexavalent Chromium	EPA 218.6
Perchlorate	EPA 314.0
pH	SM2330B/SM 4500-HB
Specific Conductance	SM 2510B
TDS	EPA 160.1/SM 2540C
Total Kjeldahl Nitrogen (TKN)	EPA 351.2
Total Organic Carbon	SM5310C/E415.3
Total Phosphorus	SM4500-PE/EPA 365.1
Turbidity	EPA 180.1
VOCs	EPA 524.2
1,2,3 -Trichloropropane (Low Detection)	CASRL 524M-TCP

Table 2-2
Surface Water Monitoring Sites as Defined in Table 5-8b of the Basin Plan Amendment

Site Name	Discharge	Owner	Type	Discharge Monitoring		Water Quality Monitoring		
				Frequency	Period	Frequency	Period	Analyses
11066460	Santa Ana River	USGS	Total Discharge	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
11072100	Temescal Creek	USGS	Total Discharge	Bi-weekly	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
11073495	Cucamonga Creek	USGS	Total Discharge	Bi-weekly	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
11073440	Chino Creek	USGS	Total Discharge	Bi-weekly	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
11074000	Santa Ana River	USGS	Total Discharge	Bi-weekly	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
RWQCP Direct	Recycled Water	City of Riverside	Recycled Water	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
RWQCP Hidden Valley	Recycled Water	City of Riverside	Recycled Water	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
Corona RW	Recycled Water	City of Corona	Recycled Water	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
RP1 Cucamonga	Recycled Water	IEUA	Recycled Water	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
RP1 Prado	Recycled Water	IEUA	Recycled Water	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
RP2	Recycled Water	IEUA	Recycled Water	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
Carbon Canyon	Recycled Water	IEUA	Recycled Water	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
RP5	Recycled Water	IEUA	Recycled Water	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
WRCRWTP	Recycled Water	WRCRWA	Recycled Water	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
SAR-MWDXing	Santa Ana River	OCWD	Total Discharge	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
SAR-HOLELK-01	Hole Lake	OCWD	Total Discharge	Bi-weekly	May-Sep	Bi-weekly	Jan - Dec	Gen. Min. & Physical
SAR-VANBUREN	Santa Ana River	OCWD	Total Discharge	Bi-weekly	May-Sep	Bi-weekly	Jan - Dec	Gen. Min. & Physical
SAR-ETIWANDA-01	Santa Ana River	OCWD	Total Discharge	Bi-weekly	May-Sep	Bi-weekly	Jan - Dec	Gen. Min. & Physical
SAR-HAMNER-01	Santa Ana River	OCWD	Total Discharge	Bi-weekly	May-Sep	Bi-weekly	Jan - Dec	Gen. Min. & Physical
SAR_RIVRD	Santa Ana River	OCWD	Total Discharge	Bi-weekly	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
SAR-DIV-PRADOWLNDS	Santa Ana River	OCWD	Total Discharge	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
SAR-BELOWDAM-01	Santa Ana River	OCWD	Total Discharge	Daily	Jan - Dec	Bi-weekly	Jan - Dec	Gen. Min. & Physical
CK-CHINO	Chino Creek	OCWD	Total Discharge	Bi-weekly	May-Sep	Bi-weekly	Jan - Dec	Gen. Min. & Physical
CK-MILL	Cucamonga Creek	OCWD	Total Discharge	Bi-weekly	May-Sep	Bi-weekly	Jan - Dec	Gen. Min. & Physical
CK-TEMESCAL	Temescal Creek	OCWD	Total Discharge	Bi-weekly	May-Sep	Bi-weekly	Jan - Dec	Gen. Min. & Physical

Table 2-3
Surface Water Monitoring Program Analytes

Analytes	Method
Major cations: K, Na, Ca, Mg	EPA 200.7
Major anions: Cl, SO_4, NO_2, NO_3	EPA 300.0
Total Alkalinity	SM 2320B
Carbonate, Bicarbonate, Hydroxide	SM 2330B
Ammonia-Nitrogen	EPA 350.1
Electrical Conductivity	SM 2510B
Perchlorate (Low Detection)	ML/EPA 314
pH	SM 4500-HB
Total Dissolved Solids	E160.1/SM2540C
Total Hardness	SM 2340B
Total Kjeldahl Nitrogen (TKN)	EPA 351.2
Turbidity	EPA 180.1
Total Organic Carbon	SM5310C/E415.3

Table 2-4
Active Surface Water Monitoring Sites

Site Name	Discharge	Type	Discharge Monitoring		Discharge	Water Quality Monitoring			Water Quality
			Frequency	Period	Monitoring Entity	Frequency	Period	Analyses	Monitoring Entity
11066460/SAR at MWD Xing	Santa Ana River	Total Discharge	Daily	Jan - Dec	USGS	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
SAR at Van Buren	Santa Ana River	Total Discharge	Bi-weekly	Jan - Dec	CBWM	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
Hole Lake Outlet	Hole Lake Outlet	Total Discharge	Bi-weekly	Jan - Dec	CBWM	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
RWQCP Direct	Recycled Water	Recycled Water	Daily	Jan - Dec	City of Riverside	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM/Riverside
SAR at Etiwanda	Santa Ana River	Total Discharge	Bi-weekly	Jan - Dec	CBWM	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
RWQCP Hidden Valley (Wetland Diversion)	Recycled Water	Recycled Water	Daily	Jan - Dec	City of Riverside	N/A	Jan - Dec	Gen. Min. & Physical	N/A
SAR at Hamner	Santa Ana River	Total Discharge	Bi-weekly	Jan - Dec	CBWM	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
SAR at River Road	Santa Ana River	Total Discharge	Bi-weekly	Jan - Dec	CBWM	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
WRCRWTP	Recycled Water	Recycled Water	Daily	Jan - Dec	WRCRWA	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM/WRCRWA
11073493/Cucamonga Creek above Ely Basin	Cucamonga Creek	Total Discharge	Daily	Jan - Dec	USGS	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
RP1 Cucamonga	Recycled Water	Recycled Water	Daily	Jan - Dec	IEUA	Bi-weekly	Jan - Dec	Gen. Min. & Physical	IEUA
11073495/Cucamonga Creek near Mira Loma	Cucamonga Creek	Total Discharge	Daily	Jan - Dec	USGS	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
Mill Creek at Chino-Corona[1]	Cucamonga Creek	Total Discharge	N/A	Jan - Dec	CBWM	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
11073300/San Antonio Creek	San Antonio Creek	Total Discharge	Daily	Jan - Dec	USGS	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
11073360/Chino Creek at Schaefer	Chino Creek	Total Discharge	Daily	Jan - Dec	USGS	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
Carbon Canyon	Recycled Water	Recycled Water	Daily	Jan - Dec	IEUA	Bi-weekly	Jan - Dec	Gen. Min. & Physical	IEUA
RP5	Recycled Water	Recycled Water	Daily	Jan - Dec	IEUA	Bi-weekly	Jan - Dec	Gen. Min. & Physical	IEUA
Chino Creek at Pine Ave	Chino Creek	Total Discharge	Bi-weekly	Jan - Dec	CBWM	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
RP1 Prado	Recycled Water	Recycled Water	Daily	Jan - Dec	IEUA	Bi-weekly	Jan - Dec	Gen. Min. & Physical	IEUA
11072100/Temescal Channel above Main at Corona	Temescal Creek	Total Discharge	Daily	Jan - Dec	USGS	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM
Corona RW	Recycled Water	Recycled Water	Daily	Jan - Dec	City of Corona	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM/Corona
11074000/SAR below Prado Dam	Santa Ana River	Total Discharge	Daily	Jan - Dec	USGS	Bi-weekly	Jan - Dec	Gen. Min. & Physical	CBWM/OCWD

[1] No discharge measurements were collected at this station; the flow is comparable to the upstream gage station at Cucamonga Creek near Mira Loma.

Table 2-5
Water Quality Samples Collected in 2009

Site Name	Discharge	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Week 14	Week 15	Week 18	Week 20	Week 22	Week 24	Week 26
11066460/SAR at MWD Xing	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at Van Buren	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X
Hole Lake Outlet	Hole Lake Discharge at SAR	X	X	X	X	X	X	X	X	X	X	X	X	X
RWQCP Direct	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at Etiwanda	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X
RWQCP Hidden Valley	Recycled Water	N/A	N/A	N/A	N/A	N/A	N/A	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]
SAR at Hamner	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at River Road	Santa Ana River	X	X	--	X	X	X	X	X	X	X	X	X	X
WRCRWTP	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11073493/Cucamonga Creek above Ely Basin	Cucamonga Creek	X	X	X	X	X	X	X	X	X	X	X	X	X
RP1 Cucamonga	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11073495/Cucamonga Creek near Mira Loma	Cucamonga Creek	X	X	X	X	X	X	X	X	X	X	X	X	X
Mill Creek at Chino-Corona	Cucamonga Creek	X	X	X	X	X	X	X	X	X	X	X	X	X
11073300/San Antonio Creek	San Antonio Creek	X	--	X	--	X	X	X	X	X	--	--	X	X
11073360/Chino Creek at Schaefer	Chino Creek	X	--	X	--	X	X	X	X	X	--	--	X	X
Carbon Canyon	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
RP5	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
Chino Creek at Pine Ave	Chino Creek	X	X	X	X	X	X	X	X	X	X	X	X	X
RP1 Prado	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11072100/Temescal Channel above Main at Corona	Temescal Creek	X	X	X	X	X	X	X	X	X	X	X	X	X
Corona RW	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11074000/SAR below Prado Dam	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X

"X" indicates that a water quality sample was collected.

"--" indicates that a water quality sample was not collected due to blocked access to the site, high flow, and/or unsafe conditions in the river.

N/A - Flows leaving Hidden Valley were not monitored for water quality by the City of Riverside during this time because no effluent flows were diverted through the wetlands.

[1] Only Total Inorganic Nitrogen (TIN) samples were collected.

Table 2-5 Continued
Water Quality Samples Collected in 2009

Site Name	Discharge	Week 28	Week 30	Week 32	Week 34	Week 36	Week 38	Week 40	Week 42	Week 44	Week 46	Week 48	Week 50	Week 52
11066460/SAR at MWD Xing	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at Van Buren	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X
Hole Lake Outlet	Hole Lake Discharge at SAR	X	X	X	X	X	X	X	X	X	X	X	X	X
RWQCP Direct	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at Etiwanda	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X
RWQCP Hidden Valley [1]	Recycled Water	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]
SAR at Hamner	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at River Road	Santa Ana River	X	X	X	X	X	X	X	X	X	X	X	X	X
WRCRWTP	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11073493/Cucamonga Creek above Ely Basin	Cucamonga Creek	X	X	X	X	X	X	X	X	X	X	X	X	X
RP1 Cucamonga	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11073495/Cucamonga Creek near Mira Loma	Cucamonga Creek	X	X	X	X	X	X	X	X	X	X	X	X	X
Mill Creek at Chino-Corona	Cucamonga Creek	X	X	X	X	X	X	X	--	X	X	X	X	X
11073300/San Antonio Creek	San Antonio Creek	X	X	X	X	X	X	X	--	X	X	X	X	X
11073360/Chino Creek at Schaefer	Chino Creek	X	X	X	X	X	X	X	--	X	X	X	X	X
Carbon Canyon	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
RP5	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
Chino Creek at Pine Ave	Chino Creek	X	X	X	X	X	X	X	X	X	X	X	X	X
RP1 Prado	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11072100/Temescal Channel above Main at Corona	Temescal Creek	X	X	X	X	X	X	X	X	X	X	X	X	X
Corona RW	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11074000/SAR below Prado Dam	Santa Ana River	X	X	X	X	X	X	X	--	X	X	X	X	X

"X" indicates that a water quality sample was collected.

"--" indicates that a water quality sample was not collected due to blocked access to the site, high flow, and/or unsafe conditions in the river.

N/A - Flows leaving Hidden Valley were not monitored for water quality by the City of Riverside during this time because no effluent flows were diverted through the wetlands.

[1] Only Total Inorganic Nitrogen (TIN) samples were collected.

Table 2-6
Discharge Data Collected in 2009

Site Name	Discharge	Type	Week 2	Week 4	Week 6	Week 8	Week 10	Week 12	Week 14	Week 16	Week 18	Week 20	Week 22	Week 24	Week 26
11066460/SAR at MWD Xing[1]	Santa Ana River	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at Van Buren[2]	Santa Ana River	Total Discharge	X	X	X	--	X	X	X	X	X	X	X	X	X
Hole Lake Outlet[2]	Hole Lake Outlet	Total Discharge	X	X	X	--	X	X	X	X	X	X	X	X	X
RWQCP Direct[1]	Recycled Water	Recycled Water	X	X	X		X	X	X	X	X	X	X	X	X
SAR at Etiwanda[2]	Santa Ana River	Total Discharge	X	X	X	--	X	X	X	X	X	X	X	X	X
RWQCP Hidden Valley	Recycled Water	Recycled Water	N/A	N/A	N/A	N/A	N/A	N/A	X	X	X	X	X	X	X
SAR at Hamner[2]	Santa Ana River	Total Discharge	X	X	X	--	X	X	X	X	X	X	X	X	X
SAR at River Road[2]	Santa Ana River	Total Discharge	X	X	--	--	--	--	--	--	--	--	--	--	--
WRCRWTP[1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11073493/Cucamonga Creek above Ely Basin[1]	Cucamonga Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
RP1 Cucamonga[1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11073495/Cucamonga Creek near Mira Loma[1]	Cucamonga Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
Mill Creek at Chino-Corona[3]	Cucamonga Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
11073300/San Antonio Creek[1]	San Antonio Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
11073360/Chino Creek at Schaefer[1]	Chino Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
Carbon Canyon[1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
RP5[1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
Chino Creek at Pine Ave	Chino Creek	Total Discharge	X	X	X	--	X	X	X	X	X	X	X	X	X
RP1 Prado[1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11072100/Temescal Channel above Main at Corona[1]	Temescal Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
Corona RW[1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11074000/SAR below Prado Dam[1]	Santa Ana River	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X

"X" indicates that a water quality sample was collected.
"--" indicates that a water quality sample was not collected due to blocked access to the site, high flow, and/or unsafe conditions in the river.
N/A - Flows leaving Hidden Valley were not monitored for water quality by the City of Riverside during this time because no effluent flows were diverted through the wetlands.
1Daily discharge data were collected.
[2]Discharge measurements were not collected during high discharge periods due to unsafe conditions.
[3]Discharge data were available at nearby site 11072100.

Table 2-6 Continued
Discharge Data Collected in 2009

Site Name	Discharge	Type	Week 28	Week 30	Week 32	Week 34	Week 36	Week 38	Week 40	Week 42	Week 44	Week 46	Week 48	Week 50	Week 52
11066460/SAR at MWD Xing [1]	Santa Ana River	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at Van Buren [2]	Santa Ana River	Total Discharge	X	X	X	X	X	X	X	--	X	X	X	--	--
Hole Lake Outlet [2]	Hole Lake Outlet	Total Discharge	X	X	X	X	X	X	X	--	X	X	X	--	--
RWQCP Direct [1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at Etiwanda [2]	Santa Ana River	Total Discharge	X	X	X	X	X	X	X	--	X	X	X	--	--
RWQCP Hidden Valley	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
SAR at Hamner [2]	Santa Ana River	Total Discharge	X	X	X	X	X	X	X	--	--	X	X	--	--
SAR at River Road [2]	Santa Ana River	Total Discharge	--	--	--	--	--	--	--	--	--	--	--	--	--
WRCRWTP [1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11073493/Cucamonga Creek above Ely Basin [1]	Cucamonga Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
RP1 Cucamonga [1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11073495/Cucamonga Creek near Mira Loma [1]	Cucamonga Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
Mill Creek at Chino-Corona [3]	Cucamonga Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
11073300/San Antonio Creek [1]	San Antonio Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
11073360/Chino Creek at Schaefer [1]	Chino Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
Carbon Canyon [1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
RP5 [1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
Chino Creek at Pine Ave	Chino Creek	Total Discharge	X	X	X	X	X	X	X	--	X	X	X	--	--
RP1 Prado [1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11072100/Temescal Channel above Main at Corona [1]	Temescal Creek	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X
Corona RW [1]	Recycled Water	Recycled Water	X	X	X	X	X	X	X	X	X	X	X	X	X
11074000/SAR below Prado Dam [1]	Santa Ana River	Total Discharge	X	X	X	X	X	X	X	X	X	X	X	X	X

"X" indicates that a water quality sample was collected.

"--" indicates that a water quality sample was not collected due to blocked access to the site, high flow, and/or unsafe conditions in the river.

N/A - Flows leaving Hidden Valley were not monitored for water quality by the City of Riverside during this time because no effluent flows were diverted through the wetlands.

1Daily discharge data were collected.

[2]Discharge measurements were not collected during high discharge periods due to unsafe conditions.

[3]Discharge data were available at nearby site 11072100.

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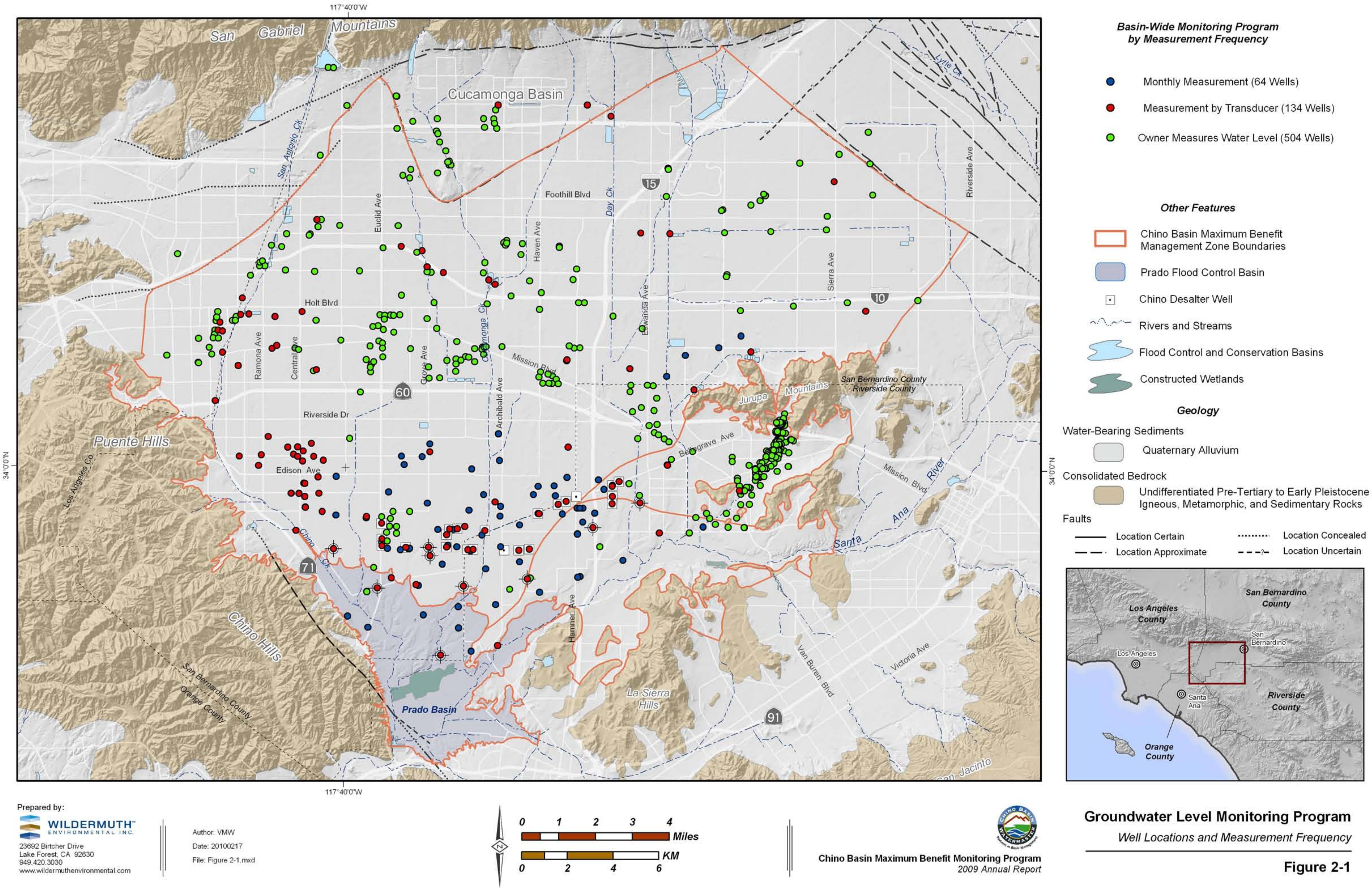

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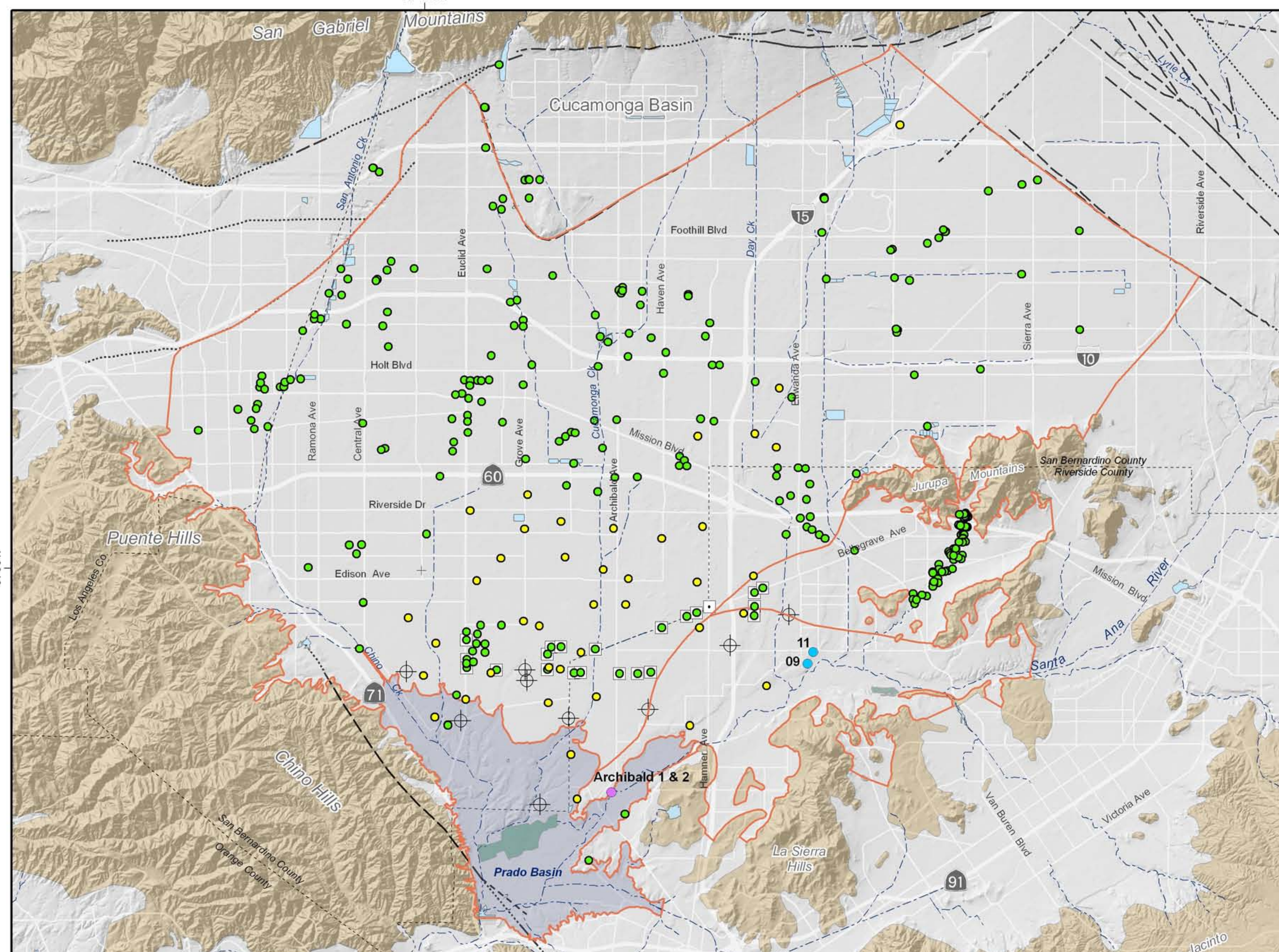
Date: 20100217
File: Figure 2-1.mxd

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Groundwater Level Monitoring Program

Well Locations and Measurement Frequency

Figure 2-1



Water Quality Monitoring Wells:

- CBDC Wells with Water Quality in 2009
- Key Wellsl Sampled in 2009
- Santa Ana River Water Compnay Wells
- USGS NAWQA Wells
- HCMP Monitoring Wells

Other Features

- Chino Basin Maximum Benefit Management Zone Boundaries
- Prado Flood Control Basin
- Chino Desalter Well
- Rivers and Streams
- Flood Control and Conservation Basins
- Constructed Wetlands

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 2-2.mxd

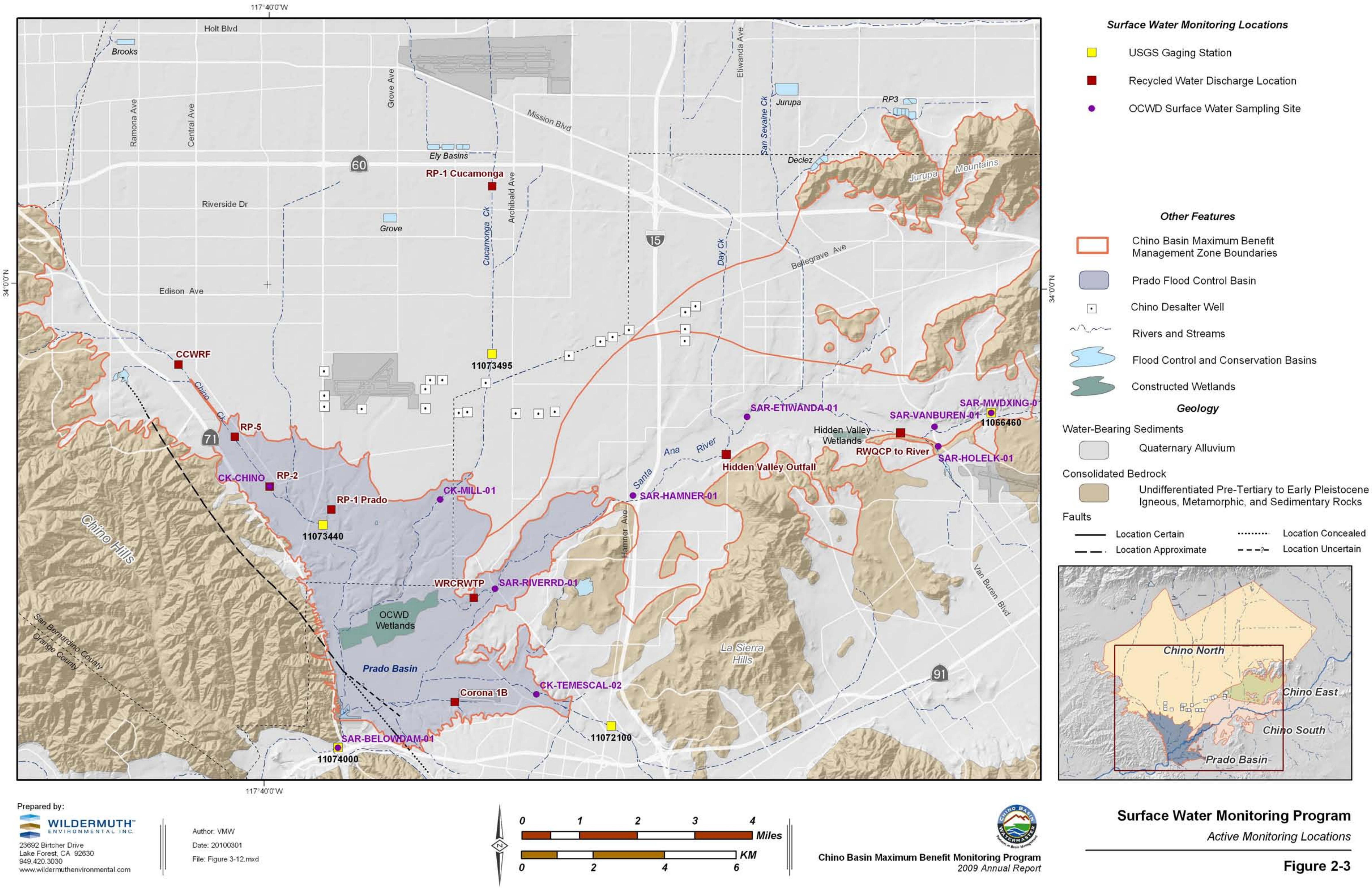
0 1 2 3 4 Miles
0 2 4 6 KM

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Groundwater Quality Monitoring Program

Wells with Water Quality Data in 2009

Figure 2-2



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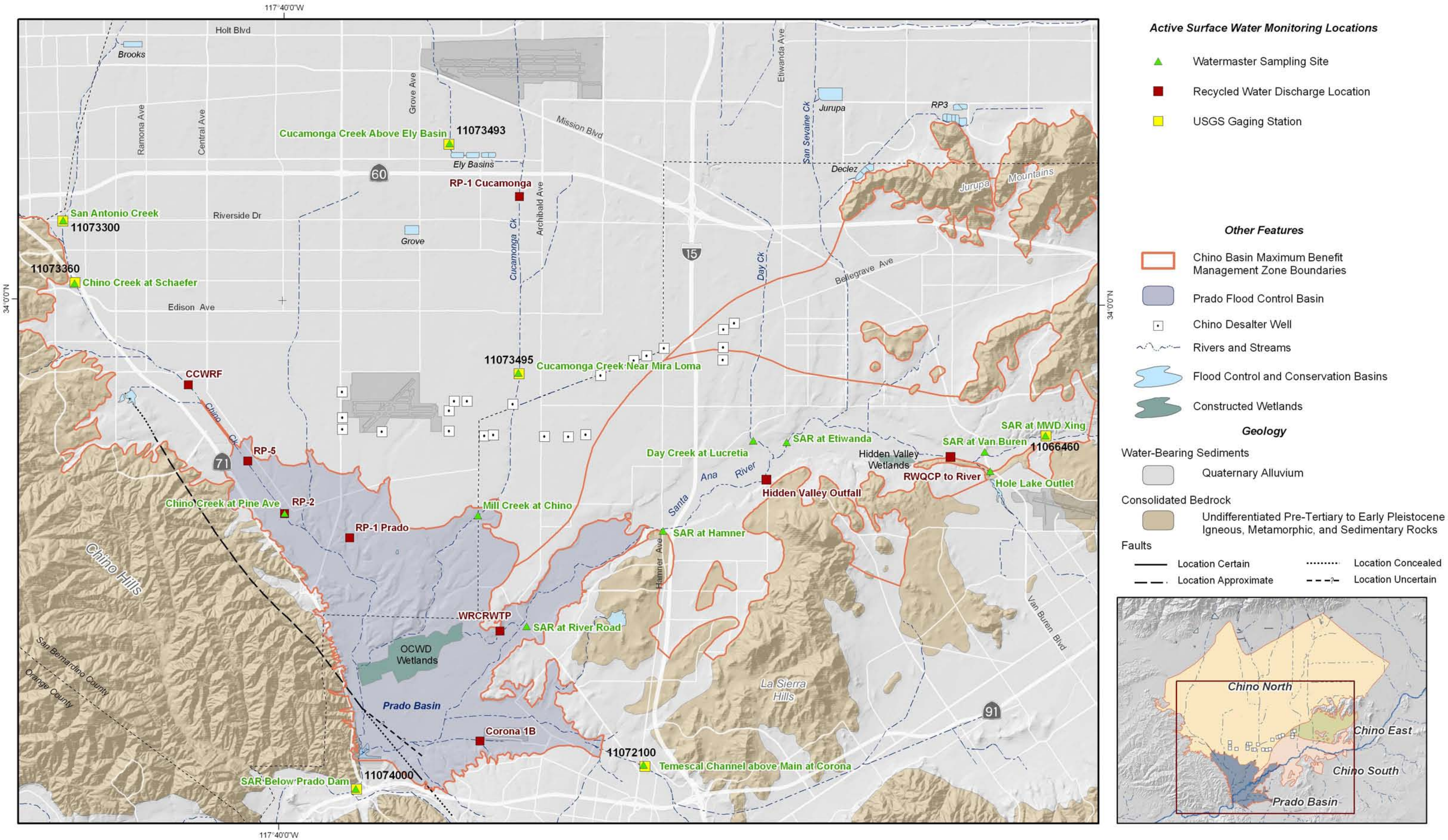
File: Figure 3-12.mxd

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Surface Water Monitoring Program

Active Monitoring Locations

Figure 2-3



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Author: VMW
Date: 20100301
File: Figure 3-12.mxd

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Surface Water Monitoring Program

Active Monitoring Locations

Figure 2-4

Figure 2-5
Total Annual Desalter Groundwater Production (2000-2009)

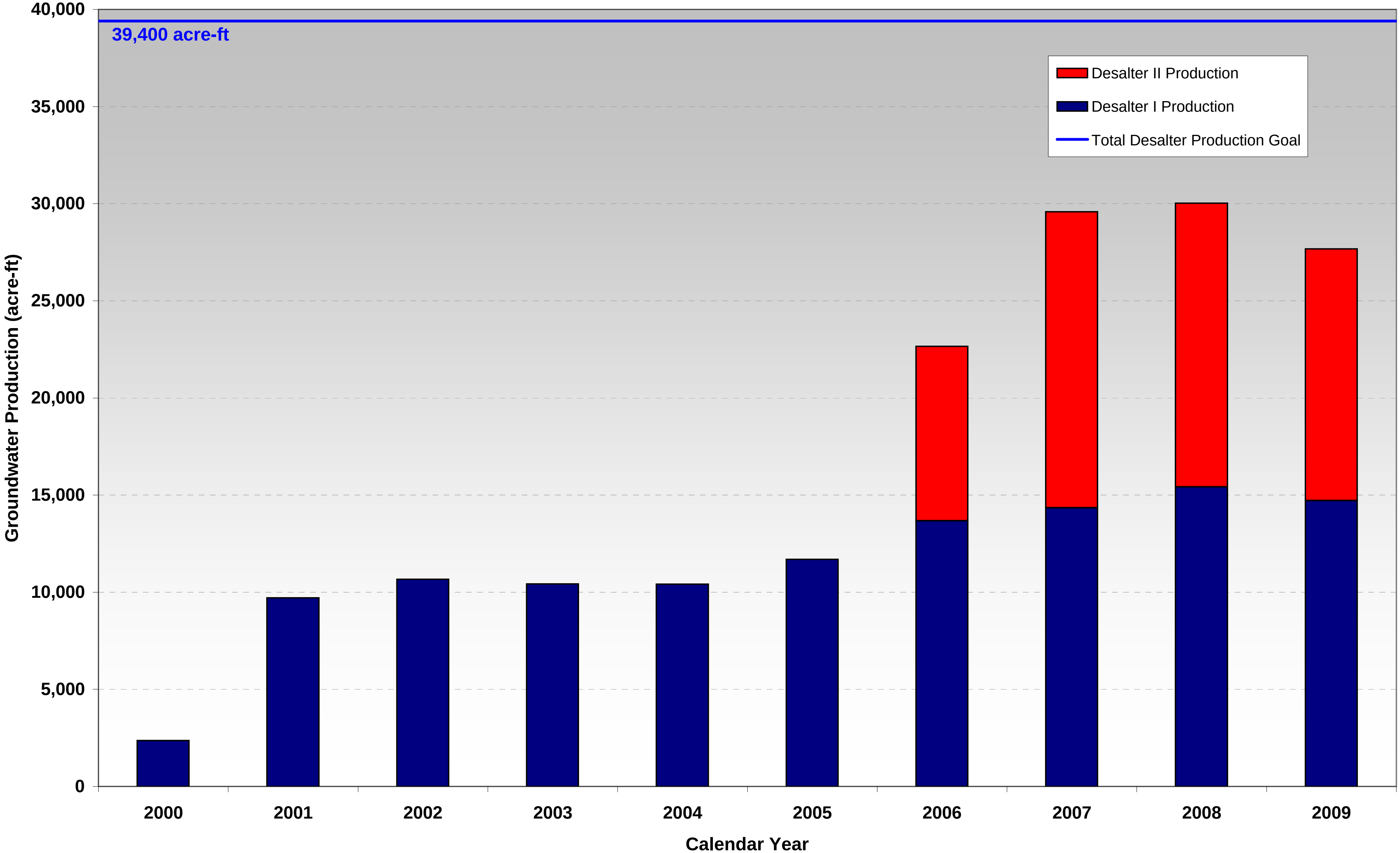

Figure 2-5 Desalter Production.xls --Figure 2-5

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Section 3 – Analysis of Monitoring Data to Evaluate Hydraulic Control

One of the intended purposes of the well fields that supply groundwater to the Chino-I and Chino-II Desalter facilities is to achieve hydraulic control. Hydraulic control is defined as eliminating groundwater discharge from Chino-North Management Zone or controlling the discharge to *de minimis* levels. Hydraulic control ensures that water management activities in Chino-North will not impair the beneficial uses of the Santa Ana River.

This section describes the results and interpretations of four independent analyses that were performed to determine the state of hydraulic control:

- An analysis of piezometric levels within and surrounding the Chino Desalter well fields
- An analysis of the well fields' capture of a VOC groundwater contaminant plume that originated in Chino-North
- A comparison of surface water quality in the Santa Ana River and groundwater quality in the Chino Basin
- An analysis of surface water discharge measurements in the Santa Ana River

3.1 Piezometric Levels

Piezometric data collected from monitoring and production wells in the southern portion of the Chino Basin during 1997-2009 were analyzed to determine the state of hydraulic control. This network of wells, referred to as "key wells," is a subset of Watermaster's Groundwater-Level Monitoring Program that was preferentially selected to assist in determining the state of hydraulic control. Two metrics were employed in this determination:

- A local analysis of piezometric levels within a gap in the Chino-I Desalter well field
- A regional analysis of piezometric levels surrounding the Chino-I and Chino-II Desalter well fields

The objective of both analyses is to determine if pumping at the Chino Desalter well fields is creating local and/or regional piezometric level depressions within the aquifer system that capture all groundwater flowing south from the Chino-North Management Zone.

3.1.1 Local Piezometric Levels within the Chino-I Desalter Well Field

In 2005, two nested HCMP monitoring well sites (HCMP-1 and HCMP-2) were installed in the immediate vicinity of the existing Chino-I Desalter well field. Each site has a monitoring well screened within the shallow aquifer system and another screened within the deep aquifer system. Figure 3-1 shows the locations of the two monitoring well sites, which are aligned with Grove Avenue and bisect a 1-mile gap in the well field. Figure 3-1 also shows the locations of wells in the HCMP key-well piezometric monitoring network.

One of the objectives of HCMP-1 and HCMP-2 is to document the development and existence of a local depression in the piezometric surfaces within the shallow and deep aquifer systems, resulting from desalter pumping and indicating hydraulic control.

HCMP-1 is located within the desalter well field, and HCMP-2 is located about 1,250 feet south and downgradient of HCMP-1. Pre-2000 hydraulic gradients in this area had a consistent southward component (~0.004 ft/ft). Compelling evidence for hydraulic control would be a reversal of the southward component of the hydraulic gradient.

If these monitoring wells do indeed document the development and existence of a local depression in the piezometric surfaces, there is reasonable confidence that the depression exists elsewhere in the vicinity of the well field where desalter wells are more densely distributed. A possible exception to this reasoning could exist within the shallow aquifer system along Euclid Avenue where the desalter wells are perforated solely within the deep aquifer system.

To increase the accuracy of this analysis, the measuring points for water levels at these wells (e.g. top of casing) were surveyed for elevation with conventional leveling techniques. The surveys used contemporary elevation data from the Ayala Park Extensometer as the elevation datum. This allows for accurate piezometric comparisons between wells.

Figure 3-2 displays and compares the piezometric time series of these monitoring wells for both the shallow and deep aquifer systems. For April 2009, the data show:

- Piezometric levels have risen at both well sites since the spring of 2008—by about four feet in the shallow aquifer system and about eight feet in the deep aquifer system.
- A slight downward vertical component of the hydraulic gradient at both wells (~0.008 ft/ft at HCMP-1 and ~0.013 ft/ft at HCMP-2). The downward hydraulic gradient has decreased since spring 2008 because the piezometric levels in the deep aquifer system have risen more than in the shallow aquifer system.
- A slight southward component of the hydraulic gradient from HCMP-1 toward HCMP-2 in both systems (~0.0011 ft/ft in the shallow aquifer system and ~0.0014 ft/ft in the deep aquifer system). The southward hydraulic gradients in both aquifer systems did not change from spring 2008 even though piezometric levels were rising.

3.1.2 Regional Piezometric Levels Surrounding the Chino Desalter Well Fields

Figures 3-3, 3-4, and 3-5 are groundwater elevation contour maps of the shallow aquifer system (Layer 1 of Watermaster's updated computer-simulation groundwater-flow model) for spring 2000, spring 2008, and spring 2009, respectively. These time periods were chosen to provide a comparison between pre-desalter pumping (spring 2000) and current conditions (post-desalter pumping during spring 2008 and 2009) at the Chino Desalter well fields. The objective of this mapping exercise is to reveal the progressive effects of Chino Desalter pumping on regional piezometric levels in the shallow aquifer system over time.

The following methods were employed to construct these maps:

- Extract the entire time series of water level data from the database for all wells in the HCMP key-well piezometric monitoring network.
- Plot and analyze the water level time series for each of these wells versus a normalized cumulative departure from the mean (CDFM) precipitation curve. (All time series charts are contained in Appendix B.)
- Choose one "static" water level data point from each time series plot for the spring of each year analyzed.
- Plot the water level data on maps with background geologic/hydrologic features and groundwater contamination plumes.
- Label and symbolize each data point with a well ID, a water level elevation value, the well's activity at the time of the measurement, and well perforation/layer information.
- Contour water level data for both the shallow and deep aquifer systems and digitize the contours.

As previously noted, Figure 3-3 shows water level contours and data for the shallow aquifer system during spring 2000. The contours depict regional groundwater flow from the northeast to the southwest under a hydraulic gradient that steepens slightly south of the current location of the Chino-I Desalter well field. This map is consistent with other regional water level contour maps (WEI, 2000; 2002) and with the conceptual model of the Chino Basin wherein groundwater flows from areas of recharge in the north/northeast toward areas of discharge in the south near the Prado Basin and the Santa Ana River. Pumping at the Chino-I Desalter well field began in late spring to early summer 2000, so its effects are not and should not be evident in this map.

Figure 3-4 shows water level contours and data for the shallow aquifer system during spring 2008. This map represents piezometric conditions eight years after the commencement of pumping at the Chino-I Desalter well field and two years after the commencement of pumping at the Chino-II Desalter well field. The contours still depict regional groundwater flow from the northeast to the southwest, but the flow field is interrupted by pumping at the Chino-I Desalter and Chino-II Desalter well fields. Regionally, contours to the north and southeast of the desalter well fields have swung in towards the central and eastern portions of the well fields where the wells are perforated primarily within the shallow aquifer system. Around the western half of the Chino-I Desalter well field, where the desalter wells are perforated primarily within the deep aquifer system, the piezometric data suggest a reduction in the southward component of the hydraulic gradient but do not indicate a gradient reversal and, hence, do not provide compelling evidence for hydraulic control in this region.

Figure 3-5 shows the water-level contours and data for the shallow aquifer system in spring 2009. The contours continue to depict a regional depression in the piezometric surface surrounding the eastern half of the Chino-I Desalter well field. A depression in the piezometric surface around the Chino-II Desalter well field has continued to increase in size and magnitude since 2008. The piezometric 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 but do not indicate a gradient reversal and, hence, do not provide compelling evidence for hydraulic control in this region.

The contours and the water level data were used to create 10x10-meter raster grids of the piezometric surfaces using a kriging method of interpolation within the ArcGIS Geostatistical Analyst extension. The grids from spring 2000 and spring 2009 were then subtracted to generate a grid of piezometric change for the shallow aquifer system, shown in Figure 3-6. This grid shows that regional piezometric levels have declined by about 5 to 50 feet throughout central and eastern portions of the study area. These piezometric declines are due, in part, to changes in groundwater production patterns during 2000-2009 (also shown in Figure 3-6) and, in particular, pumping at the Chino Desalter well fields. In the vicinity of the Chino-I Desalter well field, piezometric levels have declined by about 5 to 40 feet. The greater drawdowns are focused around the wells screened in the shallow aquifer system. Piezometric levels in the vicinity of the Chino-II Desalter well field have declined by about 20 to 60 feet, which is primarily due to the production at these wells that commenced in mid-2006. East of Archibald Avenue, in the area adjacent to the Santa Ana River, piezometric levels have declined by approximately 10 feet since 2000. In the western region of the study area (west of Euclid Avenue), piezometric levels have risen in some areas by as much as 10 feet since 2000, indicating that the regional drawdown caused by desalter pumping is not propagating beyond the western extent of the Chino-I Desalter well field.

Figure 3-7 displays the piezometric change that occurred in the shallow aquifer system between spring 2008 and spring 2009. As the figure shows, piezometric levels declined by approximately 5 to 10 feet throughout much of the eastern portion of the study area, whereas piezometric levels in the western portion of the study area increased by 1 to 5 feet. These piezometric changes appear to be mainly caused by changes in groundwater production at the desalter wells (also shown in Figure 3-7). Note that desalter wells II-6 through II-9 produced significantly more groundwater in FY 2009 than in the previous year. Within the western half of the Chino-I Desalter well field, the slight piezometric level increases are likely due to decreased groundwater production from these wells.

Figure 3-8 shows water level contours and data for the deep aquifer system in spring 2009, approximately nine years after the commencement of Chino-I Desalter pumping and three years after the commencement of Chino-II Desalter pumping. Similar to the shallow aquifer system, the contours depict regional groundwater flow from the northeast to the southwest, but the flow field is interrupted by desalter pumping. Around the western half of the Chino-I Desalter well field, there are deep localized depressions in the piezometric surface, centered on wells that are perforated within the deep aquifer system (especially around Chino-I Desalter wells 1 through 4 [I-1 through I-4]). The piezometric contours swing toward these wells, indicating a localized capture zone in this region. Around the eastern half of the Chino-I Desalter well field, the piezometric data show a general flattening of the hydraulic gradient with some localized depressions in the piezometric surface. And, around the Chino-II

Desalter well field, where all wells are perforated within the shallow and deep aquifer systems, a depression in the piezometric surface continues to develop. A comparable map for the deep aquifer system was not generated for spring 2000 due to the paucity of depth-specific water level data.

3.1.3 Interpretations of Hydraulic Control Based on Piezometric Analyses

The piezometric data collected and analyzed to date (2009), at both local and regional scales, indicate that progress toward complete hydraulic control has (1) occurred since 2000 but (2) with mixed results over the past year (spring 2008 to spring 2009).

Specific observations and interpretations with respect to the achievement of hydraulic control include:

- Desalter pumping has generated expanding and interfering cones of depression around the Chino Desalter wells in the central and eastern portions of the study area, which have caused a regional depression in the piezometric surface of the shallow aquifer system.
- The shape of the piezometric contours of the shallow aquifer system for spring 2009 suggest that hydraulic control is occurring at the desalter wells in the eastern parts of the desalter well fields (wells I-5 through I-15 and wells II-1 through II-9).
- The shape of the piezometric contours of the shallow aquifer system for spring 2009 suggest that hydraulic control is not occurring at the desalter wells in the western part of the Chino-I Desalter well field (wells I-1 through I-4) because these wells are perforated primarily within the deep aquifer system.
- The local analysis of piezometric levels (at monitoring well sites HCMP-1 and HCMP-2) does not indicate a gradient reversal in either the shallow or deep aquifer systems and, hence, does not provide compelling evidence for hydraulic control in this specific region during 2009.
- While the piezometric contours of the deep aquifer system in 2009 depict a general flattening of the hydraulic gradient and some localized deep depressions in the piezometric surface indicate local capture zones around some wells, the regional data do not yet indicate a gradient reversal across the entire length of the desalter well fields and, hence, do not yet provide compelling evidence for complete hydraulic control within the deep aquifer system.
- On a local scale, in the gap of the Chino-I Desalter well field (at monitoring well sites HCMP-1 and HCMP-2), water levels in the piezometers that are perforated in the deep aquifer system declined to all-time lows during the summer of 2007. During this period, piezometric levels fell below an elevation of about 535 feet-mean sea level (ft-msl), and the horizontal hydraulic gradient between these wells in the deep aquifer system was zero (i.e. flat). This observation indicates that the typical condition of the southward component of groundwater flow in the deep aquifer system temporarily stalled during the summer of 2007, and it was nearly

the first demonstration of hydraulic control (gradient reversal) using this metric. In 2008-09, piezometric levels recovered, and the southward component of groundwater flow in the deep aquifer system was reestablished in this area.

- In the area adjacent to the Santa Ana River and east of Archibald Avenue, piezometric levels declined by approximately 10 feet from 2000 to 2009. Agricultural pumping in this area declined over this period, which suggests that the piezometric decline is due to desalter pumping. The piezometric declines in this area are physical evidence, demonstrating that desalter pumping may be increasing Santa Ana River recharge to the Chino Basin.

The ultimate fate of groundwater that flows past the western part of the Chino-I Desalter well field is to flow southward toward Prado Basin. Figure 3-9 is a depth-to-groundwater map for spring 2009. This map was created by subtracting spring 2009 groundwater elevations in the shallow aquifer system from a 1-meter digital elevation model of the ground surface. This map indicates that about two miles south of the Chino-I Desalter well field and west of Archibald Avenue, groundwater was rising to become surface water in the tributaries of the Prado Basin during the spring of 2009.

3.2 Migration of the OIA Volatile Organic Compound Plume

Watermaster continues to implement groundwater level and quality monitoring programs in the Chino Basin to develop a comprehensive assessment of groundwater quality. These water quality data, along with historical data, are stored in a relational database. These data were most recently summarized in the *2008 State of the Basin Report* (SOB) (WEI, 2009c).

As discussed in the 2008 SOB, there are a number of point sources of VOCs in the Chino Basin. Of particular interest to the HCMP is the VOC plume—primarily TCE—south of the OIA. TCE is a widely used industrial solvent that is frequently associated with metal degreasing and other maintenance activities. Figure 3-10 shows the approximate areal extent of the plume as of 2007. The plume is up to 11,300 feet wide and 20,500 feet long, extending approximately from State Route 60 on the north and Haven Avenue on the east to Cloverdale Road on the south and Grove Avenue on the west. During the 2003 to 2007 period, the maximum TCE concentration in groundwater detected at an individual well within this plume was 38 μg/L. Figure 3-10 also shows TCE concentrations measured at individual wells in 2009.

Figure 3-11 shows the inset area of Figure 3-10 and demonstrates that the VOC plume does not currently extend beyond the Chino-I Desalter well field, given that TCE levels at all wells to the south of the desalter well field are non-detect. This finding is a necessary, but not sufficient, condition to demonstrate that the well field is capturing groundwater flow and reversing or flattening the local groundwater gradient.

3.3 Comparison of Groundwater and Surface Water Chemistry

The purpose of monitoring water chemistry in surface and groundwater is to determine if groundwater from the Chino Basin is discharging to the Santa Ana River as rising groundwater. The general water chemistry of Chino Basin groundwater is different from that of the Santa Ana River. Native groundwater in the Chino Basin typically has a calcium-bicarbonate character while the Santa Ana River reflects the influence of tertiary treated wastewater and has more of a sodium-chloride-sulfate character.

In this analysis, various sources of water are characterized through the use of Piper diagrams and a modification of the Piper method known as the water character index (WCI). WCI is a unitless parameter that can be used to generally characterize water sources in terms of their ratios of major cations and anions. WCI is analogous to a trilinear or Piper diagram, which is a graphical means of displaying the ratios of the principal ionic constituents in water (Piper, 1944; Watson & Burnett, 1995). Water character is defined by the following equation:

$$WCI = \left(\left\{ \frac{Ca + Mg}{Na + K} \right\} + \left\{ \frac{CO_3 + HCO_3}{Cl + SO_4} \right\} \right) \cdot 100$$

Where Ca, Mg, *et cetera* are expressed in terms of milliequivalents per liter (meq/L) rather than mg/L. The first term on the right hand side of the equation is the ratio of divalent to monovalent cations, and the second term is the ratio of carbonate character to chloride/sulfate character. The utility of the WCI method, compared to a Stiff or Piper/trilinear diagram, is that many data points can be plotted as a time series for a given well or surface water station. The points can also be plotted on a map to show areal and spatial distributions of water character. WCI is not used as a stand-alone comparison of surface water and groundwater chemistry but is verified with analyses of TDS and Piper diagrams as well as individual cations and anions.

The specific monitoring sites referred to in this analysis—which include the USGS NAWQA wells (Archibald 1 and 2), SARWC Wells 9 and 11, the HCMP Surface Water Stations, and publicly owned treatment works (POTWs) discharge locations—are shown in Figure 3-12.

3.3.1 Areal Distribution of WCI

If groundwater in the region between the Santa Ana River and the Chino Desalter well field—the major source of production in the southern end of the basin—is shown to contain Santa Ana River water, it would appear that groundwater discharge from Chino-North to the Santa Ana River is not occurring. Alternatively, if the chemistry of the Santa Ana River shows the influence of Chino Basin groundwater, it would appear that Chino Basin groundwater is discharging to the river.

Figure 3-13 is an areal representation of the average WCI in groundwater and surface water for the 2005 through 2009 period. Wells in the forebay areas of the Chino Basin (north and northeast) have WCI values greater than 800, which is representative of native groundwater (calcium-bicarbonate water character). Monitoring sites along the Santa Ana River from *SAR* *at MWD Xing* to *SAR at Below Prado Dam* all have WCI values less than 300, which reflects the predominance of wastewater in the surface water flow (more sodium-chloride-sulfate character). Wells along the Santa Ana River have WCI values less than 400, which reflects the influence of recharge from the wastewater dominated river. In the reach of the Santa Ana River from *Van Buren* to *Hamner,* WCI values in wells suggest that the river recharges the groundwater basin, with the recharged water flowing immediately northwest of the river in this reach. In the reach of the Santa Ana River from *Hamner* to *River Road,* WCI values range between 400 and 600, indicating less of an influence of surface water recharge on groundwater when compared to the upstream reaches. However, WCI values remain well below 400 at River Road, indicating that groundwater is not rising in this reach of the river; this will be discussed in further detail in Section 3.3.3.

When compared to similar figures from the 2005, 2006, and 2007 Annual Reports (WEI, 2006a; WEI, 2007b; WEI, 2008b), Figure 3-13 shows that there are currently much fewer wells along the Santa Ana River from which data can be analyzed for WCI. Groundwater quality data from more than 65 wells along the river were used in past analyses to demonstrate the influence of surface water recharge to the southern Chino Basin. As urbanization has replaced agricultural lands, the majority of these private production wells have been destroyed or abandoned, leaving only 13 wells in close proximity to the river to make this WCI demonstration. Despite the reduced number of wells available for monitoring, the WCI analysis shows that production by the Chino Basin desalters continues to induce surface water recharge in the reach of the Santa Ana River from Van Buren to River Road. This finding is a necessary, but not sufficient, condition to demonstrate that hydraulic control has been achieved.

3.3.2 Water Quality Changes in Reaches along the Santa Ana River

In this section, the water chemistry of the Santa Ana River from the Riverside Narrows to Prado Dam is analyzed to determine if groundwater from the Chino Basin is discharging as rising groundwater to the river. The baseflow of the Santa Ana River within the Chino Basin consists of rising groundwater from the Riverside Basin, recycled water discharged by POTWs, and rising groundwater from the Temescal and Chino Basins. From time to time, other waters are discharged to the Santa Ana River, including Arlington Desalter water, imported SWP water, and groundwater pumped from the San Bernardino area.

MWD Xing* to *Below Prado Dam. Figures 3-14 through 3-20 consist of WCI time histories, Piper plots, TDS time histories, and discharge time histories that display data from January 2004 through December 2009 for pairs of surface water stations along the Santa Ana River from *MWD Xing* to *Below Prado Dam*. Each station is referred to by its abbreviated name (e.g. “MWD Xing” instead of “Santa Ana River at MWD Xing”). If the WCIs, TDS concentrations, and Piper plots are consistent for pairs of stations, the reach is not gaining water from the surrounding groundwater basin, tributary surface water, or recycled water effluent. Concomitant changes in both WCI and TDS within a reach, however, indicate that the river is mixing with another water source: a surface discharge, rising groundwater, or both. It is important to note that occasional spikes in WCI and dips in TDS occur at surface water sites during the rainy season (typically December through March) and can make it difficult to compare reaches. For this reason, the peaks and dips from known precipitation events were not interpreted in the analysis.

MWD Xing to Van Buren. Figure 3-14 compares the water chemistry of the *MWD Xing* and *Van Buren* surface water stations. Both the WCI values and Piper plots of the two sites are consistent throughout the period of record, suggesting that groundwater and non-tributary surface discharges are not significantly entering this reach of the river. As shown in Figure 3-12, there are no recycled water discharges or significant tributaries entering this reach. The TDS concentration at *Van Buren* is slightly less than that of *MWD Xing*, suggesting a slight influence of either rising groundwater or an uncharacterized surface water inflow. As discussed later in Section 3.4, rising water estimates demonstrate that groundwater frequently rises in this reach of the river.

Van Buren to Etiwanda. Figure 3-15 compares the water chemistry of the *Van Buren* and *Etiwanda* surface water stations. Between *Van Buren* and *Etiwanda*, there are three surface water discharges to the river. One is recycled water effluent from the City of Riverside's Regional Water Quality Control Plant (RWQCP). The second is a tributary stream known as the Hole Lake Outlet. The third discharge in this reach is San Sevaine Creek, which enters the river from the north. The RWQCP discharges effluent to an earthen channel that begins just to the east of Van Buren Blvd. and runs parallel to the south bank of the Santa Ana River. Just west of Van Buren Blvd., the Hole Lake Outlet discharges to the earthen channel where it combines with the recycled water effluent. Further to the west, the combined flows enter the river at the "RWQCP Outfall," shown in Figure 3-12. The combined input of RWQCP effluent and the Hole Lake Outlet to this reach of the river is reflected in the lower WCI of the downstream *Etiwanda* station, compared to that of the *Van Buren* station. The magnitude of difference between the WCIs of these sites is consistent for the period of record, reflecting the continuous discharge of the treatment plant. The Piper plot of the *Etiwanda* surface water station shows a relatively more sodium-sulfate-chloride character than that of the *Van Buren* station, which reflects the mingling of river water with recycled water from the RWQCP and from Hole Lake. The higher TDS concentration of the water input at the RWQCP outfall has the effect of increasing the TDS of the Santa Ana River at the *Etiwanda* station. Note that the flow from the Hole Lake Outlet is much smaller than that from the RWQCP (2 cubic feet per second [cfs] compared to 50 cfs, respectively) and, therefore, does not have as great an impact on TDS at *Etiwanda* as might be expected. San Sevaine Creek water quality is unknown; however, like the Hole Lake Outlet, discharge is small in comparison to flow in the river and does not appear to influence water chemistry. The changes in WCIs and TDS concentrations from *Van Buren* to *Etiwanda* are seemingly dominated by the input of RWQCP effluent.

Etiwanda to Hamner. Figure 3-16 compares the water chemistry of the *Etiwanda* and *Hamner* surface water stations. Between *Etiwanda* and *Hamner*, there are two potential surface water inputs: water from Day Creek and a portion of the RWQCP's effluent that is discharged to this reach of the river after being diverted through the Hidden Valley Wetlands ("*Hidden Valley Outfall*," as shown in Figure 3-12). The WCIs, Piper plots, and TDS time histories of the *Day Creek* surface water station are significantly different from those of both *Etiwanda* and *Hamner* over the period of record, suggesting that Day Creek does not substantially affect this reach, given that the water quality of *Etiwanda* and *Hamner* are very similar to each other. Day

Creek has a small flow in comparison to the flow in this reach of the river (2-7 cfs compared to 90-100 cfs, respectively) and would not be expected to have a large impact on the flow-weighted water quality. The water diverted through the Hidden Valley Wetlands is only monitored for TIN monthly by The City of Riverside; therefore, it cannot be considered in the water quality analysis for this reach of the river. However, similar to Day Creek, the flow at *Hidden Valley Outfall* is much smaller in contrast to this reach of the river, and does not have a impact on the flow-weighted water quality. Furthermore, the similarity of water chemistry between the *Etiwanda* and *Hamner* stations suggests that groundwater is not rising in this reach of the river.

Hamner to River Road. Figure 3-17 compares the water chemistry of the *Hamner* and *River Road* surface water stations. The *River Road* surface water station shows a slightly higher WCI and slightly higher TDS concentrations over the period of record. However, the difference in WCI between the two sites falls within the calculation error, indicating that there is very little or no water quality change in this reach of the river. In addition, the Piper plot for this reach verifies that the two sites are similar in ionic character, suggesting that groundwater is not rising in this reach of the river.

River Road to Below Prado Dam. Figure 3-18 compares the water chemistry of the *River Road* and *Below Prado Dam* surface water stations. As shown in Figure 3-12, there are six surface water inputs to the river between *River Road* and *Below Prado Dam*: direct recycled water effluent from City of Corona Wastewater Treatment Plant 1B (Corona 1B), the WRCRWTP, and RP-1-Prado; Chino Creek at Pine, which contains effluent from Carbon Canyon and RP-5; Mill Creek at Chino, which contains effluent from RP-1-Cucamonga; and Temescal Creek. *Below Prado Dam* shows a lower WCI than *River Road* over the period of record, demonstrating the influence of the six POTWs that discharge to this reach of the river. The Piper plot demonstrates that the ionic makeup of surface water at *Below Prado Dam* is a mix between the calcium-bicarbonate chemistry of the river and the sodium-chloride dominated chemistry of POTW discharges. TDS concentrations at *Below Prado Dam* vary from slightly higher to slightly lower than those at River Road and are representative of a blend of low TDS (400 mg/L to 600mg/L) recycled water effluent from the IEUA's POTWs and higher TDS (600 mg/L to 1,000 mg/L) input from the Temescal Channel and Corona 1B.

3.3.3 Comparison of Water Quality of the Santa Ana River with Groundwater

The recharge of Santa Ana River water to the Chino Basin can be determined by comparing surface water quality with the water chemistry of shallow, near-river wells. Similarities between the WCIs, Piper plots, and TDS data of shallow wells and the WCIs, Piper plots, and TDS data of the recycled water effluent that dominates the base flow of the river are a necessary, but not sufficient, condition for determining the achievement of hydraulic control.

Etiwanda. Figure 3-19 compares the water chemistry of the *Etiwanda* surface water station with that of two near-river wells: SARWC 09 and SARWC 11. The WCIs of SARWC 09 and SARWC 11 are slightly higher than the WCI of the river at *Etiwanda*. However, over the period of record, the WCI of SARWC 11 has become almost identical to that of *Etiwanda*, displaying the influence of river water in the basin. Similarly, the Piper plot of SARWC 11 also reflects the influence of surface water recharge, showing a sodium-chloride-sulfate character that is similar to *Etiwanda*. The deeper SARWC 09 well demonstrates a slightly more calcium-bicarbonate character, which is representative of native groundwater. The TDS values at both wells are similar to those at *Etiwanda*, further suggesting that surface water is recharging to the groundwater basin. This conclusion supports the determinations made in the previous reach-by-reach analysis: Santa Ana River water is recharging the groundwater basin between *Van Buren* and *Etiwanda*.

River Road. Figure 3-20 compares the water chemistry of the *River Road* surface water station with two near-river wells: Archibald 1 and Archibald 2. The WCIs of the Archibald wells are significantly higher than the WCI of the river at *River Road*. Similarly, the Piper plots of *River Road* and the Archibald wells show distinct ionic distributions for both water sources (surface water and groundwater). The TDS concentrations of the two wells are much higher than those observed in surface water at *River Road* with concentrations between 1,000 and 1,800 mg/L versus 400 to 700 mg/L in the river. High TDS values, which are the result of historical agricultural and dairy operations, are characteristic of the shallow aquifer in the southern portion of the Chino-North Management Zone. The lower TDS concentrations at *River Road* and the WCI values, which are near 200, indicate that groundwater is not rising in this reach of the river.

3.3.4 Interpretations of Hydraulic Control Based on Surface Water and Groundwater Chemistry

It can be concluded from the reach by reach WCI, Piper plot, and TDS concentration comparisons that changes in Santa Ana River water quality from *MWD Xing* to just upstream of *River Road* are dominated by the input of surface water discharges, which primarily consist of recycled water effluent from POTWs. The comparisons of WCIs, Piper plots, and TDS concentrations between the Santa Ana River and groundwater in near river wells further support the conclusion that groundwater is not rising into the river from *MWD Xing* to *River Road*. That the influence of rising groundwater is not detected in these analyses is a necessary, but not sufficient, condition for determining the achievement of hydraulic control.

3.4 Surface Water Discharge of the Santa Ana River

The available surface water discharge record was investigated to determine the relationship between the Santa Ana River and the southern part of the Chino Basin. Two independent approaches were followed: first, all available hydrologic studies conducted in support of the 1969 Judgment in OCWD *vs.* City of Chino *et al.* and the subsequent Santa Ana River Watermaster (SARWM) reports, which are products of the 1969 Judgment, through water year 2008/09 were reviewed; and second, a reach by reach analysis of the 2009 manual discharge measurements was conducted to estimate rising groundwater.

3.4.1 Santa Ana River Judgment Accounting

The Santa Ana River was adjudicated in the 1960s, and a stipulated judgment was filed in 1969 (OCWD *vs.* City of Chino *et al.*, Case No. 117628, County of Orange). Since the judgment was filed, the SARWM has compiled annual reports that contain estimates of significant discharges to the Santa Ana River. The SARWM uses these data to compute the stormwater flow and baseflow of the river each water year. As defined in the Judgment, baseflow consists of rising groundwater and recycled water discharged to the river by dischargers in the service areas of the San Bernardino Valley Municipal Water District, the IEUA, the Western Municipal Water District, and the Eastern Municipal Water District.

For this study, discharge data from the SARWM annual reports were used to develop a hydrologic budget for the Santa Ana River between the Riverside Narrows and Prado Dam, which was, in turn, used to determine if there was a reach-wide net loss in baseflow from the Santa Ana River. Baseflow, as discussed in this analysis, consists of rising groundwater, recycled water discharges, and other non-tributary discharges (e.g. discharges from the Arlington Desalter) to the Santa Ana River and its tributaries. Baseflow is estimated as the difference between total discharge and storm water discharge.

Table 3-1 lists the Santa Ana River storm and baseflow discharges that enter the basin at Riverside Narrows and leave the basin at below Prado Dam and the various discharge components in the reach between the San Jacinto Fault and Prado Dam. The SARWM estimates the storm water component of the hydrograph and subtracts the storm water discharge from the total observed discharge to obtain a trial baseflow. Note that subsurface inflow to the Chino Basin at Riverside Narrows is negligible because Riverside Narrows is a shallow bedrock narrows that forces groundwater in the Riverside Basin to rise and become surface flow. And, there is negligible subsurface outflow from Chino Basin under the Santa Ana River because Prado Dam was constructed in a similar bedrock narrows and sits on a grout curtain that was constructed to eliminate underflow. Given these subsurface flow assumptions, the net rising groundwater from the Chino Basin to the Santa Ana River can be calculated from the SARWM tabulations using the following equation:

$$Q_{RW} = Q_{BF\_PD} - Q_{BF\_RN} - \Sigma Q_{RECi} - \Sigma Q_{NONTDj}$$

Where Q_{RW} is the net rising water from the Chino Groundwater Basin to the Santa Ana River, Q_{BF_PD} is the baseflow at below Prado Dam, Q_{BF_RN} is the baseflow at Riverside Narrows, Q_{RECi} is the i^{th} recycled water discharge to the Santa Ana River in the reach between Riverside Narrows and Prado Dam, and Q_{NONTDj} is the j^{th} other non-tributary discharge to the Santa Ana River in the reach between the Riverside Narrows and Prado Dam.

Estimates of the net rising water contribution to surface water discharge are shown in Column 15 of Table 3-1 for water years 1970/71 through 2008/09. The time history of rising groundwater is shown graphically in Figure 3-21. With two exceptions, the net rising water estimate is negative over the last 39 years, indicating that the baseflow in the Santa Ana River is recharging the Chino Basin. Based on the assumptions of this analysis, for the 2008/09 period, it is estimated that approximately 33,500 acre-ft/yr of Santa Ana River water recharged the Chino Basin between the Riverside Narrows and Prado Dam.

3.4.2 Reach by Reach Accounting

Rising groundwater estimates were made for the following Santa Ana River reaches on selected dates: MWD Xing to Van Buren (Q_A), Van Buren to Etiwanda (Q_B), Etiwanda to Hamner (Q_C), and Hamner to River Road (Q_D). The dates of these estimates correspond to dates when Watermaster staff conducted surface water discharge measurements. Rising groundwater estimates from the Chino Basin to the aforementioned reaches of the Santa Ana River were calculated using the following equations:

$$Q_A = Q_{VB} - Q_{Xing}$$
$$Q_B = Q_{ET} - Q_{VB} - Q_{HL} - Q_{RWQCP\_Riv} - Q_{SS}$$
$$Q_C = Q_{HM} - Q_{ET} - Q_{DC} - Q_{RWQCP\_HV}$$
$$Q_D = Q_{RR} - Q_{HM}$$

Where:

Q_{VB}	=	SAR Discharge at Van Buren
Q_{Xing}	=	SAR Discharge at MWD Xing
Q_{ET}	=	SAR Discharge at Etiwanda
Q_{HL}	=	Hole Lake Outlet Discharge
Q_{RWQCP_Riv}	=	RWQCP Discharge to the SAR at Structure 1
Q_{SS}	=	San Sevaine Creek Discharge to the SAR
Q_{HM}	=	SAR Discharge at Hamner
Q_{DC}	=	Day Creek Discharge to the SAR
Q_{RWQCP_HV}	=	RWQCP Discharge to the SAR through Hidden Valley
Q_{RR}	=	SAR Discharge at River Road

As discussed in Section 2.2.2, direct discharge measurements are not collected during storm events. Thus, only discharge measurements collected during dry periods were used in the rising groundwater analyses. Typically, the continuous data set would contain April through November measurements. Yet, due to the moderately dry winter in early 2009, the rising groundwater analysis includes data that was collected from January through November. Table 3-2 shows the rising groundwater estimates for the three reaches—A, B, and C—between *MWD Xing* and *Hamner* for 2009. Positive values indicate that groundwater is rising from the surrounding basin to the Santa Ana River, and negative values (shown in red) indicate that surface water is recharging the groundwater basin. In general, observed fluctuations in estimated rising groundwater are due, in part, to seasonal changes in the evapotranspiration rates of riparian vegetation, precipitation events, changes in groundwater pumping, or measurement error.

For reach A, between *MWD Xing* and *Van Buren*, rising water ranges from a low of -22 cfs to a high of 20 cfs and averages about 1 cfs. For reach B, between *Van Buren* and *Etiwanda*, rising water ranges from a low of -25 cfs to a high of 40 cfs and averages about 3 cfs. Within reach B, the volume of San Sevaine Creek discharge to the river is unknown; although, if this discharge were known and applied to the equation, it would contribute to a more negative rising groundwater estimate. For reach C, between *Etiwanda* and *Hamner*, rising water ranges from a low of -37 cfs to a high of 26 cfs and averages about -7 cfs. Total rising water along the Santa Ana River from *MWD Xing* to *Hamner* ranges from a low of -32 cfs to a high of 19 cfs and averages about -3 cfs. If the average level of recharge were sustained year long, it would correspond to an annual net recharge from the Santa Ana River to the Chino Basin (from *MWD Xing* to *Hamner*) of about 2,200 acre-ft/yr.

For reach D, between *Hamner* and *River Road*, rising water could not be quantified for this reporting period. Beginning February 2009, construction at the River Road Bridge restricted access to the River Road monitoring site. Access was allowed at a temporary location upstream, east of the bridge, for water quality sample collection; however, the conditions along the Santa Ana River at this temporary site are not suitable for measuring discharge.

The 2009 estimate of the net annual recharge of Santa Ana River water is considerably lower compared to the 2008 estimate (12,300 acre-feet/yr) for this reach of the River. The decrease in surface water recharge for 2009 is primarily attributed to decreases in surface water recharge in Reaches A and B. Watermaster is currently investigating the decrease in surface water recharge and has identified two potential causes. The first is the reestablishment of the Hidden Valley Wetlands in 2009 as a diversion for the City of Riverside's WWTP effluent. The Hidden Valley Wetlands are located just south of the river between *Van Buren* and *Etiwanda* (see Figure 3-12*)*. Surface water recharge at the wetlands ponds may be forcing groundwater to rise into the River between *Van Buren* and *Etiwanda*. The second potential cause is the regional effort to eradicate the invasive *Arundo donax* plant from the Santa Ana River Watershed. *Arundo donax* consumes water at a rate of about 5.6 acre-ft per acre per year, which is nearly three times more water than native vegetation. In the past, what appeared to be large quantities of surface water recharge in reaches A and B may have actually been water losses to evapotranspiration when *Arundo donax* was more prominent along the river. At this time, there is not enough data available to quantify the impact of these activities on the flow of the Santa Ana River.

3.4.3 Interpretations of Hydraulic Control Based on Surface Water Discharge Analyses

The analysis of Santa Ana River discharge reveals that throughout the year there is an overall net loss of surface water flow between *MWD Xing* and *Below Prado*. The reach by reach analysis indicates that, in some reaches, surface water is recharging the surrounding groundwater basin and, in others, groundwater is occasionally rising to become surface flow. Generally, the majority of surface water recharge occurs between *MWD Xing* and *River Road*, and the majority of rising groundwater occurs between *River Road* and *Below Prado*. The amount of rising groundwater in the Santa Ana River cannot be quantified with the surface water discharge data. An analysis of whether or not the impact of a relatively small volume of high TDS rising groundwater is *de minimus*, in terms of impacts to downstream beneficial uses, is provided in Section 4.

3.5 Integrated Review of Monitoring Data

Sections 3.1 through 3.4 of this report detail the analysis of independent lines of evidence to demonstrate the extent of hydraulic control of subsurface outflows from Chino-North, using groundwater elevation, groundwater and surface water quality, and surface water discharge data collected in 2009 for the HCMP. Figure 3-22 demonstrates how the 2007 Watermaster Model corroborates the conclusions drawn from three of these lines of evidence: it shows the spring 2009 layer 1 (shallow aquifer) groundwater elevation contours, based on monitoring data; the extent of the OIA VOC plume; WCIs for shallow aquifer wells; and the spring 2010 layer 1 groundwater flow vectors predicted by the 2007 Watermaster Model.

While each type of data presented in this figure is independent of the next, they all demonstrate that hydraulic control has been achieved to the east of Chino-I Desalter well number 5. Moreover, the measured and modeled groundwater flow directions are generally consistent across the southern Chino Basin with some variations due to interpretations of groundwater elevations from wells with variable constructions and short-term piezometric responses to localized pumping. Close examination of the flow vectors at the southern boundary of the OIA plume shows that groundwater flows into the desalters from the south and the north, thus corroborating the non-detect levels of TCE measured south of the well field. In addition, the flow vectors corroborate the observed WCIs of wells along the river (values of 200-400), evidencing that Santa Ana River water has migrated about one mile away from the river in a northwesterly direction into the Chino Basin.

To the west of Chino-I Desalter well number 5, the model results show that Chino-North groundwater flows beyond the Desalter well field, confirming that hydraulic control has yet to be achieved in this area. While this is the present case, the modeling work performed in support of the OBMP and Peace II process demonstrates that full hydraulic control of subsurface outflows from Chino-North can be achieved through the expansion of the desalter program to full capacity when coupled with reoperation of the Basin (WEI, 2009d). A new desalter well field, the CCWF, will be constructed among Chino-I Desalter wells 1 through 4 and to the west of these wells. The approximate locations of the six proposed wells are shown in Figure 3-23. The CCWF has been designed to pump groundwater from the shallow aquifer system to help achieve hydraulic control in the region to the west of Chino-I Desalter well number 5. Figure 3-23 also shows the layer 1 groundwater elevation contours and the layer 1 groundwater flow direction predicted by the 2007 Watermaster Model for the year 2020: the expansion of the desalter program, combined with the planned strategic reduction in basin groundwater storage (reoperation), results in a reversal of the hydraulic gradient across the entire desalter well field, demonstrating that full hydraulic control is possible and expected once these programs are established (WEI 2009d).

Table 3-1
Estimate of Net Rising Groundwater to the Santa Ana River between San Bernardino and Prado Dam
(acre-ft/yr)

Water Year	Santa Ana River at Riverside Narrows								Santa Ana River below Prado Dam								
	(1) Groundwater Discharge from Bunker Hill	(2) Recycled Water Discharges	(3) Non-Tributary Discharges	(4)=(6)-(5) Q_{BF_RN} Non-Storm Discharge at Riverside Narrows	(5) Storm Discharge at Riverside Narrows	(6) Total Discharge at Riverside Narrows	(7)=(1)+(2)+(3) Groundwater Discharge from Bunker Hill + Recycled Water Discharge + Other Non-Tributary Discharges	(8)=(4)-(7) Net Rising Water Contribution to Surface Discharge	(9) ΣQ_{REC} Recycled Water Discharges	(10) ΣQ_{NONTD} Non-Tributary Discharges	(11)=(13)-(12) Q_{BF_PD} Non-Storm Discharge at Prado Dam	(12) Storm Discharge at Prado Dam	(13) Total Discharge at Prado Dam	(14)=(4)+(9)+(10) Non-Storm Discharge at Riverside Narrows + Recycled Water Discharge + Other Non-Tributary Discharges	(15)=(11)-(14) Q_{RW} Net Rising Water Contribution to Surface Discharge	(16)=(13)-(6) Gain in Total Flow from Riverside Narrows to Prado Dam	(17)=(12)-(5) Gain in Storm Water Discharge between Riverside Narrows and Prado Dam
1970 - 1971	0	22,650	0	35,681	7,051	42,732	22,650	13,031	21,810	0	38,402	13,462	51,864	57,491	(19,089)	9,132	6,411
1971 - 1972	0	20,650	0	35,161	6,096	41,257	20,650	14,511	28,980	0	40,416	11,327	51,743	64,141	(23,725)	10,486	5,231
1972 - 1973	0	23,460	11,617	17,582	15,466	33,048	35,077	(17,495)	32,780	0	49,472	28,485	77,957	50,362	(890)	44,909	13,019
1973 - 1974	0	22,530	0	17,203	8,291	25,494	22,530	(5,327)	36,830	63,035	107,784	19,543	127,327	117,068	(9,284)	101,833	11,252
1974 - 1975	0	21,050	0	16,771	4,199	20,970	21,050	(4,279)	40,600	27,939	81,742	11,655	93,397	85,310	(3,568)	72,427	7,456
1975 - 1976	0	22,030	0	18,350	9,277	27,627	22,030	(3,680)	42,680	60,170	106,797	13,793	120,590	121,200	(14,403)	92,963	4,516
1976 - 1977	0	23,240	0	19,474	5,397	24,871	23,240	(3,766)	41,800	8,350	57,603	14,675	72,278	69,624	(12,021)	47,407	9,278
1977 - 1978	0	24,780	0	23,100	159,400	182,500	24,780	(1,680)	44,220	1,466	60,707	194,349	255,056	68,786	(8,079)	72,556	34,949
1978 - 1979	200	25,940	0	27,208	20,708	47,916	26,140	1,068	46,570	9,897	82,572	62,646	145,218	83,675	(1,103)	97,302	41,938
1979 - 1980	1,000	27,540	0	25,805	228,528	254,333	28,540	(2,735)	48,200	23,820	90,921	445,253	536,174	97,825	(6,904)	281,841	216,725
1980 - 1981	3,000	27,850	0	18,915	15,783	34,698	30,850	(11,935)	52,300	0	91,377	26,923	118,300	71,215	20,162	83,602	11,140
1981 - 1982	6,500	30,590	0	31,715	51,335	83,050	37,090	(5,375)	55,990	0	81,883	61,819	143,702	87,705	(5,822)	60,652	10,484
1982 - 1983	11,000	31,380	0	55,884	224,103	279,987	42,380	13,504	55,960	7,720	120,566	306,519	427,085	119,564	1,002	147,098	82,416
1983 - 1984	14,000	29,610	0	55,403	27,684	83,087	43,610	11,793	57,190	12,550	122,116	55,825	177,941	125,143	(3,027)	94,854	28,141
1984 - 1985	12,000	31,170	0	63,968	15,145	79,113	43,170	20,798	63,440	3,883	125,358	37,889	163,247	131,291	(5,933)	84,134	22,744
1985 - 1986	8,000	33,450	0	64,631	34,969	99,600	41,450	23,181	65,620	1,836	127,550	70,158	197,708	132,087	(4,537)	98,108	35,189
1986 - 1987	5,000	36,330	0	57,965	20,128	78,093	41,330	16,635	68,670	0	120,182	23,343	143,525	126,635	(6,453)	65,432	3,215
1987 - 1988	3,000	39,160	0	53,526	26,521	80,047	42,160	11,366	77,500	5,679	130,117	42,714	172,831	136,705	(6,588)	92,784	16,193
1988 - 1989	1,700	39,470	0	50,330	12,387	62,717	41,170	9,160	85,260	6,582	126,488	33,171	159,659	142,172	(15,684)	96,942	20,784
1989 - 1990	1,000	40,420	0	51,500	7,000	58,500	41,420	10,080	82,840	1,020	120,503	24,314	144,817	135,360	(14,857)	86,317	17,314
1990 - 1991	500	39,530	394	43,710	30,815	74,525	40,424	3,286	84,230	8,052	119,911	75,275	195,186	135,992	(16,081)	120,661	44,460
1991 - 1992	100	37,080	0	38,610	33,158	71,768	37,180	1,430	89,360	8,033	115,551	82,729	198,280	136,003	(20,452)	126,512	49,571
1992 - 1993	0	38,220	0	39,714	227,670	267,384	38,220	1,494	95,570	5,273	133,438	438,563	572,001	140,557	(7,119)	304,617	210,893
1993 - 1994	0	36,170	144	29,639	15,838	45,477	36,314	(6,675)	90,180	5,424	117,075	41,622	158,697	125,243	(8,168)	113,220	25,784
1994 - 1995	0	38,650	2,206	45,632	199,985	245,617	40,856	4,776	95,020	18,945	144,619	284,651	429,270	159,597	(14,978)	183,653	84,666
1995 - 1996	0	43,660	1,470	53,935	29,321	83,256	45,130	8,805	95,270	25,137	158,468	58,692	217,160	174,342	(15,874)	133,904	29,371
1996 - 1997	0	49,960	2,762	63,285	43,995	107,280	52,722	10,563	93,760	48,473	187,911	61,783	249,694	205,518	(17,607)	142,414	17,788
1997 - 1998	0	56,746	1,342	64,147	150,228	214,375	58,088	6,059	104,774	6,665	162,029	300,604	462,633	175,586	(13,557)	248,258	150,376
1998 - 1999	0	54,111	0	70,912	5,382	76,294	54,111	16,801	112,349	2,684	161,321	23,673	184,994	185,945	(24,624)	108,700	18,291
1999 - 2000	0	52,404	0	61,260	14,312	75,572	52,404	8,856	112,380	19,945	168,214	40,269	208,483	193,585	(25,371)	132,911	25,957
2000 - 2001	0	57,753	2,760	62,366	15,725	78,091	60,513	1,853	115,097	10,686	167,305	54,621	221,926	188,149	(20,844)	143,835	38,896
2001 - 2002	0	52,465	9,410	65,845	2,999	68,844	61,875	3,970	110,283	9,053	164,353	10,615	174,968	185,181	(20,828)	106,124	7,616
2002 - 2003	0	53,833	3,664	59,089	33,077	92,166	57,497	1,592	117,208	8,570	158,347	97,810	256,157	184,867	(26,520)	163,991	64,733
2003 - 2004	0	52,808	1,537	53,980	23,356	77,336	54,345	(365)	110,907	10,598	156,785	57,317	214,102	175,485	(18,700)	136,766	33,961
2004 - 2005	0	54,592	0	63,384	292,119	355,503	54,592	8,792	133,684	964	169,017	469,515	638,532	198,032	(29,016)	283,028	177,396
2005 - 2006	0	54,426	727	65,570	46,270	111,840	55,153	10,417	126,192	1,473	161,840	85,734	247,574	193,235	(31,395)	135,734	39,464
2006 - 2007	0	51,668	1,846	55,002	2,866	57,868	53,514	1,488	120,247	2,324	143,246	12,901	156,147	177,573	(34,327)	98,279	10,035
2007 - 2008	0	50,297	4,065	48,537	30,082	78,619	54,362	(5,825)	108,175	5,385	130,798	68,896	199,694	162,097	(31,299)	121,075	38,814
2008 - 2009	0	47,298	1,460	43,080	25,947	69,027	48,758	(5,678)	97,802	1,671	109,039	53,662	162,701	142,553	(33,514)	93,674	27,715
Total	67,000	1,494,971	45,404	1,767,869	2,122,613	3,890,482	1,607,375	160,494	3,061,728	433,302	4,711,823	3,816,795	8,528,618	5,262,899	(551,076)	4,638,135	1,694,182
Average	1,718	38,333	1,164	45,330	54,426	99,756	41,215	4,115	78,506	11,110	120,816	97,867	218,683	134,946	(14,130)	118,927	43,441
Standard Dev	3,629	12,101	2,478	17,078	77,863	80,743	12,367	9,048	31,181	15,397	38,578	127,675	139,778	44,426	11,249	66,378	54,124
Coef of Var	211%	32%	213%	38%	143%	81%	30%	220%	40%	139%	32%	130%	64%	33%	-80%	56%	125%
Median	0	38,220	0	50,330	23,356	77,336	41,420	3,286	84,230	6,582	122,116	54,621	177,941	135,992	(14,857)	101,833	25,957
Max	14,000	57,753	11,617	70,912	292,119	355,503	61,875	23,181	133,684	63,035	187,911	469,515	638,532	205,518	20,162	304,617	216,725
Min	0	20,650	0	16,771	2,866	20,970	20,650	(17,495)	21,810	0	38,402	10,615	51,743	50,362	(34,327)	9,132	3,215

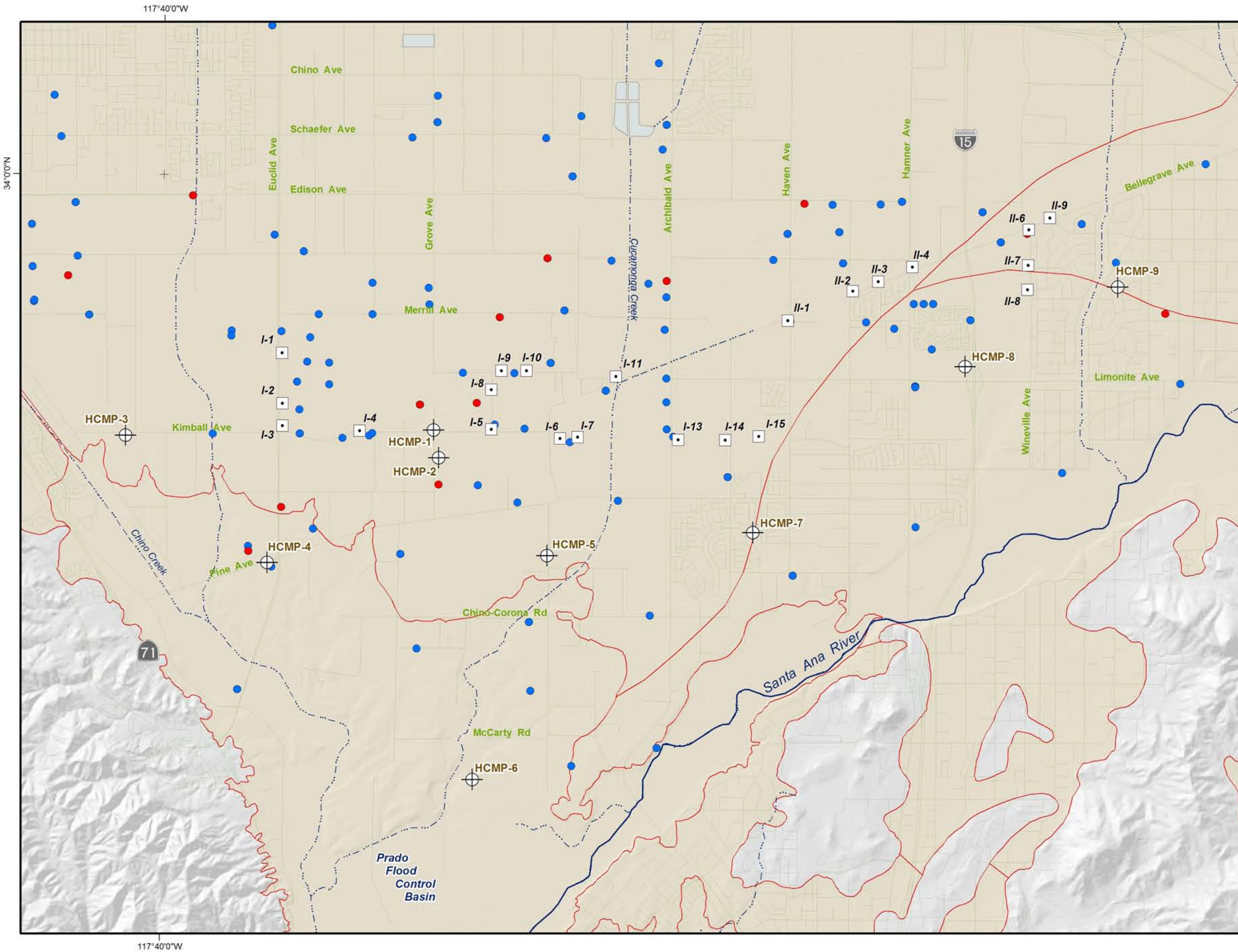
Source -- All data except "Groundwater Discharge from Bunker Hill" were obtained from the Annual Reports of the SARWM. "Groundwater Discharge from Bunker Hill" was abstracted from Table 6 of the draft report *Hydrology, Description of Computer Models, and Evaluation of Selected Water-Management Alternatives in the San Bernardino Area, California* (USGS, 1997).

(Red Text) indicates negative values.

Table 3-2
2009 Rising Groundwater Calculations

Measurement Date	Q_A MWD Xing to Van Buren (cfs)	Q_B Van Buren to Etiwanda (cfs)	Q_C Etiwanda to Hamner (cfs)	Q_D Hamner to River Road (cfs)	Reach Q_A to Q_C Total Rising Water MWD Xing to Hamner (cfs)	Reach Q_A to Q_C Total Rising Water MWD Xing to Hamner (acre-ft/day)
7-Jan-09	(12)	0	(3)	-	(14)	(29)
21-Jan-09	(2)	2	(13)	-	(14)	(28)
4-Feb-09	(22)	2	(12)	-	(32)	(63)
4-Mar-09	7	(20)	(12)	-	(24)	(49)
18-Mar-09	(19)	40	(3)	-	18	35
01-Apr-09	1	26	(8)	-	19	37
15-Apr-09	(3)	36	(37)	-	(4)	(8)
29-Apr-09	12	9	(10)	-	11	22
13-May-09	20	6	(18)	-	8	15
27-May-09	(1)	0	(20)	-	(21)	(43)
10-Jun-09	(5)	13	(6)	-	3	5
24-Jun-09	(7)	(25)	26	-	(6)	(11)
08-Jul-09	1	(1)	(3)	-	(4)	(8)
22-Jul-09	7	9	(2)	-	14	28
05-Aug-09	4	4	(3)	-	4	8
19-Aug-09	(3)	5	(22)	-	(19)	(38)
02-Sep-09	3	1	(12)	-	(9)	(17)
16-Sep-09	10	(10)	2	-	2	4
30-Sep-09	4	(6)	(13)	-	(15)	(30)
28-Oct-09	9	(10)	-	-	(1)	(2)
11-Nov-09	6	(8)	5	-	3	6
24-Nov-09	11	(7)	12	-	16	33
Average	*1*	*3*	*(7)*	*N/A*	*(3)*	*(6)*
Max	*20*	*40*	*26*	*N/A*	*19*	*37*
Min	*(22)*	*(25)*	*(37)*	*N/A*	*(32)*	*(63)*

" - " -- indicates that a direct discharge measurement was not possible due to blocked access to site, high flow, and/or unsafe conditions..
(Red Text) indicates negative values.



HCMP Key-Well Piezometric Monitoring Network

- Nested HCMP Piezometric Monitoring Well
- Key Well for Water-Level Monitoring
- Key Well Lost (Destroyed since Spring 2008)
- Chino Desalter Well

Other Map Features

- Unconsolidated Sediments
- Management Zone Boundaries

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0 1 Miles
0 2 KM

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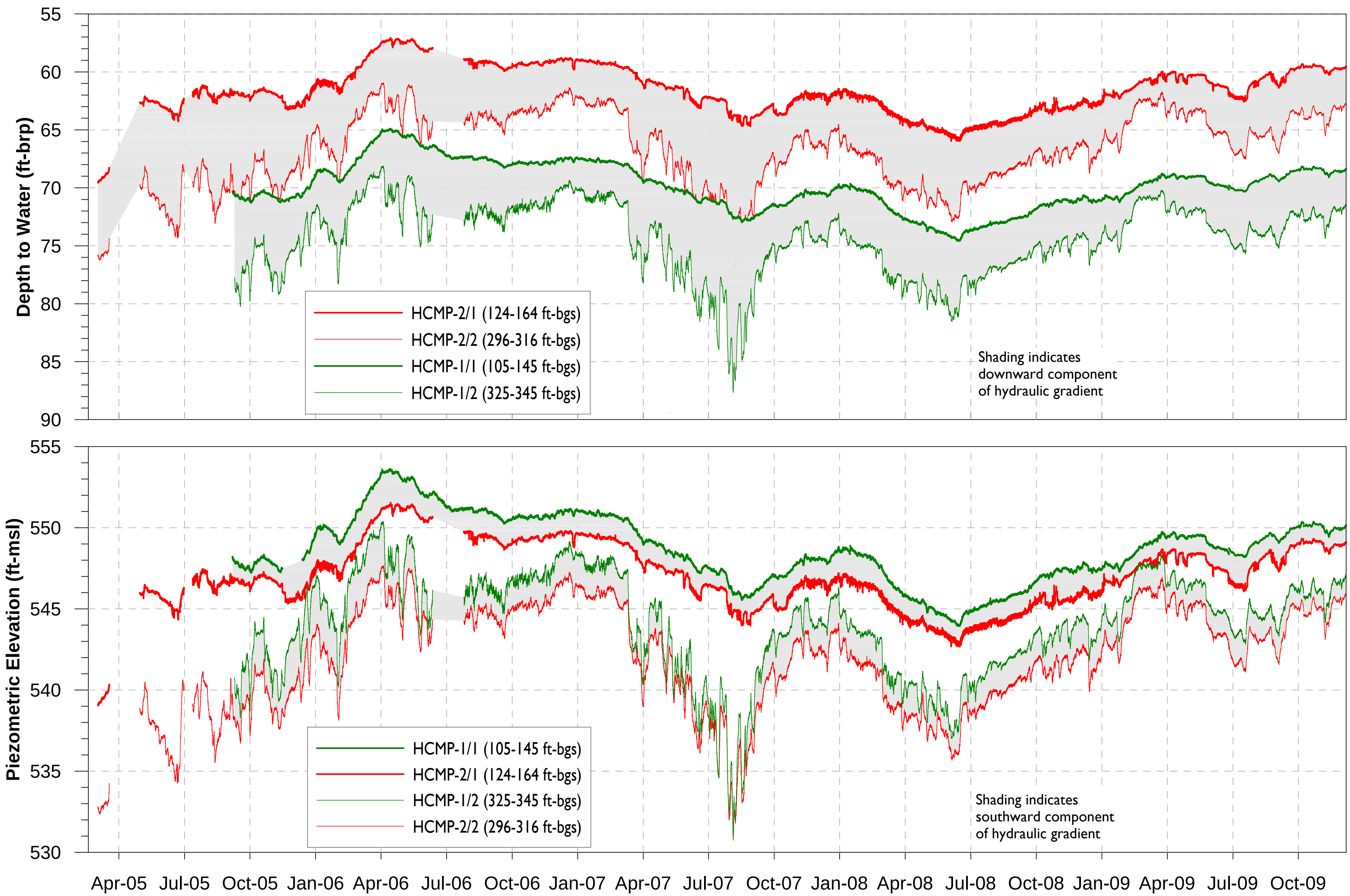
2009 Annual Report

Well Location Map

Chino Desalter and HCMP Monitoring Wells

Figure 3-1

Figure 3-2
Piezometric Time Series for HCMP-1 and HCMP-2



HCMP-1_v_HCMP-2_2009.grf

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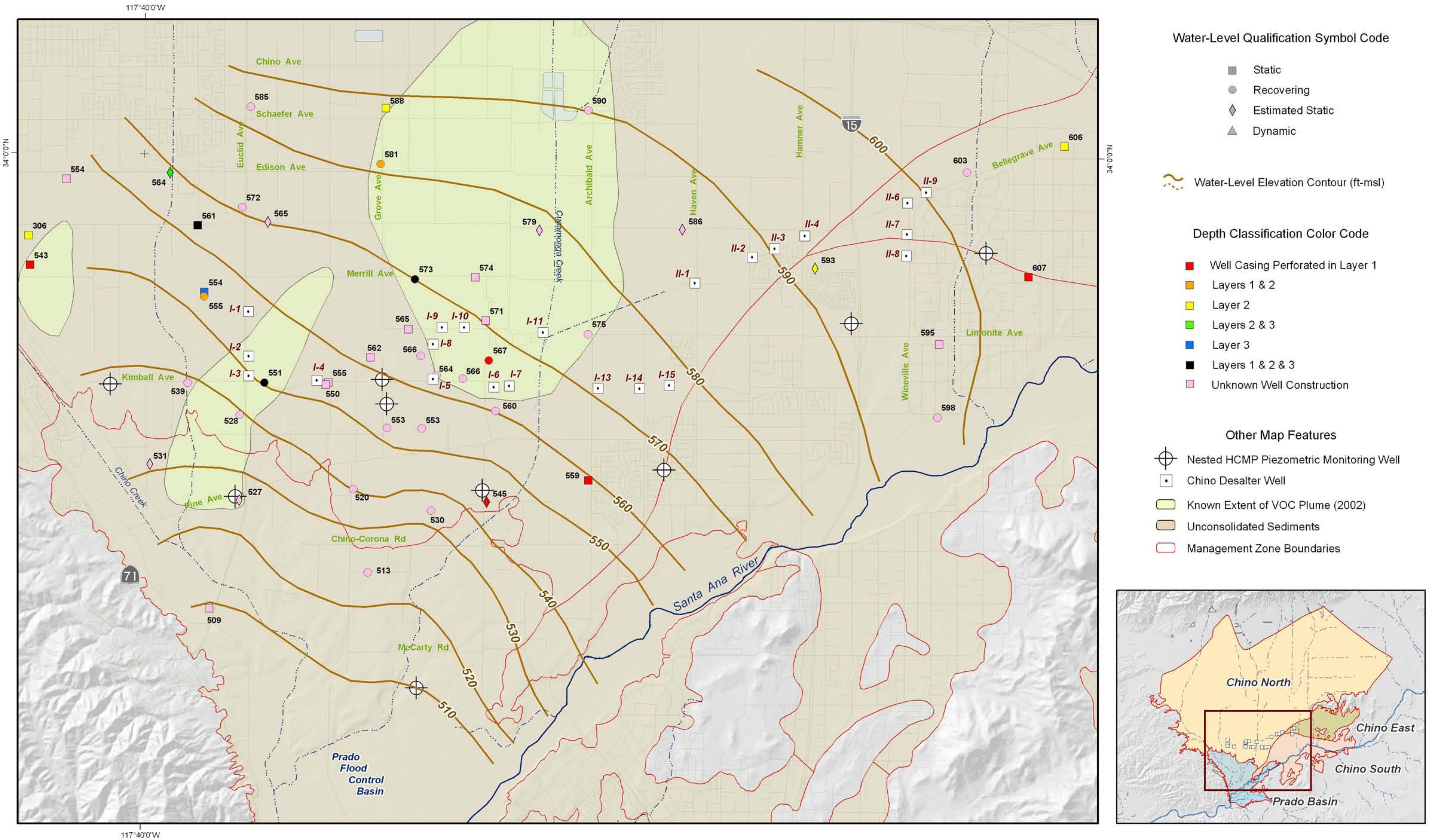

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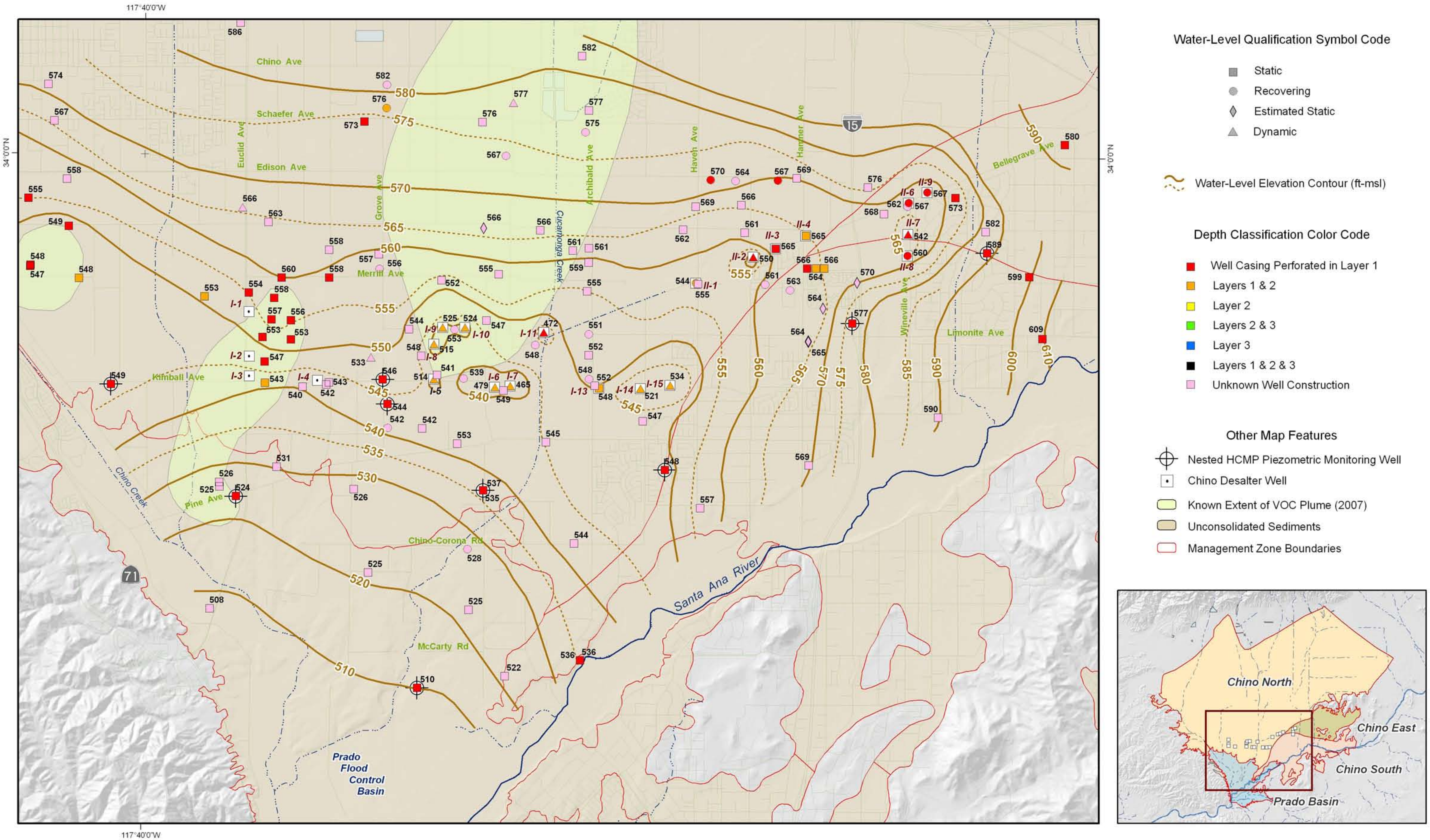
2009 Annual Report

Groundwater Elevation for Spring 2000

Model Layer 1 -- Shallow Aquifer System

Figure 3-3



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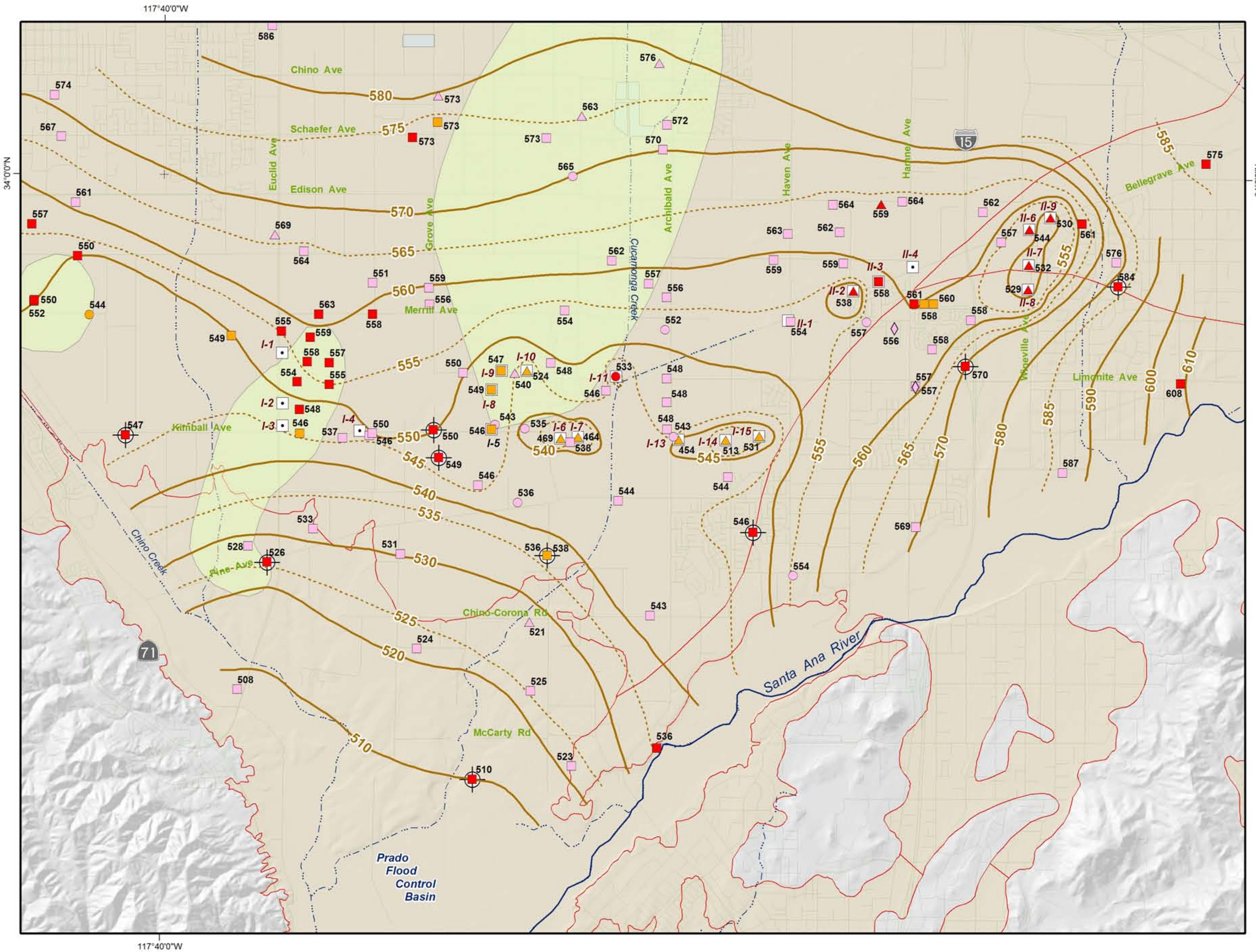
0 1 Miles
0 2 KM

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Groundwater Elevation for Spring 2008

Model Layer 1 -- Shallow Aquifer System

Figure 3-4



Water-Level Qualification Symbol Code

- Static
- Recovering
- Estimated Static
- Dynamic

Water-Level Elevation Contour (ft-msl)

Depth Classification Color Code

- Well Casing Perforated in Layer 1
- Layers 1 & 2
- Layer 2
- Layers 2 & 3
- Layer 3
- Layers 1 & 2 & 3
- Unknown Well Construction

Other Map Features

- Nested HCMP Piezometric Monitoring Well
- Chino Desalter Well
- Known Extent of VOC Plume (2007)
- Unconsolidated Sediments
- Management Zone Boundaries

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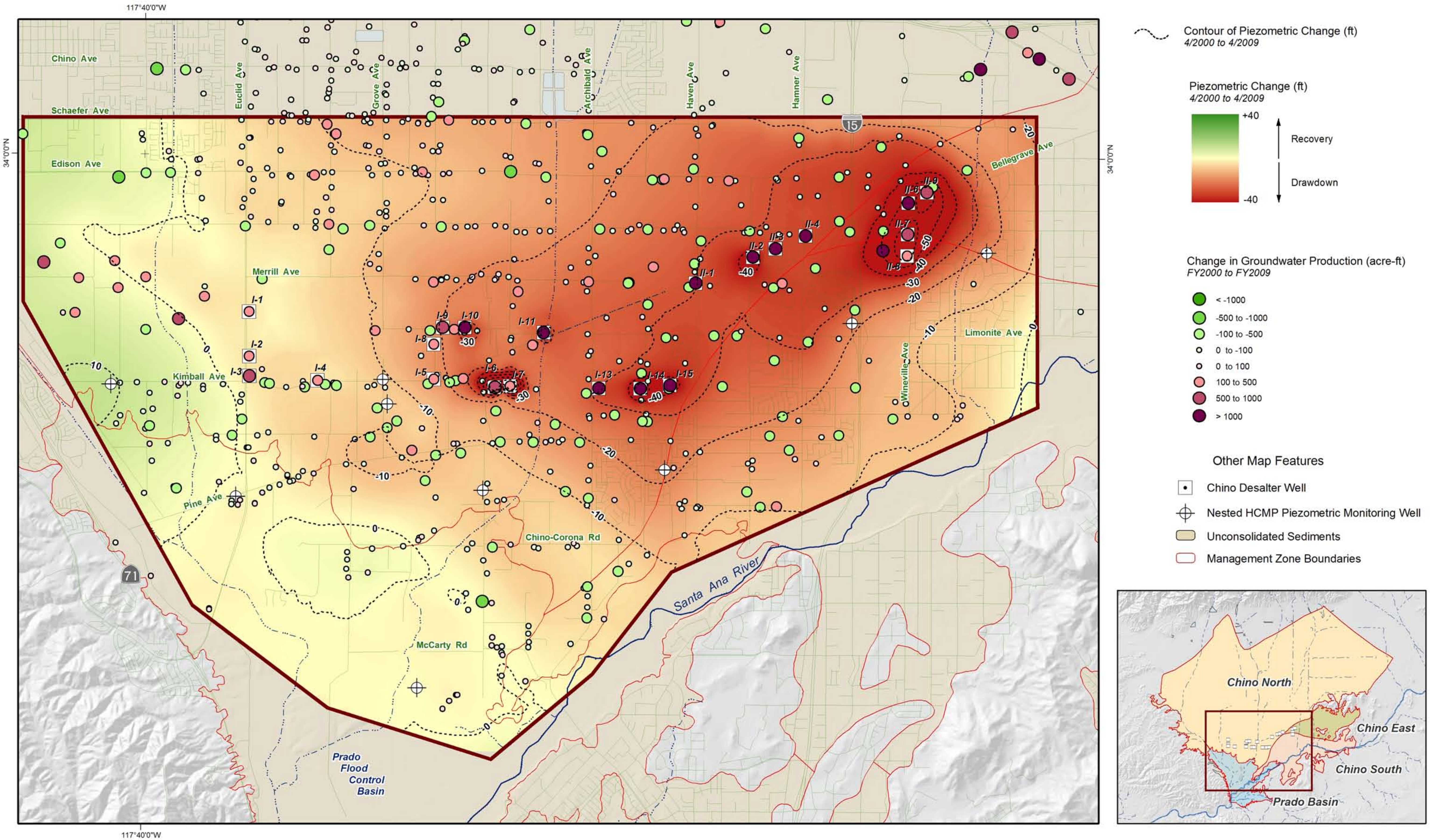
0 1 Miles
0 2 KM

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Groundwater Elevation for Spring 2009

Model Layer 1 -- Shallow Aquifer System

Figure 3-5



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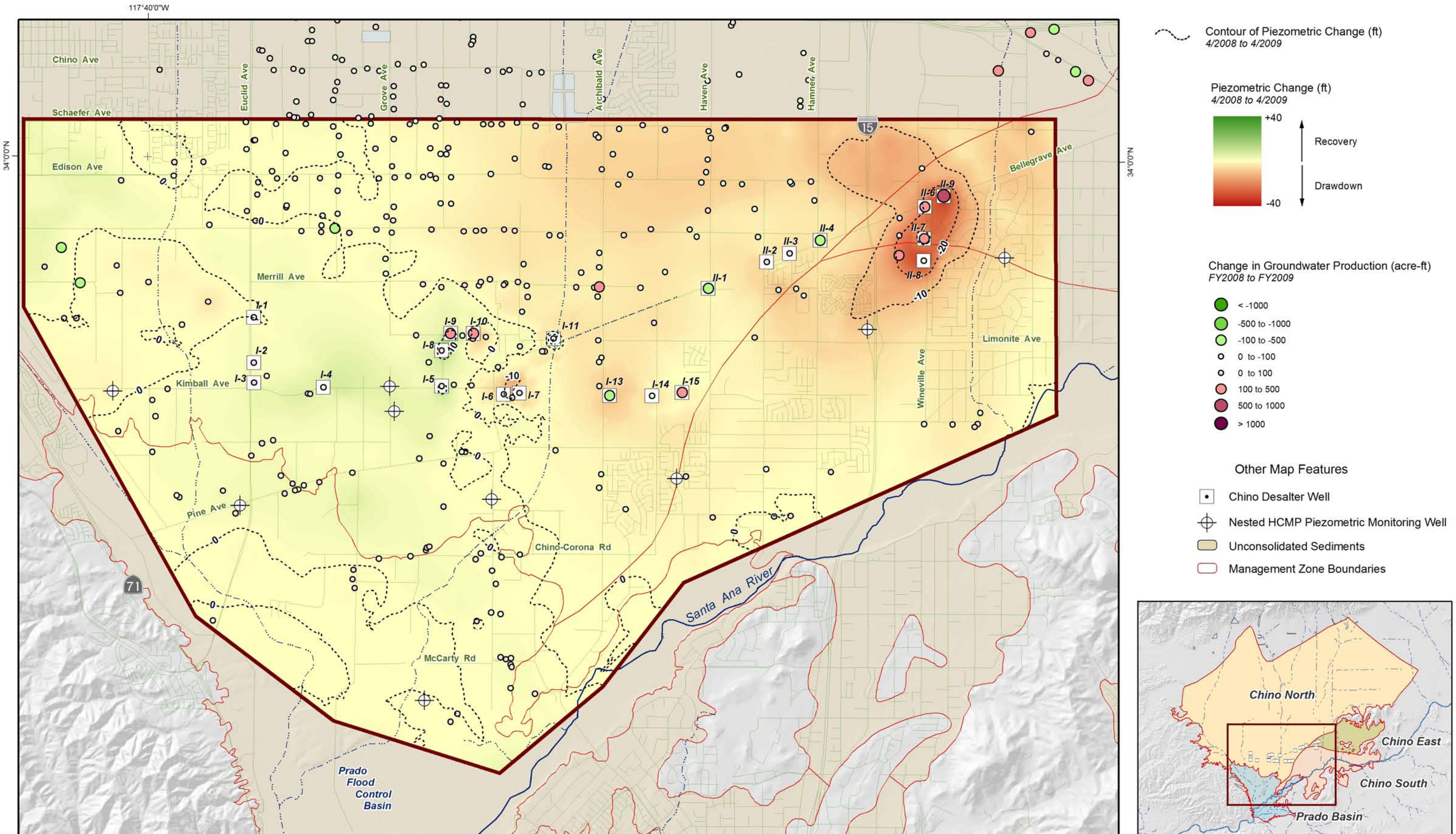
0 1 Miles
0 2 KM

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Piezometric Change (4/2000 - 4/2009)

Model Layer 1 -- Shallow Aquifer System

Figure 3-6



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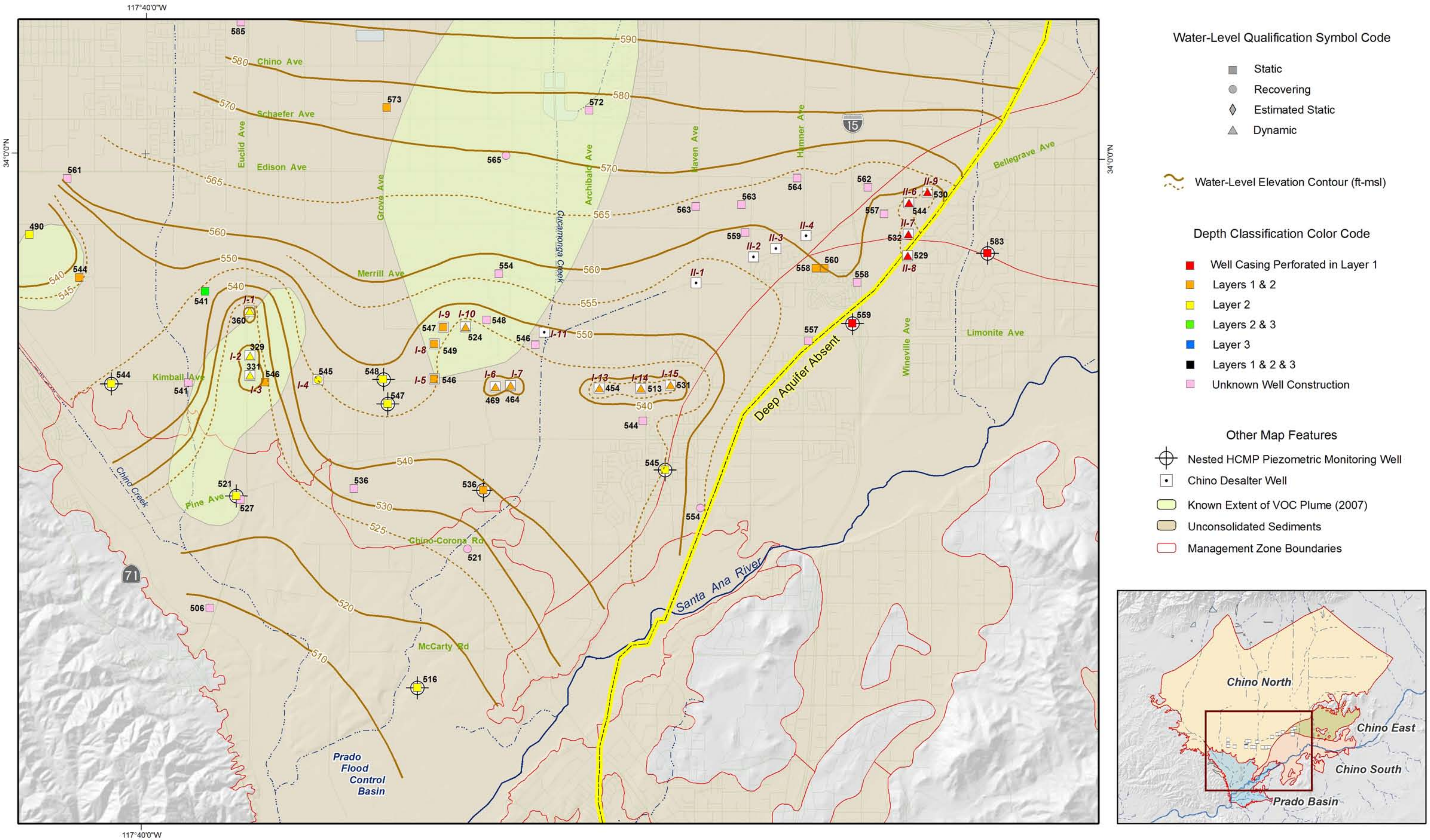
0 1 Miles
0 2 KM

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Piezometric Change (4/2008 - 4/2009)

Model Layer 1 -- Shallow Aquifer System

Figure 3-7



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0 1 Miles

0 2 KM

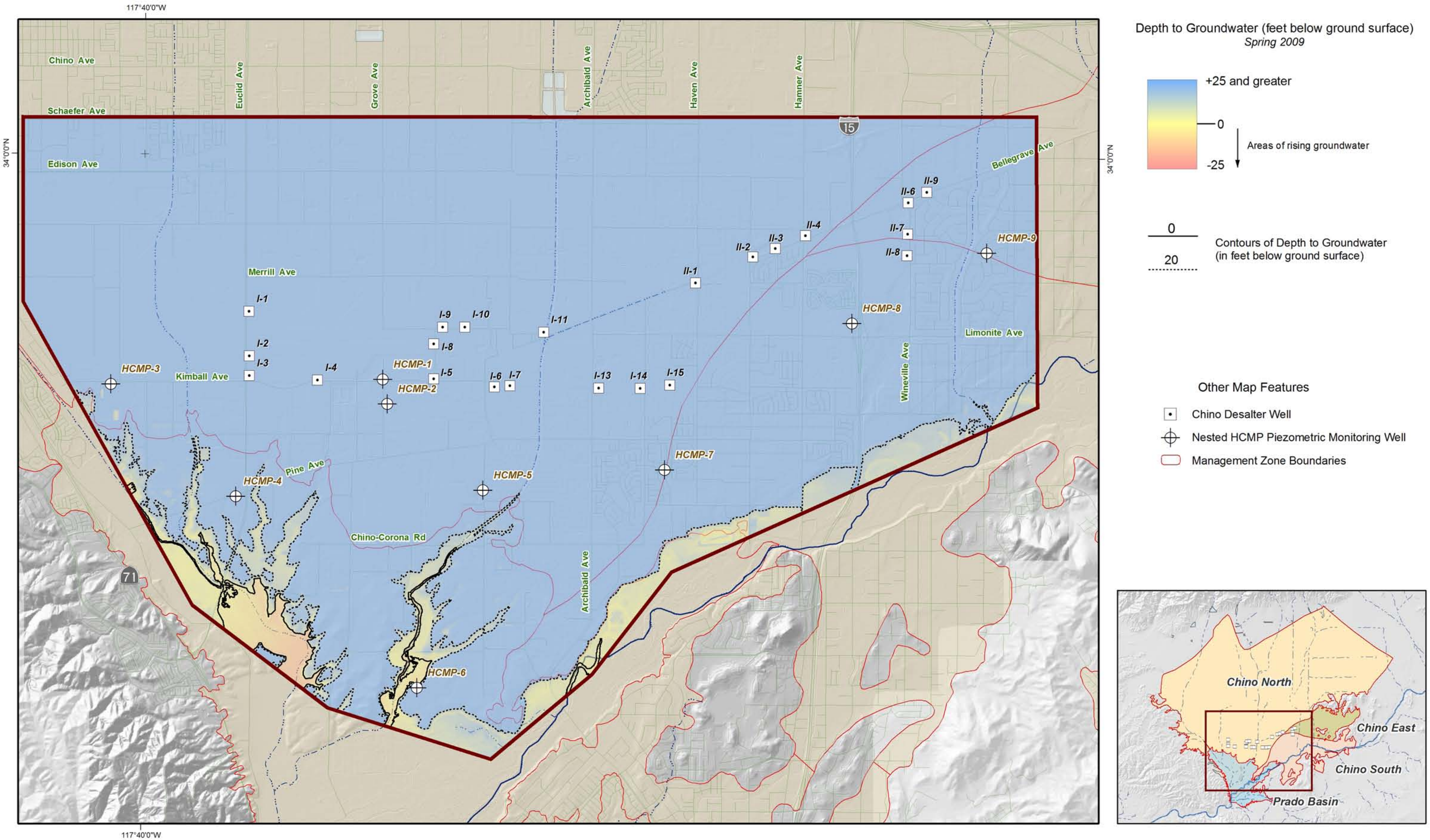
Chino Basin Maximum Benefit Monitoring Program

2009 Annual Report

Groundwater Elevation for Spring 2009

Model Layers 2 & 3 -- Deep Aquifer System

Figure 3-8



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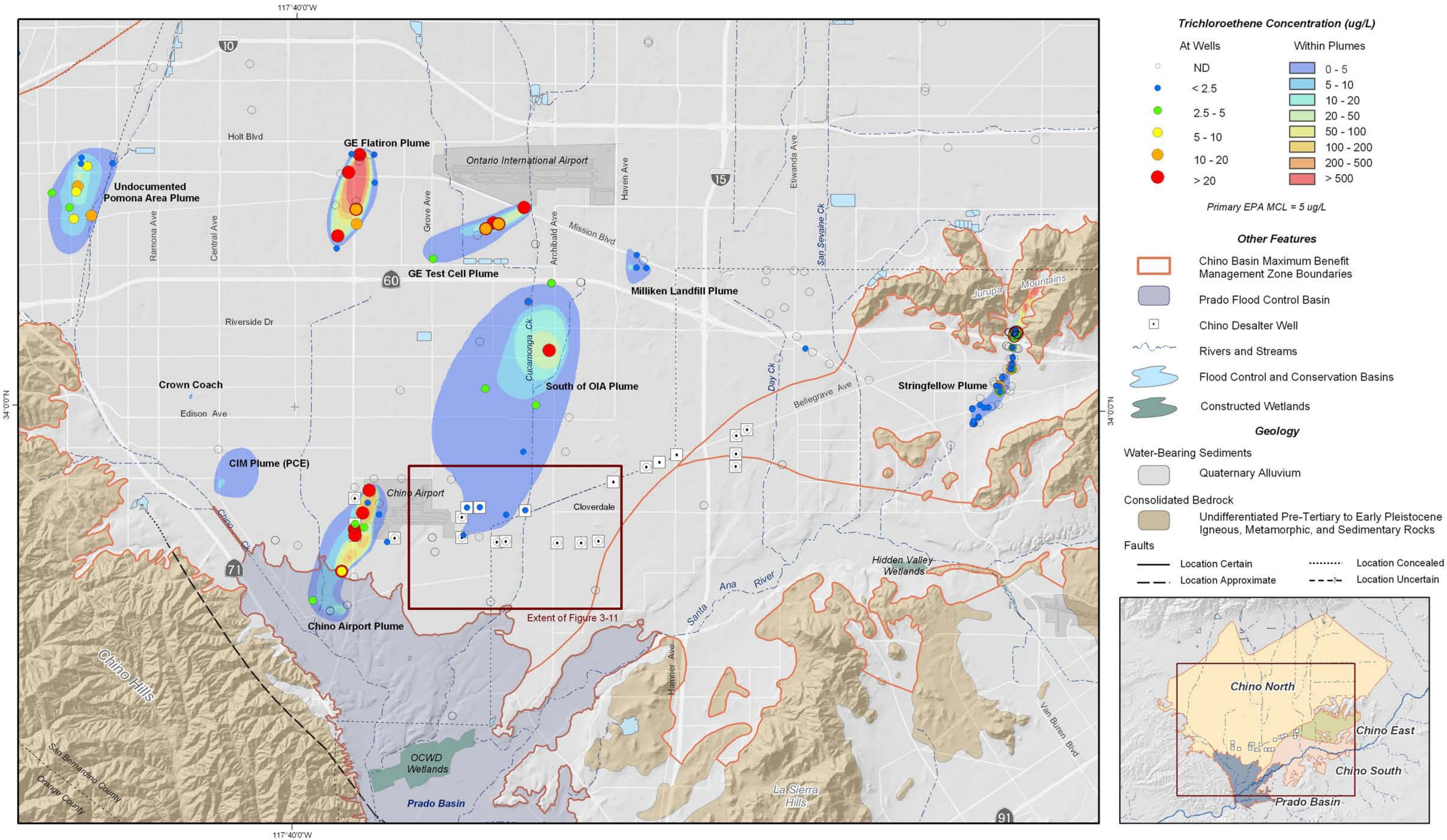
2009 Annual Report

Depth to Groundwater for Spring 2009

Model Layer 1 -- Shallow Aquifer System

Figure 3-9



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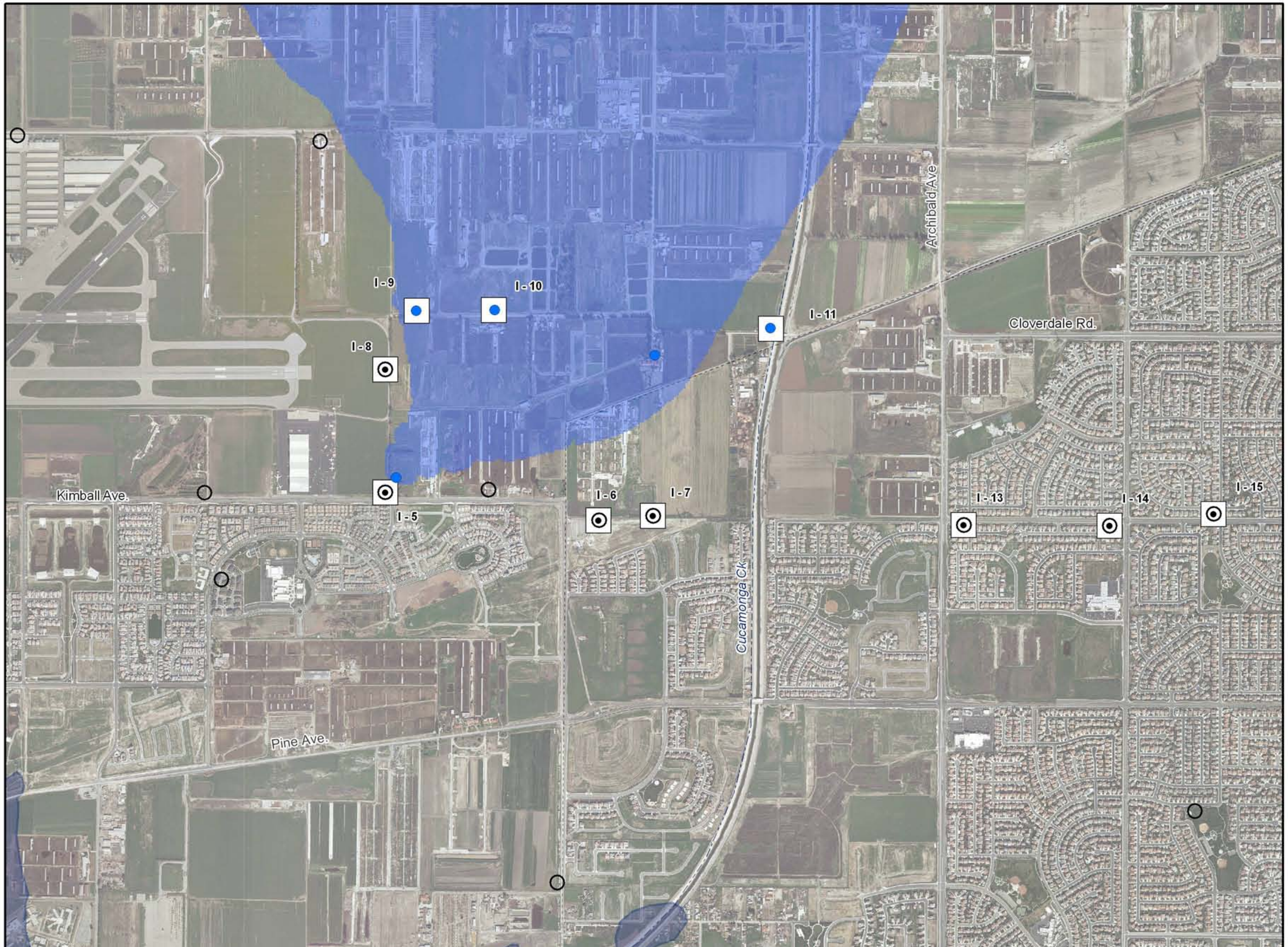
Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Trichloroethene in Groundwater

Maximum Concentration 2009

Figure 3-10



Trichloroethene Concentration (ug/L)

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

Within Plumes
- 0 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
- 200 - 500
- > 500

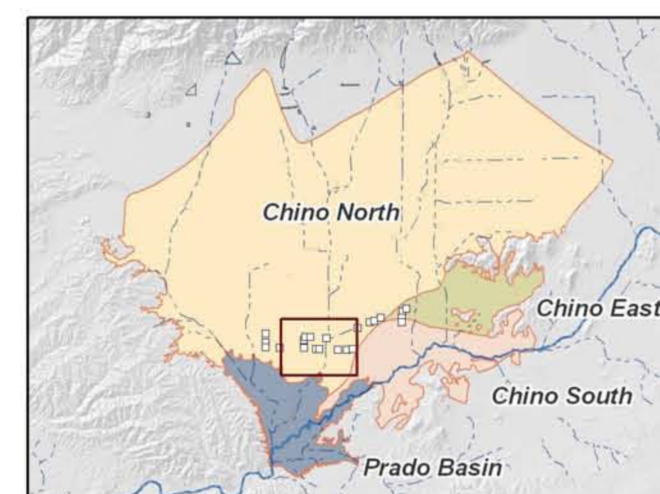
Primary EPA MCL = 5 ug/L

Other Features

- Prado Flood Control Basin
- Chino Desalter Well
- Rivers and Streams

Geology

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



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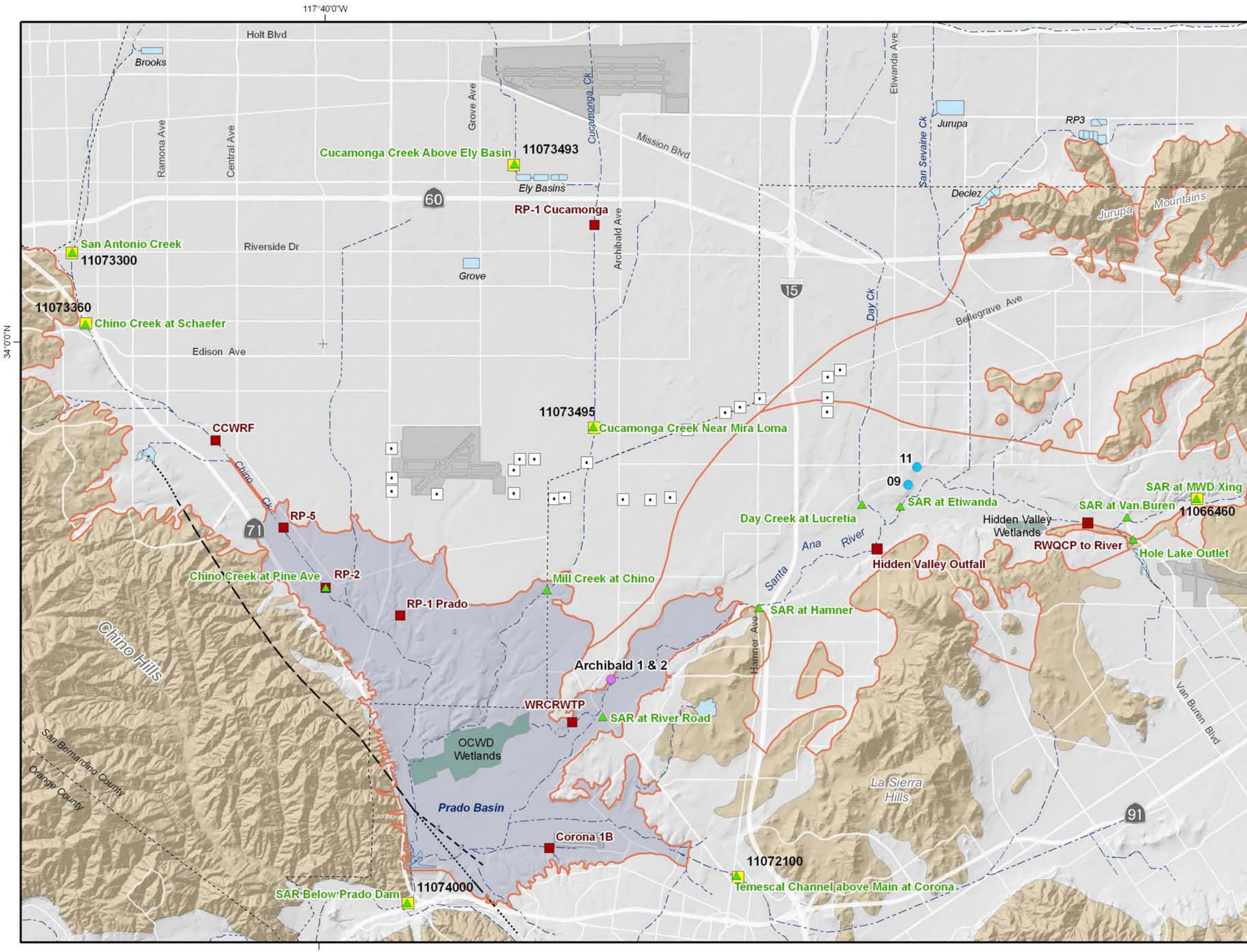
0 0.25 0.5 0.75 1 Miles
0 0.5 1 1.5 KM

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Trichloroethene in Groundwater

Maximum Concentration 2009 - Inset Area

Figure 3-11



Surface Water Monitoring Locations

- HCMP Surface Water Sampling Site
- USGS Gaging Stations
- Recycled Water Discharge Locations

Near River Well Locations

- Santa Ana River Water Company Wells
- USGS NAWQA Wells

Other Features

- Chino Basin Maximum Benefit Management Zone Boundaries
- Prado Flood Control Basin
- Chino Desalter Well
- Rivers and Streams
- Flood Control and Conservation Basins
- Constructed Wetlands

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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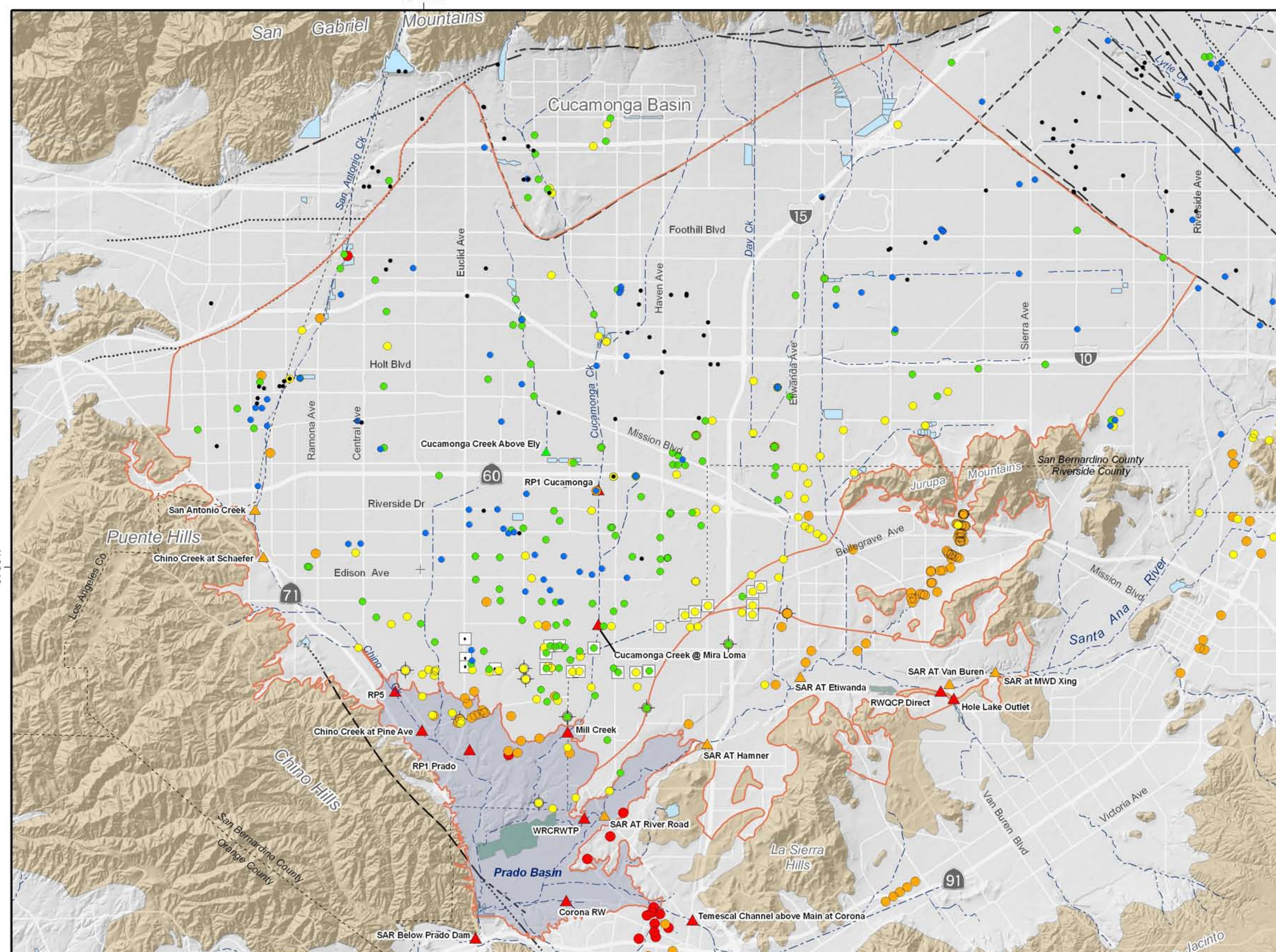
0 1 2 3 4 Miles
0 2 4 6 KM

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Surface Water Sites and Near River Wells

Monitoring Locations Used to Compare Water Quality

Figure 3-12



Main Features

Average WCI in Groundwater (2005-2009)

- < 200
- 200 - 400
- 400 - 600
- 600 - 800
- 800 - 1000
- > 1000

Average WCI in Surface Water (2005-2009)

- < 200
- 200 - 400
- 400 - 600
- 600 - 800

Other Features

- Chino Basin Maximum Benefit Management Zone Boundaries
- Prado Flood Control Basin
- HCMP Monitoring Wells
- Chino Desalter Well
- Rivers and Streams
- Flood Control and Conservation Basins
- Constructed Wetlands

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 Miles
0 2 4 6 KM

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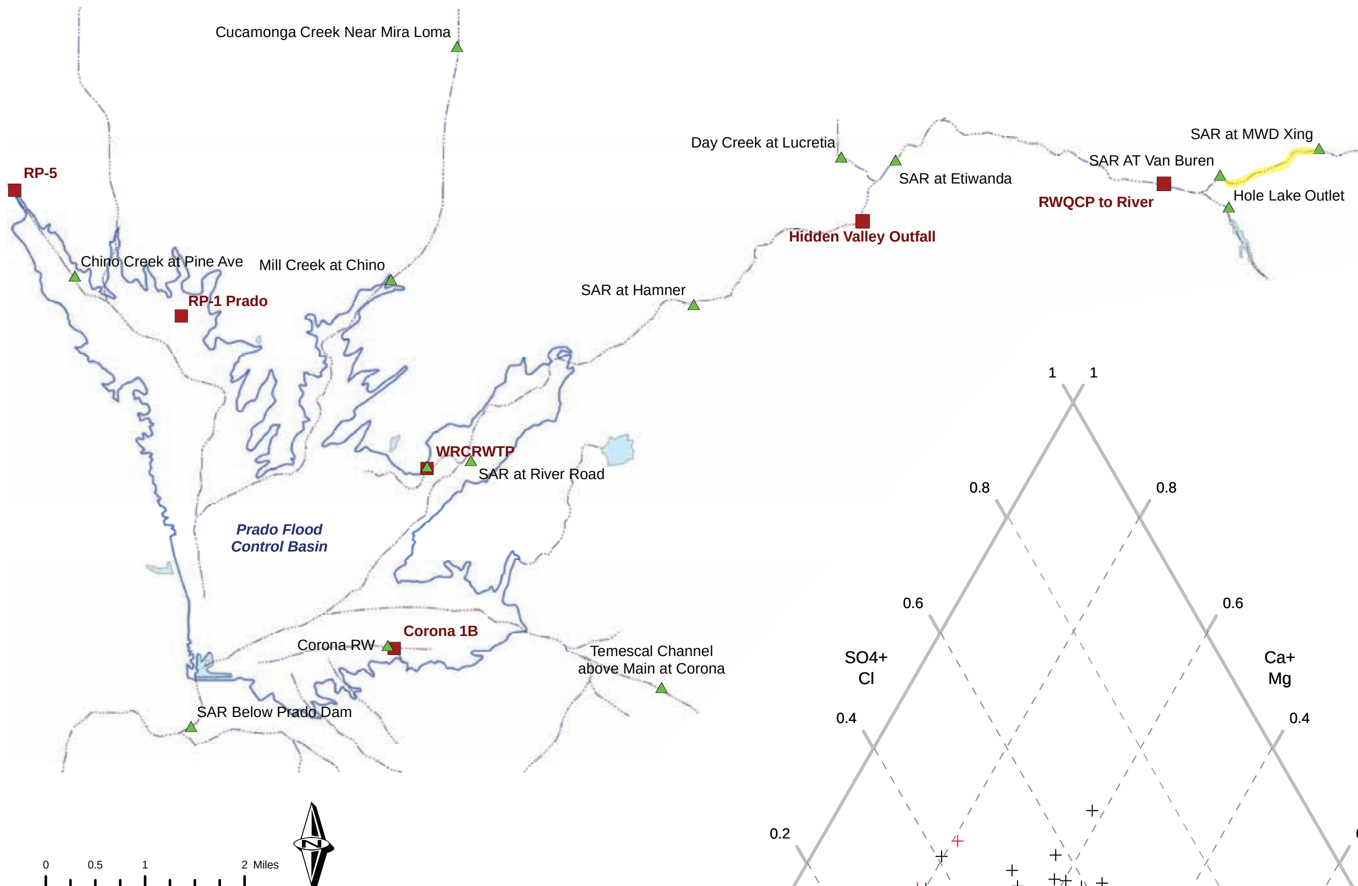
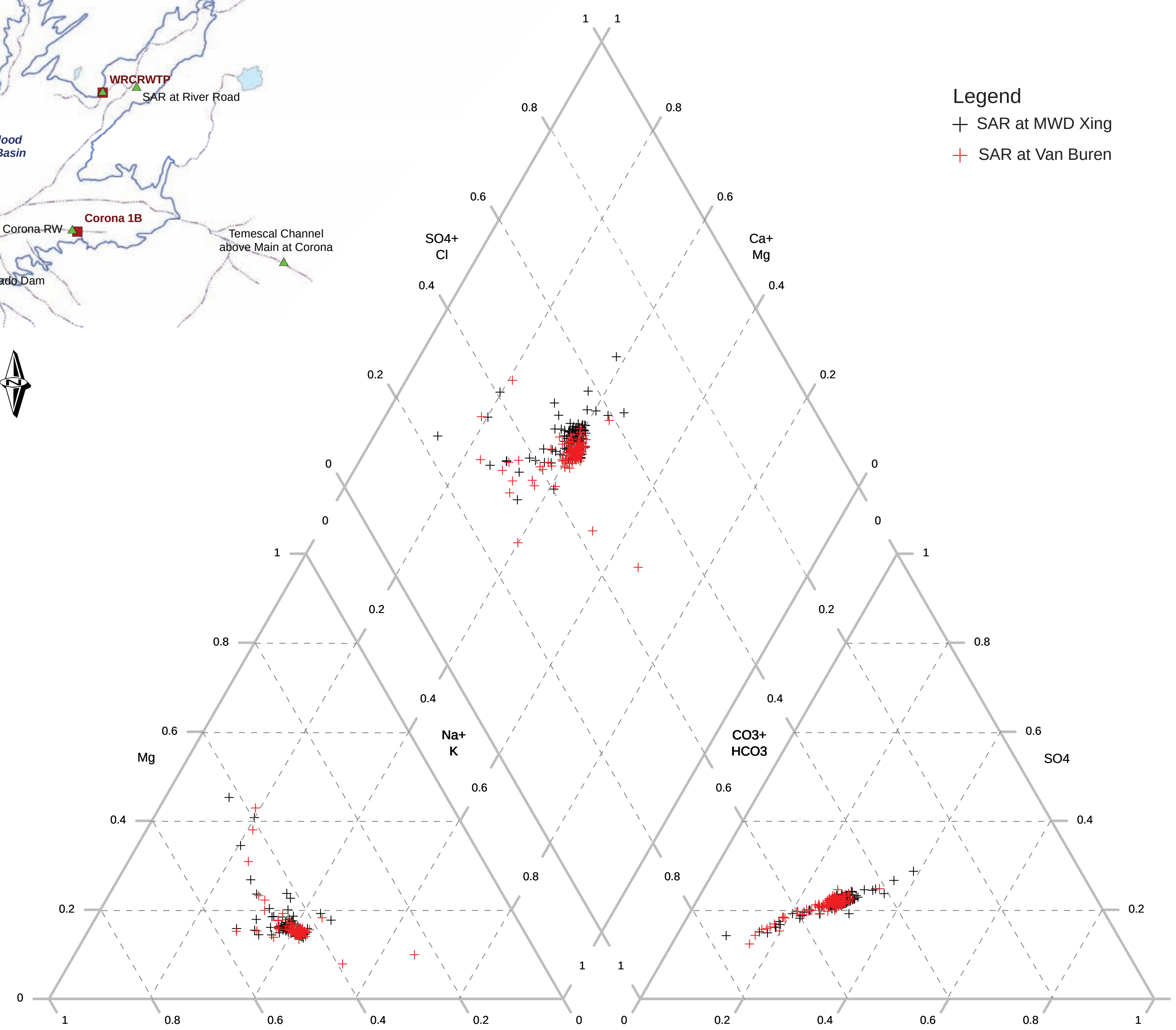
2009 Annual Report

Water Character Index in Groundwater
2005 - 2009

Figure 3-13





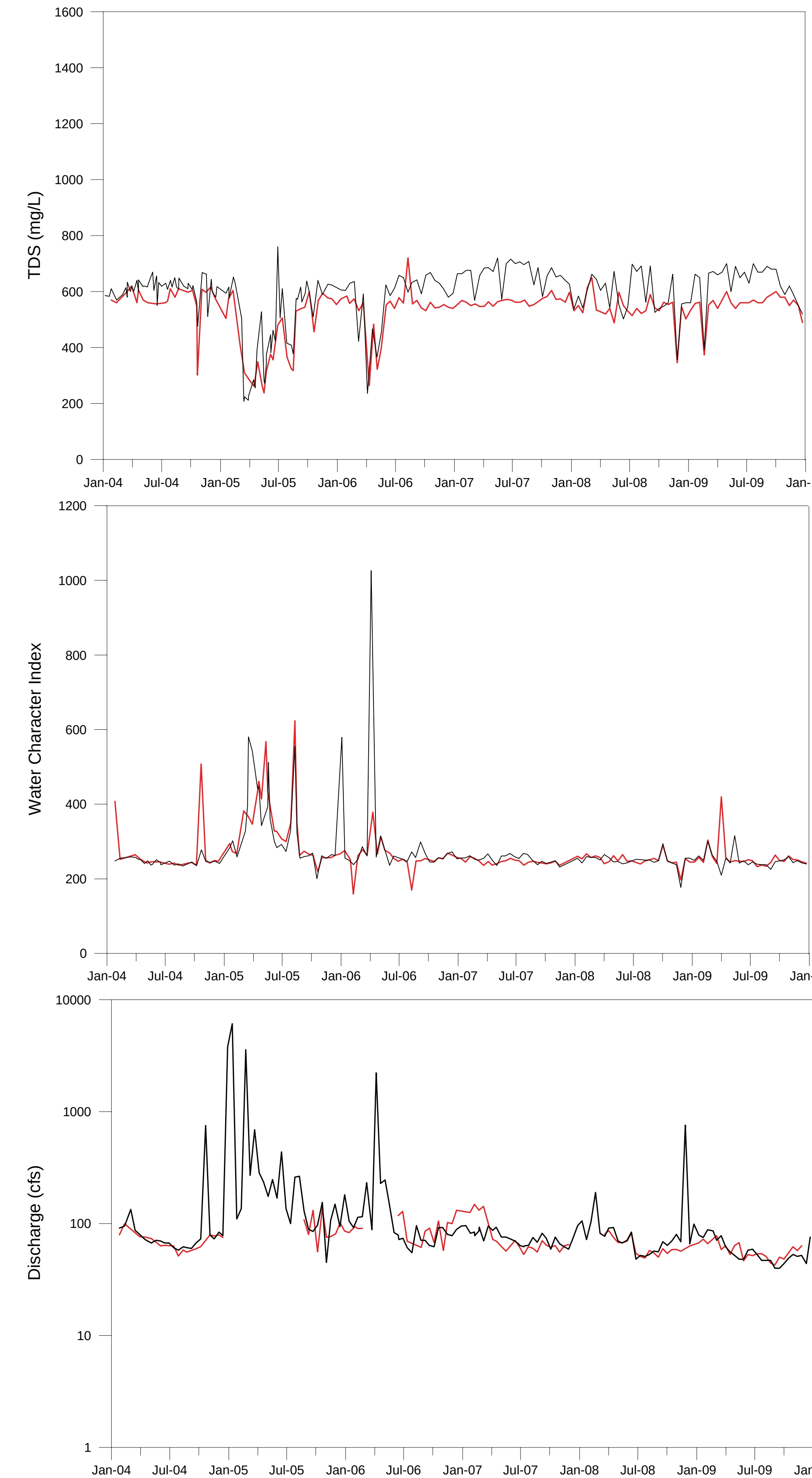


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Figure 3-14
Piper Plot, TDS, WCI, and Discharge at MWD Xing and Van Buren

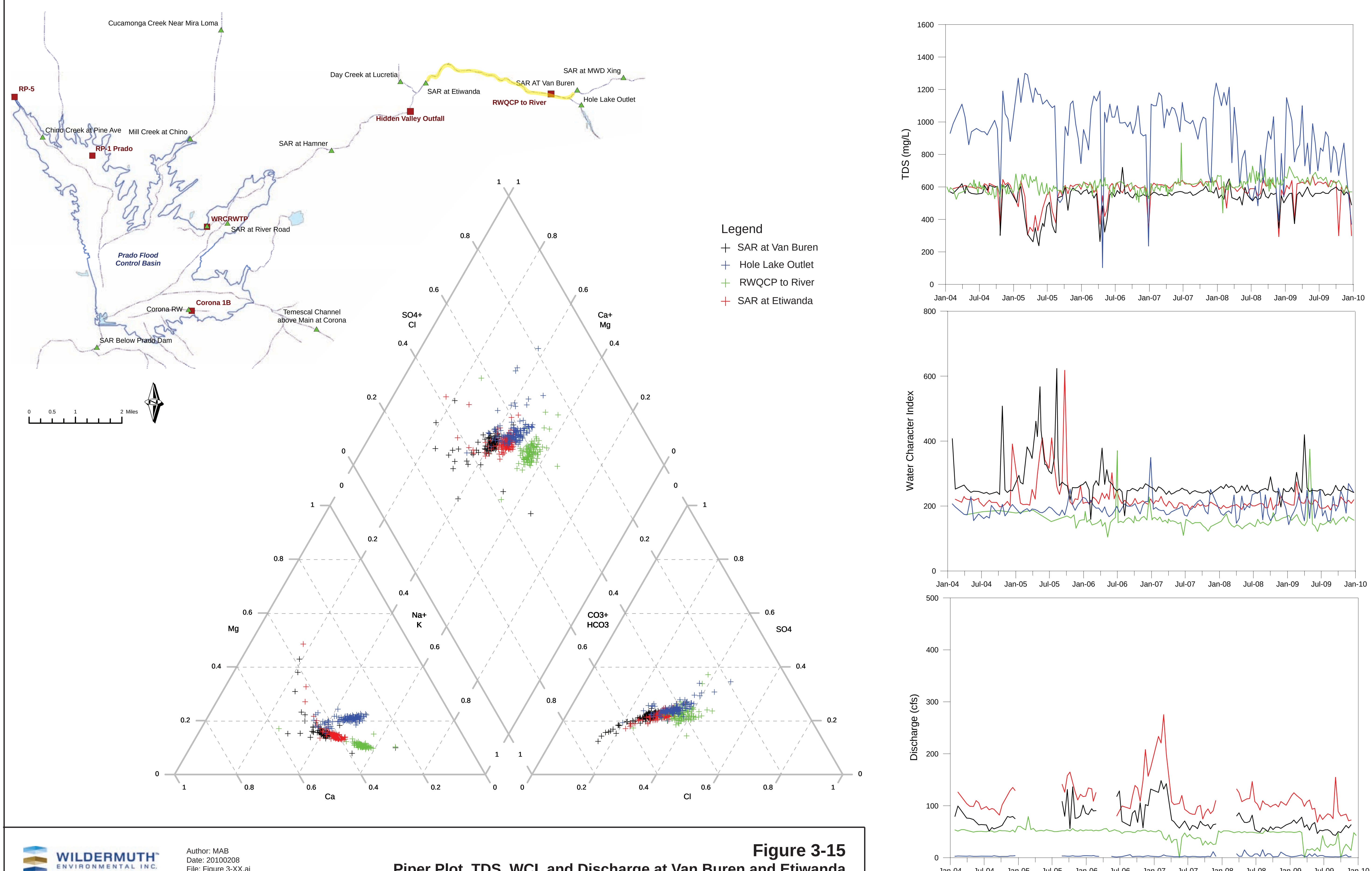

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Figure 3-15
Piper Plot, TDS, WCI, and Discharge at Van Buren and Etiwanda

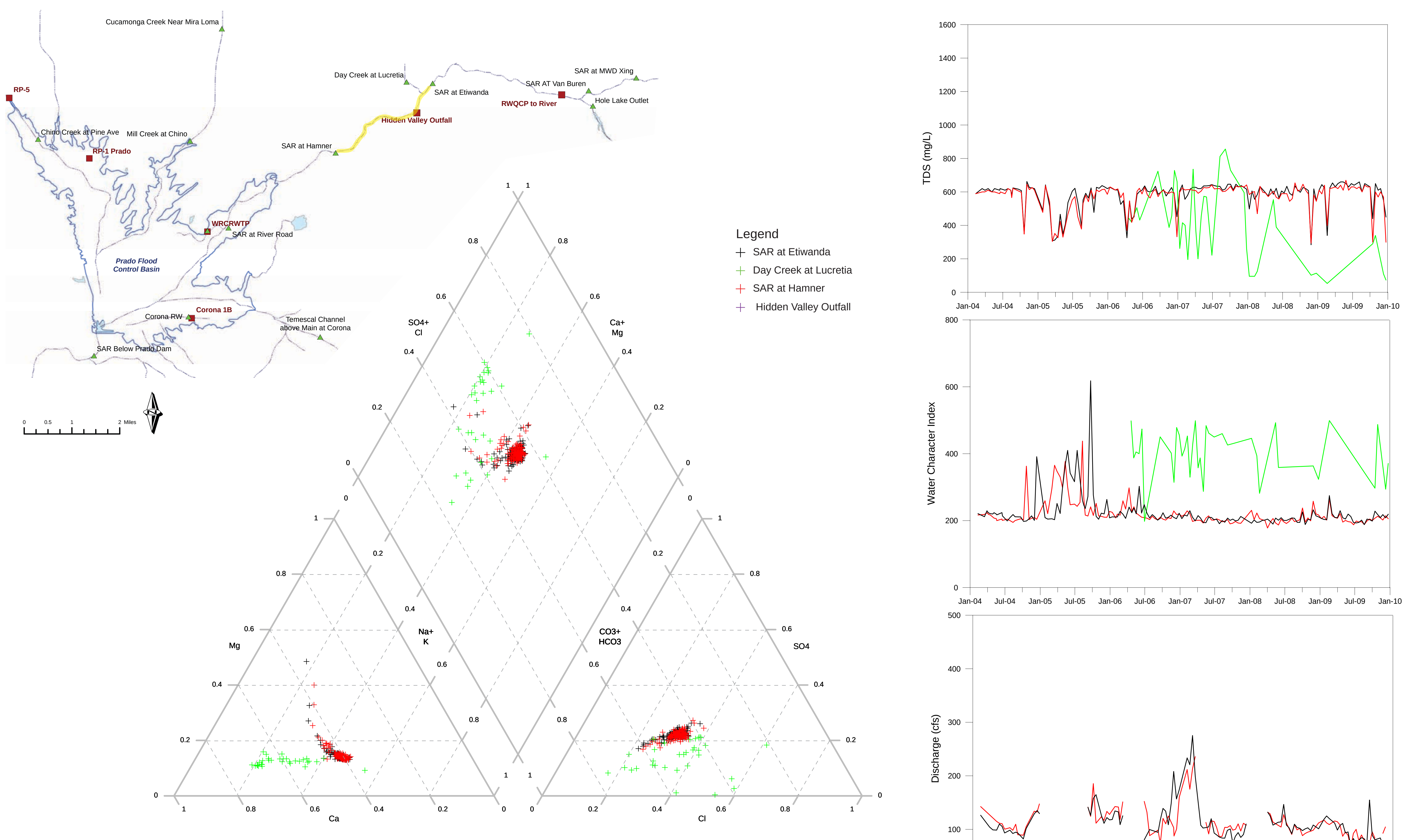

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Figure 3-16
Piper Plot, TDS, WCI, and Discharge at Etiwanda and Hamner

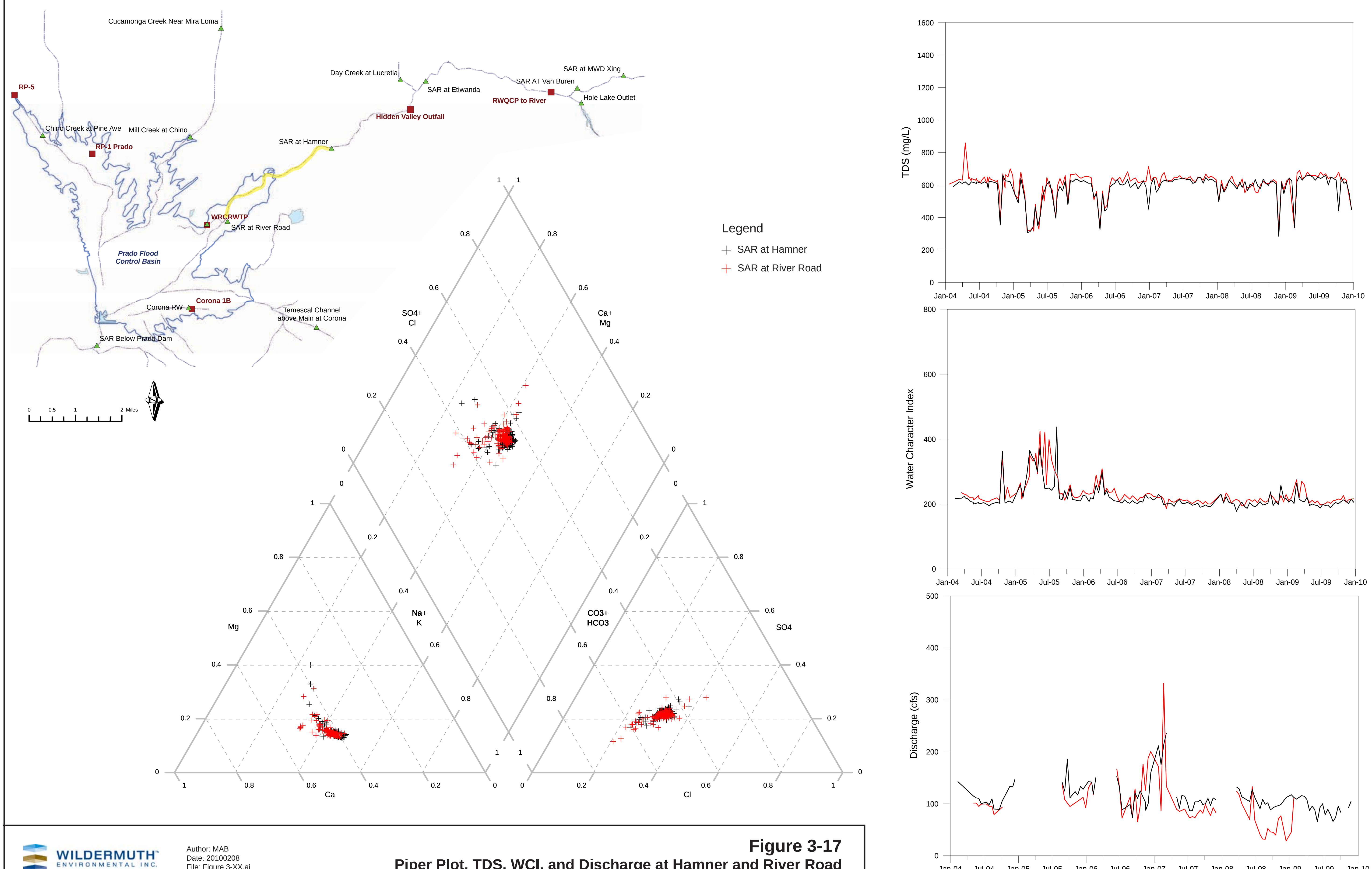

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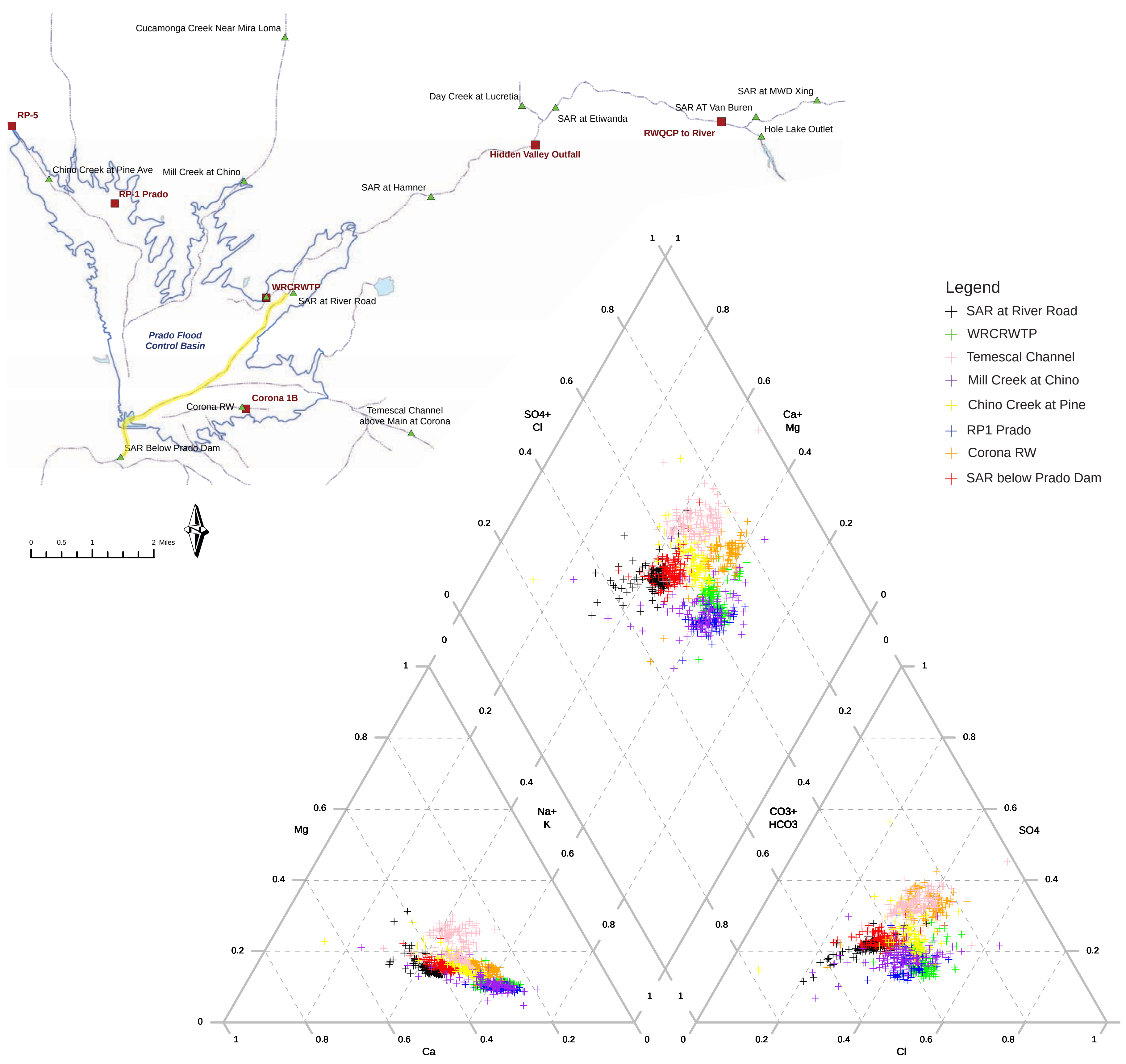
Figure 3-17
Piper Plot, TDS, WCI, and Discharge at Hamner and River Road



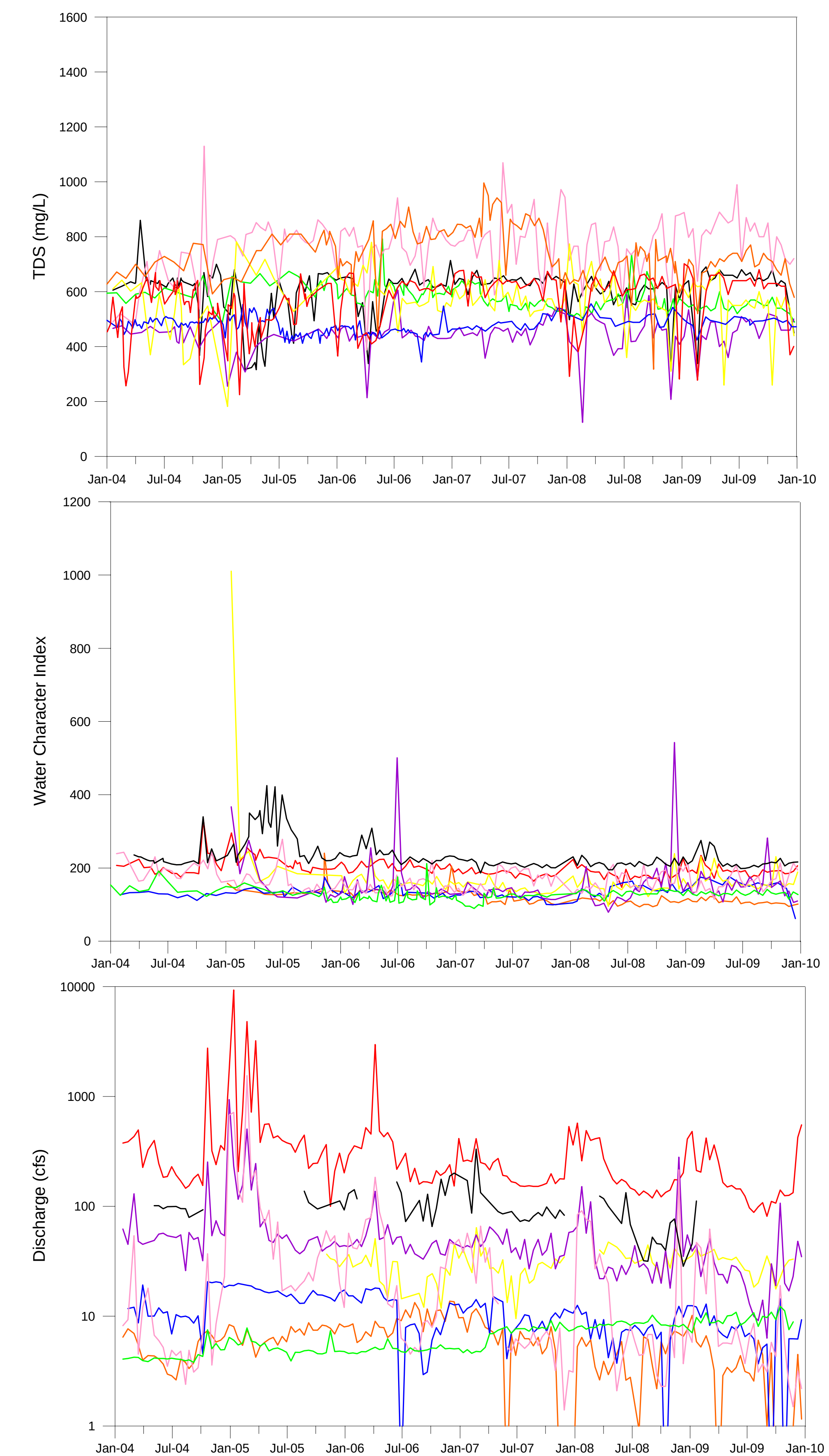


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Figure 3-18
Piper Plot, TDS, WCI, and Discharge at River Road and Below Prado Dam

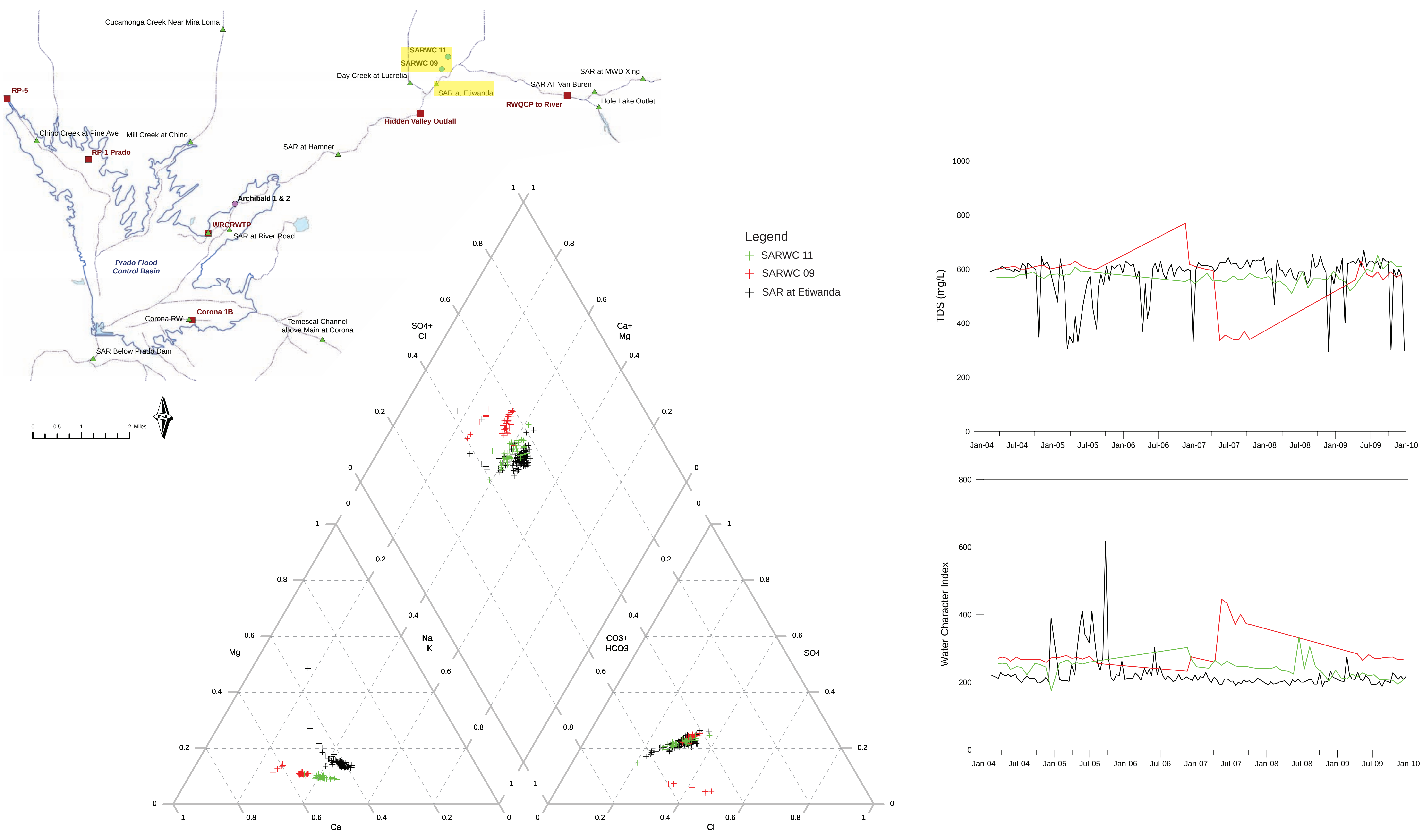

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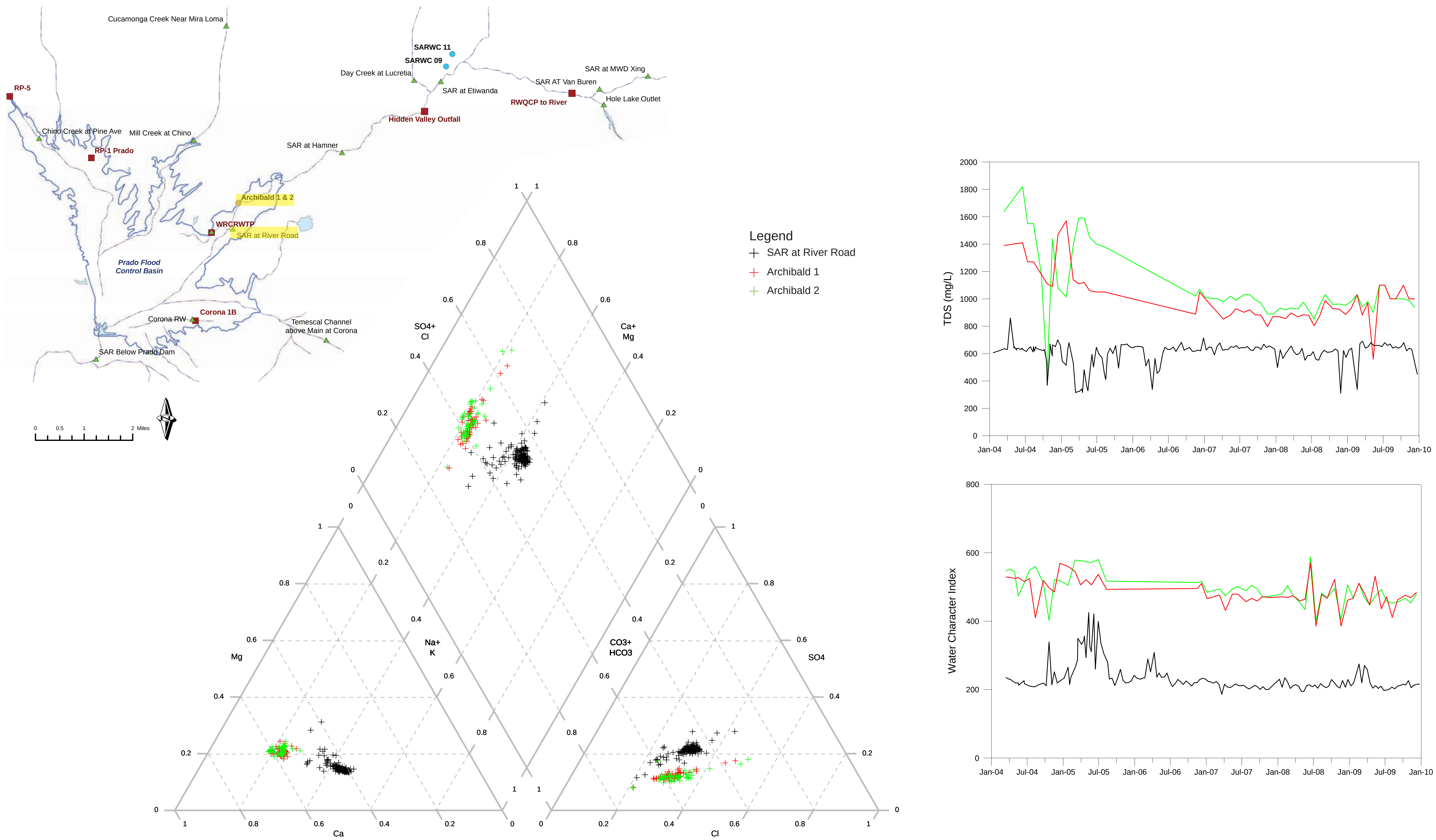
Figure 3-19
Piper Plot, TDS, and WCI at Etiwanda and SARWC 9 & 11



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Author: MAB
Date: 20100208
File: Figure 3-XX.ai

Figure 3-20

Piper Plot, TDS, and WCI at River Road and Archibald 1 & 2

Figure 3-21
Net Annual Rising Groundwater to the Santa Ana River between Riverside Narrows and Prado Dam
Water Years 1970/71 through 2008/09

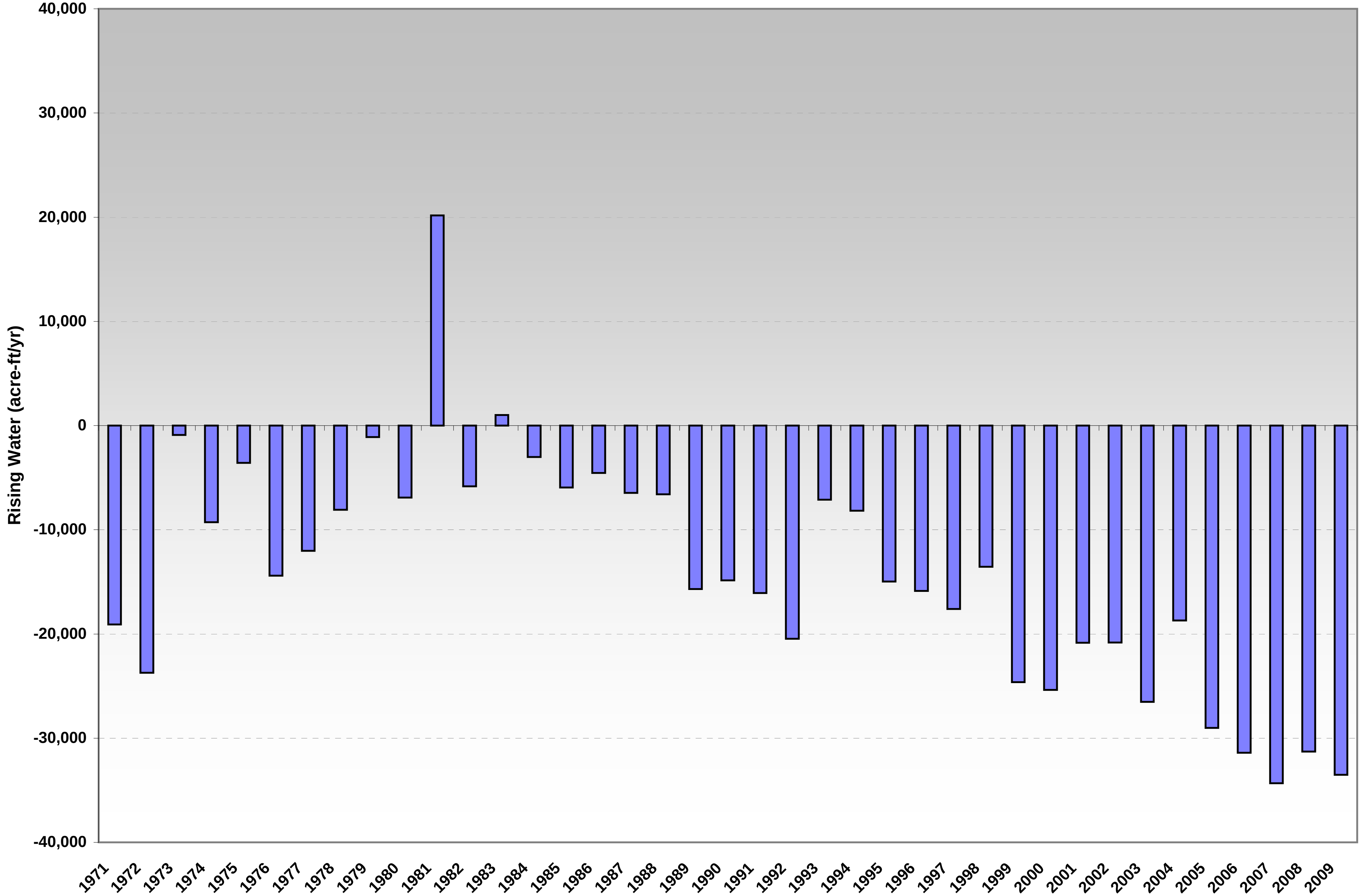

Table 3-1_Figure 3-21_v2 -- Fig_3-21

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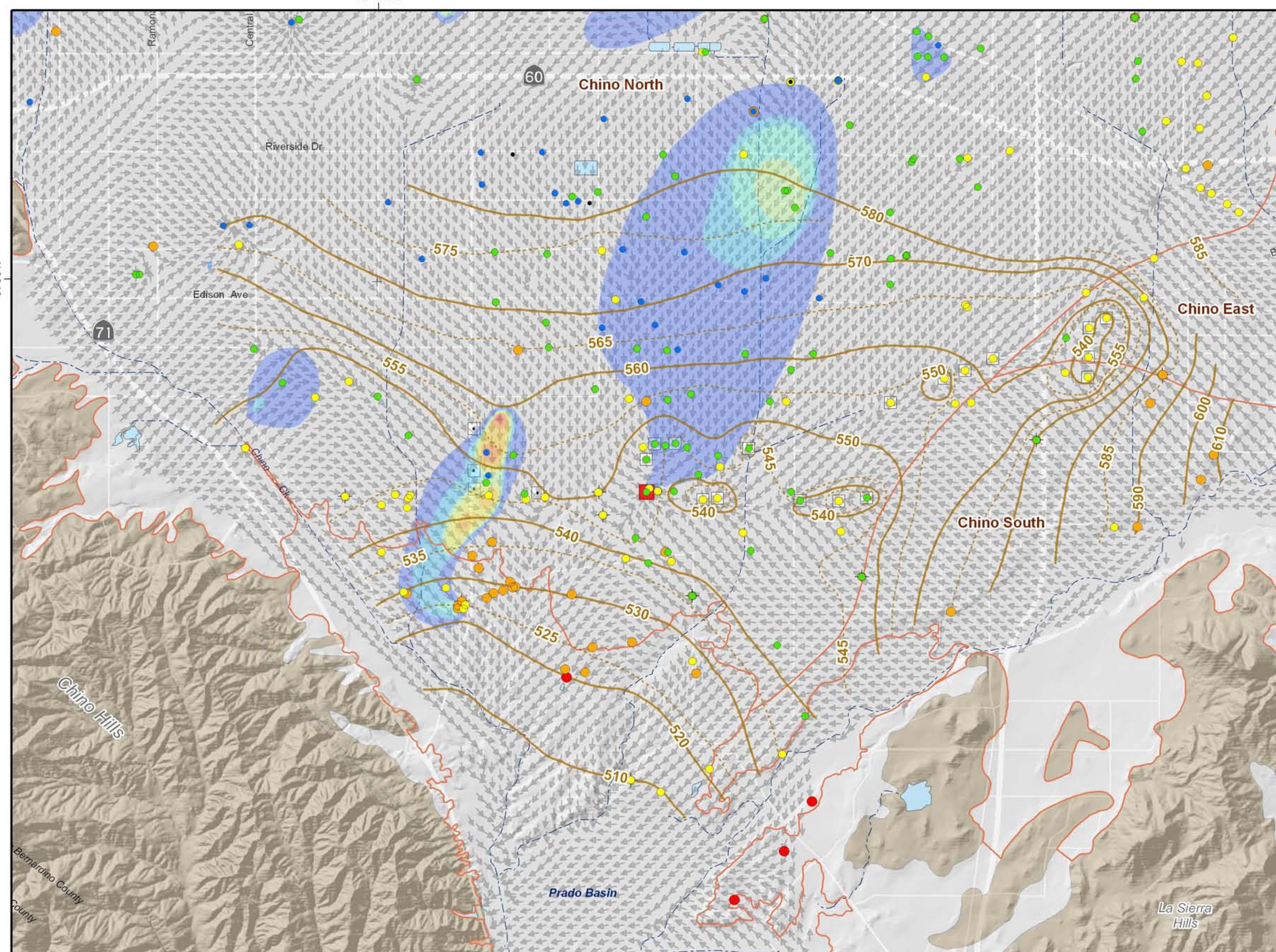

Main Features

Average Water Character Index at Wells (2005-2009)

- < 200
- 200 - 400
- 400 - 600
- 600 - 800
- 800 - 1000
- > 1000

2009 Measured Groundwater Elevation Contours

2010 Groundwater Flow Vectors- (Model Layer 1- Peace II Alternative)

Chino Desalter Well **(Well I-5 is Red)**

Other Features

Chino Basin Maximum Benefit Management Zone Boundaries

Prado Flood Control Basin

HCMP Monitoring Wells

Rivers and Streams

Flood Control and 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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Date: 20100211
File: Fig 3-13.mxd

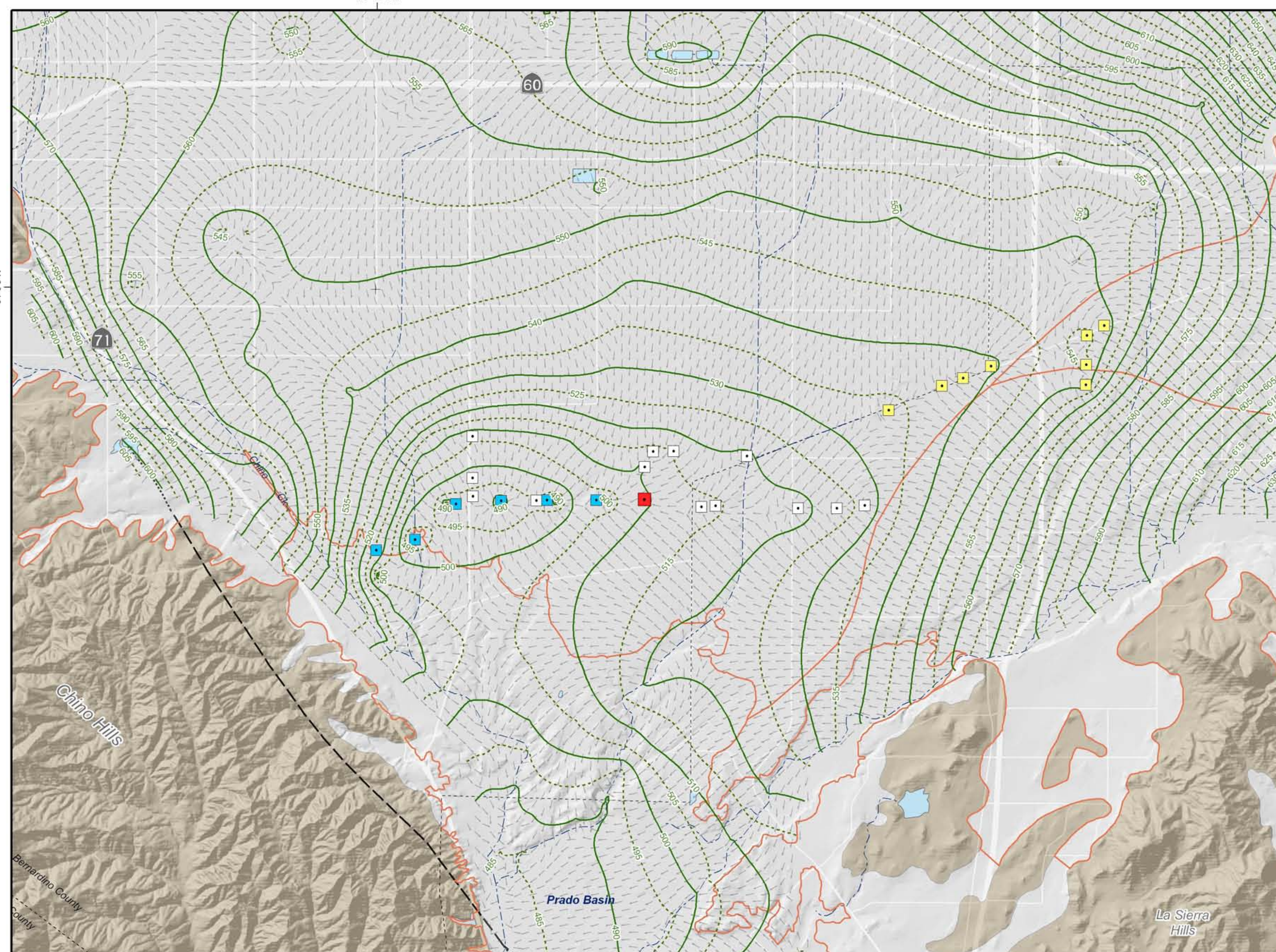
Scale: 0 1 2 3 4 Miles; 0 2 4 6 KM

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Integrated Analysis of Hydraulic Control

Comparison of Measured Data with Watermaster's Groundwater Model

Figure 3-22



Main Features

2020 Groundwater Elevation Contours

2020 Groundwater Flow Vectors- (Model Layer 1- Peace II Alternative)

Chino-I Desalter Well **(Well I-5 is Red)**

Chino-II Desalter Well

Proposed Chino Creek Well

Other Features

Chino Basin Maximum Benefit Management Zone Boundaries

Prado Flood Control Basin

Rivers and Streams

Flood Control and Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Faults

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0 1 2 3 4 Miles
0 2 4 6 KM

Chino Basin Maximum Benefit Monitoring Program
2009 Annual Report

Layer 1 Groundwater Elevation Contours and Flow Directions in the Southern Chino Basin

Peace II Alternative -- 2020

Figure 3-23

Section 4 – Conclusions and Recommendations

This section summarizes the conclusions of the HCMP to date and presents Watermaster and the IEUA's recommendations for the modification of the HCMP.

4.1 Conclusions

When it was designed in 2004, the intent of the HCMP was to use four lines of evidence to demonstrate whether and to what extent the hydraulic control of Chino Basin groundwater is being achieved. The concept of using multiple lines of evidence was included in the HCMP because it was not clear that one line of evidence would be sufficient to demonstrate hydraulic control. The first line of evidence is to collect and analyze groundwater-elevation data to determine the direction of groundwater flow in the southern part of the basin and whether or not hydraulic control is being achieved by pumping at the Chino Desalter well fields. The second line of evidence is to collect and analyze the chemistry of basin-wide groundwater and the Santa Ana River (a) to determine whether or not the OIA VOC plume is migrating beyond the Chino Desalter well fields and (b) to identify the source of groundwater in the area between the Santa Ana River and the Chino Desalter wells. The third line of evidence is to collect and analyze surface water discharge and water quality measurements to determine the extent and magnitude of groundwater discharge to the Santa Ana River. The fourth line of evidence is to use Watermaster's computer-simulation groundwater flow model to corroborate the results and interpretations of the first three lines of evidence. Watermaster staff has been collecting surface and groundwater data pursuant to the Regional Board approved monitoring plan (R8-2005-0064) since 2004—a period of six years. The following is a brief summary of the HCMP conclusions through 2009.

- **Piezometric Levels**. The piezometric data collected and analyzed to date, at both local and regional scales, indicate that progress toward complete hydraulic control has occurred since 2000. The shape of the piezometric contours of the shallow aquifer system for spring 2009 suggest that hydraulic control is occurring at the desalter wells in the central and eastern part of the combined well fields (Chino-I Desalter wells 5 through 15 and Chino-II Desalter wells 1 through 9). In the western part of the Chino-I Desalter well field (wells 1 through 4), the shape of the piezometric contours suggests that hydraulic control is not occurring because these wells are perforated primarily within the deep aquifer system. The ultimate fate of groundwater that flows past the western part of the desalter well fields is to flow southward toward the Prado Basin where it can rise to become surface water in the Santa Ana River. In the area adjacent to the Santa Ana River and east of Archibald Avenue, piezometric levels declined by approximately 10 feet from 2000 to 2009. Agricultural pumping in this area declined over this period, which suggests that the piezometric decline is due to desalter pumping. The piezometric declines in this area are physical evidence that suggest desalter pumping is increasing Santa Ana River recharge to the Chino Basin.

- **VOC Contaminant Plume**. The 2009 sampling and analysis of water quality from wells in the vicinity of the Chino-I Desalter well field demonstrated that the OIA

VOC contaminant plume has not migrated beyond the well field. This finding suggests that hydraulic control is continuing to occur in the vicinity of Chino-I Desalter wells 5 through 11.

- **Comparison of Surface Water and Groundwater Quality**. Review of the surface water quality results collected between 2005 and 2009 suggests that there is not a significant amount of discharge to the Santa Ana River from the Chino Basin. Reach by reach comparisons of WCI, piper plots, and TDS demonstrate that changes in Santa Ana River water quality, from the Riverside Narrows to downstream below Prado Dam, are dominated by the discharge of wastewater effluent from POTWs. Furthermore, a comparison of the general water character of the Santa Ana River to that of wells that are perforated in the shallow aquifer suggests that water from the Santa Ana River is recharging the groundwater basin between Van Buren Avenue and Archibald Avenue. The near-river wells have WCI values that range between 200 and 600, representing a mixture of river water character (200) and native groundwater (700-800).

- **Analysis of Surface Water Discharge Measurements**. An analysis of the discharge data collected in 2009 from the Riverside Narrows to Hamner Avenue suggests that groundwater occasionally rises into the river, but that there is an overall net loss of surface water flow in this reach of the Santa Ana River. Total rising water along the Santa Ana River from *MWD Xing* to *Hamner* averaged about -3 cfs in 2009. If the average level of recharge were sustained year long in this reach, it would correspond to an annual net recharge to the Chino Basin of about 2,200 acre-ft, a decrease from 12,000 acre-ft in 2008. Review of the SARWM data suggests that the net loss of surface water from the Riverside Narrows to Prado Dam in water year 2008-09 was about 33,500 acre-ft. The volume of rising groundwater in the Santa Ana River cannot be quantified with the surface water discharge data.

- **Comparison with Watermaster's 2007 Groundwater Model**. The measured (2009) and modeled (2010) groundwater flow directions are generally consistent across the entire southern end of the Chino Basin with some variations due to interpretations of groundwater elevations from wells with variable constructions and short-term piezometric responses to localized pumping. A close look at the flow vectors at the southern boundary of the OIA plume shows that groundwater flows into the desalters from both the south and the north, thus corroborating the capture of Chino-North groundwater as suggested by the piezometric contours and the non- detect levels of TCE measured to the south of the well field. The flow vectors along the river also corroborate the WCI evidence (values of 200-400), which shows that Santa Ana River water has migrated about a mile away from the river in a northwesterly direction into the Chino Basin. The model results also confirm that hydraulic control has yet to be achieved to the west of Chino-I Desalter Well 5.

In summary, the results of the HCMP to date have demonstrated that hydraulic control has been achieved across the central and eastern portions of the Chino Desalter well fields and that groundwater discharge from Chino-North to the Prado Basin occurs only to the west of Chino-I Desalter Well 5.

4.2 Recommendations

There are two recommendations of this annual report:

1. Future annual reports should focus on the analysis of groundwater data (piezometric levels and groundwater quality) and deemphasize the analysis of surface water data (flow and water quality).
2. If Watermaster and the IEUA have satisfied all other Chino Basin maximum benefit commitments, the Regional Board should reduce the surface water monitoring commitments in the Chino Basin Maximum Benefit Monitoring Program as currently defined in the Basin Plan.

The logic that supports these recommendations follows.

One of the main conclusions of this report (described above) is that the capture of groundwater originating in the Chino-North Management Zone by the well fields that supply the Chino Desalters is incomplete. The area where capture is not occurring is west of Well 5 in the Chino-I Desalter well field (see Figure 3-22). The groundwater modeling performed for Watermaster indicates that about 5,000 acre-ft/yr flows through this area from Chino-North into Prado Basin within the shallow aquifer system (WEI, 2009d). Recent groundwater monitoring data indicate that the TDS concentration of this groundwater is about 500-900 mg/L and the nitrate-nitrogen concentration is about 10-30 mg/L. The ultimate fate of groundwater that flows past the desalter well field is discharge by (i) pumping at wells, (ii) evapotranspiration by riparian vegetation in Prado Basin, and/or (iii) rising groundwater in the Prado Basin.

The groundwater modeling referenced above indicated that in 2009, the outflow of rising groundwater in the Prado Basin was about 13,300 acre-ft/yr. The Wasteload Allocation Model (WLAM), a calibrated surface water model that has been used by the Basin Monitoring Program Task Force to set TDS and TIN wasteload allocations for the Santa Ana River, indicated that the rising groundwater in Prado Basin was about 13,900 acre-ft/yr with TDS and nitrate-nitrogen concentrations of about 853 mg/L and 11 mg/L, respectively (WEI, 2009b).

Watermaster and the IEUA assert that the groundwater that currently flows past the west side of the desalter well field and the outflow of rising groundwater in Prado Basin have had, and will continue to have, a *de minimis* impact on the water quality of the Santa Ana River at Prado Dam. This assertion is based first on the analysis of historical surface water data and second on the predictive computer-simulation modeling of surface water in the Santa Ana River watershed and groundwater in the Chino Basin. In addition, as discussed in Section 3, a new desalter well field (the CCWF) that has been designed to pump groundwater from the shallow aquifer system will be constructed to help achieve hydraulic control in the region to the west of Chino-I Desalter well number 5.

Historical surface water flow and quality. To analyze the influence of rising groundwater on the flow and quality of the Santa Ana River in the past, historical data was obtained from the most recent annual report of the SARWM (2010). The historical estimates of rising groundwater in Prado Basin were obtained from the groundwater-flow modeling of the Chino Basin (WEI, 2007a; WEI, 2009d).

Figure 4-1 is a time-series chart of historical flow and TDS concentrations of the Santa Ana River as summarized from data collected at the USGS gaging station at Below Prado. This time series chart also shows the 5-year moving average of the annual flow-weighted TDS of the Santa Ana River at Below Prado, the metric the Regional Board uses to measure compliance with the TDS objective for Reach 2 of the Santa Ana River (Reach 2 TDS metric). Note, as the figure demonstrates, that:

- Since about 1980, rising groundwater in the Prado Basin has been a small percentage of total flow in the Santa Ana River at Below Prado—ranging from about 2 percent to 12 percent in any one year.
- Since about 1980, the Reach 2 TDS metric has ranged between 481 to 603 mg/L and has never exceeded the TDS objective of 650 mg/L—even during extended dry periods when storm water dilution of the Santa Ana River is relatively little (e.g. 1984-1990, 1999-2004).
- Currently (2008-09,) the Reach 2 TDS metric is 498 mg/L, which is slightly higher than its all-time minimum value of 481 mg/L. Based on the past 30 years of historical data, it appears unlikely that the metric will approach the Reach 2 objective of 650 mg/L unless other conditions that affect flow and quality of the Santa Ana River change substantially (e.g. wastewater effluent discharge and quality and/or storm flow).

These observations suggest that rising groundwater in Prado Basin has had minor influence on both the flow and TDS concentration of the Santa Ana River since about 1980 and, during this time, has never contributed to an exceedance of the TDS objective for Reach 2.

Predictive Computer-Simulation Modeling of Surface Water. To estimate the influence of rising groundwater on the flow and quality of the Santa Ana River in the future, computer-simulation modeling of surface water flow and quality was performed for the Santa Ana River Watershed upstream of Prado Dam for 2010 and 2020 conditions. These projections were made using the WLAM, which predicted a range of expected flow and TDS concentrations in the Santa Ana River under (1) constant POTW discharge during 2010 and 2020, (2) constant land use, and (3) variable precipitation and runoff that was based on a 50-year period of historical precipitation (1950-1999).

Calibration of the WLAM determined that rising groundwater in the Prado Basin generally occurred at a constant rate of 13,900 acre-ft/yr with a TDS concentration of 853 mg/L over the calibration period (1994-2006). To quantify the influence of rising groundwater on flow and TDS in the Santa Ana River, the WLAM was run with and without rising groundwater in the Prado Basin for planned conditions in 2010 and 2020.

Figures 4-2 and 4-3 show the results of the WLAM runs for 2010 and 2020. Both figures show a range of possible flow and TDS for the Santa Ana River at Below Prado under (1) planned POTW discharges and (2) variable precipitation and runoff.

2010 Conditions. Figure 4-2 shows that with rising groundwater included and with POTW discharges as planned for 2010, the percent contribution of rising groundwater to total flow in the Santa Ana River is expected to range from 4 percent to 22 percent in any single year with a 50-year average of about 12 percent. The annual flow-weighted TDS concentration at Below Prado is expected to range from 222 to 638 mg/L with a 50-year flow-weighted average of 414 mg/L.

Figure 4-2 also shows the results of a WLAM run that included the same assumptions except all rising groundwater in the Prado Basin was removed. Comparison of the model results indicates that rising groundwater in the Prado Basin increases the flow-weighted TDS concentration of the Santa Ana River at Below Prado by 14 to 31 mg/L in any single year and by 28 mg/L as a 50-year flow-weighted average. As a percent change, the TDS increases caused by rising groundwater in the Prado Basin range between 4 and 8 percent, which is a small enough increase that it may not be detectable by standard laboratory methods of analysis for TDS concentrations (R. Dean [MWH Labs], personal communication, March 24, 2010).

2020 Conditions. Figure 4-3 shows that with rising groundwater included and with POTW discharges as planned for 2020, the percent contribution of rising groundwater to total flow in the Santa Ana River is expected to range from 4 percent to 17 percent in any single year with a 50-year average of about 10 percent. The annual flow-weighted TDS concentration at Below Prado is expected to range from 240 to 630 mg/L with a 50-year flow-weighted average of 437 mg/L.

Figure 4-3 also shows the results of a WLAM run that included the same assumptions except all rising groundwater in the Prado Basin was removed. Comparison of model results indicates that rising groundwater in Prado Basin increases the flow-weighted TDS concentration of the Santa Ana River at Below Prado by 13 to 25 mg/L in any single year and by 23 mg/L as a 50-year flow-weighted average. As a percent change, the TDS increases caused by rising groundwater in Prado Basin range between 4 and 6 percent, which is a small enough increase that it may not be detectable by standard laboratory methods of analysis for TDS concentrations (R. Dean [MWH Labs], personal communication, March 24, 2010).

Figures 4-2 and 4-3 also show the 5-year moving average of the annual flow-weighted TDS of the Santa Ana River at Below Prado—the Regional Board's Reach 2 TDS metric. These predicted metrics indicate that the Reach 2 TDS metric will not exceed the Reach 2 TDS objective of 650 mg/L with or without rising groundwater and over a wide range of climatic conditions.

The WLAM projections suggest that rising groundwater in the Prado Basin will have a minor influence on both the flow and TDS concentration of the Santa Ana River through 2020 and, during this time, will not contribute to an exceedance of the TDS objective for Reach 2.

Predictive Computer-Simulation Modeling of Groundwater. Watermaster recently performed a predictive analysis of a major water management program for the Chino Basin called the Peace II Project. Two major components of the Peace II Project include the controlled overdraft of 400,000 acre-ft of groundwater storage and the construction of the CCWF to augment supply for the Chino Desalter facilities. Together, the controlled overdraft and the CCWF are predicted to achieve and maintain hydraulic control (WEI, 2009d), as defined as the elimination of groundwater discharge from Chino-North Management Zone or the control of the discharge to *de minimis* levels.

In the process of achieving and maintaining hydraulic control, as defined above, the groundwater model predicts that the outflow of rising groundwater in the Prado Basin will decline from about 15,663 acre-ft in 2006 to about 9,081 acre-ft in 2030, a decrease of about 42 percent (WEI, 2009d).

Based on the analysis of historical data and the model predictions above, Watermaster and the IEUA assert that:

1. The influence of rising groundwater in the Prado Basin on the flow and quality of the Santa Ana River has been, and currently is, *de minimis.*
2. In the near future, as the complete capture of groundwater outflow from Chino-North develops around the Chino Desalter well fields, the influence of rising groundwater in the Prado Basin on the flow and quality of the Santa Ana River will be even less.
3. Based on (1) and (2) above, the elimination of groundwater discharge from the Chino-North Management Zone by the Chino Desalter well fields or the control of the discharge to *de minimis* levels (measurable definition of hydraulic control) is the same as controlling groundwater discharge from Chino Basin to the Santa Ana River to *de minimis* levels (Basin Plan definition of hydraulic control). Hence, the measurable definition of hydraulic control is appropriate.

Based on these assertions, Watermaster and the IEUA recommend that:

1. Future annual reports should focus on the analysis of groundwater data (piezometric levels and groundwater quality) since these are the main data sets used to show the extent of complete capture of Chino-North groundwater by the Chino Desalter well fields.
2. Future annual reports should deemphasize the analysis of surface water data (flow and water quality) since these data are not necessary to show the extent of the complete capture of Chino-North groundwater by the Chino Desalter well fields. Future annual reports should continue to report on flow and quality at Below Prado as a check on the conclusion that the influence of rising groundwater in the Prado Basin on the flow and quality of the Santa Ana River is *de minimis.*
3. If Watermaster and the IEUA have satisfied all other Chino Basin maximum benefit commitments, the Regional Board should reduce the surface water monitoring commitments in the Chino Basin Maximum Benefit Monitoring Program as they are currently defined in the Basin Plan.

Figure 4-1
TDS and Components of Flow of the Santa Ana River at Below Prado

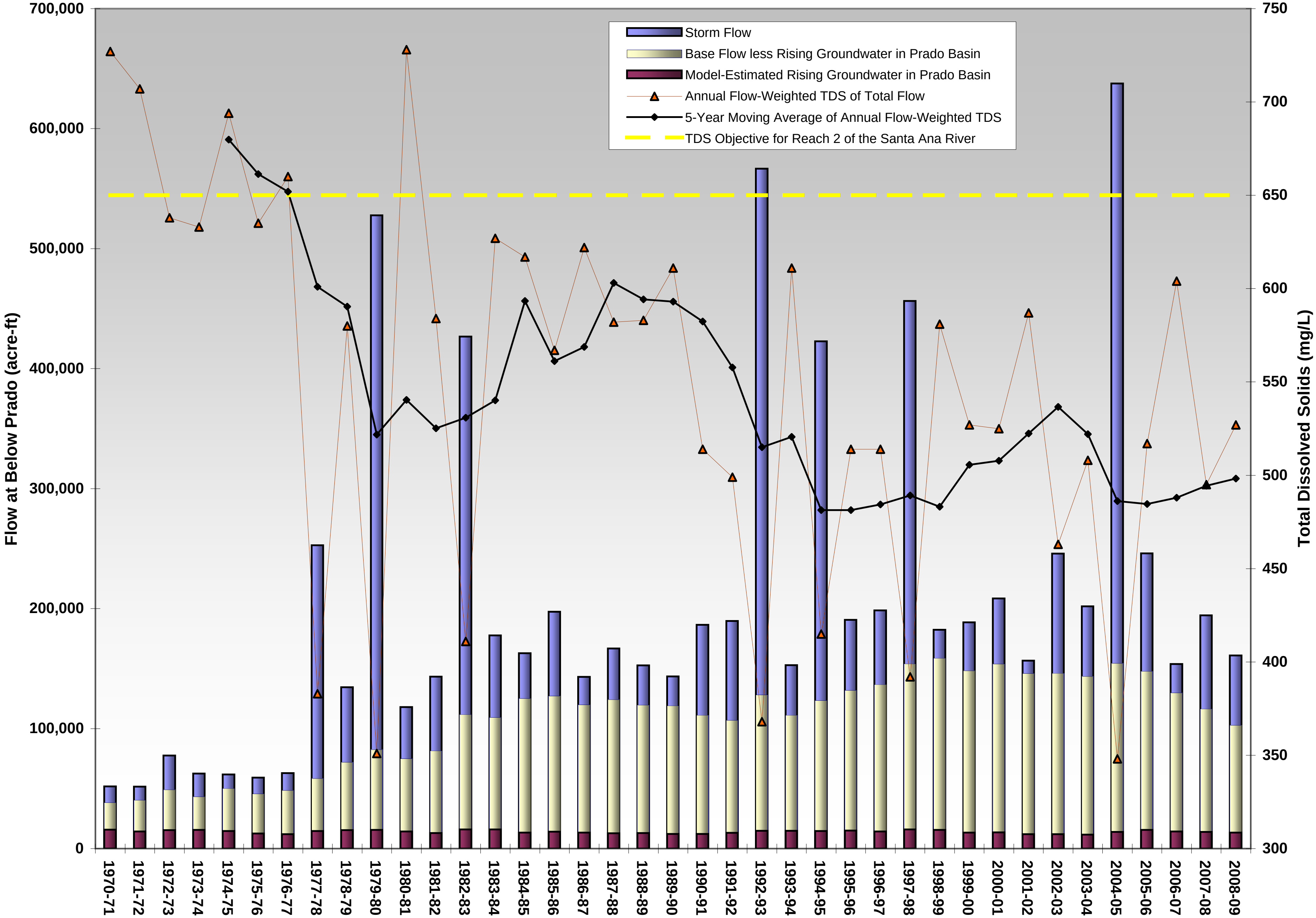

Figure 4-1_Impact at Prado.xls -- Chart2

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Figure 4-2
Projected Annual Flow and TDS Concentration of the Santa Ana River at Below Prado with and without Rising Groundwater in Prado Basin
WLAM Scenario 7a - Planned Reuse and Discharge in 2010

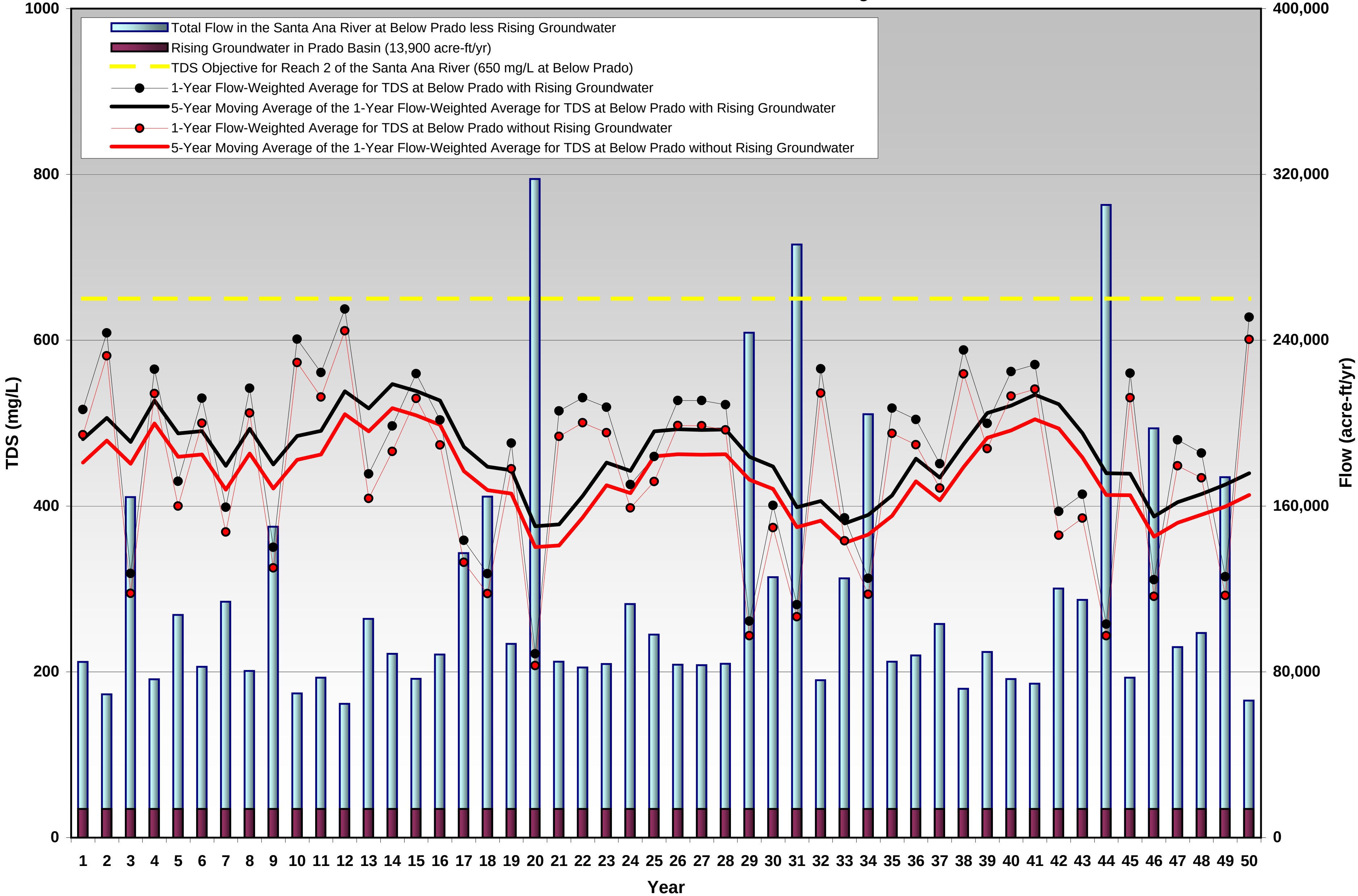

Figure 4-2_WLAM_2010.xls -- Fig4-2_2010 TDS

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Figure 4-3
Projected Annual Flow and TDS Concentration
of the Santa Ana River at Below Prado with and without Rising Groundwater in Prado Basin
WLAM Scenario 7d - Planned Reuse and Discharge in 2020

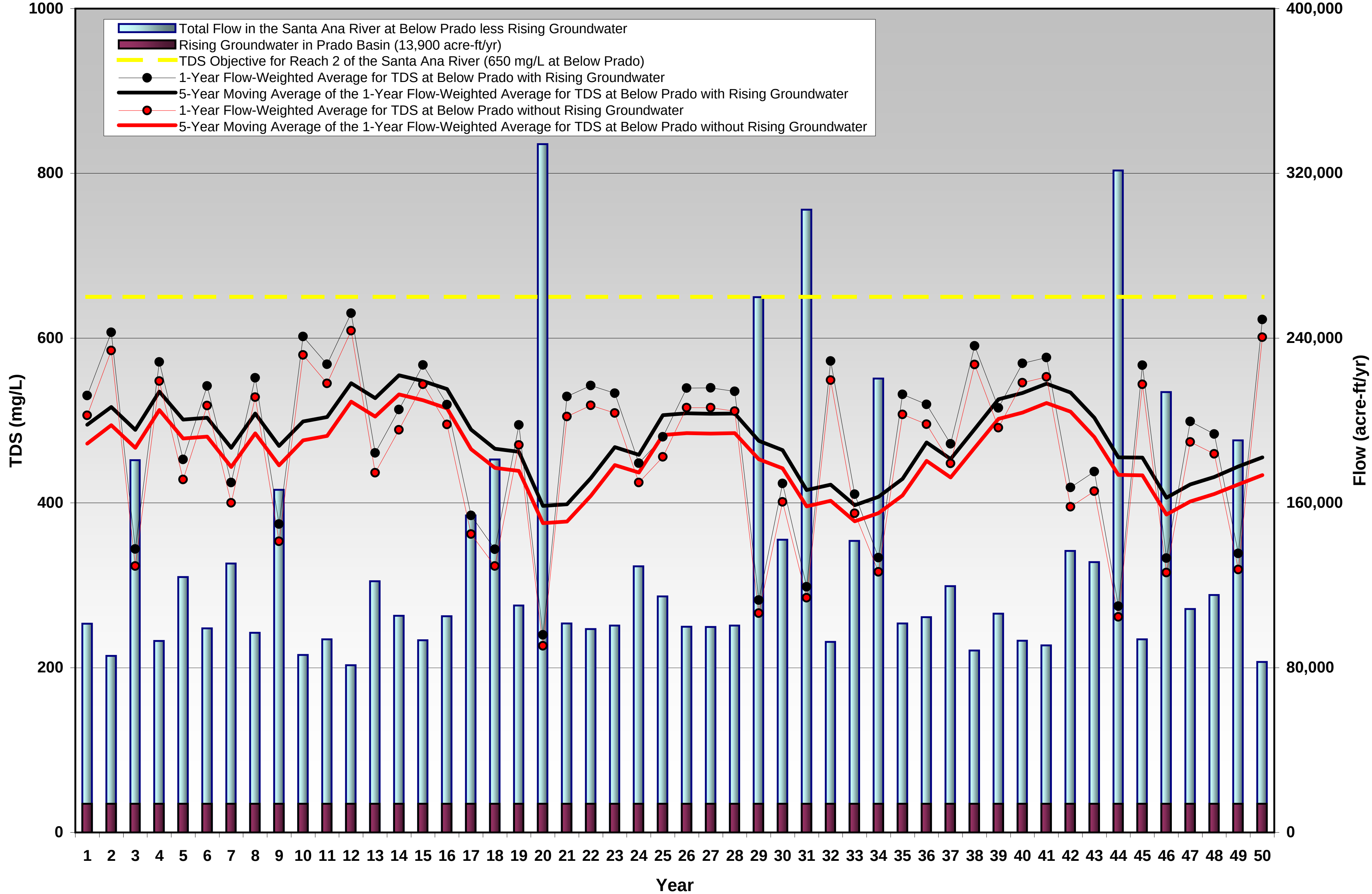

Figure 4-3_WLAM_2020.xls -- Fig 4-3_2020 TDS

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Black and Veatch. (2008). *Optimum Basin Management Program, Chino Basin Dry-Year Yield Program Expansion – Project Development Report, Volumes I – IV, December, 2008*.

California Environmental Protection Agency. (1994). *Representative Sampling of Ground Water for Hazardous Substance. Guidance Manual for Ground Water Investigations* (Interim Final).

California Regional Water Quality Control Board, Santa Ana Region. (2004). *Resolution No. R8-2004-0001 Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate an Updated Total Dissolved Solids (TDS) and Nitrogen Management Plan for the Santa Ana Region.*

California Regional Water Quality Control Board, Santa Ana Region. (2008). *Water Quality Control Plan Santa Ana River Basin (Region 8) 1995. Updated February 2008*.

Chino Basin Municipal Water District v. City of Chino et al., San Bernardino Superior Court, No. 164327. (1978).

Inland Empire Utilities Agency. (2008). *Final Water Demand and Supply Forecasts for the Chino Basin Dry Year Yield Expansion Program CEQA Analysis – Tech Memo #2 - Supplement to the April 16,2088 IEUA Tech Memo #1 – Net Groundwater Replenishment Obligations through 2015 Based Upon Projected Water Demands and Available Supplies to the Chino Basin*.

James M. Montgomery, Consulting Engineers, Inc. (1991). *Nitrogen and TDS Studies, Santa Ana Watershed.*

Montgomery Watson. (1995). *Chino Basin Water Resources Management Study.*

Piper, A. M. (1944). *A Graphic Procedure in the Geochemical Interpretation of Water*. Transactions, American Geophysical Union, 914-928.

Santa Ana River Watermaster. (2010). *Thirty-Ninth Annual Report of the Santa Ana River Watermaster for Water Year October 1, 2008 – September 30, 2009*. Draft Report. Prepared for Orange County Water District v. City of Chino, et al. Case No. 117628 – County of Orange.

US EPA. (1998). *EPA Guidance for Quality Assurance Project Plans*. EPA QA/G-5. Office of Research and Development. EPA/600/R-98/018.

Watson, I., & Burnett, A. (1995). H*ydrology: An Environmental Approach*. Boca Raton: CRC Press.

Wildermuth, M.J. (1993). *Letter Report to Montgomery Watson regarding the Combined Well Field for the Chino Basin Desalter. September 21, 1993.*

Wildermuth Environmental, Inc. (1999). *Optimum Basin Management Program. Phase I Report.* Prepared for the Chino Basin Watermaster.

Wildermuth Environmental, Inc. (2000). *TIN/TDS Phase 2A: Tasks 1 through 5, TIN/TDS Study of the Santa Ana Watershed, Technical Memorandum.*

Wildermuth Environmental, Inc. (2002). *Optimum Basin Management Program, Draft Final Initial State of the Basin Report*. Prepared for the Chino Basin Watermaster.

Wildermuth Environmental, Inc. (2004). *Optimum Basin Management Program, Final Hydraulic Control Monitoring Program Work Plan*. Prepared for the Chino Basin Watermaster and the Inland Empire Utilities Agency.

Wildermuth Environmental, Inc. (2005). *Optimum Basin Management Program, State of the Basin Report–2004*. Prepared for the Chino Basin Watermaster.

Wildermuth Environmental, Inc. (2006a). *Chino Basin Maximum Benefit Monitoring Program 2005 Annual Report*. Prepared for the Chino Basin Watermaster and the Inland Empire Utilities Agency.

Wildermuth Environmental, Inc. (2006b). *Draft Report, Analysis of Future Replenishment and Desalter Plans Pursuant to the Peace Agreement and Peace II Process*. Prepared for the Chino Basin Watermaster.

Wildermuth Environmental, Inc. (2006c). *Draft Report, Addendum to the Draft April 2006 Report, Analysis of Future Replenishment and Desalter Plans Pursuant to the Peace Agreement and Peace II Process*. Prepared for the Chino Basin Watermaster.

Wildermuth Environmental, Inc. (2007a). *Chino Basin Groundwater Model Documentation and Evaluation of the Peace II Project Description.*

Wildermuth Environmental, Inc. (2007b). *Chino Basin Maximum Benefit Monitoring Program 2006 Annual Report*. Prepared for the Chino Basin Watermaster and Inland Empire Utilities Agency.

Wildermuth Environmental, Inc. (2007c). *Optimum Basin Management Program, State of the Basin Report–2006*. Prepared for the Chino Basin Watermaster.

Wildermuth Environmental, Inc. (2007d). *Letter to Kenneth R. Manning - Evaluation of Alternative 1C and Declining Safe Yield.*

Wildermuth Environmental, Inc. (2008a*). Response to Condition Subsequent No. 3 from the Order Confirming Motion for Approval of the Peace II*. Prepared for the Chino Basin Watermaster.

Wildermuth Environmental, Inc. (2008b). *Chino Basin Maximum Benefit Monitoring Program 2007 Annual Report*. Prepared for the Chino Basin Watermaster and the Inland Empire Utilities Agency.

Wildermuth Environmental, Inc. (2009a). *Chino Basin Maximum Benefit Monitoring Program 2008 Annual Report*. Prepared for the Chino Basin Watermaster and the Inland Empire Utilities Agency.

Wildermuth Environmental, Inc. (2009b). *2004 Basin Plan Amendment Required Monitoring and Analyses, 2008 Santa Ana River Wasteload Allocation Model Report*. Prepared for Basin Monitoring Program Task Force.

Wildermuth Environmental, Inc. (2009c). *Chino Basin Optimum Basin Management Program, State of the Basin Report–2008*. Prepared for the Chino Basin Watermaster.

Wildermuth Environmental, Inc. (2009d). *2009 Production Optimization and Evaluation of the Peace II Project Description*. Prepared for the Chino Basin Watermaster.

Appendix A

HCMP Database

Appendix B

Key-Well Water Level Time Histories