Chino Basin Optimum Basin Management Program
2012 State of the Basin Atlas

WILDERMUTH™
ENVIRONMENTAL INC.

prepared for
Chino Basin Watermaster
June 2012

CHINO BASIN WATERMASTER

2012 State of the Basin Atlas

June 2013

Prepared for

Chino Basin Watermaster
Partners in Basin Management

Prepared by

WILDERMUTH™
ENVIRONMENTAL INC.

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Acronyms, Abbreviations, and Initialisms	
µg/L	micrograms per liter
1,1,1-TCA	1,1,1-trichloroethane
1,1-DCE	1,1-dichloroethene
1,2,3-TCP	1,2,3-trichloropropane
1,2-DCA	1,2-dichloroethane
acre-ft	acre-feet
acre-ft/yr	acre-feet per year
AWQ	ambient water quality
Basin Plan	Water Quality Control Plan for the Santa Ana River Basin
BM	bench mark
CAO	Cleanup and Abatement Order
CBWM ID	Chino Basin Watermaster Well Identification
CDA	Chino Desalter Authority
CDFM	cumulative departure from mean
CDPH	California Department of Public Health (formerly the Department of Health Services)
CIM	California Institution for Men
cis-1,2-DCE	cis-1,2-dichloroethene
CVWD	Cucamonga Valley Water District
DLR	detection limit for reporting
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EPA	US Environmental Protection Agency
ft	feet
ft-bgs	feet below ground surface
ft-brp	feet below reference point (*e.g.* static surveyed measurement point)
FY	fiscal year
GE	General Electric
GIS	Geographic Information System
HCMP	Hydraulic Control Monitoring Program
IEUA	Inland Empire Utilities Agency
InSAR	Synthetic Aperture Radar Interferometry
JCSD	Jurupa Community Services District
KM	kilometer
MCL	maximum contaminant level
mg/L	milligrams per liter
MSL	Milliken Sanitary Landfill
MVWD	Monte Vista Water District
MWDSC	Metropolitan Water District of Southern California
MZ	Management Zone
NO_3 - N	nitrate expressed as nitrogen
ND	non-detect
OBMP	Optimum Basin Management Program
PBMZ	Prado Basin Management Zone
PCE	tetrachloroethene
PRISM	Parameter-Elevation Regressions on Independent Slope Model
PRP	potentially responsible party
POTW	Publicly Owned Treatment Works
RP	Regional Plant
RWQCB	Regional Water Quality Control Board
SARWC	Santa Ana River Water Company
SBCFCD	San Bernardino County Flood Control District
SOB	State of the Basin
SWP	State Water Project
TCE	trichloroethene
TDS	total dissolved solids
US EPA	US Environmental Protection Agency
USGS	US Geological Survey
VOC	volatile organic compound
Watermaster	Chino Basin Watermaster
WEI	Wildermuth Environmental, Inc.
XRef	anonymous well reference ID

The Chino Basin Optimum Basin Management Program (OBMP) was developed pursuant to the Judgment (*Chino Basin Municipal Water District v. City of Chino, et al.*) and a ruling by the Court on February 19, 1998 (WEI, 1999). The OBMP maps a strategy that provides for the enhanced yield of the Chino Basin and seeks to provide reliable, high-quality, water supplies for the development that is expected to occur within the Basin. An important element of the OBMP is the monitoring of the Chino Basin and the periodic analysis and reporting of these data.

Monitoring is performed in accordance with *OBMP Program Element 1 – Develop and Implement a Comprehensive Monitoring Program* which includes the monitoring of basin hydrology, pumping, recharge, groundwater levels, groundwater quality, and land subsidence. The monitoring is performed by basin pumpers, Chino Basin Watermaster (Watermaster) staff, and other cooperating entities. Watermaster staff collects and compiles the monitoring data into relational databases to support data analysis and reporting.

As a reporting mechanism and pursuant to the OBMP Phase 1 Report, the Peace Agreement and its associated Implementation Plan, and the November 15, 2001 Court Order, Watermaster staff prepares a *State of the Basin Report* every two years. In October 2002, Watermaster completed the *Initial State of the Basin Report* (WEI, 2002). The baseline for this report was on or about July 1, 2000—the point in time that represents the adoption of the Peace Agreement and the start of OBMP implementation. Subsequent *State of the Basin Reports* (WEI, 2005; 2007; 2009a; 2011c) were used to:

- describe the then-current state of the Basin with respect to production, recharge, groundwater levels, storage, groundwater quality, land subsidence, and hydraulic control.
- demonstrate the progress made since July 1, 2000, when Watermaster commenced several OBMP-spawned investigations and initiatives related to groundwater levels and quality, land subsidence, recharge assessments, recharge master planning, hydraulic control, desalter planning and engineering, and production meter installation.

This 2012 *State of the Basin Report* is an atlas-style document. It consists of detailed exhibits that characterize groundwater production, groundwater levels, storage changes, groundwater quality, land subsidence, and recharge through fiscal year 2011/12. These exhibits are grouped into the following sections:

Introduction: This section describes the background and objectives of the *State of the Basin Report* and contains exhibits that show the Chino Basin Management Zones (MZ) and water service areas of the major water purveyors that overlie the Basin.

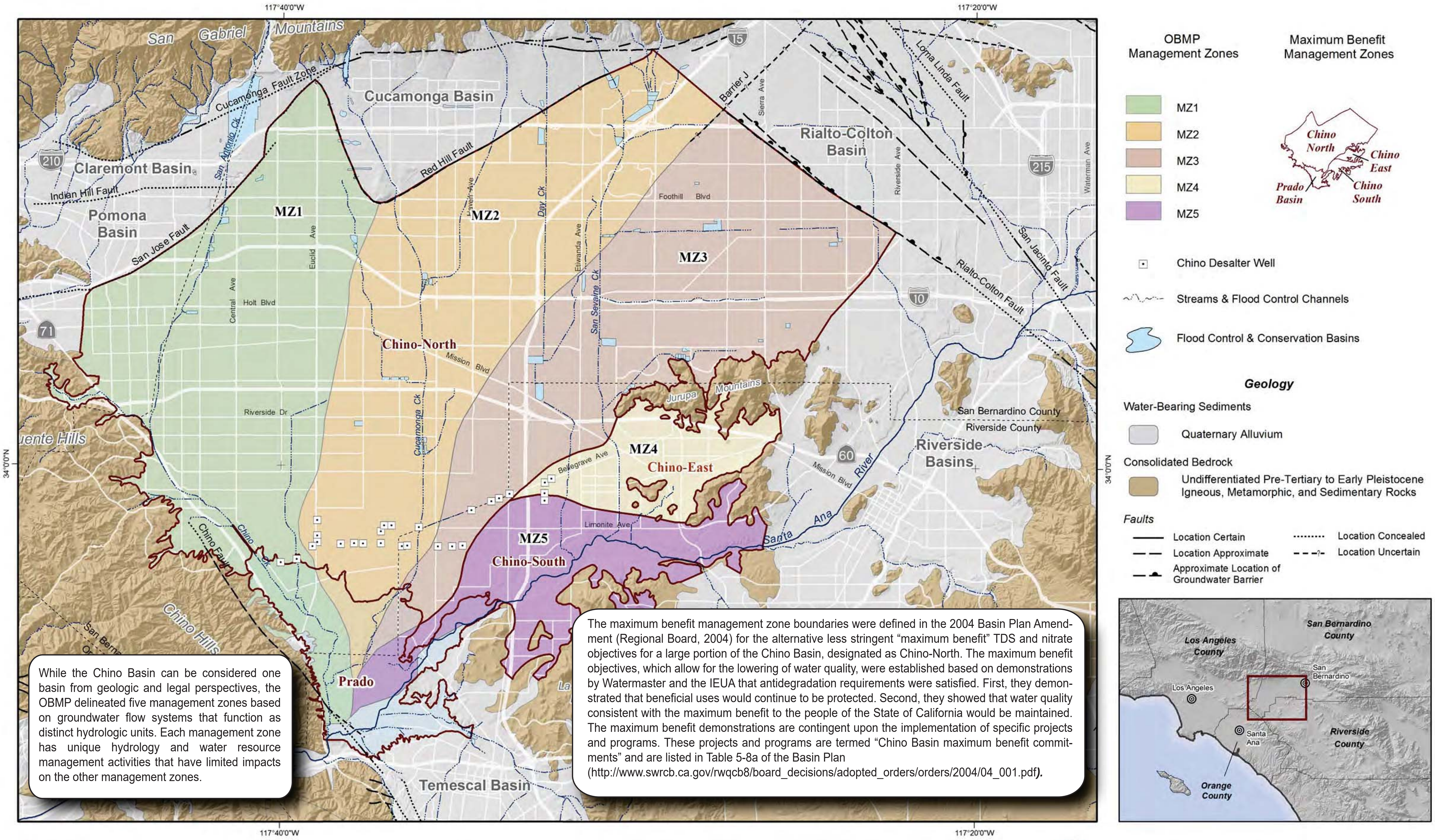
General Hydrologic Conditions: This section contains exhibits that characterize the hydrologic history of the Basin during the base period for the Judgment (1965-1974), the period of the Judgment (1978 to the present), and the period of the Peace Agreement (2000 to the present). This information is useful for characterizing other changes in Basin conditions, including groundwater levels, storage, water quality, recharge and subsidence.

Basin Production and Recharge: This section contains exhibits that characterize groundwater production and recharge over time and space. This information is useful in understanding historical changes in groundwater levels and quality.

Groundwater Levels and Storage: This section contains exhibits that characterize groundwater flow patterns, the change in groundwater elevations, and the change in groundwater storage since 2000. The section includes groundwater-elevation maps for spring 2000, spring 2010, and spring 2012; groundwater-elevation-change maps for 2000 to 2012 and 2010 to 2012; and storage-change maps for 2000 to 2012 and 2010 to 2012. The section also includes exhibits that characterize the time history of groundwater levels throughout the Chino Basin and correlates the change in groundwater levels to observed precipitation, recharge, and pumping patterns.

Groundwater Quality: This section contains exhibits that characterize the groundwater quality across the Chino Basin. The constituents characterized include total dissolved solids (TDS), nitrate, and other constituents of concern. This characterization includes time-series charts of TDS and nitrate, maps of the spatial distribution of constituent concentrations, and a current map of the known point-source contaminants in groundwater as of 2012.

Land Subsidence Monitoring: This section contains exhibits that characterize the history and current state of land subsidence and ground fissuring in the Chino Basin.



OBMP Management Zones

- 🟩 MZ1
- 🟧 MZ2
- 🟫 MZ3
- 🟨 MZ4
- 🟪 MZ5

⊡ Chino Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Faults

Location Certain

Location Approximate

Approximate Location of Groundwater Barrier

Location Concealed

Location Uncertain

While the Chino Basin can be considered one basin from geologic and legal perspectives, the OBMP delineated five management zones based on groundwater flow systems that function as distinct hydrologic units. Each management zone has unique hydrology and water resource management activities that have limited impacts on the other management zones.

The maximum benefit management zone boundaries were defined in the 2004 Basin Plan Amendment (Regional Board, 2004) for the alternative less stringent "maximum benefit" TDS and nitrate objectives for a large portion of the Chino Basin, designated as Chino-North. 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 the maximum benefit to the people of the State of California would be maintained. The 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 Basin Plan (http://www.swrcb.ca.gov/rwqcb8/board_decisions/adopted_orders/orders/2004/04_001.pdf).

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Date: 12/14/2012

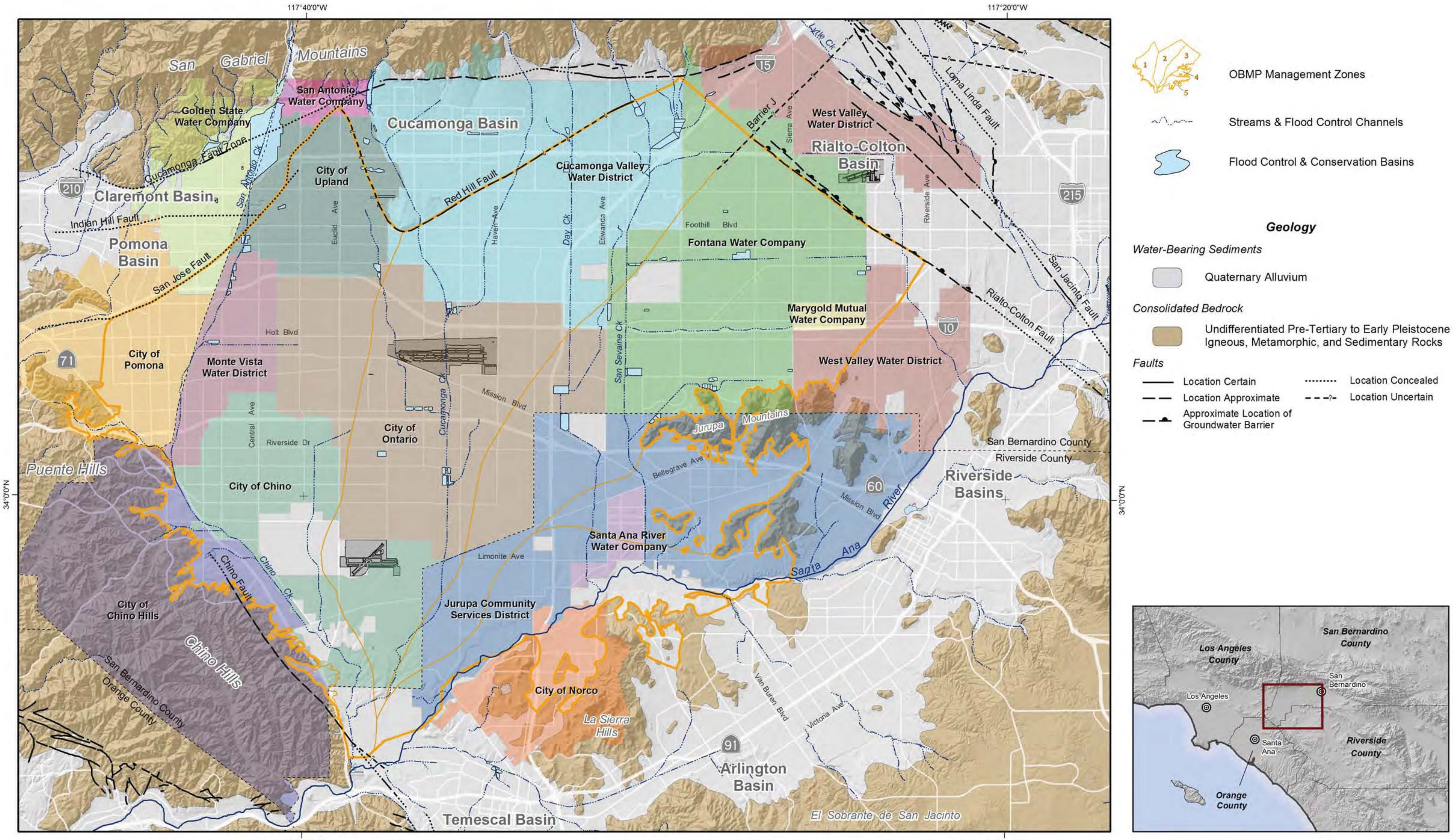
Document Name: Exhibit_1_ChinoGWbasins

2012 State of the Basin
Introduction

Chino Groundwater Basin

OBMP and Maximum Benefit Management Zones

Exhibit 1



0 1 2 3 4 5 Miles

0 2 4 6 8 KM

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2012 State of the Basin
Introduction

Water Service Areas of the Major Appropriative Pool Parties of the Chino Basin Watermaster

Exhibit 2

The exhibits in this section characterize the hydrologic setting of the Chino Basin and its importance to water supply and groundwater management within the Basin.

The Chino Basin covers about 240 square miles and is located centrally within the Santa Ana River Watershed. Exhibit 3 shows the location of the Chino Basin within the context of the upper Santa Ana River Watershed. The Santa Ana River flows southwest through the Chino Basin from the Riverside Narrows to Prado Dam. Downstream of Prado Dam, the Santa Ana River flows through the Orange County Basin and out to the ocean. In total, the drainage area of the Santa Ana River Watershed at Prado Dam is about 1,490 square miles. The following streams are tributary to the Santa Ana River within the Chino Basin: San Sevaine Creek, Day Creek, Deer Creek, Cucamonga Creek, and San Antonio/Chino Creek. These tributaries generally flow from north to south. The time of concentration[1] to Prado Dam for the Santa Ana River is estimated to be between one to two days. By contrast the time of concentration to Prado Dam for tributaries that flow from north to south in the Chino Basin is a few hours.

Exhibit 3 shows the locations of three San Bernardino County Flood Control District (SBCFCD) precipitation stations: the San Bernardino Hospital station, located centrally in the Santa Ana River Watershed tributary to the Chino Basin; an Ontario hybrid station (combined records of SBCFCD 1017 and 1075), located in the central Chino Basin; and a Montclair station, located in the northwestern portion of the Basin. Exhibit 3 also shows the U.S. Geological Survey's stream-gaging stations on the Santa Ana River at Riverside Narrows (*SAR at MWD Xing*) and below Prado Dam (*SAR at Below Prado Dam).*

Precipitation is a major source of recharge to the Chino Basin; thus, the magnitude and temporal pattern of this recharge can be understood by analyzing long-term precipitation records. In Exhibit 4, annual precipitation totals are plotted from the Ontario station (1915 to 2012) and the San Bernardino Hospital station (1901 to 2012). Exhibit 4 characterizes the long-term precipitation trends within and upstream of the Chino Basin. The mean annual precipitation totals at the Ontario and San Bernardino Hospital stations are 15.46 inches and 16.35 inches, respectfully. Exhibit 4 also includes a plot of the cumulative departure from mean precipitation (CDFM), which is used to characterize the occurrence and magnitude of the wet and dry periods. Positive sloping segments of the CDFM plot (trending upward to the right) indicate wet periods, and negative sloping segments of the CDFM plot (trending downward to the right) indicate dry periods. The longest dry period for the 1900 to 2012 record is from 1945 to 1976—a 32 year period.

The Safe Yield of the Chino Basin was computed using a base period of 1965 through 1974, a period of ten years. This base period had two years of above average precipitation, eight years of below average precipitation, and falls within the 1945 through 1976 dry period. The average annual precipitation for the base period was 14.64 inches, or 0.77 inches less than the long-term annual average. The post-Peace-Agreement period runs from July 2000 to present, a twelve-year period. The post-Peace-Agreement period contains four years of above-average precipitation and eight years below average precipitation. The average annual precipitation during the post-Peace-Agreement period is 14.87 inches, or 0.59 inches less than the long-term annual average, which is comparable to the 1945 through 1976 dry period. Precipitation during the base period in which the Safe Yield was initially estimated— and the post-Peace-Agreement period, is less than average; thus the yield developed during these periods is likely less than the yield that would be developed from a longer more hydrologically representative period.

Exhibit 5 shows the historical relationship between precipitation and storm water discharge in the Chino Basin and uses a double-mass curve analysis to illustrate the change in the precipitation-discharge relationship. A double-mass analysis is an arithmetic plot of the accumulated values of observations for two related variables that are paired in time and thought to be related. As long as the relationship between those two variables remains constant, the double-mass curve will appear as a straight line (constant slope). A change in slope indicates that the relationship has changed; the break in slope denotes the timing of that change.

Specifically, in Exhibit 5, the double-mass curve analysis was used to look at precipitation versus storm water discharge reckoned at Prado Dam (*SAR at Below Prado Dam),* and precipitation versus storm water discharge generated between Riverside Narrows and Prado Dam (storm water reckoned at *SAR at Below Prado Dam* minus storm water reckoned at *SAR at MWD Xing).* In each plot, the slope of the double-mass curve after water year 1976/77 is much steeper than prior years. The change in curvature suggests that a significant change occurred in the precipitation-discharge relationship: there is an increase in the magnitude of storm water discharge starting in the late 1970s. This increase in storm water discharge is due to land surface modifications caused by the conversion from agricultural to urban uses, the rapid post-1969 lining of stream channels in the Chino Basin and elsewhere in the upper Santa Ana Watershed, and other associated drainage system modifications. The hydrologic effects of land use changes and channel lining were apparently masked by the below average precipitation years that preceded the 1978 through 1983 wet period. These charts indicate that storm water recharge in the Chino Basin declined as the stream channels were lined and that the storm water available for recharge in the Basin has increased significantly with the urbanization. In fact, the average annual decrease in storm water recharge due to the lining of stream channels in the Chino Basin was recently estimated to be about 16,000 acre-ft/yr (WEI, 2010).

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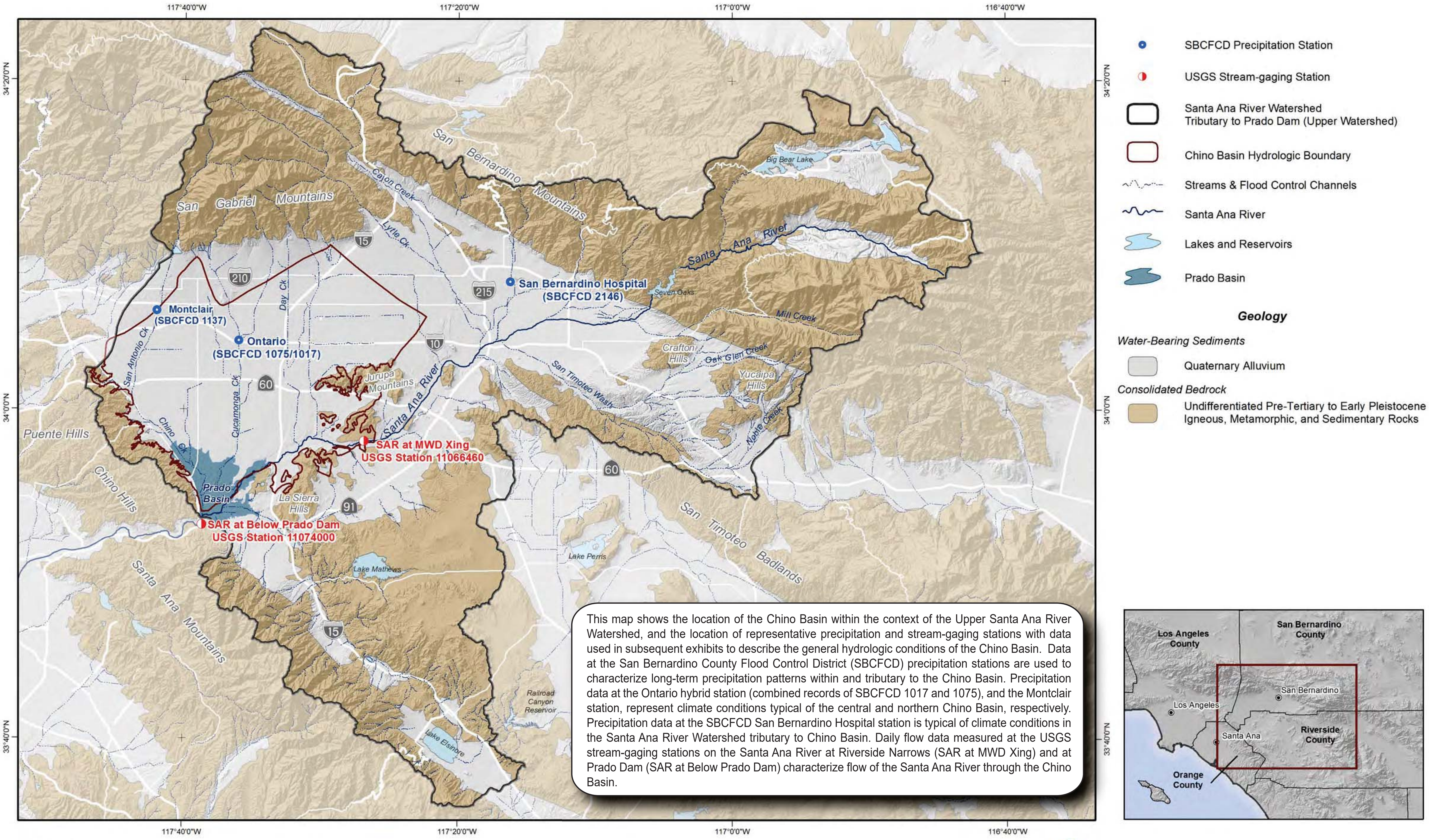
[1] The time of concentration is the time it takes for runoff from the most distant upstream part of the watershed to reach a specified point of interest.



This map shows the location of the Chino Basin within the context of the Upper Santa Ana River Watershed, and the location of representative precipitation and stream-gaging stations with data used in subsequent exhibits to describe the general hydrologic conditions of the Chino Basin. Data at the San Bernardino County Flood Control District (SBCFCD) precipitation stations are used to characterize long-term precipitation patterns within and tributary to the Chino Basin. Precipitation data at the Ontario hybrid station (combined records of SBCFCD 1017 and 1075), and the Montclair station, represent climate conditions typical of the central and northern Chino Basin, respectively. Precipitation data at the SBCFCD San Bernardino Hospital station is typical of climate conditions in the Santa Ana River Watershed tributary to Chino Basin. Daily flow data measured at the USGS stream-gaging stations on the Santa Ana River at Riverside Narrows (SAR at MWD Xing) and at Prado Dam (SAR at Below Prado Dam) characterize flow of the Santa Ana River through the Chino Basin.

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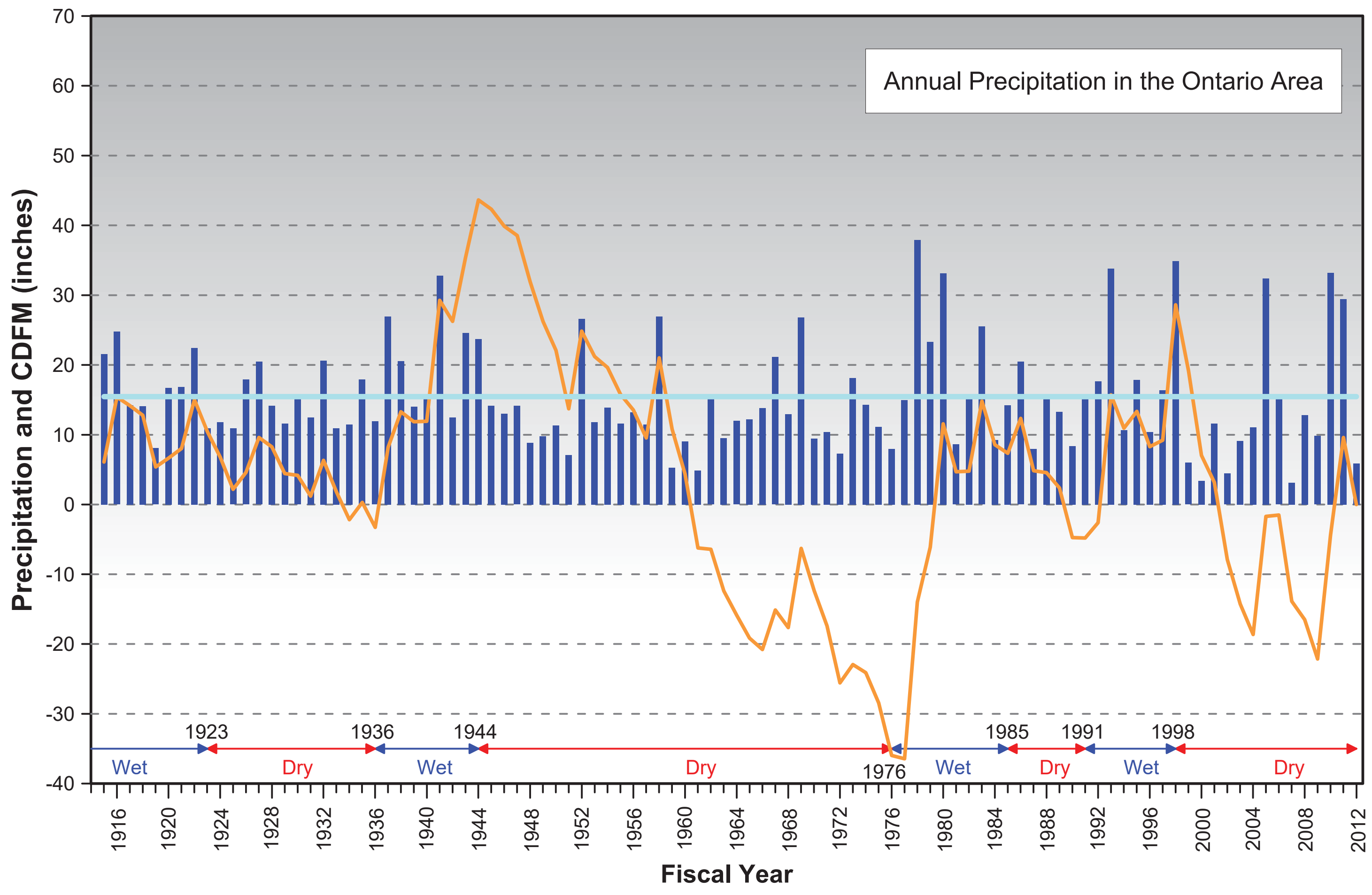
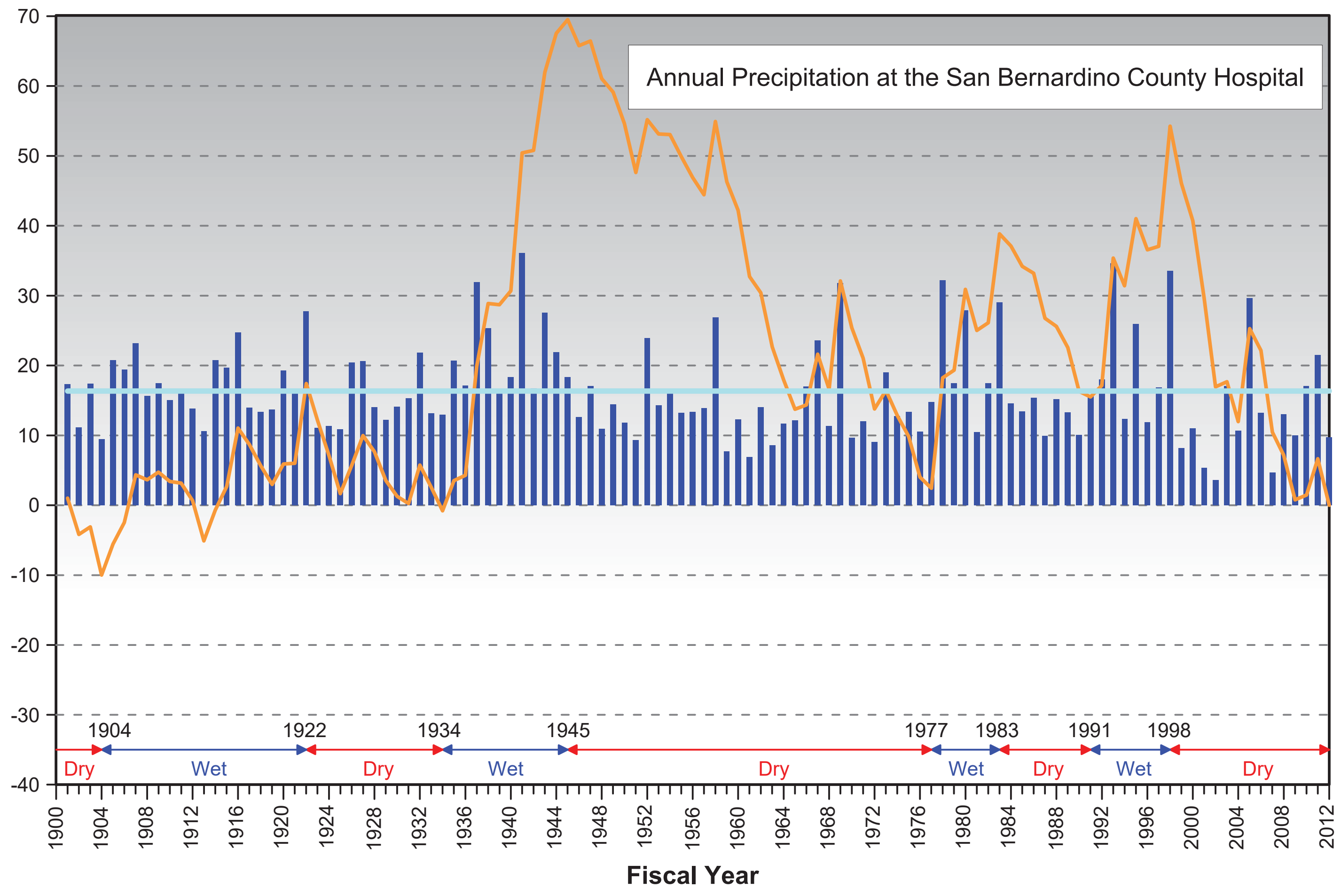
0 5 10 15 Miles
0 10 20 KM

2012 State of the Basin
General Hydrologic Conditions

Santa Ana River Watershed Tributary to Prado Dam

Exhibit 3





Annual Statistics of Long-Term Precipitation Records

(inches)

Statistics	Ontario Area*	San Bernardino Hospital
Period of Record (Fiscal Year)	1915 to 2012	1901 to 2012
Mean	15.46	16.35
Minimum	3.09	3.61
Maximum	37.92	36.10
Standard Deviation	7.68	6.68
Mean + 1 Standard Deviation	23.14	23.03
Coefficient of Variation	50%	41%

* Two precipitation stations in the Ontario Area (SBCFCD 1075 and 1017) were combined to create a long-term record. These two precipitation stations are in close proximity to each other and their overlapping records are highly correlated. Recent data is from SBCFCD Station 1017.

The Chino Basin has a semi-arid Mediterranean climate. Precipitation is a major source of groundwater recharge for the Basin; thus, the magnitude and temporal pattern of this recharge can be understood by analyzing long-term precipitation records. Shown here are the long-term precipitation records for the Ontario Area (located centrally within the Chino Basin) and the San Bernardino Hospital (located within the Santa Ana River Watershed, upstream of the Chino Basin). These figures show the fiscal year annual precipitation totals, long-term average annual precipitation, and the cumulative departure from mean precipitation (CDFM). The CDFM plot is a useful way to characterize the occurrence and magnitude of wet and dry periods: positive sloping segments (trending upward to the right) indicate wet periods, and negative sloping segments (trending downward to the right) indicate dry periods. In the Ontario area, four series of wet-dry cycles are apparent: prior to 1914 through 1936, 1937 through 1976, 1977 through 1991, and 1992 through 2012. The record of the San Bernardino Hospital station shows the same pattern of wet-dry cycles. The ratio of dry years to wet years is about three to two. That is, for every ten years, about six years will have below average precipitation and four years will have greater than average precipitation. That said, the 1945 through 1976 dry period is 32 years long. During that dry period, in the Ontario area there were 26 dry years to six wet years, averaging about 2.38 inches per year below the average annual precipitation, and at the San Bernardino station, there were 24 dry years to eight wet years, averaging about two inches per year below the average annual precipitation.

The base period used to compute the Safe Yield of the Chino Basin in the 1978 Judgment was 1965 through 1974, a period of ten years. This base period had three years of above-average precipitation and seven years of below-average precipitation, and falls within the 1945 through 1976 dry period. The average annual precipitation for the base period was 14.64 inches, or 0.77 inches less than the long-term annual average. The post-Peace-Agreement period is from July 2000 to present, a twelve-year period. The post-Peace-Agreement period contains four above-average precipitation years: 2005, 2006, 2010 and 2011; the remaining years had below average precipitation. The average annual precipitation during the post-Peace Agreement period is 14.87 inches, or 0.59 inches less than the long-term annual average. One of the takeaways from these charts is that the recharge from precipitation during the base period in which the Safe Yield was initially estimated— and the post-Peace-Agreement period, should be less than average; thus, the yield developed during these periods is likely less than the yield that would be developed from a longer more hydrologically-representative period.

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▬ Annual Precipitation (inches)

▬ Long-Term Average Annual Precipitation (inches)

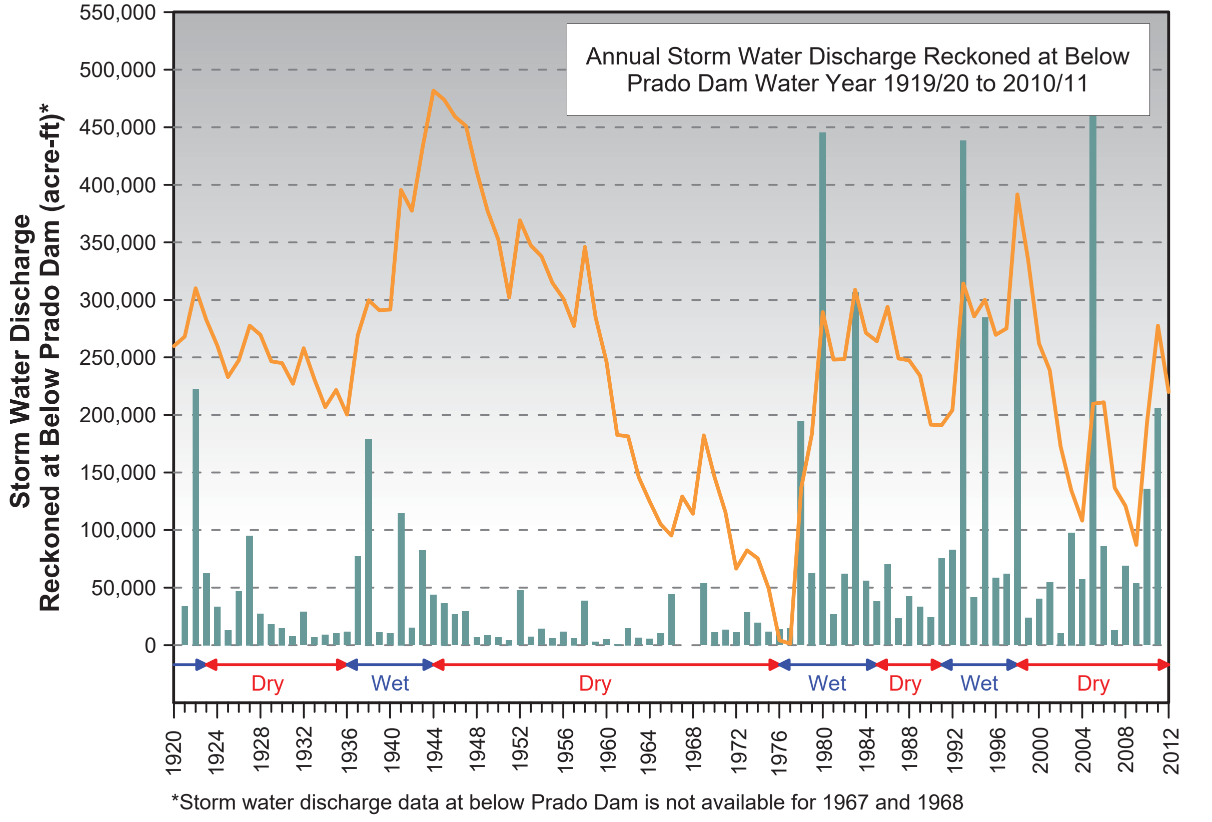
▬ Cumulative Departure from Mean Precipitation

CHINO BASIN WATERMASTER

2012 State of the Basin
General Hydrologic Conditions

Long-Term Precipitation Within and Upstream of the Chino Basin

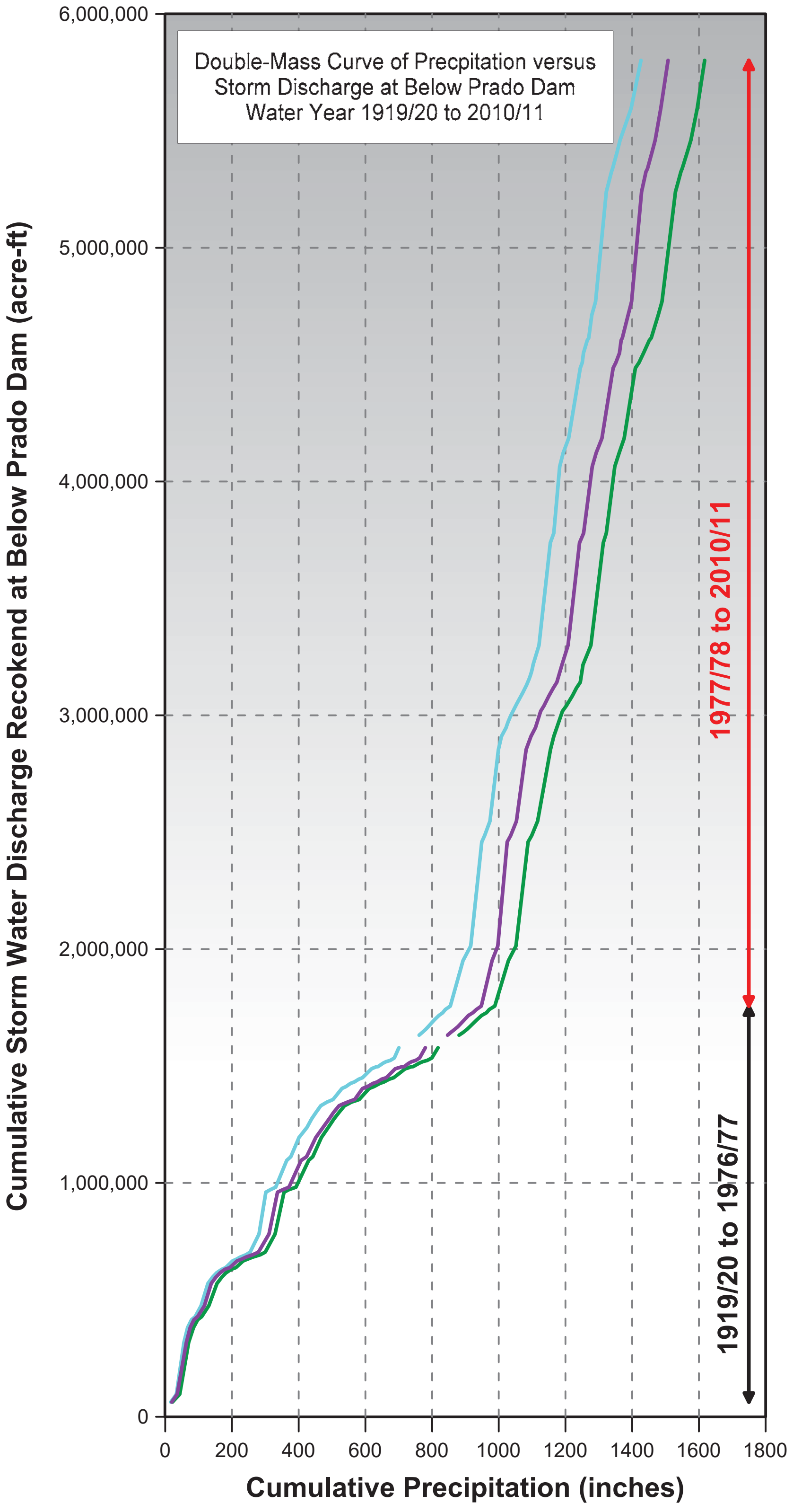
Exhibit 4

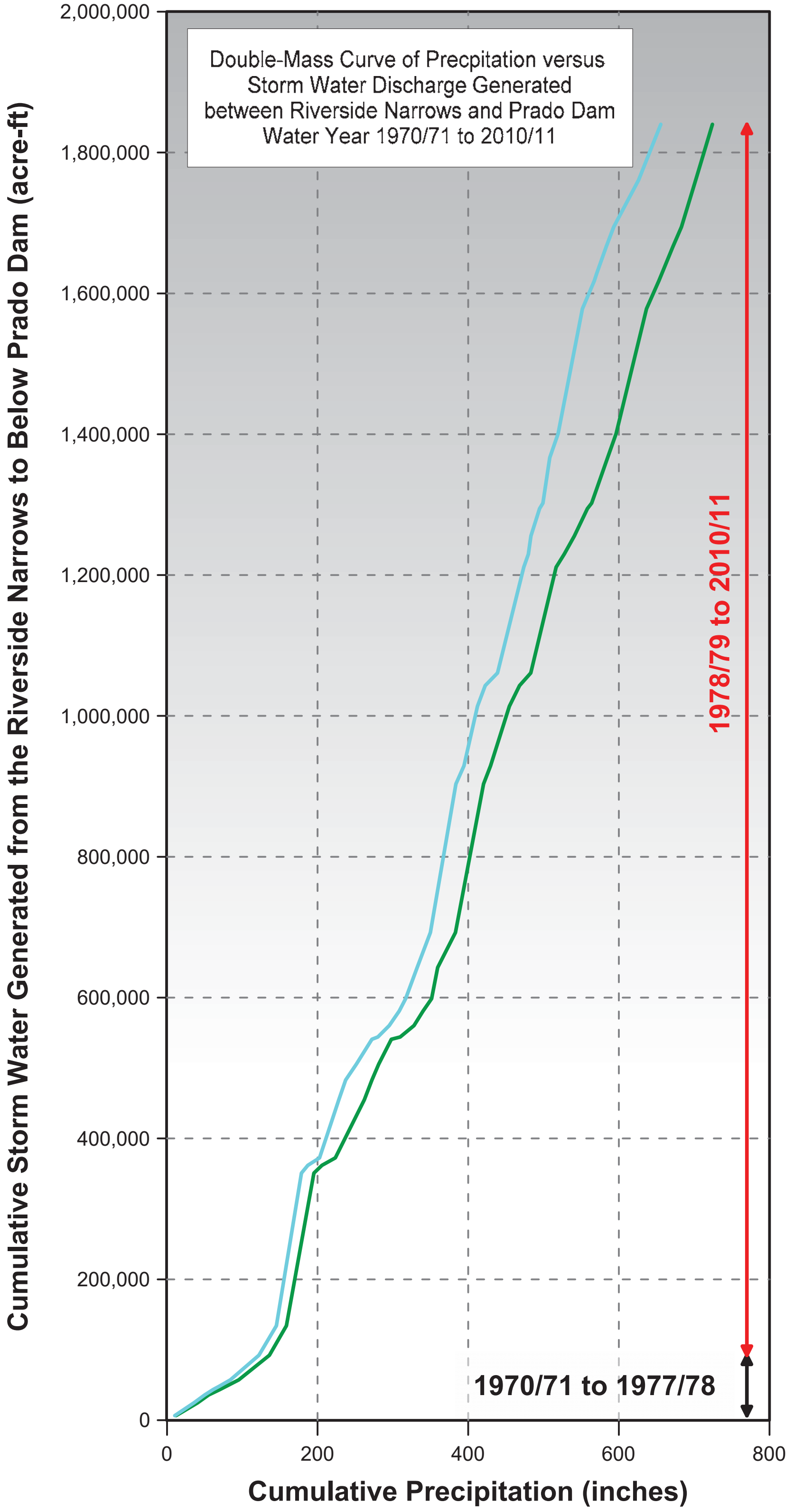


*Storm water discharge data at below Prado Dam is not available for 1967 and 1968

As seen in the graph entitled Annual Storm Water Discharge Reckoned at Below Prado Dam, around water year 1976/1977, the relationship of precipitation to storm water discharge changed significantly such that there was more discharge per unit of precipitation produced after this time (compare the amount of storm water runoff for the 1936 to 1944 wet period with the 1977 to 1983 wet period).

A double-mass curve analysis can illustrate the change in the precipitation-runoff relationship. A double-mass curve analysis is an arithmetic plot of the accumulated values of observations for two related variables that are paired in time and thought to be related. As long as the relationship between those two variables remains constant, the double-mass curve will appear as a straight line (constant slope). A change in slope indicates that the relationship has changed; the break in slope denotes the timing of that change. Shown here are double-mass curves of precipitation at stations in and around the Chino Basin versus: storm water discharge reckoned at Below Prado Dam; and storm water discharge generated between Riverside Narrows and Prado Dam (storm water discharge reckoned at SAR at Below Prado Dam minus storm water discharge reckoned at SAR at MWD Xing). Note that in each plot, the slope of the double-mass curve after water year 1976/1977 is much steeper than prior years. The change in curvature suggests that a significant change occurred in the precipitation-discharge relationship: there is an increase in the magnitude of storm water discharge starting in the late 1970s. This increase in storm water discharge is due to land surface modifications caused by the conversion from agricultural to urban uses, the rapid post-1969 lining of stream channels in the Chino Basin and elsewhere in the upper Santa Ana Watershed, and other associated drainage system improvements. These charts indicate that natural storm water recharge in the Chino Basin declined as the channels were lined and that the storm water component of the Santa Ana River at Prado Dam has increased significantly with the urbanization. The average annual decrease in storm water recharge due to the lining of stream channels in the Chino Basin was estimated to be about 16,000 acre-ft/yr (WEI, 2010).





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Cumulative Departure from Mean Precipitation (Ontario Station)

Storm Water at Prado Dam (acre-ft)

Cumulative Precipitation at Montclair vs. Storm Water

Cumulative Precipitation at Ontario vs. Storm Water Flow

Cumulative Precipitation at San Bernardino County Hospital vs. Storm Water Flow

2012 State of the Basin
General Hydrologic Conditions

Relationship of Precipitation and Storm Water Discharge in the Chino Basin

Water Year 1919/20 to 2010/11

Exhibit 5

The exhibits in this section characterize the physical state of the Chino Basin with respect to groundwater production and artificial recharge. Future re-determinations of Safe Yield for the Chino Basin will be based largely on accurate estimations of groundwater production, artificial recharge, and basin storage changes over time.

Since its establishment in 1978, Watermaster has collected information to estimate total groundwater production from the Basin. The Watermaster Rules and Regulations require groundwater producers that produce in excess of 10 acre-feet per year (acre-ft/yr) to install and maintain meters on their well(s). Appropriative Pool, Overlying Non-Agricultural Pool, and Chino Desalter well production estimates are based on flow-meter data that are provided by producers on a quarterly basis. Agricultural Pool estimates are based on water duty methods and flow-meter data collected by Watermaster staff on a quarterly basis. Minimal producer estimates are determined by Watermaster staff on an annual basis. All production data in the Chino Basin are entered into Watermaster's database. Watermaster summarizes and reports on groundwater production data over the fiscal year (FY) that begins on July 1. Exhibit 6 shows the locations of all active production wells in the Basin during FY 2011/2012.

Exhibit 7 depicts the annual groundwater production by Pool for FY 1977/1978 through 2011/2012. There are two bar charts in Exhibit 7— 7a) shows the actual production by Pool as recorded in Watermasters' production database; 7b) shows the actual production in Watermaster's database for the Appropriative Pool, Overlying Non-Agricultural Pool, and Chino Desalter Authority (CDA), with the Agricultural Pool production amounts from the Chino Basin Model. The modeled agricultural production was determined using historical land use data, and land use requirements. Prior to the implementation of the meter installation program during 2001 to 2003, the modeled historical agricultural production is regarded as more accurate than the estimates of Agricultural Pool production in Watermaster's database.

Total groundwater production in Chino Basin has ranged from a maximum of about 189,000 acre-ft during FY 2008/2009 to a low of about 123,000 acre-ft during FY 1982/1983, and has averaged about 154,000 acre-ft/yr. The spatial distribution of production has shifted since 1978. Agricultural Pool production, which has been mainly concentrated south of the 60 Freeway, dropped from about 56 percent of total production in FY 1977/1978 to 15 percent as of FY 2011/2012. During the same period, Appropriative Pool production increased from about 38 percent of total production in FY 1977/1978 to 83 percent as of FY 2011/2012 (for this characterization, this is the sum of production for the Appropriative Pool and the CDA. Increases in Appropriative Pool production have approximately kept pace with the decline in agricultural production. Production in the Overlying Non-Agricultural Pool declined from about six percent of total production in FY 1977/1978 to two percent as of FY 2011/2012.

Exhibits 8 through 10 are maps that illustrate the location and magnitude of groundwater production at wells in the Chino Basin for FYs 1977/1978 (Watermaster established), 1999/2000 (commencement of the OBMP), and 2011/2012 (current conditions). These figures indicate the following:

- There was a basin-wide increase in the number of wells producing over 1,000 acre-ft/yr between 1978 and 2012. This is consistent with (i) the land transition from agricultural to urban uses, (ii) the trend of increasing imported water costs, and (iii) the construction of the desalters.
- From FY 1977/1978 to 1999/2000, production south of the 60 Freeway deceased from 59 percent to 32 percent of total production in the Chino Basin, while production north of the 60 Freeway increased from 41 percent to 68 percent of total production. This shift in production patterns is due to a decline in irrigated agriculture and an increase in urbanization south of the 60 Freeway, and an increase in urbanization north of the 60 Freeway.
- From FY 1999/2000 to 2011/2012, production north of the 60 Freeway deceased from 68 percent to 60 percent of total production in the Chino Basin, while production at wells south of the 60 Freeway increased from 32 percent to 40 percent of total production. The number of active agricultural wells in the southern portion of the Basin decreased by about 50 percent. The eight percent increase in total groundwater production south of the 60 Freeway is due to the onset of desalter pumping, which progressively increased since start-up in 2000 and currently totals about 30,000 acre-ft/yr.

The Chino Basin desalters were described in the OBMP Phase 1 Report (WEI, 1999) as facilities that would *"Enhance Basin Water Supplies"* and *"Protect and Enhance Water Quality."* Exhibit 11 is a map that displays the locations of the wells and desalter facilities, and summarizes the history of desalter production in the southern portion of the Chino Basin.

The objectives of the Chino Basin Groundwater Recharge Program are to enhance water supply reliability and improve groundwater quality throughout the Chino Basin by increasing the recharge of storm water, imported water, and recycled water. For further information on Watermaster's requirements for recharge, see Section 5.1 of the Peace Agreement, Article 8 of the Peace II Agreement, the 2010 Recharge Master Plan Update (WEI, 2010).

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

- California Regional Water Quality Control Board, Santa Ana Region, Order No. R8-2007-0039, Water Recycling Requirements for Inland Empire Utilities Agency and Chino Basin Watermaster, Chino Basin Recycled Groundwater Recharge Program, Phase I and Phase II Projects, San Bernardino County. June 29, 2007.
- California Regional Water Quality Control Board, Santa Ana Region. Order No. R8-2009-0057. Amending Order No. R8-2007-0039, October 30, 2009.
- California Regional Water Quality Control Board, Santa Ana Region. Revised Monitoring and Reporting Program No. R8-2007-0039 for the Inland Empire Utilities Agency and Chino Basin Watermaster, Chino Basin Recycled Groundwater Recharge Program, Phase I and Phase II Projects, San Bernardino County. October 27, 2010.

Exhibit 12 shows the locations of the recharge basins in Chino Basin symbolized by the types of waters that are recharged, including storm water, urban runoff, recycled water, and imported water. The volumes of recharge that occur at each basin are monitored and recorded by IEUA. Exhibit 13 lists the operable recharge facilities in the Chino Basin and summarizes annual recharge by type for the period of June 1, 2000 through June 30, 2012.[2] The following are the general trends in recharge:

- Storm-water recharge at the recharge basins was not measured prior to FY 2004/2005. Since then, annual storm-water recharge has ranged from about 4,700 acre-ft to 17,600 acre-ft and has averaged about 11,700 acre-ft/yr. Storm-water recharge is important to Watermaster because volumes greater than 5,600 acre-ft/yr are considered New Yield.

- Since 2000, annual imported-water recharge has ranged from 0 to 34,567 acre-ft and has averaged about 11,200 acre-ft/yr. The wide range in annual imported water recharged is reflective of the MWDSC Dry Year Yield (DYY) conjunctive use storage program in the Chino Basin. During FYs 2004/2005, 2005/2006, and 2006/2007, imported water recharge was well above average because the MWDSC was doing a "put" operation pursuant to the DYY storage program. During FYs 2007/2008, 2008/2009, 2009/2010, and 2010/2011, imported water recharge was well below average due to the lack of low-cost replenishment water supplied by MWDSC. In FY 2011/2012, about 22,500 acre-ft of imported water was recharged in Chino Basin. This large amount of imported water recharged during that year, is because of the availability of low-cost Tier 1 water from MWDSC at that time.

- Since 2000, annual recycled-water recharge has ranged from 49 to 8,634 acre-ft. In FY 2005/2006, recycled water recharge increased from an average of about 300 acre-ft/yr to about 4,700 acre-ft/yr after the implementation of the Recycled Water Groundwater Recharge Program. After the expansion of the program in 2007, recycled-water recharge continued to increase and reached a historical high of 8,634 acre-ft/yr in FY 2011/2012.

Since the late 1990s, the reuse of recycled water has increased in the Chino Basin. Recycled water is utilized two ways: (i) direct non-potable uses such as irrigation and (ii) indirect potable reuse via groundwater recharge. Exhibits 12, 13, and 14 characterize the reuse of recycled water in the Chino Basin through FY 2011/2012.

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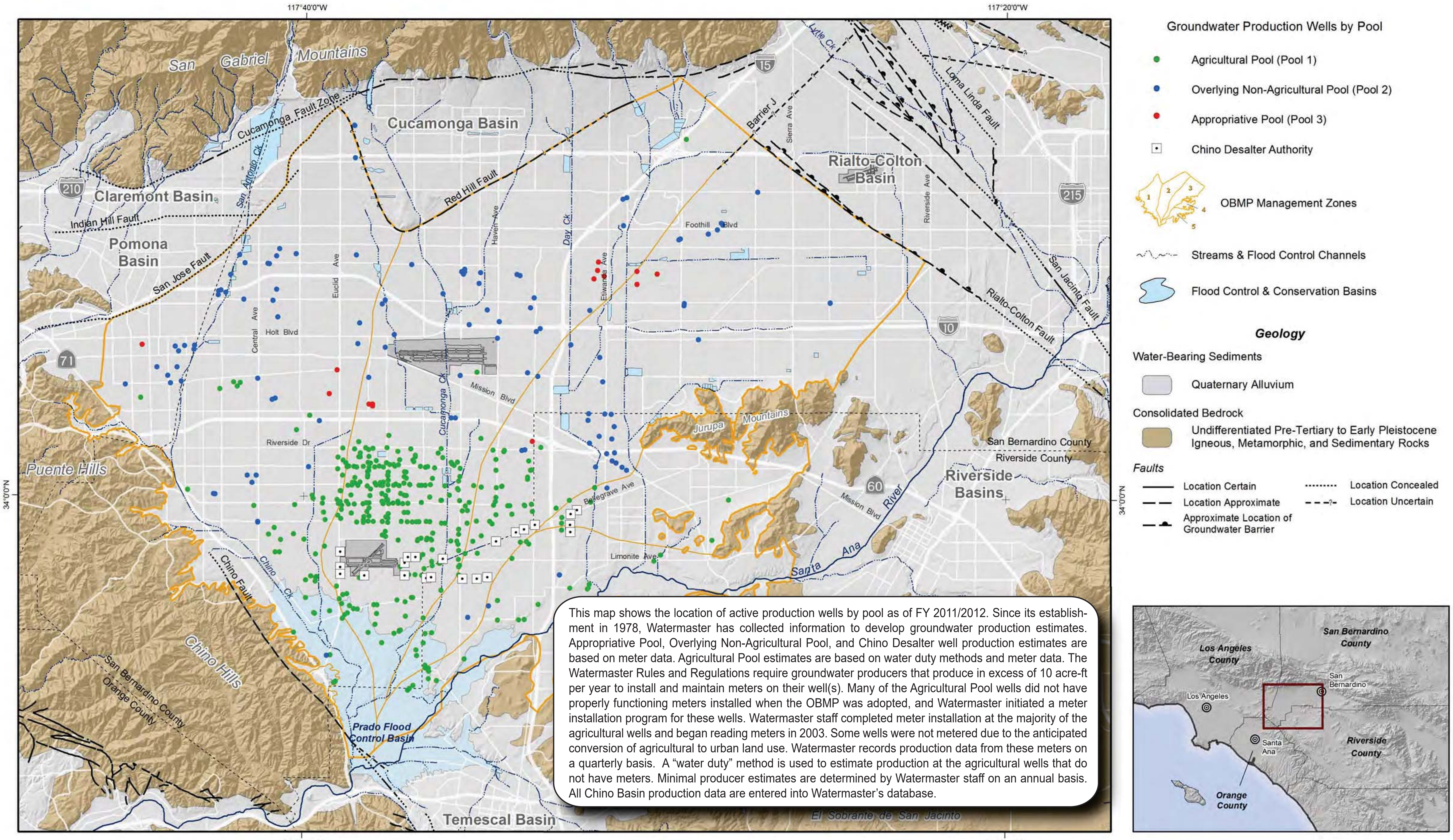
[2] The IEUA does not distinguish storm water from urban runoff in the recharge tabulations it submits to Watermaster.



This map shows the location of active production wells by pool as of FY 2011/2012. Since its establishment in 1978, Watermaster has collected information to develop groundwater production estimates. Appropriative Pool, Overlying Non-Agricultural Pool, and Chino Desalter well production estimates are based on meter data. Agricultural Pool estimates are based on water duty methods and meter data. The Watermaster Rules and Regulations require groundwater producers that produce in excess of 10 acre-ft per year to install and maintain meters on their well(s). Many of the Agricultural Pool wells did not have properly functioning meters installed when the OBMP was adopted, and Watermaster initiated a meter installation program for these wells. Watermaster staff completed meter installation at the majority of the agricultural wells and began reading meters in 2003. Some wells were not metered due to the anticipated conversion of agricultural to urban land use. Watermaster records production data from these meters on a quarterly basis. A "water duty" method is used to estimate production at the agricultural wells that do not have meters. Minimal producer estimates are determined by Watermaster staff on an annual basis. All Chino Basin production data are entered into Watermaster's database.

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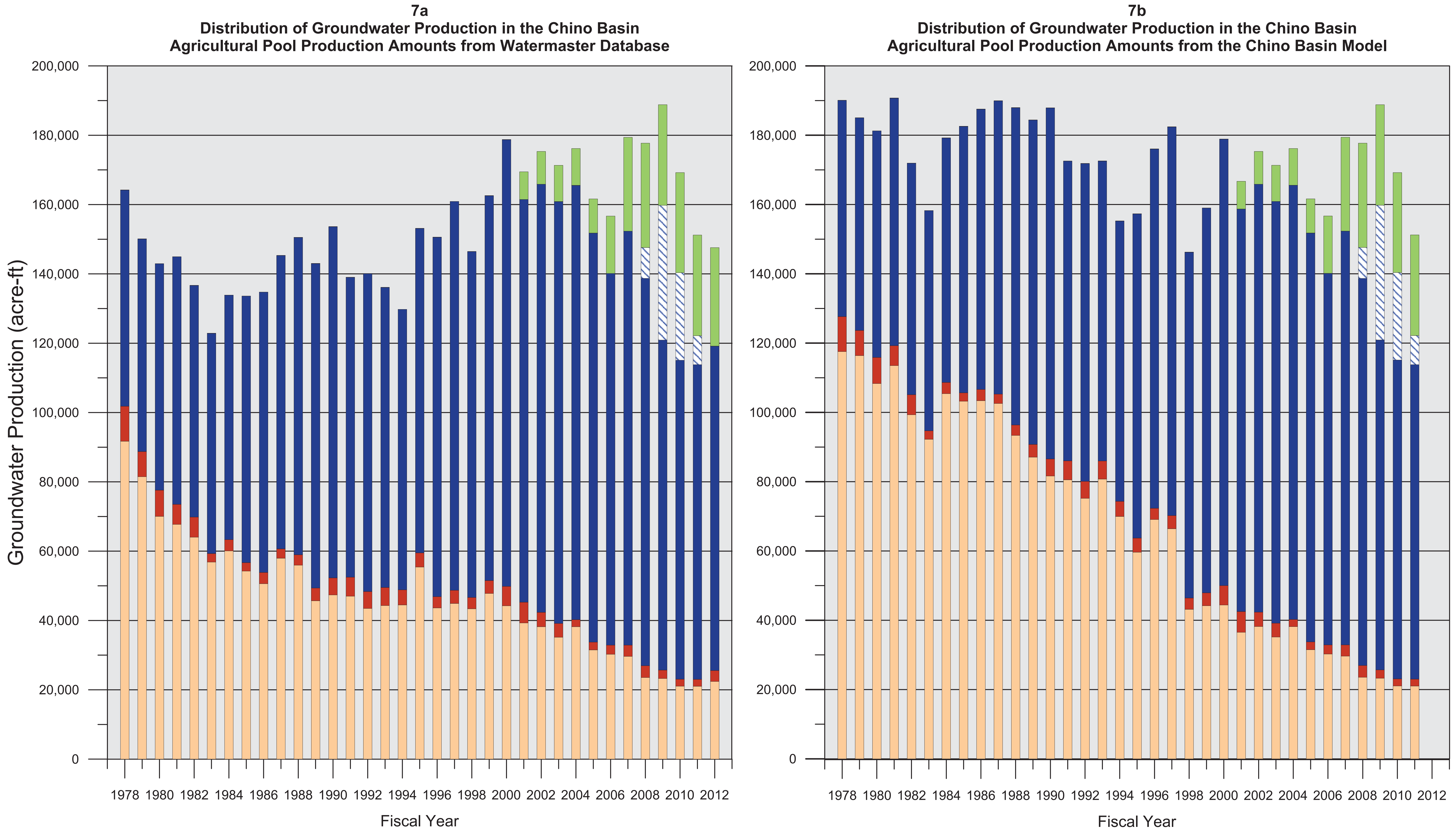
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Basin Production and Recharge

Active Groundwater Production Wells

Fiscal Year 2011/2012

Exhibit 6



🟧 Agricultural Pool

🟥 Overlying Non-Agricultural Pool

🟦 Appropriative Pool

▨ Appropriative Pool - MWDSC Dry Year Yield Program

🟩 Chino Desalter Authority

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Date: 06/05/2013
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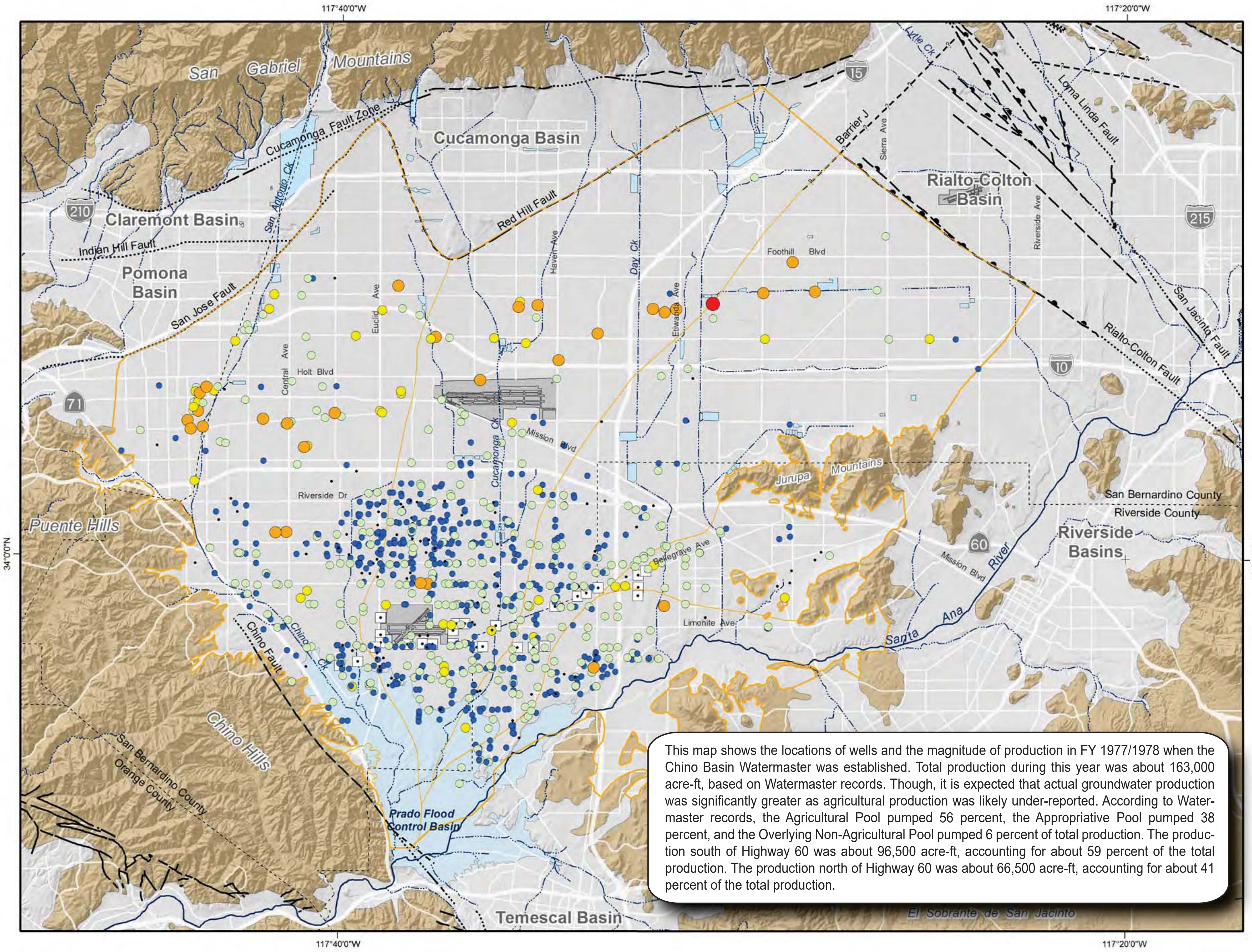
2012 State of the Basin
Basin Production and Recharge

Distribution of Groundwater Production
Fiscal Year 1978 to 2012

Exhibit 7



This map shows the locations of wells and the magnitude of production in FY 1977/1978 when the Chino Basin Watermaster was established. Total production during this year was about 163,000 acre-ft, based on Watermaster records. Though, it is expected that actual groundwater production was significantly greater as agricultural production was likely under-reported. According to Watermaster records, the Agricultural Pool pumped 56 percent, the Appropriative Pool pumped 38 percent, and the Overlying Non-Agricultural Pool pumped 6 percent of total production. The production south of Highway 60 was about 96,500 acre-ft, accounting for about 59 percent of the total production. The production north of Highway 60 was about 66,500 acre-ft, accounting for about 41 percent of the total production.

Groundwater Production
Fiscal Year 1977/1978 (acre-ft)

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

OBMP Management Zones

▣ Chino Desalter Wells

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Faults

Location Certain

Location Approximate

Approximate Location of Groundwater Barrier

Location Concealed

Location Uncertain

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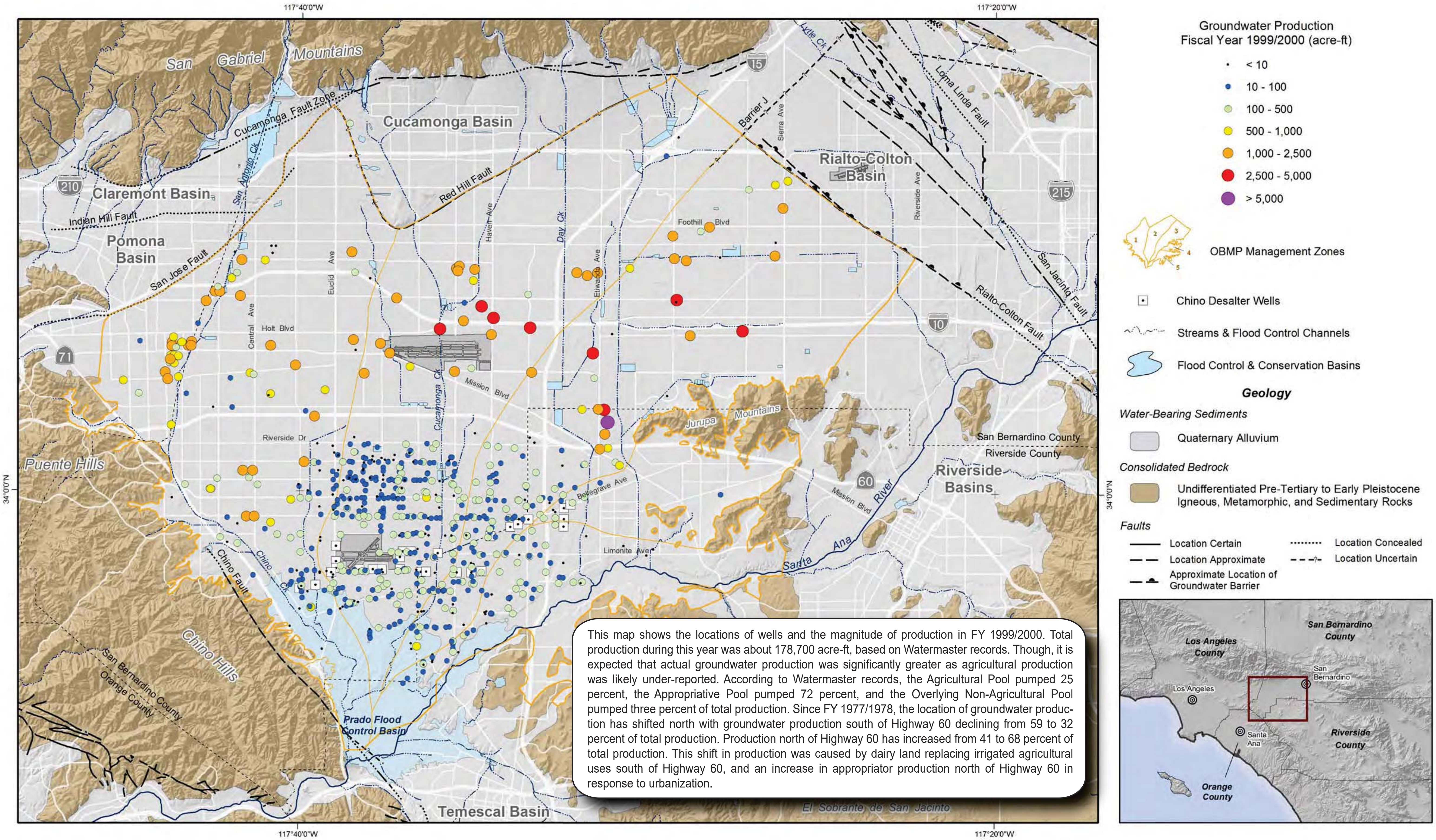
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

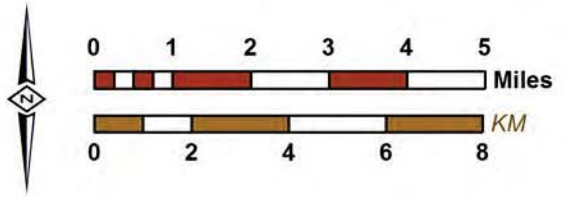
2012 State of the Basin
Basin Production and Recharge

Groundwater Production by Well
Fiscal Year 1977/1978

Exhibit 8



This map shows the locations of wells and the magnitude of production in FY 1999/2000. Total production during this year was about 178,700 acre-ft, based on Watermaster records. Though, it is expected that actual groundwater production was significantly greater as agricultural production was likely under-reported. According to Watermaster records, the Agricultural Pool pumped 25 percent, the Appropriative Pool pumped 72 percent, and the Overlying Non-Agricultural Pool pumped three percent of total production. Since FY 1977/1978, the location of groundwater production has shifted north with groundwater production south of Highway 60 declining from 59 to 32 percent of total production. Production north of Highway 60 has increased from 41 to 68 percent of total production. This shift in production was caused by dairy land replacing irrigated agricultural uses south of Highway 60, and an increase in appropriator production north of Highway 60 in response to urbanization.



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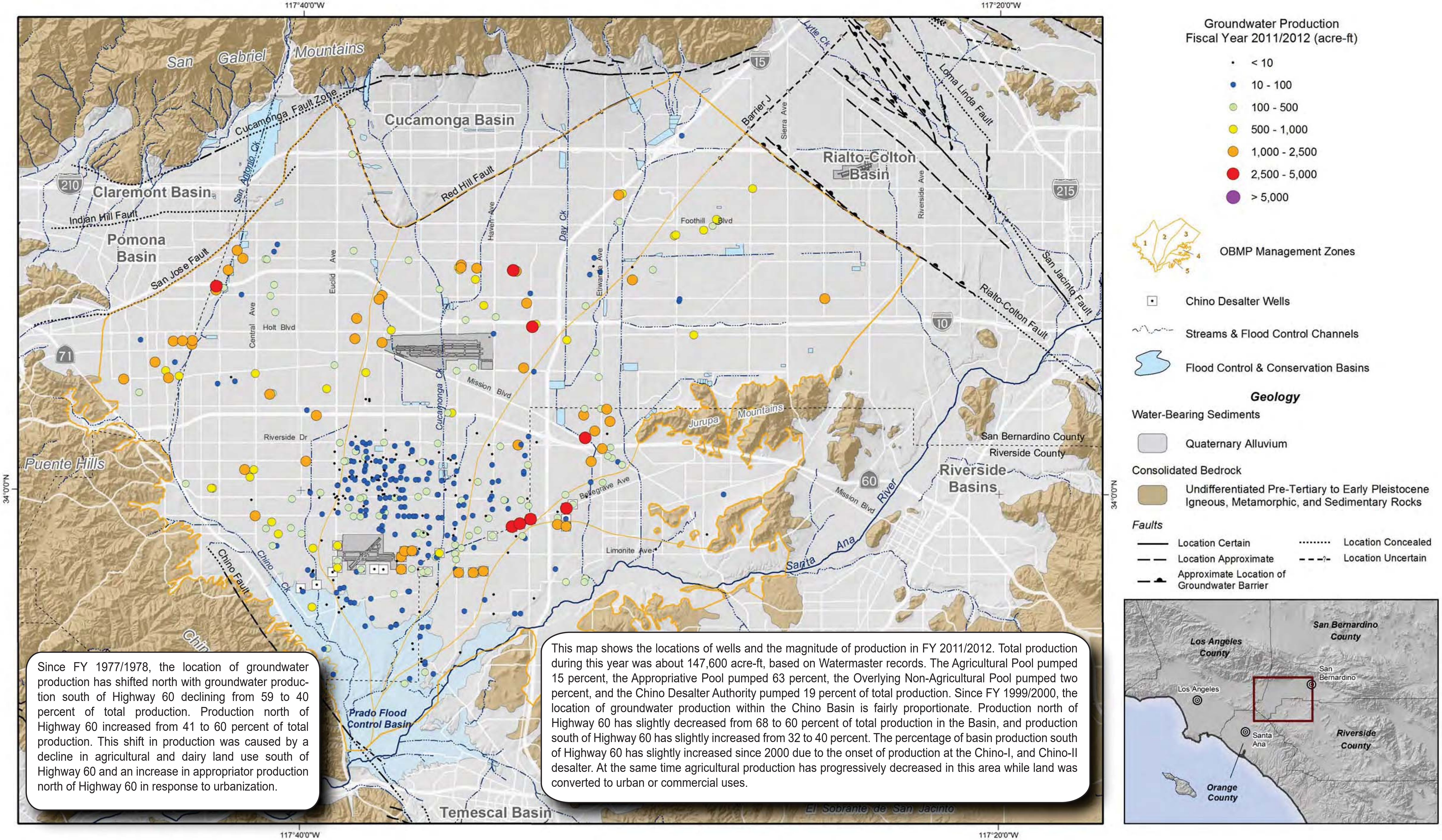
2012 State of the Basin
Basin Production and Recharge

Groundwater Production by Well

Fiscal Year 1999/2000

Exhibit 9



Since FY 1977/1978, the location of groundwater production has shifted north with groundwater production south of Highway 60 declining from 59 to 40 percent of total production. Production north of Highway 60 increased from 41 to 60 percent of total production. This shift in production was caused by a decline in agricultural and dairy land use south of Highway 60 and an increase in appropriator production north of Highway 60 in response to urbanization.

This map shows the locations of wells and the magnitude of production in FY 2011/2012. Total production during this year was about 147,600 acre-ft, based on Watermaster records. The Agricultural Pool pumped 15 percent, the Appropriative Pool pumped 63 percent, the Overlying Non-Agricultural Pool pumped two percent, and the Chino Desalter Authority pumped 19 percent of total production. Since FY 1999/2000, the location of groundwater production within the Chino Basin is fairly proportionate. Production north of Highway 60 has slightly decreased from 68 to 60 percent of total production in the Basin, and production south of Highway 60 has slightly increased from 32 to 40 percent. The percentage of basin production south of Highway 60 has slightly increased since 2000 due to the onset of production at the Chino-I, and Chino-II desalter. At the same time agricultural production has progressively decreased in this area while land was converted to urban or commercial uses.

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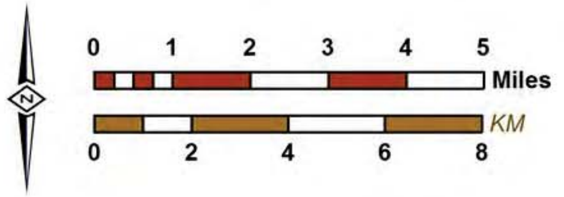
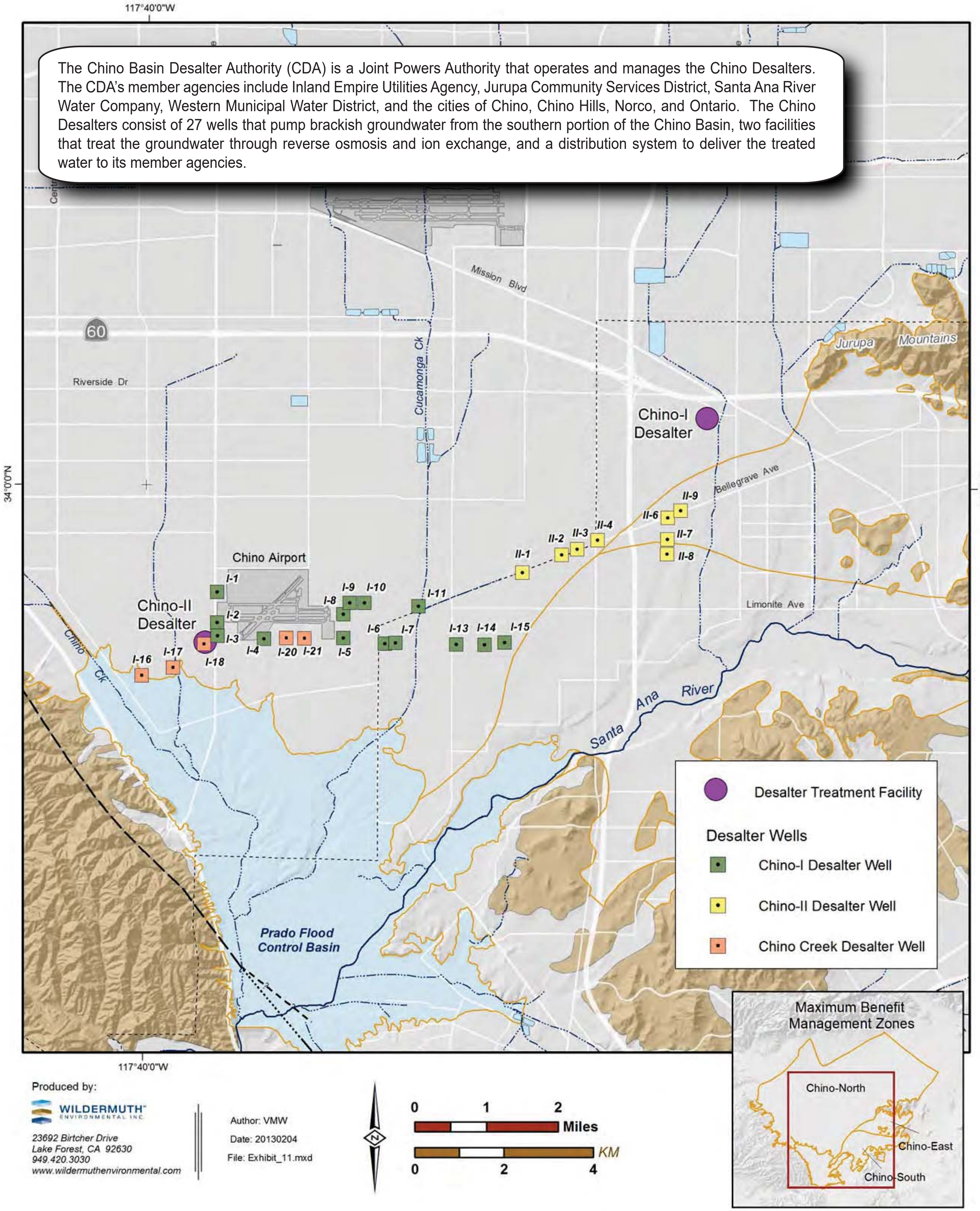


2012 State of the Basin
Basin Production and Recharge

Groundwater Production by Well

Fiscal Year 2011/2012

Exhibit 10



The Chino Basin Desalter Authority (CDA) is a Joint Powers Authority that operates and manages the Chino Desalters. The CDA's member agencies include Inland Empire Utilities Agency, Jurupa Community Services District, Santa Ana River Water Company, Western Municipal Water District, and the cities of Chino, Chino Hills, Norco, and Ontario. The Chino Desalters consist of 27 wells that pump brackish groundwater from the southern portion of the Chino Basin, two facilities that treat the groundwater through reverse osmosis and ion exchange, and a distribution system to deliver the treated water to its member agencies.

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The need for the Chino Desalters was described in Program Elements 3 & 5 of the OBMP Phase 1 Report. During the 1900s, the land uses in southern portion of the Chino Basin were primarily agricultural, and groundwater was the primary water supply for agriculture. Over time, groundwater quality degraded in this area, and currently is not suitable for municipal use unless treated to reduce TDS, nitrate, and other contaminant concentrations. The OBMP recognized that urban land uses and their water demands would ultimately replace the agriculture. If municipal pumping did not replace the decreased agricultural pumping, groundwater levels would rise and discharge to the Santa Ana River. The potential consequences of this occurrence would be (i) loss of Safe Yield in the Chino Basin and (ii) degradation of the quality of the Santa Ana River which could impact the downstream beneficial uses of the River in Orange County. These consequences would come with high costs to the Chino Basin parties to mitigate, and to comply with water-quality regulations.

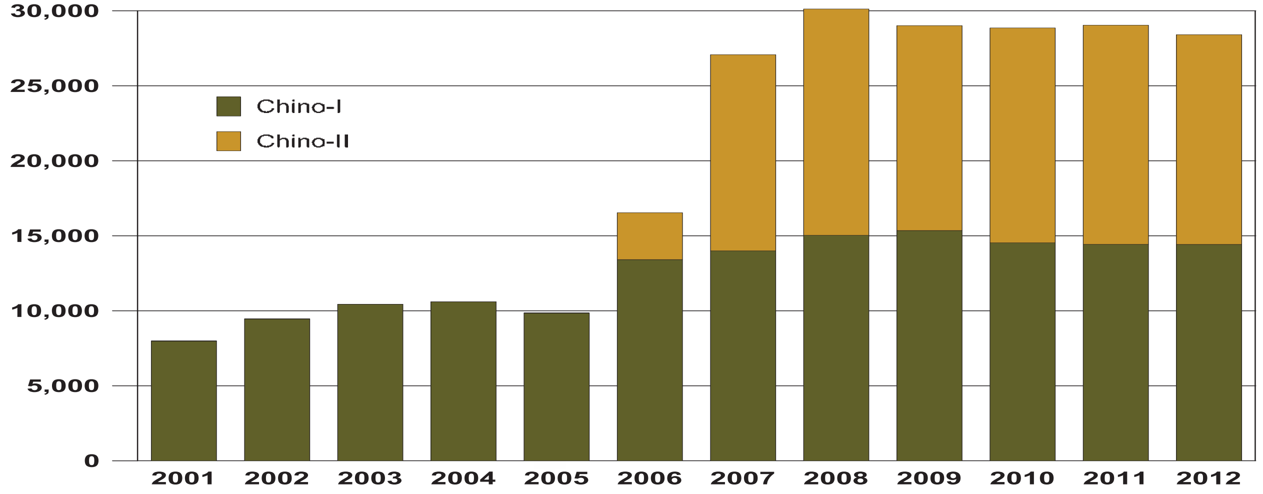
The Chino Desalters were hence designed to replace the expected decrease in agricultural production and accomplish the following objectives: meet the emerging municipal demands in the Chino Basin, maintain or enhance the Safe Yield, remove groundwater contaminants, and protect the beneficial uses of the Santa Ana River. The first desalter facility and well field, the Chino-I Desalter, began operation in 2000 and had an original design capacity of 8 mgd (about 9,000 acre-ft/yr). In 2005, Chino-I was expanded to a capacity of 14 mgd (about 17,000 acre-ft/yr). The Chino-II Desalter began operating in June 2006 at a capacity of 15 mgd (about 16,000 acre-ft/yr). Currently, the Chino-I and Chino-II Desalters produce about 30,000 acre-ft/yr of groundwater. Shown on the chart below is annual groundwater-production for the Chino Desalters.

The Chino Desalters are fundamental to achieving "Hydraulic Control" in the southern portion of Chino Basin. Hydraulic Control is achieved when groundwater discharge from the Chino-North management zone to Prado Basin is eliminated or reduced to de minimis levels. The Regional Board made Hydraulic Control a commitment for the Watermaster and IEUA in the 2004 Basin Plan Amendment in exchange for relaxed groundwater-quality objectives in Chino-North. These so-called "maximum benefit" objectives allow for the implementation of recycled-water reuse in Chino Basin for both direct use and recharge while simultaneously assuring the protection of beneficial uses of the Santa Ana River.

Pursuant to the Peace and Peace II Agreements, Watermaster's goal is 40,000 acre-ft/yr for desalter production. The CDA's most recent expansion was the construction of the Chino Creek Well Field (CCWF). Five wells of the CCWF were built in 2011 and 2012 in the southwestern portion of the Chino Basin. Production at the CCWF is scheduled to begin in 2015 and will help to achieve Hydraulic Control in the west where it has not yet been achieved.

As described in the Peace II Agreement, through re-operation and pursuant to a Judgment Amendment, Watermaster will engage in controlled overdraft of 400,000 acre-ft through 2030, allocated specifically to meet the replenishment obligation of the desalters (WEI, 2009b). Previous investigations have shown that re-operation is required to achieve Hydraulic Control (WEI, 2007). Re-operation water is divided into two tranches: the first tranche of 225,000 acre-ft is dedicated for the replenishment of groundwater produced by existing desalters; the second tranche of 175,000 acre-ft will be used at a rate of 10,000 acre-ft/yr through 2030 for the replenishment obligation of the current desalter expansion. The new yield created by desalter pumping and re-operation is credited to the desalters, and will be used to reduce the desalter replenishment obligation in the future.

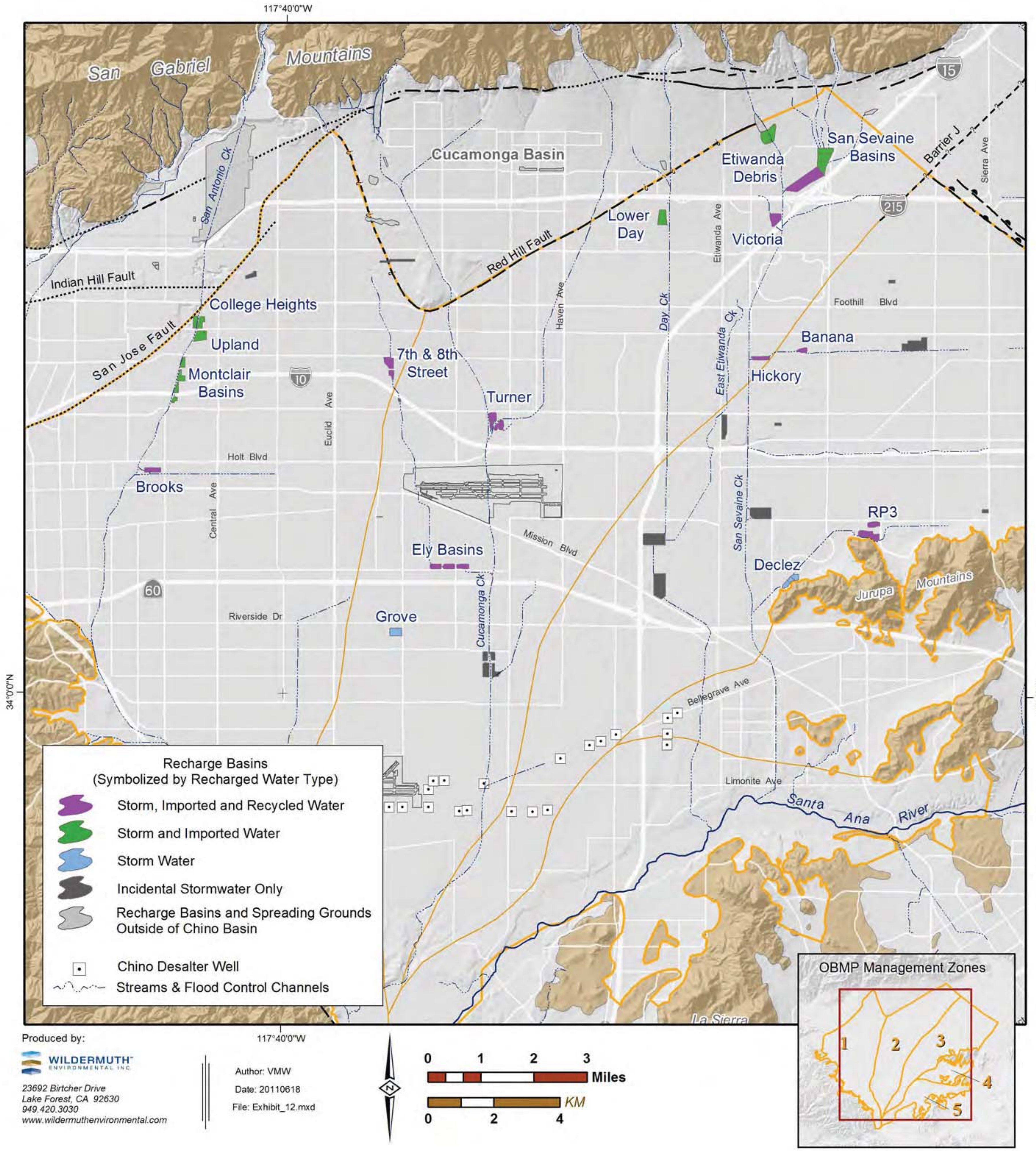
Groundwater Production for the Chino Desalters *(by fiscal year in acre-ft)*



2012 State of the Basin
Basin Production and Recharge

Desalter Well Production
Fiscal Year 2011/2012

Exhibit 11



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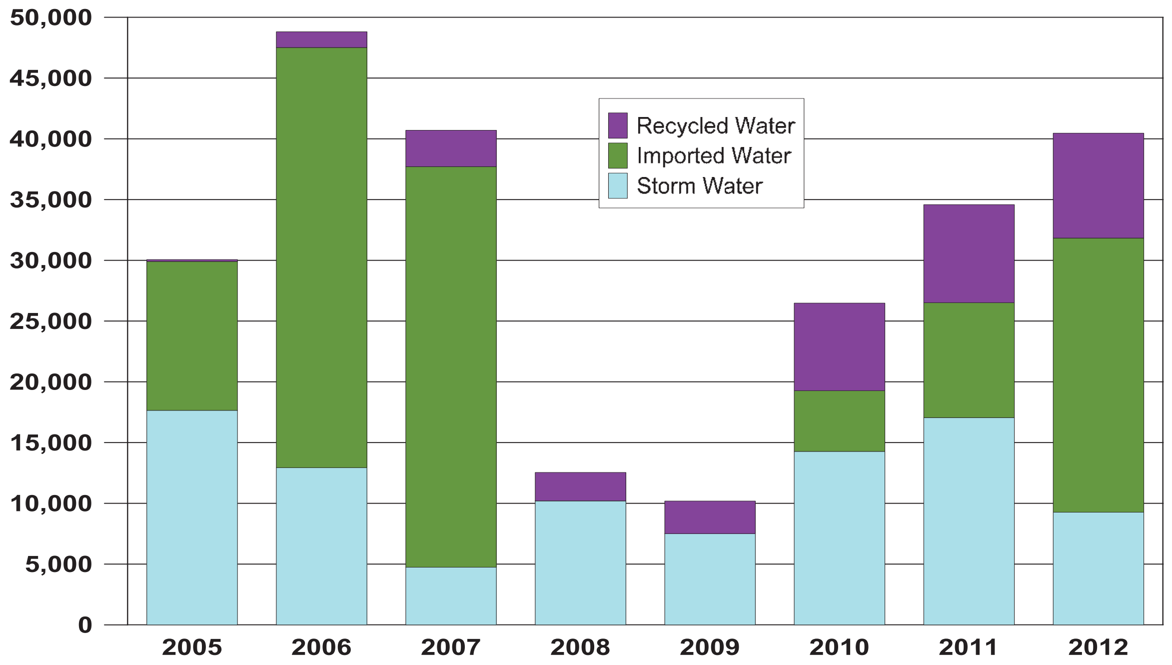
There are four types of water recharged within the Chino Basin: imported water, storm water, urban runoff, and recycled water. Since the implementation of the OBMP, the recharge of storm water and recycled water has increased in the Chino Basin, relieving some dependence on imported water for direct use and replenishment. The operation of the Chino Desalters and the increase in storm water recharge has provided mitigation for the expanded use of recycled water.

IEUA records daily volumes of all types of water routed to all recharge basins, and monitoring of all recharge is performed by IEUA. Since about 2004, sensors have been installed at some of the recharge basins to monitor stage, and the data are used to calculate recharge volumes. This monitoring program is important to Watermaster because storm-water recharge greater than 5,600 acre-ft/yr is considered new yield. The IEUA does not distinguish storm water from urban runoff in the recharge tabulations it submits to Watermaster. Watermaster maintains a centralized database of the recharge volumes. See Exhibit 13 for the fiscal year totals of recharged water by type, by recharge basin, for FYs 2000/2001 to 2011/2012.

Shown on the chart below is the annual recharge by water type since the initiation of the Chino Basin Recycled Water Groundwater Recharge Program in FY 2004/2005.

Water Recharged in the Chino Basin *(by fiscal year in acre-ft)*



Groundwater Recharge in the Chino Basin

2012 State of the Basin
Basin Production and Recharge

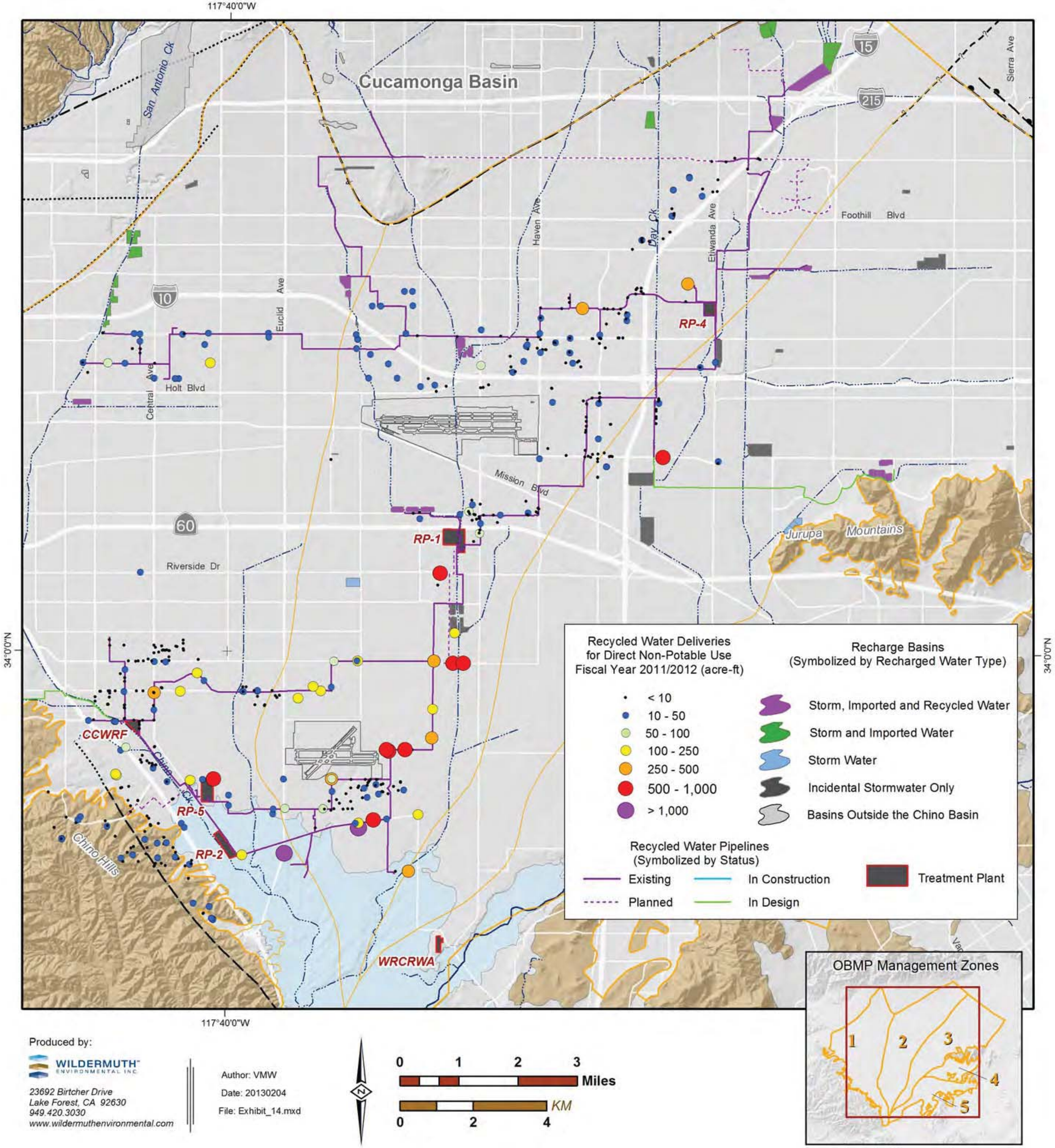
Exhibit 12

Exhibit 13
Summary of Annual Wet Water Recharge Records in the Chino Basin
(acre-ft)

Basin Name	FY 2000/2001				FY 2001/2002				FY 2002/2003				FY 2003/2004				FY 2004/2005				FY 2005/2006			
	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge
MVWD ASR Well	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	0	0	0	0	0	0	0	0
College Heights Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	0	0	0	0	108	5,326	0	5,434
Upland Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	989	0	0	989	214	5,985	0	6,199
Montclair Basins	NM	6,530	0	6,530	NM	6,500	0	6,500	NM	6,499	0	6,499	NM	3,558	0	3,558	3,350	7,887	0	11,237	1,296	5,579	0	6,875
Brooks Street Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	1776	0	0	1,776	524	2,032	0	2,556
7th and 8th Street Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	620	0	0	620	1,271	0	0	1,271
Ely Basins	NM	0	500	500	NM	0	505	505	NM	0	185	185	NM	0	49	49	2,010	0	158	2,168	1,531	0	188	1,719
Grove Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	0	0	0	0	133	0	0	133
Turner Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	1428	310	0	1,738	2,575	346	0	2,921
Lower Day Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	2798	107	0	2,905	624	2,810	0	3,434
Etiwanda Debris Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	2,812	0	2,812	0	2,137	0	2,137	20	2,488	0	2,508
Victoria Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	0	0	0	0	330	0	0	330
San Sevaine	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	1,211	0	1,211	2,830	1,621	0	4,451	2,072	9,172	0	11,244
Hickory Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	298	197	0	495	438	636	586	1,660
Banana Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	425	0	0	425	300	193	529	1,022
RP-3 Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	1,105	0	0	1,105	767	0	0	767
Declez Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	19	0	0	19	737	0	0	737
Totals:	NM	6,530	500	7,030	NM	6,500	505	7,005	NM	6,499	185	6,684	NM	7,582	49	7,631	17,648	12,258	158	30,065	12,940	34,567	1,303	48,810

Basin Name	FY 2006/2007				FY 2007/2008				FY 2008/2009				FY 2009/2010				FY 2010/2011				FY 2011/2012			
	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge	Storm Water	Imported Water	Recycled Water	Total Recharge
MVWD ASR Well	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	186	0	186	0	889	0	889
College Heights Basins	1	3,125	0	3,126	172	0	0	172	0	0	0	0	65	382	0	447	593	559	0	1,152	4	578	0	582
Upland Basin	195	7,068	0	7,263	312	0	0	312	274	0	0	274	532	0	0	532	1,308	899	0	2,207	222	2,118	0	2,340
Montclair Basins	355	10,681	0	11,036	859	0	0	859	611	0	0	611	937	4,592	0	5,529	1762	3,672	0	5,434	703	11,893	0	12,596
Brooks Street Basin	205	1,604	0	1,809	475	0	0	475	434	0	1,605	2,039	666	0	1,695	2,361	628	0	1,373	2,001	363	561	836	1,760
7th and 8th Street Basins	640	0	0	640	959	0	1,054	2,013	1,139	0	352	1,491	1,744	6	1,067	2,817	1583	543	1,871	3,997	1,047	572	641	2,260
Ely Basins	631	0	466	1,097	1,603	0	562	2,165	927	0	364	1,291	1,164	0	246	1,410	1415	83	757	2,255	1,096	885	393	2,374
Grove Basin	166	0	0	166	326	0	0	326	405	0	0	405	351	0	0	351	431	0	0	431	400	0	0	400
Turner Basins	406	313	1,237	1,956	1,542	0	0	1,542	1,200	0	171	1,371	2,220	0	397	2,617	2308	0	53	2,361	1,879	199	1,034	3,112
Lower Day Basin	78	2,266	0	2,344	303	0	0	303	168	0	0	168	540	3	0	543	703	894	0	1,597	158	1,439	0	1,597
Etiwanda Debris Basins	0	1,160	0	1,160	10	0	0	10	28	0	0	28	775	7	0	782	1213	147	0	1,360	100	567	0	667
Victoria Basin	260	0	0	260	427	0	0	427	250	0	0	250	494	2	0	496	461	69	773	1,303	221	281	665	1,167
San Sevaine	244	5,749	0	5,993	749	0	0	749	225	0	0	225	993	0	0	993	1049	1,707	396	3,152	436	1,228	513	2,177
Hickory Basin	536	212	647	1,395	949	0	567	1,516	199	0	46	245	700	7	856	1,563	371	10	776	1,157	258	515	783	1,556
Banana Basin	226	783	643	1,653	278	0	157	435	383	0	40	423	416	0	898	1,314	149	0	267	416	247	0	1,915	2,162
RP-3 Basins	802	0	0	802	511	0	0	511	613	0	106	719	1,902	1	2,051	3,954	2201	882	1,799	4,882	1,339	1,724	1,789	4,852
Declez Basin	0	0	0	0	730	0	0	730	656	0	0	656	774	0	0	774	877	0	0	877	798	0	65	863
Totals:	4,745	32,960	2,993	40,698	10,205	0	2,340	12,545	7,512	0	2,684	10,196	14,273	5,000	7,210	26,483	17,052	9,650	8,065	34,767	9,271	23,449	8,634	41,354

NM - Not measured



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File: Exhibit_14.mxd

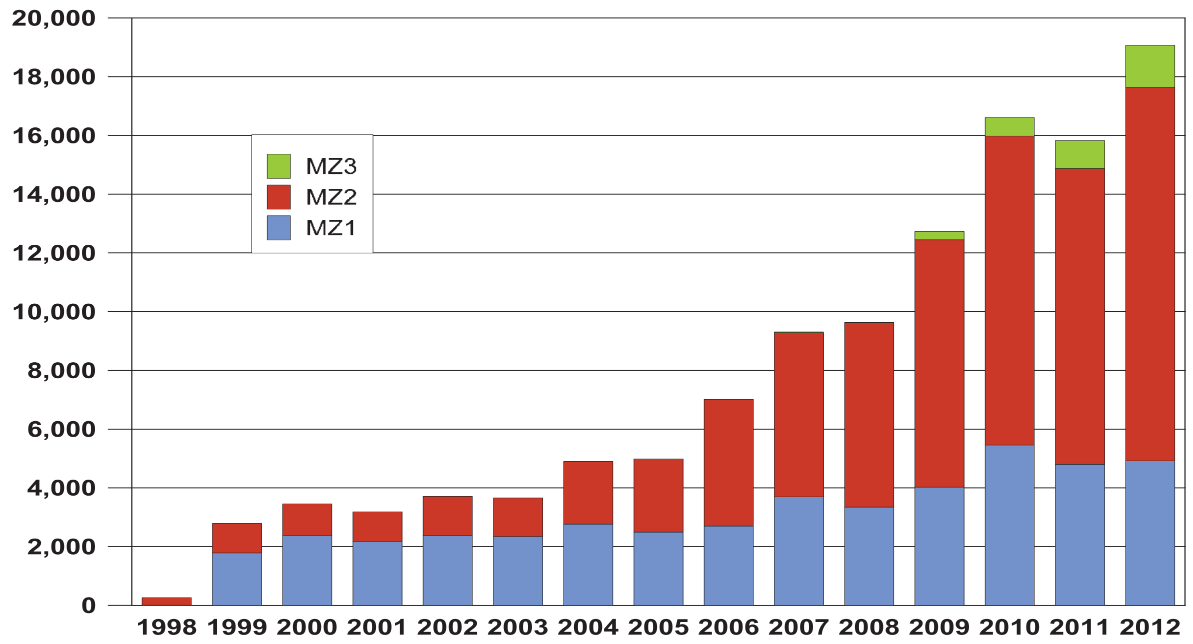
The direct use of recycled water in Chino Basin was an activity identified in the OBMP to achieve Goal No. 1 – Enhance Basin Water Supplies. The 2004 Basin Plan Amendment (Regional Board, 2004) was the instrumental regulatory construct that allowed for the aggressive expansion of recycled-water reuse in the Chino Basin. IEUA owns and operates the four treatment facilities in the Chino Basin which produce recycled water for reuse: Regional Plant No. 1 (RP-1), Regional Plant No. 4 (RP-4), Regional Plant No. 5 (RP-5), and Carbon Canyon Water Reclamation Facility (CCWRF).

This exhibit characterizes the direct use of recycled water in the Chino Basin from 1998 to 2012. Recycled water is reused directly for non-potable uses, which include: irrigation of crops, animal pastures, freeway landscape, parks, schools, and golf courses; commercial laundry and car washes; outdoor cleaning and construction; toilet plumping; and industrial processes. The direct use of recycled water began in 1997 after the completion of distribution pipelines from CCWRF to the cities of Chino and Chino Hills. The direct use of recycled water in Chino Basin has increased fivefold from about 250 acre-ft in FY 1997/1998 to about 19,000 acre-ft in FY 2001/2012. Direct use of recycled water increases the availability of native and imported waters for higher-priority beneficial uses. IEUA has progressively built infrastructure to deliver recycled water throughout much of the Chino Basin. IEUA member agencies that currently use recycled water for direct use are the cities of Chino, Chino Hills, and Ontario, CVWD, and MVWD. Future users of recycled water for direct use will include the cities of Fontana and Upland.

Recycled water also is used in the Chino Basin for indirect potable reuse via groundwater recharge. Currently, the recharge of recycled water can occur at the San Sevaine, Victoria, Banana, Hickory, Turner, 7th&8th Street, Ely, RP-3, and Brooks basins. Exhibit 12 shows the locations of the recharge basins that are used to recharge recycled in the Chino Basin, and Exhibit 13 shows the amount of recycled water recharged by basin.

In FY 2011/2012, about 8,600 acre-ft of recycled water was recharged. Total reuse of recycled water in the Chino Basin in FY 2011/2012 was about 28,000 acre-ft, which was about 50% of the total effluent produced from IEUA's treatment plants. IEUA is continuing its efforts to expand the recycled-water distribution system throughout the Chino Basin for direct non-potable uses and indirect potable reuse via recharge— further relieving demands on native and imported waters.

Direct Use of Recycled Water by Management Zone *(by fiscal year in acre-ft)*



2012 State of the Basin
Basin Production and Recharge

Recycled Water Deliveries for Direct Use

Fiscal Year 2011/2012

Exhibit 14

The exhibits in this section show the physical state of the Chino Basin with respect to groundwater levels and change in storage. The groundwater-level data used to generate these exhibits were collected and compiled as part of Watermaster's groundwater-level monitoring program.

Prior to OBMP implementation, there was no formal groundwater-level monitoring program in the Chino Basin. Problems with historical groundwater-level monitoring included an inadequate areal distribution of wells that were monitored, short time histories, questionable data quality, and insufficient resources to develop and conduct a comprehensive program. The OBMP defined a new, comprehensive, basin-wide groundwater-level monitoring program pursuant to *OBMP Program Element 1 – Develop and Implement a Comprehensive Monitoring Program.* The monitoring program has been refined over time to satisfy the evolving needs of the Watermaster and IEUA, such as new regulatory requirements, and to increase efficiency.

The groundwater-level monitoring program supports many Watermaster functions, such as the periodic reassessment of Safe Yield, the monitoring and management of land subsidence, and the assessment of Hydraulic Control. The data are also used to update and re-calibrate Watermaster's computer-simulation groundwater-flow model, to understand directions of groundwater flow, to compute storage changes, to interpret water quality data, and to identify areas of the basin where recharge and discharge are not in balance.

Exhibit 15 shows the locations and measurement frequencies of all wells currently in Watermaster's groundwater-level monitoring program. Water levels are measured at private wells and dedicated monitoring wells by Watermaster staff using manual methods once per month or with pressure transducers that record water levels once every 15 minutes. Water levels are also measured by well owners, including municipal water agencies, private water companies, the California Department of Toxic Substance Control (DTSC), the County of San Bernardino, and various private consulting firms. Typically, water levels are measured by well owners monthly, and Watermaster staff collects these data from the well owners quarterly. All water-level data are checked by Watermaster staff and uploaded to a centralized database management system that can be accessed online through HydroDaVE^{SM}.

The groundwater-level data were used to create groundwater-elevation contour maps for the shallow aquifer system in the Chino Basin for spring 2000 (Exhibit 16), spring 2010 (Exhibit 17), and spring 2012 (Exhibit 18). Groundwater elevations from spring 2010 and spring 2012 were subtracted to generate a map of water-level change over the two-year period since the last State of the Basin analysis (Exhibit 19). Groundwater elevations from spring 2000 and spring 2012 were subtracted to generate a map of water-level change over the twelve-year period since the OBMP and Peace Agreement implementation (Exhibit 20).

Achieving "Hydraulic Control" in the southern portion of Chino Basin is an important objective of Watermaster, IEUA, and the Santa Ana Regional Water Quality Control Board (RWQCB). Hydraulic Control is achieved when groundwater discharge from the Chino-North management zone to Prado Basin is eliminated or reduced to de minimis levels. The RWQCB made Hydraulic Control a commitment for the Watermaster and IEUA in the 2004 Basin Plan Amendment in exchange for relaxed groundwater-quality objectives in Chino-North. These objectives, called "maximum-benefit" objectives allow for the implementation of recycled-water reuse in Chino Basin for both direct use and recharge while simultaneously assuring the protection of beneficial uses of the Santa Ana River. Achieving Hydraulic Control also enhances the yield of the Chino Basin by controlling water levels in the southern portion of the Chino Basin, which has the effect of reducing outflow as rising groundwater and increasing streambed recharge in the Santa Ana River.

Groundwater-level data are used to assess the state of Hydraulic Control. Data are collected from a selected set of "key wells" and are mapped and analyzed annually. Exhibit 21 shows groundwater-elevation contours and data for the shallow aquifer system within the southern portion of the Chino Basin in spring 2000—prior to any significant pumping by the Chino-I Desalter wells. Exhibit 22 shows groundwater-elevation contours and data for the shallow aquifer system in spring 2012—approximately twelve years after the commencement of Chino-I Desalter pumping and six years after the commencement of Chino-II Desalter pumping. These exhibits include a brief interpretation of the state of Hydraulic Control. For an in-depth discussion of Hydraulic Control, see *Chino Basin Maximum Benefit Monitoring Program 2010 Annual Report* (WEI, 2012).

Exhibit 23 shows the location of selected wells across the Chino Basin that have long time-histories of water-levels. The time-histories describe the long-term trends in groundwater levels in the different management zones of the Chino Basin. The wells were selected based on geographic location within the management zone, well-screen intervals, and the length, density, and quality of water-level records. Exhibits 24 through 28 show water-level time-series charts for these wells by management zone for the period of 1978 to 2012. On these exhibits, the behavior of water levels at these wells is compared to climate, groundwater production, and recharge to reveal the cause-and-effect relationships. To show the relationship between groundwater levels and climate, a cumulative departure from mean precipitation (CDFM) plot is shown. Positive sloping lines on the CDFM plot indicate wet years or wet periods. Negatively sloping lines indicate dry years or dry periods. For example, 1978 to 1983 was an extremely wet period, and it is represented by a positively sloping line. Bar charts of annual pumping and artificial recharge by management zone are shown to shown to demonstrate the relationships between groundwater levels and pumping and/or artificial recharge.

The volume of groundwater in storage within an aquifer is a function of the volume of the aquifer materials and the volume of pore space within the aquifer material that will readily yield water under the force of gravity. The change in storage over a particular time period is determined by multiplying the water-level change by the specific yield of the aquifer materials over which the water-level change occurred. Watermaster developed a GIS-based model to estimate groundwater storage changes in two time periods: spring 2000 to spring 2012 (total change in storage since the OBMP and Peace Agreement Implementation), and spring 2010 to spring 2012 (total change in storage since the 2010 SOB Report).

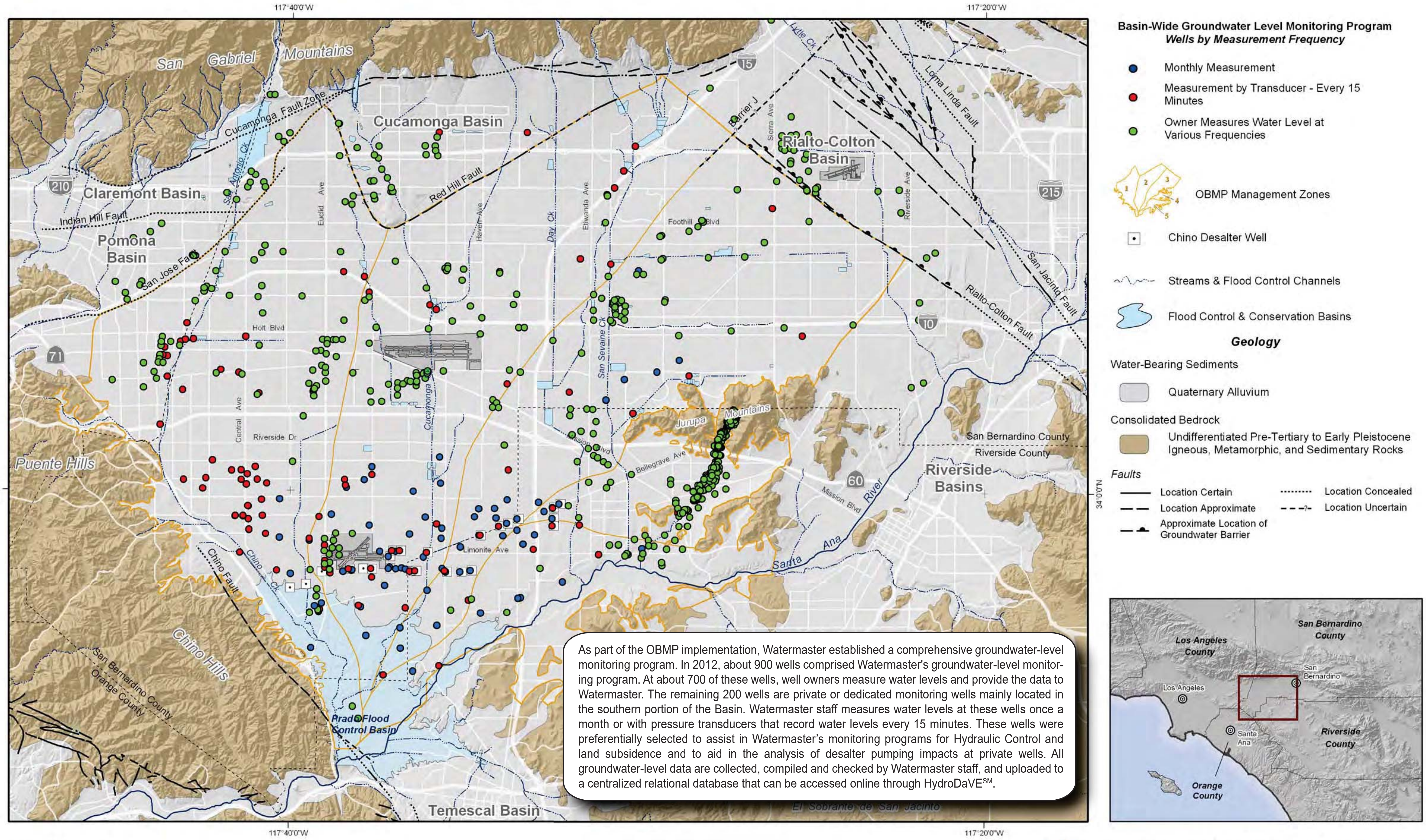
The storage change (ΔS, in acre-feet) for a period is calculated as follows:

$$\text{Change in Storage } (\Delta S) = \Delta WL * SY_{avg} * A$$

Where ΔWL is the change in groundwater elevation for a specific period (feet), SY_{avg} is the thickness-weighted average specific yield of the sediments where the groundwater elevation change occurred, and A is the area (acres) where storage and groundwater elevation have changed.

Exhibit 29 illustrates the change in storage for the period of 2010 to 2012, which was about +23,000 acre-ft. Exhibit 30 illustrates the change in storage for the period of 2000 to 2012, which was about -161,000 acre-ft or about -13,400 acre-ft/yr.

Defined in the OBMP Implementation Plan, the Operational Storage Requirement is the groundwater storage in the Chino Basin that is necessary to maintain Safe Yield, and the Safe Storage is the maximum storage in the Basin that will not cause significant water quality and high-groundwater related problems. The Safe Storage Capacity is the difference between the Operational Storage Requirement and the Safe Storage. Watermaster was required to evaluate the Operational Storage Requirement, Safe Storage, and Safe Storage Capacity of the Chino Basin in FY 2002/2003, and determined that the Operational Storage Requirement is 5,980,000 acre-ft which corresponds to the year 2000 estimate of groundwater in storage— the Safe Storage is 6,480,000 acre-ft., and the Safe Storage Capacity is 500,000 acre-ft (WEI, 2003b). These storage parameters of the Chino Basin have not been evaluated since FY 2002/2003.



As part of the OBMP implementation, Watermaster established a comprehensive groundwater-level monitoring program. In 2012, about 900 wells comprised Watermaster's groundwater-level monitoring program. At about 700 of these wells, well owners measure water levels and provide the data to Watermaster. The remaining 200 wells are private or dedicated monitoring wells mainly located in the southern portion of the Basin. Watermaster staff measures water levels at these wells once a month or with pressure transducers that record water levels every 15 minutes. These wells were preferentially selected to assist in Watermaster's monitoring programs for Hydraulic Control and land subsidence and to aid in the analysis of desalter pumping impacts at private wells. All groundwater-level data are collected, compiled and checked by Watermaster staff, and uploaded to a centralized relational database that can be accessed online through HydroDaVE^{SM}.

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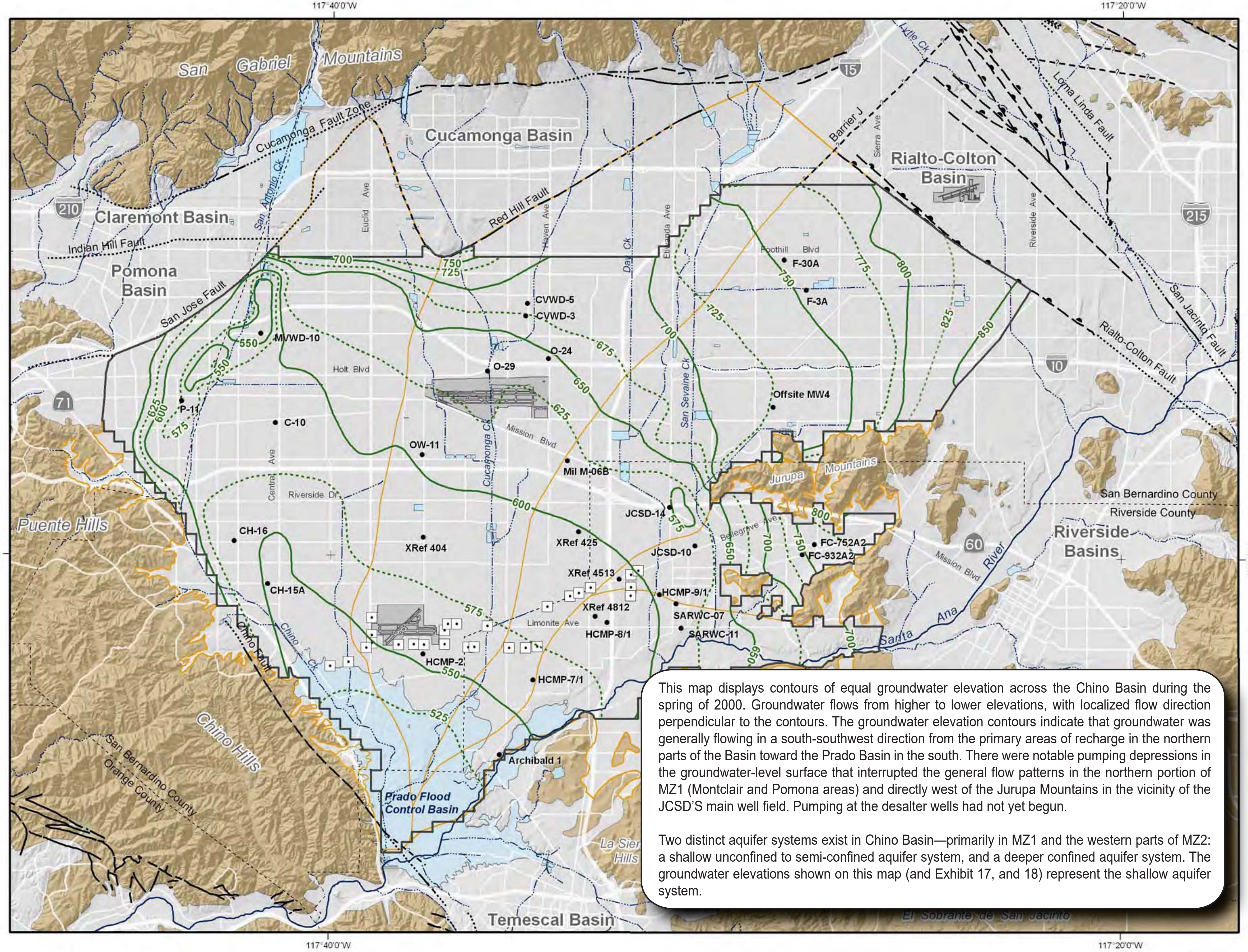
2012 State of the Basin
Groundwater Levels

Groundwater Level Monitoring Network

Well Location and Measurement Frequency as of 2012

Exhibit 15



This map displays contours of equal groundwater elevation across the Chino Basin during the spring of 2000. Groundwater flows from higher to lower elevations, with localized flow direction perpendicular to the contours. The groundwater elevation contours indicate that groundwater was generally flowing in a south-southwest direction from the primary areas of recharge in the northern parts of the Basin toward the Prado Basin in the south. There were notable pumping depressions in the groundwater-level surface that interrupted the general flow patterns in the northern portion of MZ1 (Montclair and Pomona areas) and directly west of the Jurupa Mountains in the vicinity of the JCSD'S main well field. Pumping at the desalter wells had not yet begun.

Two distinct aquifer systems exist in Chino Basin—primarily in MZ1 and the western parts of MZ2: a shallow unconfined to semi-confined aquifer system, and a deeper confined aquifer system. The groundwater elevations shown on this map (and Exhibit 17, and 18) represent the shallow aquifer system.

800 / 775 — Groundwater Elevation Contours (feet above mean sea-level)

▢ Boundry of Contoured Area (contours are not shown outside of this boundary due to lack of water level data)

● Well With a Water-Level Time History Plotted on Exhibits 24 through 28.

OBMP Management Zones

▣ Chino Desalter Wells

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

▢ Quaternary Alluvium

Consolidated Bedrock

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

Faults

- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

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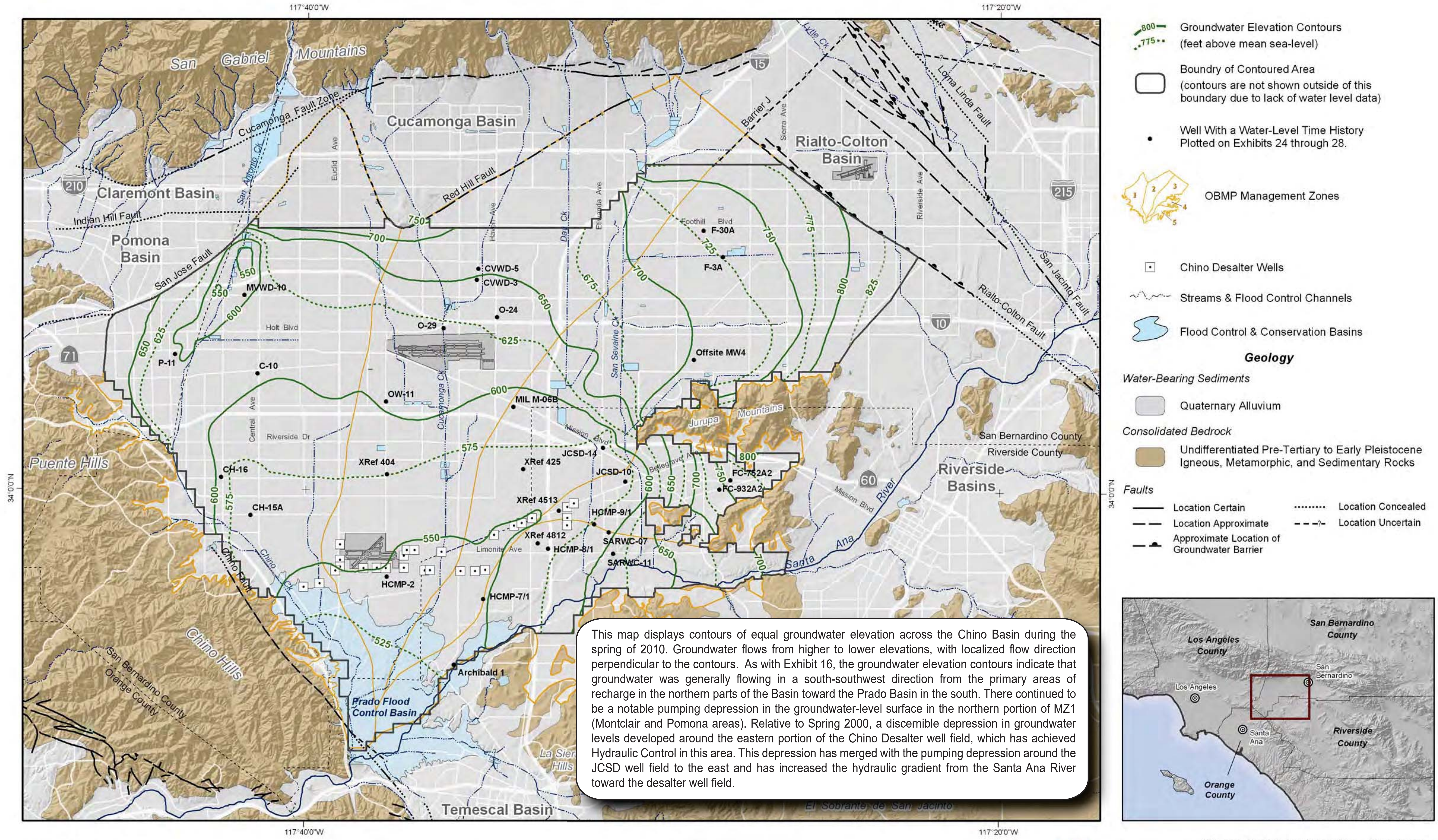
2012 State of the Basin
Groundwater Levels

Groundwater Elevation Contours in Spring 2000

Shallow Aquifer System

Exhibit 16



This map displays contours of equal groundwater elevation across the Chino Basin during the spring of 2010. Groundwater flows from higher to lower elevations, with localized flow direction perpendicular to the contours. As with Exhibit 16, the groundwater elevation contours indicate that groundwater was generally flowing in a south-southwest direction from the primary areas of recharge in the northern parts of the Basin toward the Prado Basin in the south. There continued to be a notable pumping depression in the groundwater-level surface in the northern portion of MZ1 (Montclair and Pomona areas). Relative to Spring 2000, a discernible depression in groundwater levels developed around the eastern portion of the Chino Desalter well field, which has achieved Hydraulic Control in this area. This depression has merged with the pumping depression around the JCSD well field to the east and has increased the hydraulic gradient from the Santa Ana River toward the desalter well field.

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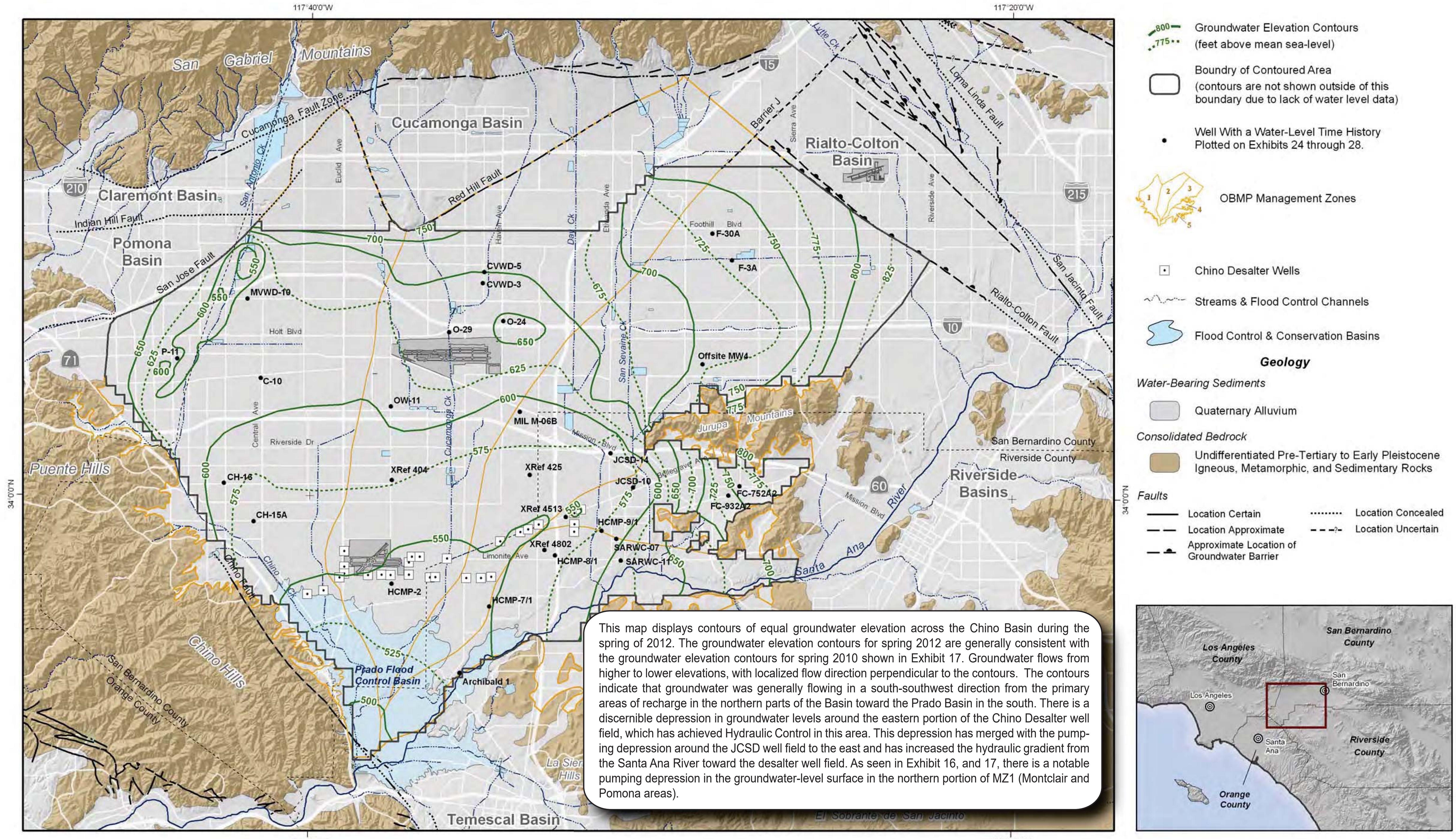
2012 State of the Basin
Groundwater Levels

Groundwater Elevation Contours in Spring 2010

Shallow Aquifer System

Exhibit 17



This map displays contours of equal groundwater elevation across the Chino Basin during the spring of 2012. The groundwater elevation contours for spring 2012 are generally consistent with the groundwater elevation contours for spring 2010 shown in Exhibit 17. Groundwater flows from higher to lower elevations, with localized flow direction perpendicular to the contours. The contours indicate that groundwater was generally flowing in a south-southwest direction from the primary areas of recharge in the northern parts of the Basin toward the Prado Basin in the south. There is a discernible depression in groundwater levels around the eastern portion of the Chino Desalter well field, which has achieved Hydraulic Control in this area. This depression has merged with the pumping depression around the JCSD well field to the east and has increased the hydraulic gradient from the Santa Ana River toward the desalter well field. As seen in Exhibit 16, and 17, there is a notable pumping depression in the groundwater-level surface in the northern portion of MZ1 (Montclair and Pomona areas).

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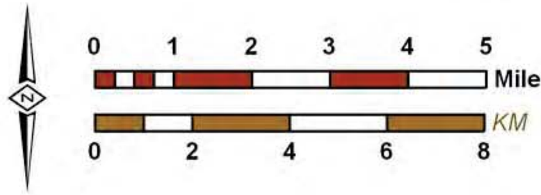
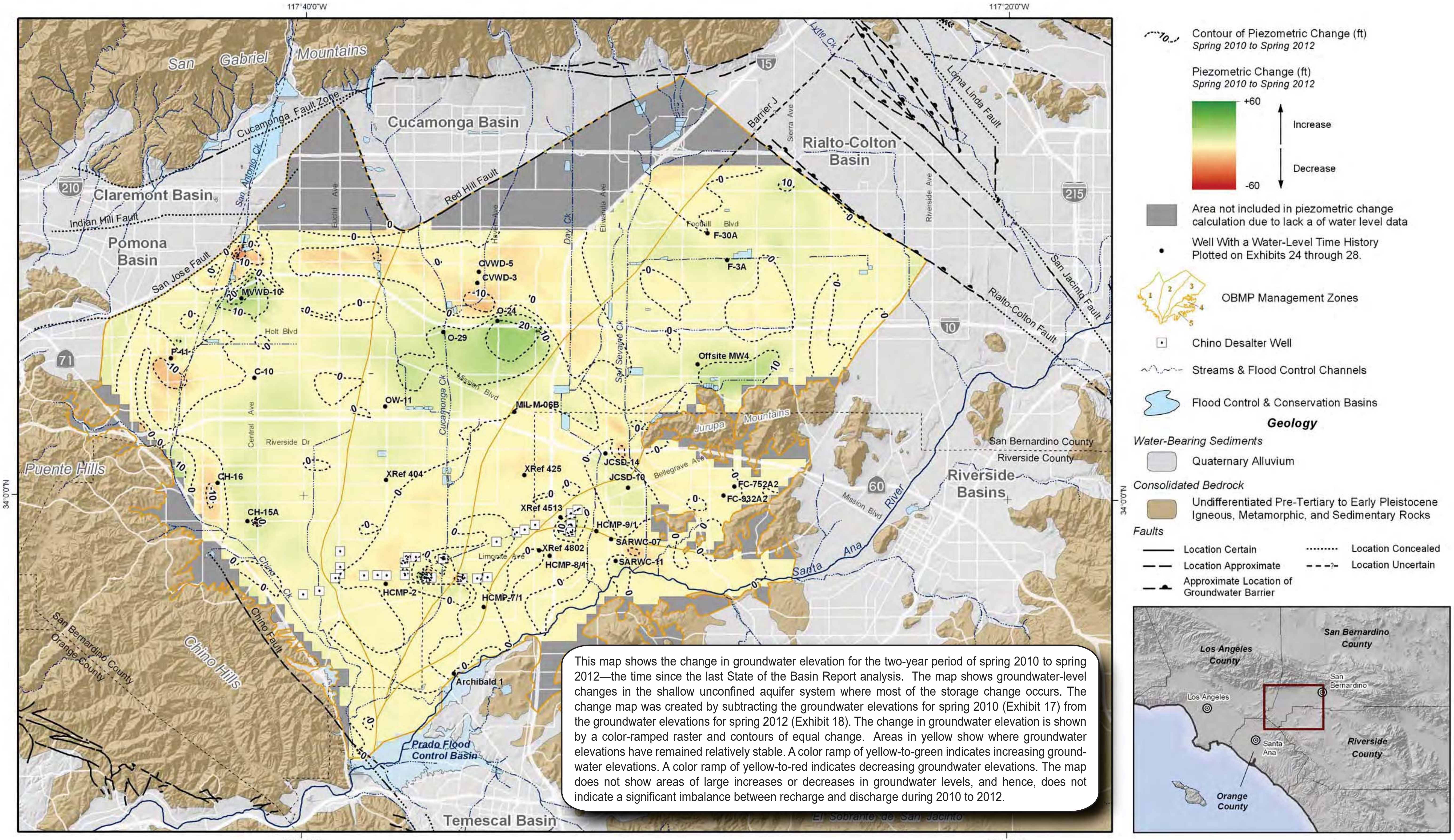


2012 State of the Basin
Groundwater Levels

Groundwater Elevation Contours in Spring 2012

Shallow Aquifer System

Exhibit 18



This map shows the change in groundwater elevation for the two-year period of spring 2010 to spring 2012—the time since the last State of the Basin Report analysis. The map shows groundwater-level changes in the shallow unconfined aquifer system where most of the storage change occurs. The change map was created by subtracting the groundwater elevations for spring 2010 (Exhibit 17) from the groundwater elevations for spring 2012 (Exhibit 18). The change in groundwater elevation is shown by a color-ramped raster and contours of equal change. Areas in yellow show where groundwater elevations have remained relatively stable. A color ramp of yellow-to-green indicates increasing groundwater elevations. A color ramp of yellow-to-red indicates decreasing groundwater elevations. The map does not show areas of large increases or decreases in groundwater levels, and hence, does not indicate a significant imbalance between recharge and discharge during 2010 to 2012.

0 1 2 3 4 5 Miles

0 2 4 6 8 KM

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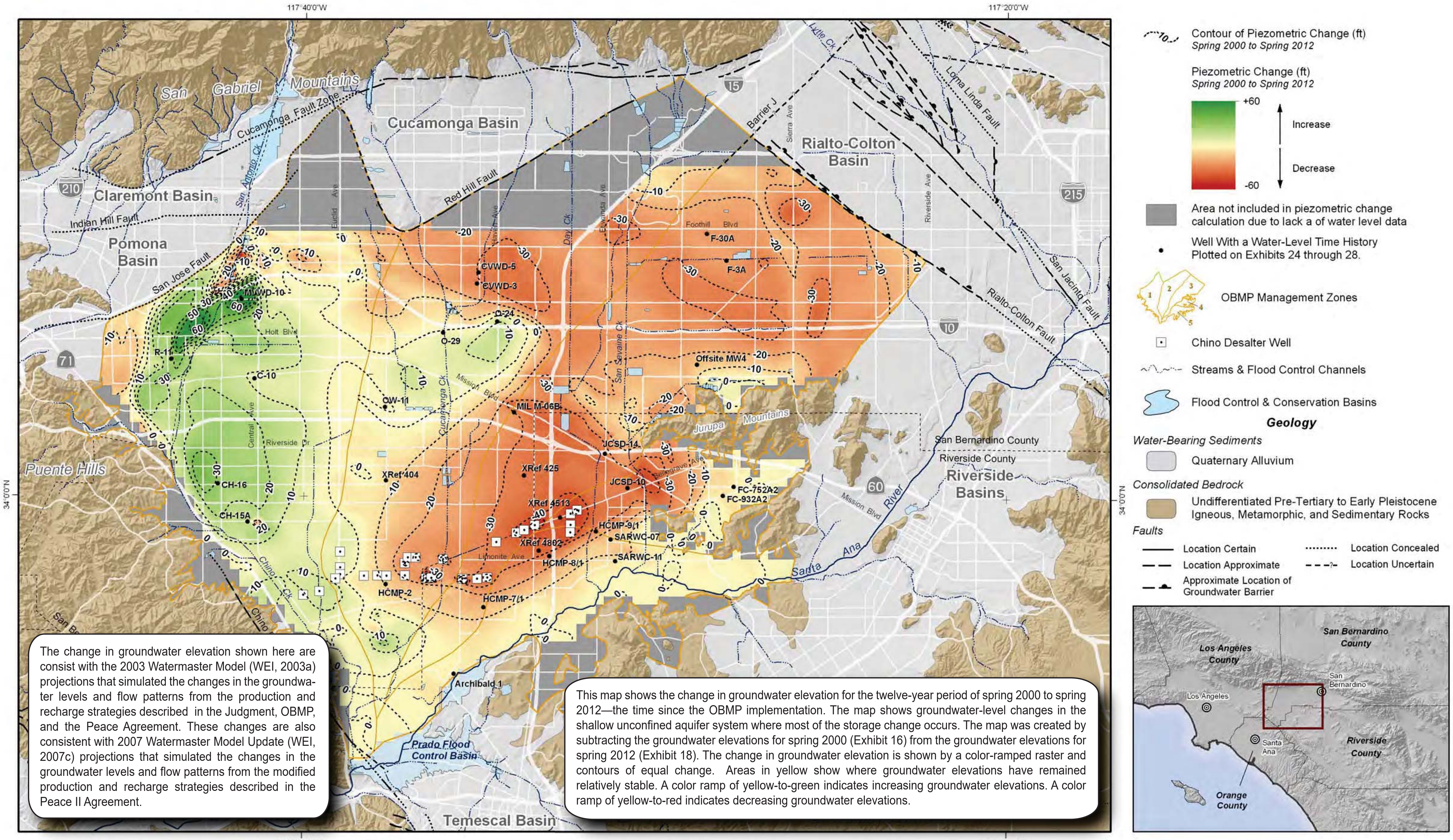
2012 State of the Basin
Groundwater Levels

Groundwater Level Change from Spring 2010 to Spring 2012

Shallow Aquifer System

Exhibit 19



The change in groundwater elevation shown here are consist with the 2003 Watermaster Model (WEI, 2003a) projections that simulated the changes in the groundwater levels and flow patterns from the production and recharge strategies described in the Judgment, OBMP, and the Peace Agreement. These changes are also consistent with 2007 Watermaster Model Update (WEI, 2007c) projections that simulated the changes in the groundwater levels and flow patterns from the modified production and recharge strategies described in the Peace II Agreement.

This map shows the change in groundwater elevation for the twelve-year period of spring 2000 to spring 2012—the time since the OBMP implementation. The map shows groundwater-level changes in the shallow unconfined aquifer system where most of the storage change occurs. The map was created by subtracting the groundwater elevations for spring 2000 (Exhibit 16) from the groundwater elevations for spring 2012 (Exhibit 18). The change in groundwater elevation is shown by a color-ramped raster and contours of equal change. Areas in yellow show where groundwater elevations have remained relatively stable. A color ramp of yellow-to-green indicates increasing groundwater elevations. A color ramp of yellow-to-red indicates decreasing groundwater elevations.

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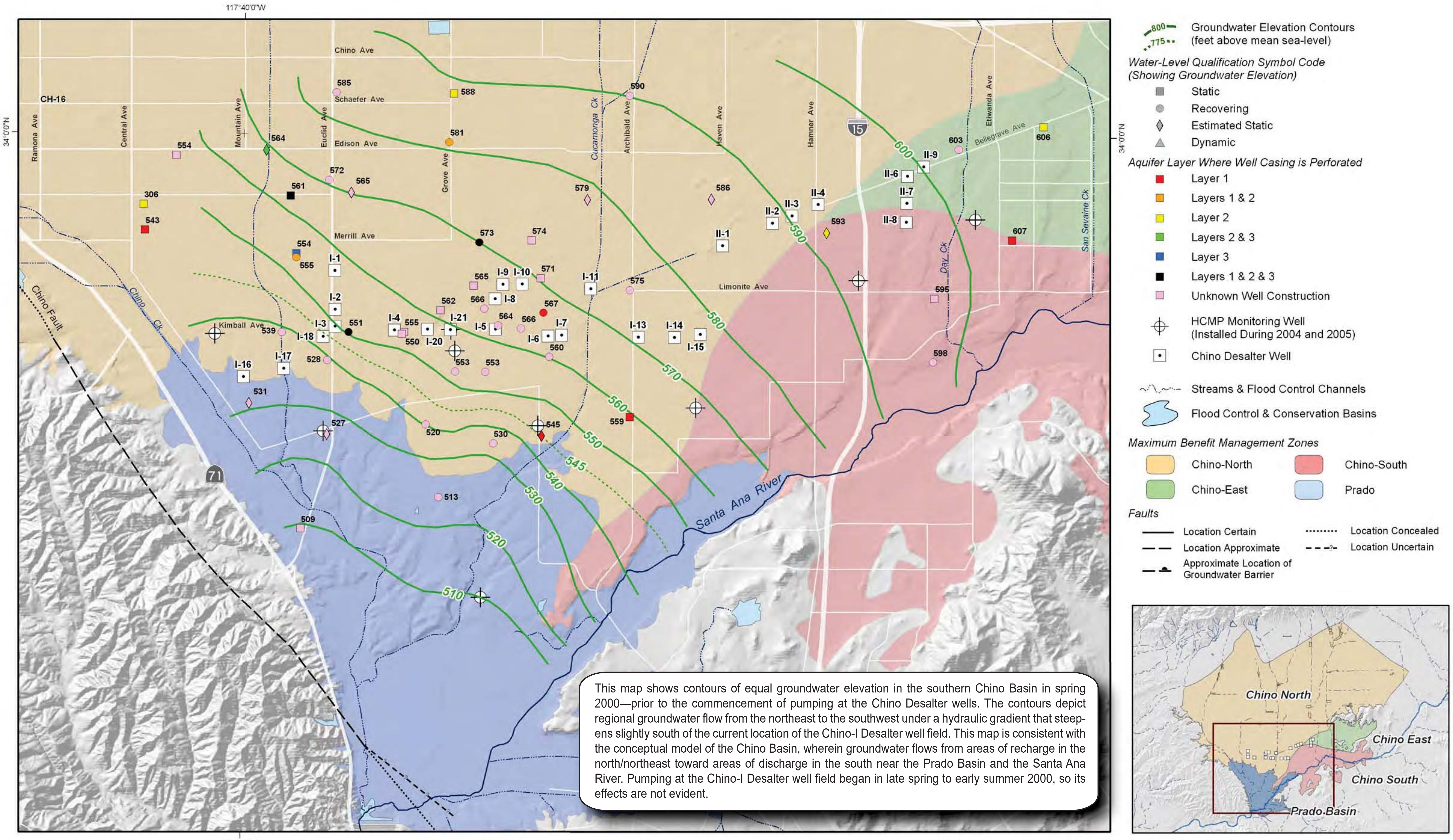
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Levels

Groundwater Level Change

Spring 2000 to Spring 2012

Exhibit 20



This map shows contours of equal groundwater elevation in the southern Chino Basin in spring 2000—prior to the commencement of pumping at the Chino Desalter wells. 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 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 evident.

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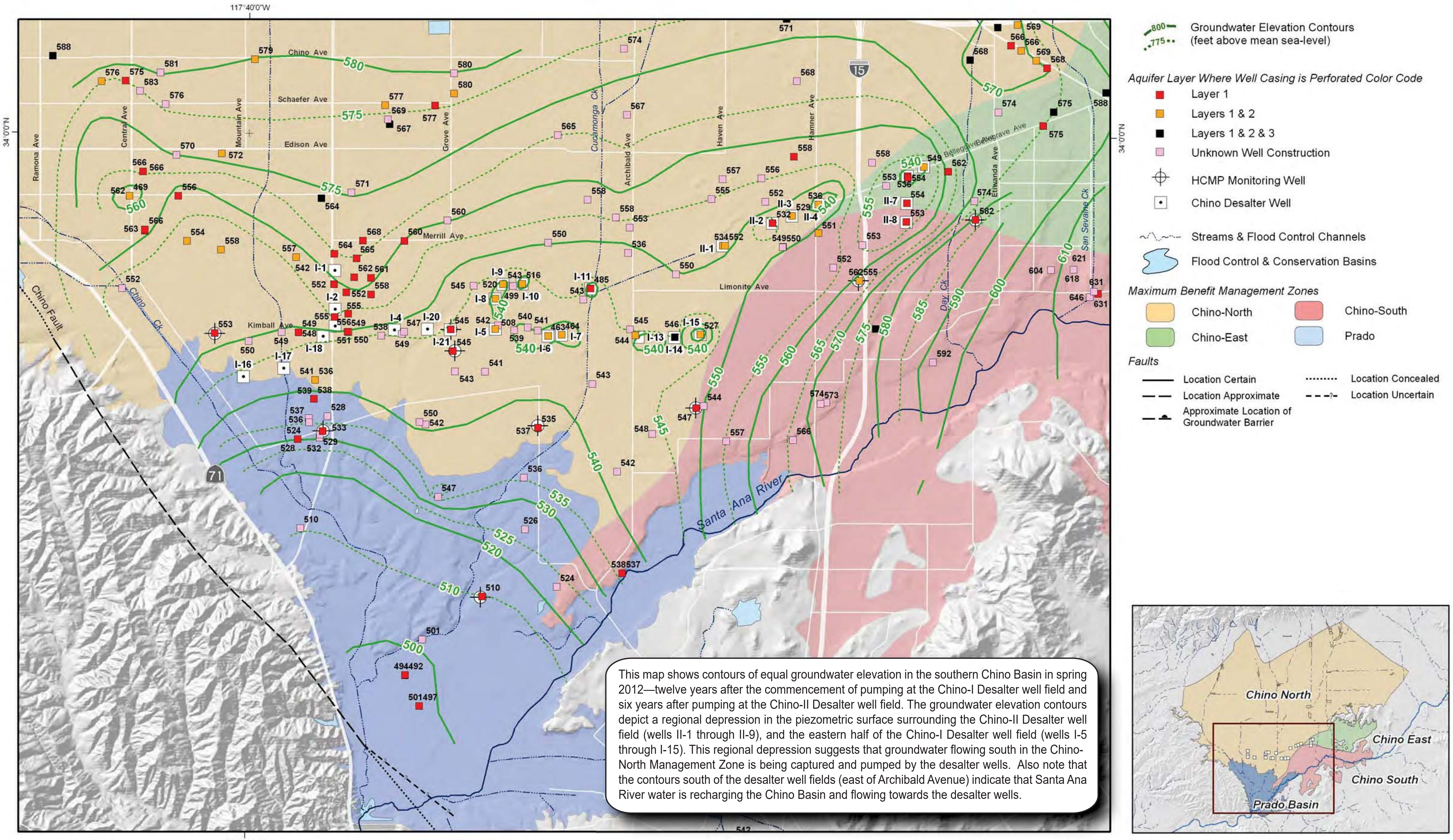
2012 State of the Basin
Groundwater Levels

State of Hydraulic Control in Spring 2000

Shallow Aquifer System

Exhibit 21



This map shows contours of equal groundwater elevation in the southern Chino Basin in spring 2012—twelve years after the commencement of pumping at the Chino-I Desalter well field and six years after pumping at the Chino-II Desalter well field. The groundwater elevation contours depict a regional depression in the piezometric surface surrounding the Chino-II Desalter well field (wells II-1 through II-9), and the eastern half of the Chino-I Desalter well field (wells I-5 through I-15). This regional depression suggests that groundwater flowing south in the Chino-North Management Zone is being captured and pumped by the desalter wells. Also note that the contours south of the desalter well fields (east of Archibald Avenue) indicate that Santa Ana River water is recharging the Chino Basin and flowing towards the desalter wells.

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File: Exhibit_22.mxd

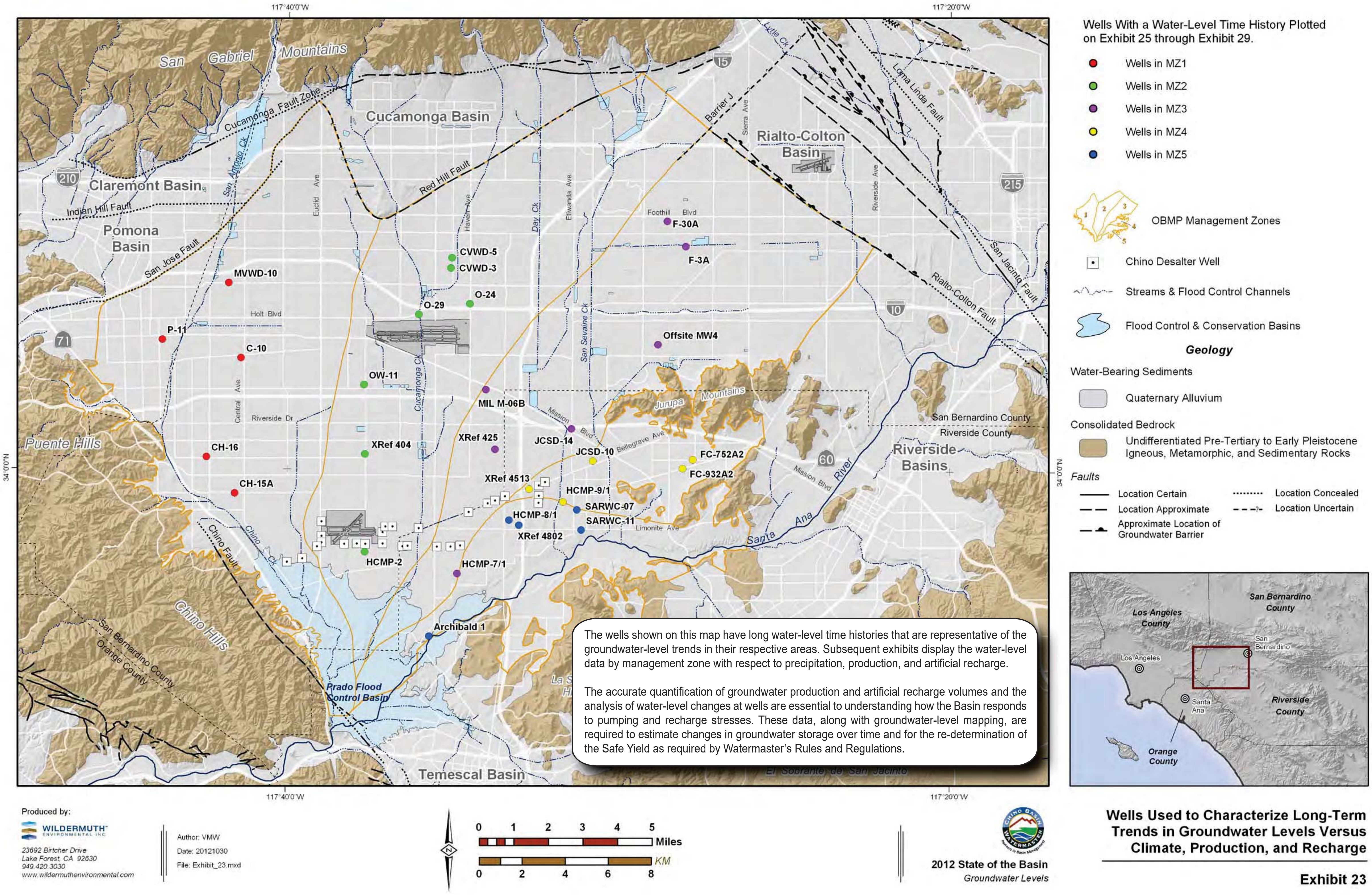
0 1 2 Miles
0 1 2 3 KM

2012 State of the Basin
Groundwater Levels

State of Hydraulic Control in Spring 2012

Shallow Aquifer System

Exhibit 22



The wells shown on this map have long water-level time histories that are representative of the groundwater-level trends in their respective areas. Subsequent exhibits display the water-level data by management zone with respect to precipitation, production, and artificial recharge.

The accurate quantification of groundwater production and artificial recharge volumes and the analysis of water-level changes at wells are essential to understanding how the Basin responds to pumping and recharge stresses. These data, along with groundwater-level mapping, are required to estimate changes in groundwater storage over time and for the re-determination of the Safe Yield as required by Watermaster's Rules and Regulations.

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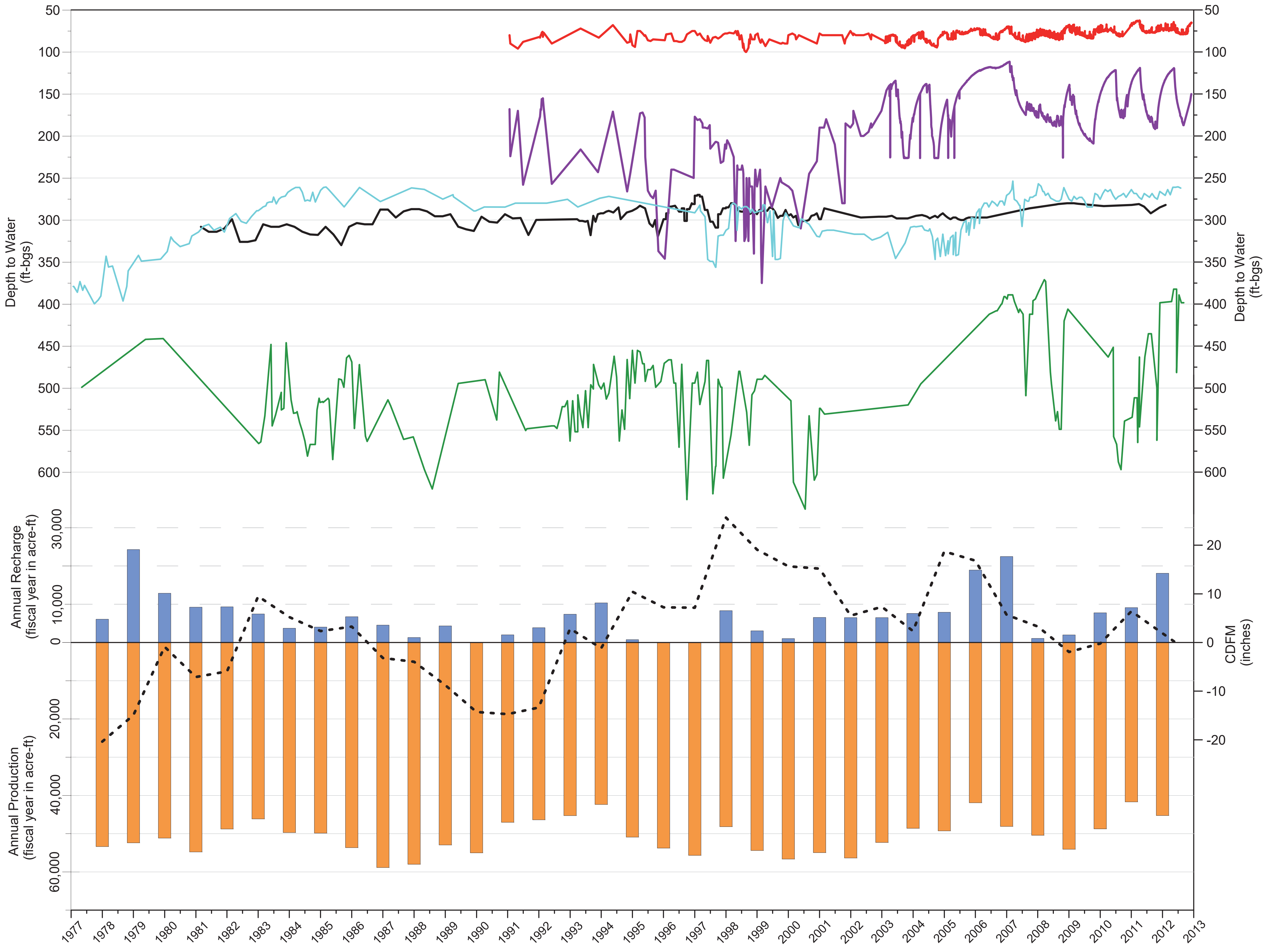
2012 State of the Basin
Groundwater Levels

Wells Used to Characterize Long-Term Trends in Groundwater Levels Versus Climate, Production, and Recharge

Exhibit 23



This exhibit is a time-series chart that displays groundwater levels at wells, annual production, and annual artificial recharge to basins, in MZ1, for the time period since the Judgment to FY 2011/2012. Climate is displayed as CDFM precipitation plot using the PRISM data from 1895 to 2012. Upward sloping lines on the CDFM curve indicate wet years or wet periods. Downward sloping lines indicate dry years or dry periods.

Water levels at wells MVWD-10, P-11, and C-10 are representative of groundwater-level trends in the central and northern portions of MZ1. From about 1995 to 2003, water levels generally declined in these areas due to increased production and relatively small volumes of wet water recharge in MZ1. From about 2003 to 2012 water levels increased in this area due to a decrease in production and an increase in artificial recharge to basins in the northern portion of MZ1. The changes in water levels in the central and northern portion of MZ1 since 2003 also coincide with a dry period, and the "put and take" cycle associated with Metropolitan Water District of Southern California's Dry Year Yield storage program in Chino Basin.

Water levels at well CH-16 are representative of groundwater-level trends in the deep, confined aquifer system in the southern portion of MZ1. Water levels at this well are influenced by pumping from nearby wells that are also screened within the deep aquifer system. During the 1990s, water levels at this well declined by up to 200 feet due to increased pumping from the deep aquifer system in this area. From 2000 to 2007, water levels at this well increased primarily due to decreased pumping from the deep aquifer system associated with the implementation of the MZ1 Subsidence Management Plan (WEI, 2007b), and have remained stable since.

Water levels at well CH-15A are representative of groundwater-level trends in the shallow, unconfined aquifer system in the southern portion of MZ1. Historically, water levels in CH-15A have been stable, from 80 to 90 ft-bgs, and showed only small fluctuations in response to nearby pumping. Since 2000, water levels have risen by about 15 feet, which is primarily due to a decrease in local pumping.

Since 2000, generally in MZ1 groundwater levels have increased, annual production has decreased, and annual artificial recharge to basins has increased. The time from 2000 to 2012 was a relatively dry period— as indicated by the CDFM precipitation plot.

Groundwater Levels at Wells (Perforated Interval Depth)

— MVWD 10 (540-1,084 ft-bgs)	— CH-16 (430-940 ft-bgs)
— P-11 (168-550 ft-bgs)	— CH-15A (190-310 ft-bgs)
— C-10 (350-1,090 ft-bgs)	

Production, Recharge, and Precipitation

🟦	Recharge of Imported Water and Recycled Water at Basins in MZ1
🟧	Groundwater Production from Wells in the MZ1
- - - -	CDFM Precipitation Plot - Data from PRISM 4-km grid for 1895-2012; Spatial Average for Chino Basin

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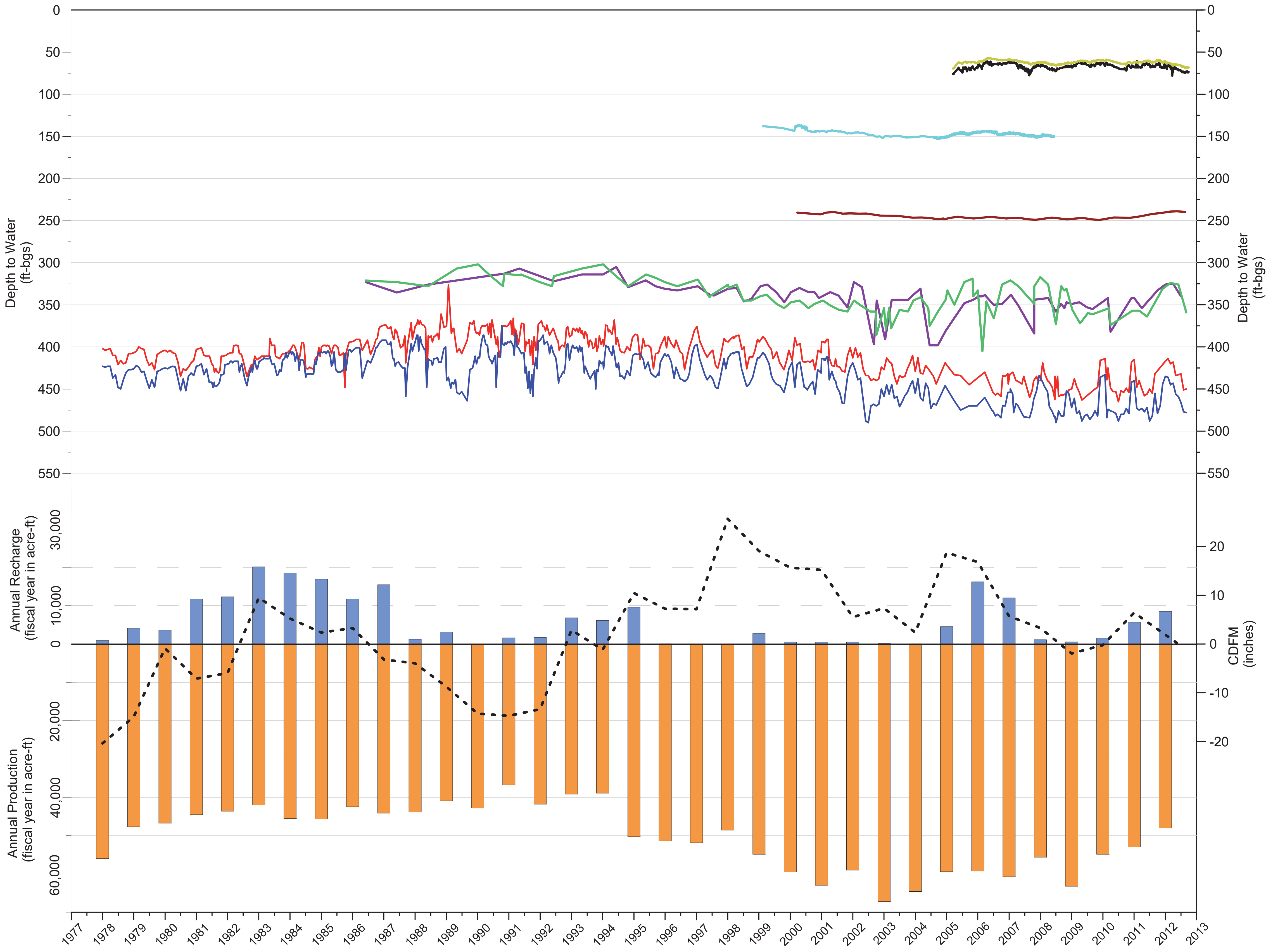
Date: 06/04/2013
File: Exhibit_24.grf

2012 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate – MZ1
1978 to 2012

Exhibit 24



This exhibit is a time-series chart that displays groundwater levels at wells, annual production, and annual artificial recharge to basins, in MZ2, for the time period since the Judgment to FY 2011/2012. Climate is displayed as CDFM precipitation plot using the PRISM data from 1895 to 2012. Upward sloping lines on the CDFM curve indicate wet years or wet periods. Downward sloping lines indicate dry years or dry periods.

Water levels at wells CVWD-3 and CVWD-5 are representative of groundwater-level trends in the northern portions of MZ2. Water levels increased from 1978 to about 1990— likely due to a combination of the 1978 to 1983 wet period, decreased production following the execution of the Judgment, and the initiation of artificial recharge of imported water in the San Sevaine and Etiwanda Basins. From 1990 to 2010, water levels in this portion on MZ2 have progressively declined by about 50 feet due to increased production in this region. From 2010 to 2012, water levels have remained relatively stable, likely due to a decreased production and increased recharge at the San Sevaine, and Victoria basins.

Water levels at wells O-29 and O-24 are representative of groundwater-level trends in the upper-central portion of MZ2. The water levels at O-29 and O-24 follow a similar pattern of decrease beginning in 1990 as the seen in wells in the northern portion of MZ2, however since 2010 water levels have increased 10 to 20 feet. This water level increase is prominent in Exhibit 19, which shows the change in groundwater elevation from spring 2010 to spring 2012. This increase is likely due to a decrease in production, and an increase in recharge at the Turner, San Sevaine, and Victoria basins.

Water level data at wells OW-11 and XRef 404 (private well) located in the lower-central portion of MZ2 are representative of trends in this region, which is south of the recharge basins, and north of the pumping influence of the Chino-I Desalter wells. From 2000 to 2012, water levels have remained stable, which indicates a relatively balance of recharge and discharge in this area of Chino Basin.

Water levels at wells HCMP-2/1 (shallow aquifer) and HCMP-2/2 (deep aquifer) are representative of groundwater-level trends at the southern portion of MZ2, just south of the Chino-I Desalter wells. One of the objectives of the desalter well field is to draw down water levels in the southern portion of Chino Basin to achieve Hydraulic Control. Chino-I Desalter well field began pumping in late 2000 and steadily increased in production till 2008. The water levels at HCMP-2/1 and HCMP-2/2 have remained relatively stable since the wells were constructed in 2005, which suggests that Hydraulic Control is not yet being achieved in this portion of the desalter well field.

Since 2000, generally in MZ2 groundwater levels have decreased or remained stable, annual production has decreased, and annual recharge to basins has increased. The time from 2000 to 2012 was a relatively dry period— as indicated by the CDFM precipitation plot.

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Groundwater Levels at Wells (Perforated Interval Depth)

- ― CVWD-5 (538-1,238 ft-bgs)
- ― CVWD-3 (341-810 ft-bgs)
- ― O-29 (400-1,095 ft-bgs)
- ― O-24 (484-952 ft-bgs)
- ― OW-11 (323-333 ft-bgs)
- ― X Ref 404 (274-354 ft-bgs)
- ― HCMP-2/2 (296-316 ft-bgs)
- ― HCMP-2/1 (124-164 ft-bgs)

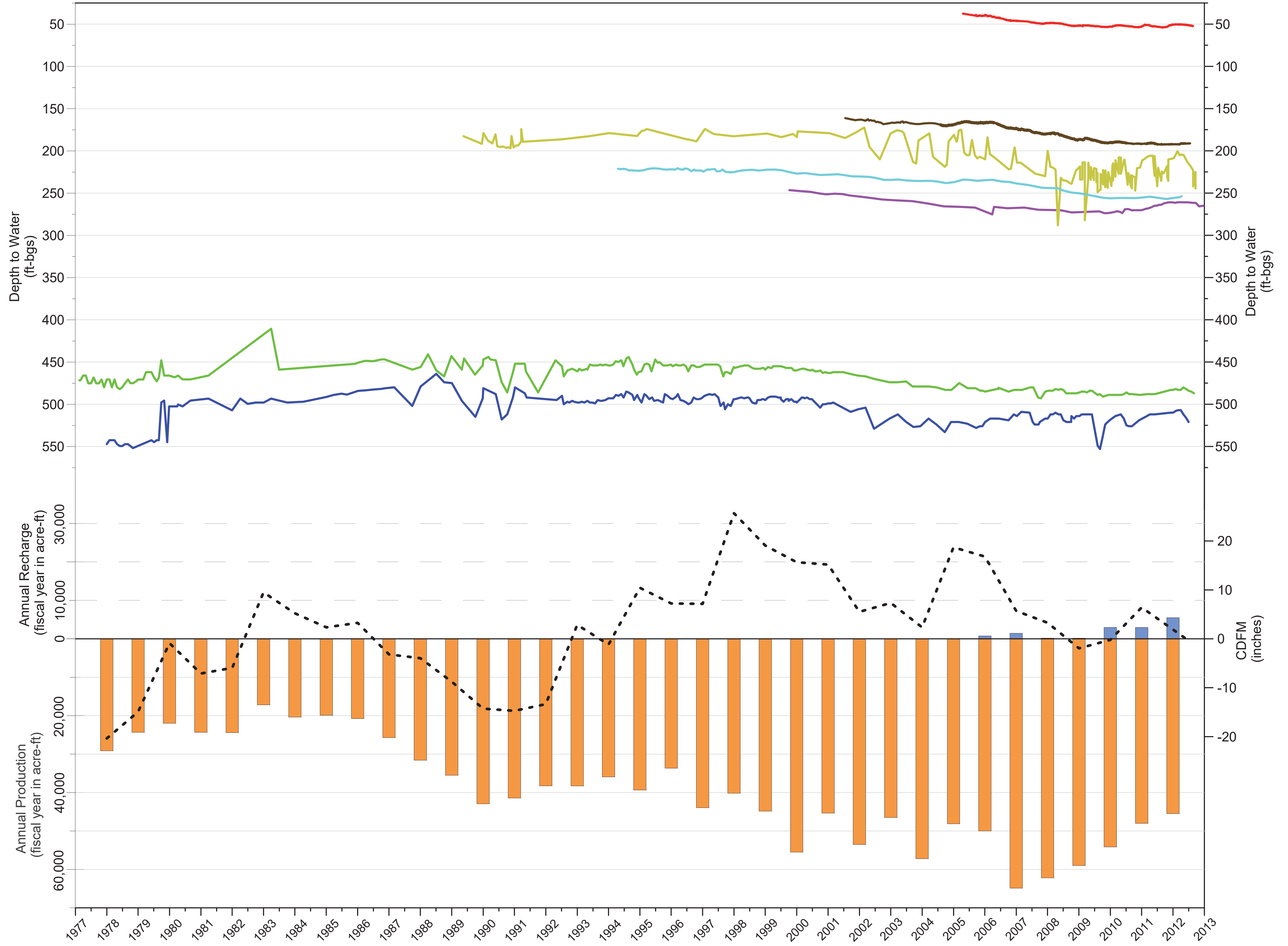
Production, Recharge, and Precipitation

- ▬ Recharge of Imported Water and Recycled Water at Basins in MZ2
- ▬ Groundwater Production from Wells in the MZ2
- - - - CDFM Precipitation Plot - Data from PRISM 4-km grid for 1895-2012; Spatial Average for Chino Basin

2012 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate – MZ2
1978 to 2012

Exhibit 25



This exhibit is a time-series chart that displays groundwater levels at wells, annual production, and annual artificial recharge to basins, in MZ3, for the time period since the Judgment to FY 2011/2012. Climate is displayed as CDFM precipitation plot using the PRISM data from 1895 to 2012. Upward sloping lines on the CDFM curve indicate wet years or wet periods. Downward sloping lines indicate dry years or dry periods.

Water levels at wells F-30A and F-3A are representative of groundwater-level trends in the northeastern portions of MZ3. Water levels were relatively stable from 1978 to about 1995. From 1995 to 2007, water levels declined by approximately 25-30 feet due to a dry climatic period and increased pumping in MZ3. Since 2010, water levels have remained relatively stable.

Water levels at wells Offsite MW4, Mill M-06B, JCSD-14, and XRef 425 (private well) are representative of groundwater-level trends in the central portion of MZ3. From about 1998 to 2010, water levels at these wells progressively declined by about 30 feet due to a dry climatic period and increased pumping in MZ3. From 2010 to 2012 water levels at Mill M-06B, JCSD-14, and XRef 425 have remained relatively stable, and water levels at Offsite MW4 have increased by about 10 feet from 2010 to 2012. The water level increase seen at Offsite MW4 is likely due to improvements to, and the increase of, the recharge of storm water and recycled water at the RP3 recharge basins.

Water levels at well HCMP-7/1 are representative of groundwater-level trends in the southernmost portion of MZ3—just south of the Chino-II Desalter well field and just north of the Santa Ana River. From 2006 to 2012, water levels at this well progressively declined by about 12 feet. This drawdown is mainly due to pumping at the Chino-II Desalter and is necessary for Hydraulic Control to be achieved in this portion of the Chino Basin; and to enhance recharge of the Santa Ana River. See Exhibits 21 and 22 for further explanation of Hydraulic Control.

Since 2000, generally in MZ3 groundwater levels have decreased, annual production has increased, and annual recharge has increased. The time from 2000 to 2012 was a relatively dry period— as indicated by the CDFM precipitation plot.

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Groundwater Levels at Wells (Perforated Interval Depth)

- ▬ F-30A (507-864 ft-bgs)
- ▬ F-3A (380-854 ft-bgs)
- ▬ Offsite MW4 (222-282 ft-bgs)
- ▬ M-06B (255-275 ft-bgs)
- ▬ JCSD-14 (210-370 ft-bgs)
- ▬ XRef 425 (no perf data)
- ▬ HCMP-7/1 (70-110 ft-bgs)

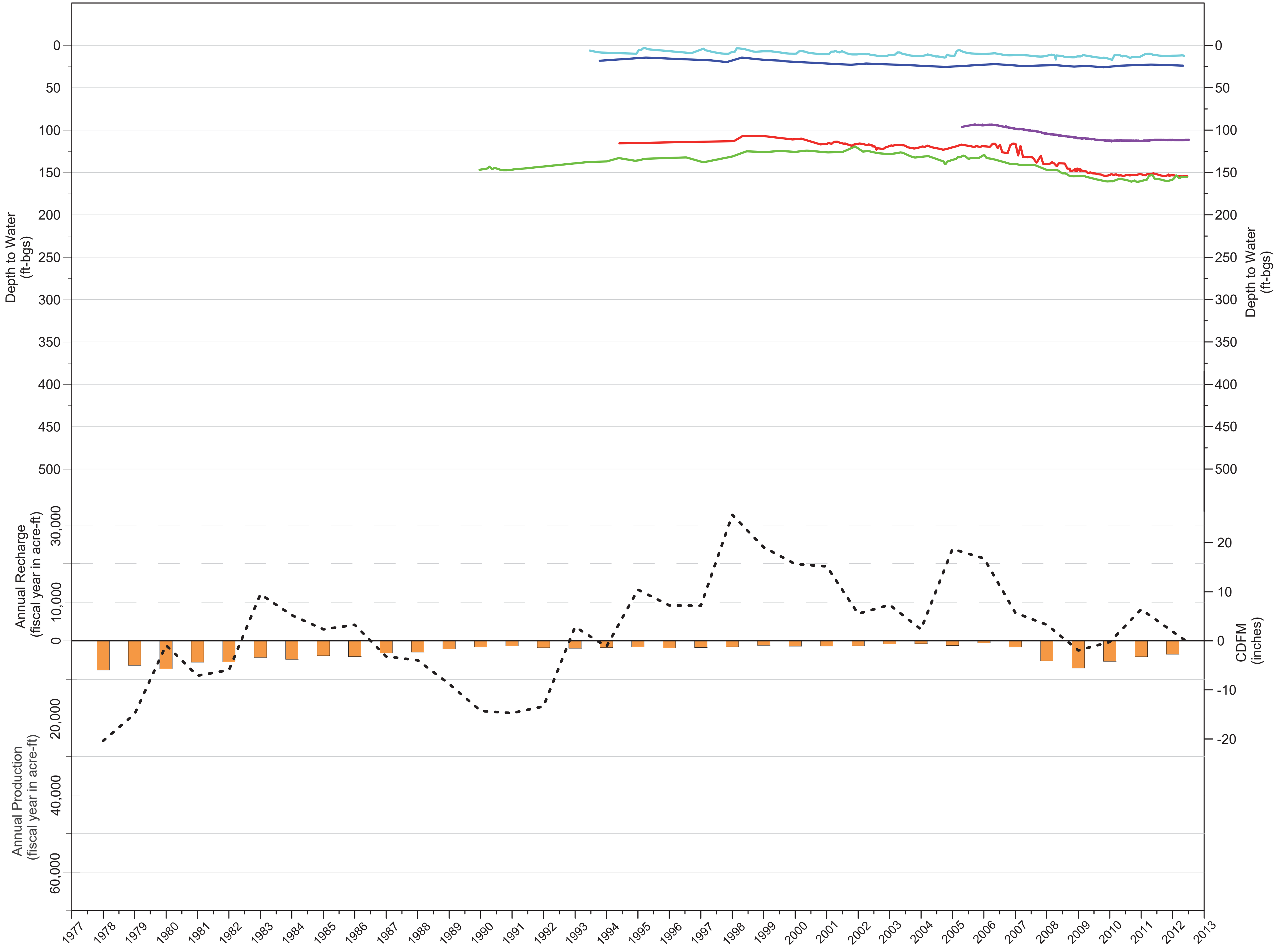
Production, Recharge, and Precipitation

- 🟦 Recharge of Imported Water and Recycled Water at Basins in MZ3
- 🟧 Groundwater Production from Wells in the MZ3
- - - - CDFM Precipitation Plot - Data from PRISM 4-km grid 1895-2012; Spatial Average for Chino Basin

2012 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate – MZ3
1978 to 2012

Exhibit 26



This exhibit is a time-series chart that displays groundwater levels at wells, annual production, and annual artificial recharge to basins, in MZ4, for the time period since the Judgment to FY 2011/2012. Climate is displayed as CDFM precipitation plot using the PRISM data from 1895 to 2012. Upward sloping lines on the CDFM curve indicate wet years or wet periods, and downward sloping lines indicate dry years or dry periods.

Water levels at wells JCSD-10, XRef 4513 (private well), and HCMP-9/1 are representative of groundwater-level trends in the western portion of MZ4—in the vicinity of the major well fields of the Jurupa Community Services District (JCSD) and the Chino-II Desalter. Water levels at JCSD-10 and XRef 4513 began to decrease around 2000, and show a notable acceleration in drawdown around 2006 when pumping at Chino-II Desalter wells commenced. A similar decrease is seen in HCMP-9/1, where water levels decreased by about 18 feet since the wells construction in 2005. Overall in this portion of MZ4, water levels have decreased by about 35 feet since 2000, due to a dry climatic period and increased pumping. The drawdown seen at the wells in the eastern portion of MZ4, is necessary for Hydraulic Control to be achieved in this portion of the Chino Basin. See Exhibits 21 and 22 for further explanation of Hydraulic Control. The drawdown in this area is also a concern of JCSD with regard to the production sustainability at their wells.

Water levels at wells FC-752A2 and FC-932A2 are representative of groundwater-level trends in the eastern portion of MZ4. From 2000 to 2012 the water levels at these wells have remained relatively stable.

Since 2000, generally in MZ4 groundwater levels have decreased, and annual production has increased. The time from 2000 to 2012 was a relatively dry period— as indicated by the CDFM precipitation plot.

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Groundwater Levels at Wells (Perforated Interval Depth)

- — JCSD-10 (no perf data)
- — XRef 4513 (no perf data)
- — HCMP-9/1 (110-150 ft-bgs)
- — FC-752A2 (no perf data)
- — FC-932A2 (no perf data)

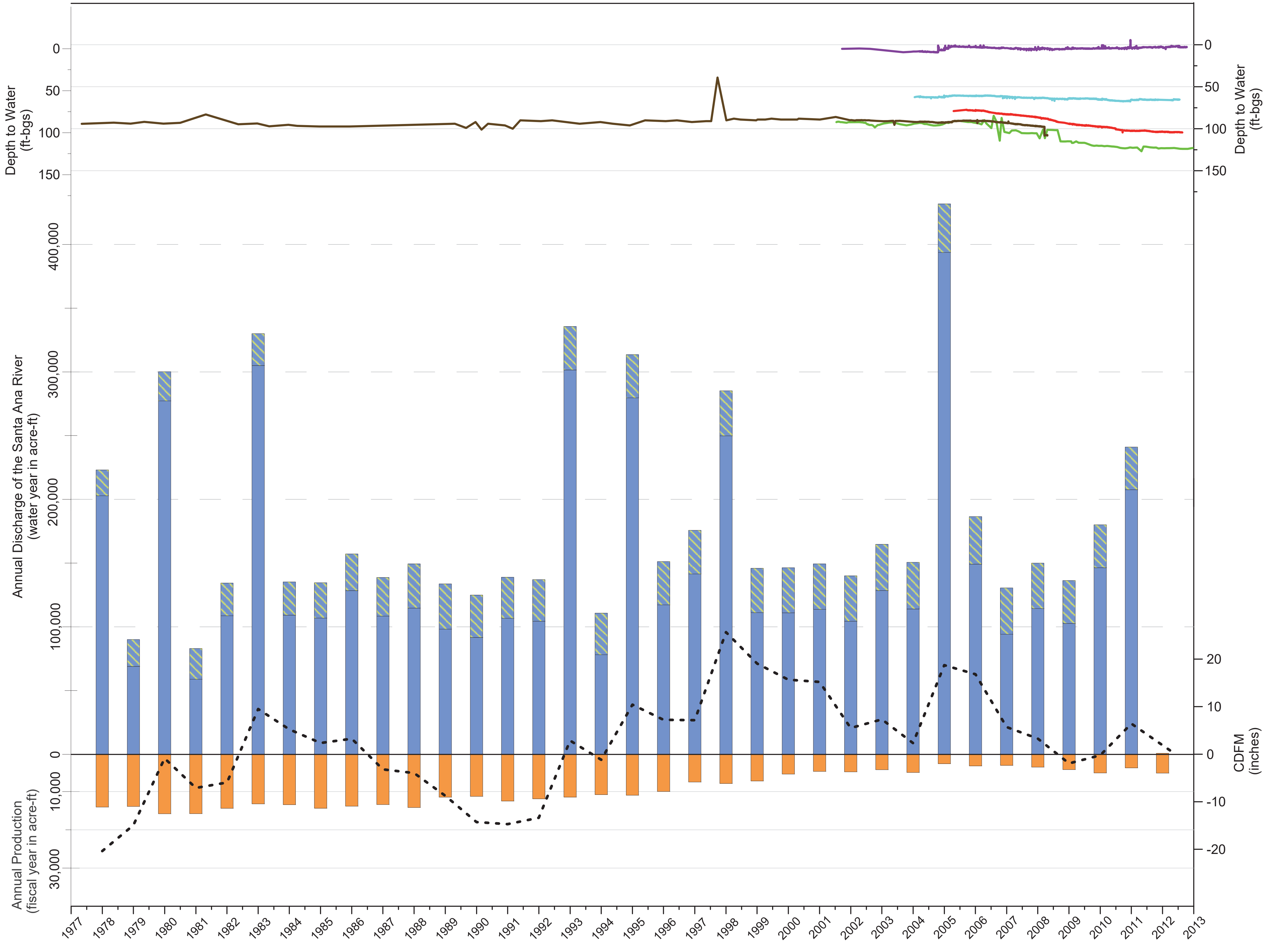
Production, Recharge, and Precipitation

- 🟦 Recharge of Imported Water and Recycled Water at Basins in MZ4
- 🟧 Groundwater Production from Wells in the MZ4
- - - - CDFM Precipitation Plot - Data from PRISM 4-km grid for 1895-2012; Spatial Average for Chino Basin

2012 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate – MZ4
1978 to 2012

Exhibit 27



This exhibit is a time-series chart that displays groundwater levels and annual production at wells in MZ5, and annual discharge of the Santa Ana River through MZ5, for the time period since the Judgment to FY 2011/2012. Total discharge of the Santa Ana River through the MZ5 area is represented by the total flow measured by the USGS at the *SAR at MWD Xing* station, and the total effluent discharged to the Santa Ana River from the City of Riverside's WWTP. MZ5 is a groundwater flow system that parallels the Santa Ana River. The discharge of the Santa Ana River shown in this chart represents the total potential volume of Santa Ana River water that can recharge the Chino Basin in MZ5. Climate is displayed as CDFM precipitation plot using the PRISM data from 1895 to 2012. Upward sloping lines on the CDFM curve indicate wet years or wet periods. Downward sloping lines indicate dry years or dry periods.

Water levels at wells XRef 4802 (private well), SARWC-07, SARWC-11, and HCMP-8/1 are representative of groundwater levels in the eastern portion of MZ5 where the Santa Ana River is recharging the Chino Basin. From 2005 to 2012, water levels at these wells have progressively declined by about five to 25 feet. This drawdown is consistent with increased pumping at the desalter wells and is a necessary occurrence to achieve Hydraulic Control in this portion of the Chino Basin. This drawdown also indicates that recharge of the Santa Ana River is being enhanced in this vicinity. See Exhibits 21 and 22 for further explanation of Hydraulic Control.

Water levels at the Archibald 1 well are representative of groundwater levels in the southwestern portion of MZ5, where groundwater is very near the ground surface and could be rising to become flow in the Santa Ana River. Water levels at this near-river well have remained relatively stable since monitoring began in 2000.

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Groundwater Levels at Wells (Perforated Interval Depth)

— XRef 4802 (no perf data)
— SARWC-07 (100-172 ft-bgs)
— HCMP-8/1 (75-115 ft-bgs)
— SARWC-11 (75-230 ft-bgs)
— Archibald 1(75-85 ft-bgs)

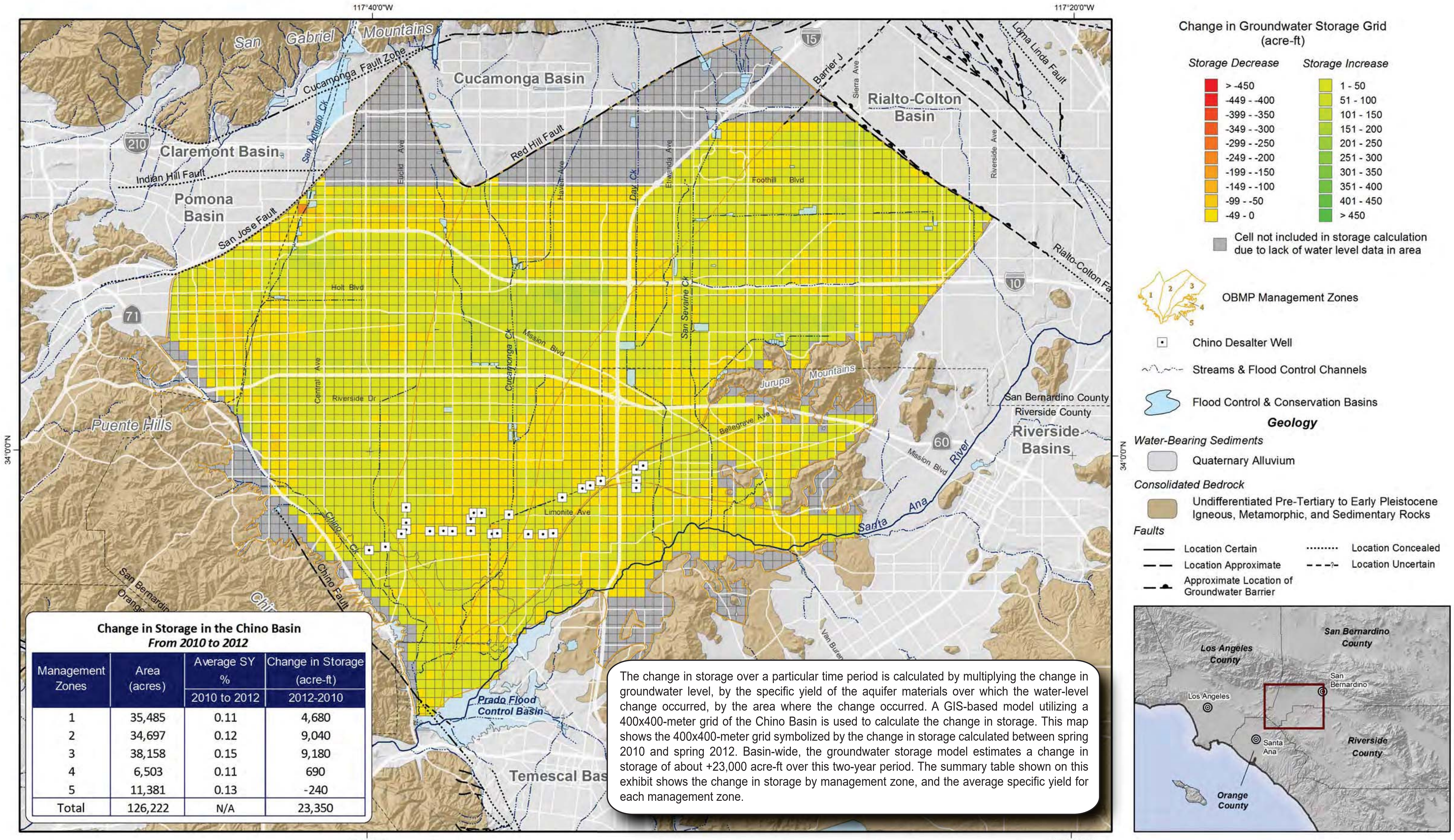
Production, Recharge, and Precipitation

■ Flow of the Santa Ana River at MWD *Xing*
▨ Discharge from the City of Riverside WWTP
■ Groundwater Production from Wells in the MZ5
- - - CDFM Precipitation Plot - Data from PRISM 4-km grid
for 1895-2012; Spatial Average for Chino Basin

2012 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels,
Production, Recharge, and Climate – MZ5
1978 to 2012

Exhibit 28



Change in Storage in the Chino Basin
From 2010 to 2012

Management Zones	Area (acres)	Average SY %	Change in Storage (acre-ft)
		2010 to 2012	2012-2010
1	35,485	0.11	4,680
2	34,697	0.12	9,040
3	38,158	0.15	9,180
4	6,503	0.11	690
5	11,381	0.13	-240
Total	126,222	N/A	23,350

The change in storage over a particular time period is calculated by multiplying the change in groundwater level, by the specific yield of the aquifer materials over which the water-level change occurred, by the area where the change occurred. A GIS-based model utilizing a 400x400-meter grid of the Chino Basin is used to calculate the change in storage. This map shows the 400x400-meter grid symbolized by the change in storage calculated between spring 2010 and spring 2012. Basin-wide, the groundwater storage model estimates a change in storage of about +23,000 acre-ft over this two-year period. The summary table shown on this exhibit shows the change in storage by management zone, and the average specific yield for each management zone.

0 1 2 3 4 5 Miles

0 2 4 6 8 KM

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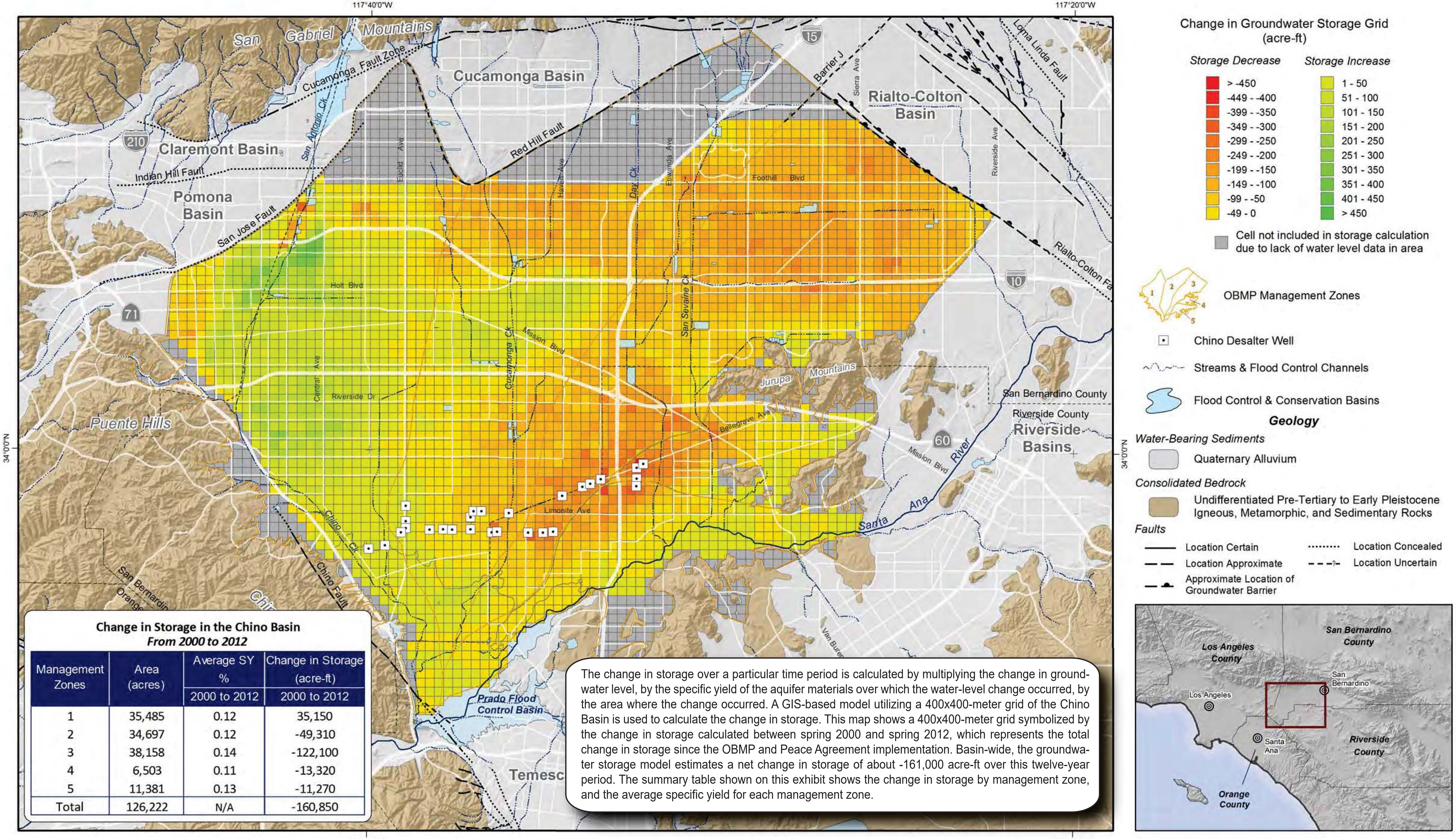
2012 State of the Basin
Groundwater Levels

Change in Groundwater Storage

Spring 2010 to Spring 2012

Exhibit 29



Change in Storage in the Chino Basin
From 2000 to 2012

Management Zones	Area (acres)	Average SY %	Change in Storage (acre-ft)
		2000 to 2012	2000 to 2012
1	35,485	0.12	35,150
2	34,697	0.12	-49,310
3	38,158	0.14	-122,100
4	6,503	0.11	-13,320
5	11,381	0.13	-11,270
Total	126,222	N/A	-160,850

The change in storage over a particular time period is calculated by multiplying the change in groundwater level, by the specific yield of the aquifer materials over which the water-level change occurred, by the area where the change occurred. A GIS-based model utilizing a 400x400-meter grid of the Chino Basin is used to calculate the change in storage. This map shows a 400x400-meter grid symbolized by the change in storage calculated between spring 2000 and spring 2012, which represents the total change in storage since the OBMP and Peace Agreement implementation. Basin-wide, the groundwater storage model estimates a net change in storage of about -161,000 acre-ft over this twelve-year period. The summary table shown on this exhibit shows the change in storage by management zone, and the average specific yield for each management zone.

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2012 State of the Basin
Groundwater Levels

Change in Groundwater Storage

Spring 2000 to Spring 2012

Exhibit 30

The exhibits in this section show the physical state of the Chino Basin with respect to groundwater quality, using data from the Chino Basin groundwater quality monitoring programs.

Prior to OBMP implementation, historical water quality data were obtained from the California Department of Water Resources (DWR) and supplemented with data from some producers in the Appropriative Pool and data from the State of California Department of Public Health (CDPH) database. As part of the OBMP implementation *Program Element 1 – Develop and Implement a Comprehensive Monitoring Program,* Watermaster began conducting a more robust water quality monitoring program. The Groundwater Quality Monitoring Program relies on well owners or their consultants to sample for water quality and provide that data to Watermaster on a routine cooperative basis, and Watermaster than supplements with data obtained through their own sampling programs. Watermaster obtains groundwater quality in the Chino Basin through the following programs:

- **Annual Key Well Groundwater Quality Monitoring Program.** Historically, water quality data were very limited for the private wells in the southern portion of the Basin. In 1999, the comprehensive monitoring program initiated the systematic sampling of private wells south of State Route 60 in the Chino Basin. Over a three-year period from 1999 to 2001, Watermaster sampled all available wells at least twice to develop a robust baseline dataset. This program has since been reduced to approximately 120 key wells, located predominantly in the southern portion of the Basin: 100 wells are sampled on a triennial basis, and 20 are sampled on an annual basis.

- **HCMP Sampling.** Watermaster collects groundwater quality samples from the nine nested HCMP monitoring wells to demonstrate whether Hydraulic Control is being achieved. Each nest contains up to three wells in the borehole. 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 US Geological Survey (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).

- **Chino Basin Data Collection (CBDC).** Watermaster routinely and proactively collects groundwater quality data from well owners, such as 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 RWQCB (landfills, groundwater quality investigations, *etc.*), the Department of Toxic Substances Control (DTSC) for the Stringfellow National Priorities List (NPL) site, the USGS, and others. These data are collected from the well owners and monitoring entities twice per year.

All groundwater quality data are checked by Watermaster staff and uploaded to a centralized database management system that can be accessed online through HydroDaVE^{SM}. Groundwater quality data collected by Watermaster are used for: this biennial State of the Basin report; the triennial ambient water quality update mandated by the Water Quality Control Plan for the Santa Ana River Basin (Region 8) (Basin Plan); the demonstration of Hydraulic Control—a maximum benefit commitment in the Basin Plan; and other uses. Data are also used for monitoring nonpoint source groundwater contamination and plumes associated with point source discharges and to assess the overall health of the groundwater basin. Groundwater quality data are also used in conjunction with numerical models to assist Watermaster and other parties in evaluating proposed groundwater remediation strategies.

Exhibit 31 shows all wells with groundwater quality monitoring results for the five-year period from July 2007 to June 2012—the period prior to the 2012 SOB analysis date of June 30, 2012. All available groundwater quality data for this period were analyzed synoptically and temporally at all the production and monitoring wells. Hence, the data do not represent a programmatic investigation of potential sources nor do they represent a randomized study that was designed to ascertain the water quality status of the Chino Basin. These data do, however, represent the most comprehensive information available to date.

All groundwater quality data for the five-year period from July 2007 through June 2012 in the Chino Basin were analyzed for any exceedances of Primary or Secondary, Federal or State, Maximum Contaminant Levels (MCLs), or State Notification Levels (NLs). Wells with constituent concentrations greater than half the MCL represent areas that warrant concern and inclusion into a long-term monitoring program. Understanding the spatial distribution of wells with concentrations greater than regulatory standards is important because it indicates areas in the Basin where groundwater may be impaired from a beneficial use standpoint. Exhibits 32 through 43 show the areal distribution of constituents of potential concern (COPC) in the Chino Basin. The COPCs in the Chino Basin are defined as follows:

- Constituents associated with salt and nutrient management planning, which are primarily total dissolved solids (TDS), nitrate as nitrogen (NO_3-N).
- Other constituents where a primary MCL was exceeded in twenty or more wells from July 2007 to June 2012 and are not exclusive to one particular known-point source (*i.e.*, the Stringfellow National Priorities List [NPL or Superfund] Site), which include TDS, NO_3-N, perchlorate, total chromium, arsenic, trichloroethene (TCE), tetrachloroethene (PCE), *cis*-1,2-dichloroethene (*cis*-1,2DCE), and 1,1-dichloroethene (1,1-DCE).
- Constituents for which the CDPH is in the process of developing an MCL that may impact future beneficial use of groundwater, which include hexavalent chromium and 1,2,3-trichloropropane (1,2,3-TCP).

The water quality standards exceedances are noted on the exhibits, the maximum concentration value for each well is plotted. The following class interval convention is applied to each water quality map:

Symbol	Class Interval
○	Not Detected
🔵	<0.5x WQS[3], but detected
🟢	0.5x WQS to WQS
🟡	WQS to 2x WQS
🟠	2x WQS to 4x WQS
🔴	> 4x WQS

Exhibit 44 shows the locations of various known point-source discharges to groundwater and associated areas of degradation. Understanding point sources of concern in the Chino Basin is critical to the overall management of groundwater quality. To ensure that Chino Basin groundwater remains a sustainable resource,

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[3] Where WQS is the appropriate water quality standard.

Watermaster must closely monitor point-source discharges and emerging contaminates of concern. Watermaster works closely with the RWQCB and the potentially responsible parties (PRPs) within the Chino Basin. The following is a summary of all the regulatory and voluntary contamination monitoring in the Chino Basin that are currently known to Watermaster:

- **Plume:** Alumax Aluminum Recycling Facility
  Constituents of Concern: TDS, sulfate, nitrate, chloride
  Order: RWQCB Cleanup and Abatement Order 99-38

- **Plume:** Archibald South Plume – South of Ontario Airport
  Constituents of Concern: volatile organic chemicals (VOCs)
  Order: This plume is currently being voluntarily investigated by a group of potentially responsible parties per seven Draft Cleanup and Abatement Orders

- **Plume:** Chino Airport
  Constituents of Concern: VOCs
  Order: RWQCB Cleanup and Abatement Order 90-134

- **Plume:** California Institute for Men (No Further Action status, as of 2/17/2009)
  Constituents of Concern: VOCs
  Order: Voluntary Cleanup and Monitoring

- **Plume:** Former Crown Coach International Facility
  Constituents of Concern: VOCs and Solvents
  Order: Voluntary Cleanup and Monitoring

- **Plume:** General Electric Flatiron Facility
  Constituents of Concern: VOCs and hexavalent chromium
  Order: Voluntary Cleanup and Monitoring

- **Plume:** General Electric Test Cell Facility
  Constituents of Concern: VOCs
  Order: Voluntary Cleanup and Monitoring

- **Plume:** Former Kaiser Steel Mill
  Constituents of Concern: TDS, total organic carbon (TOC), VOCs
  Order: RWQCB Order No. 91-40 Closed. Kaiser granted capacity in the Chino II Desalter to remediate.

- **Plume:** Former Kaiser Steel Mill – CCG Property
  Constituents of Concern: chromium, hexavalent chromium, other metals, VOCs
  Order: DTSC Consent Order 00/01-001

- **Plume:** Milliken Sanitary Landfill
  Constituents of Concern: VOCs
  Order: RWQCB Order No. 81-003

- **Plume:** Upland Sanitary Landfill
  Constituents of Concern: VOCs
  Order RWQCB Order No 98-99-07

- **Plume:** Stringfellow National Priorities List (NPL) Site
  Constituents of Concern: VOCs, perchlorate, N-nitrosodimethylamine (NDMA), trace metals
  Order: The Stringfellow Site is the subject of US Environmental Protection Agency (EPA) Records of Decision (RODs): EPA/ROD/R09-84/007, EPA/ROD/R09-83/005, EPA/ROD/R09-87/016, and EPA/ROD/R09-90/048.

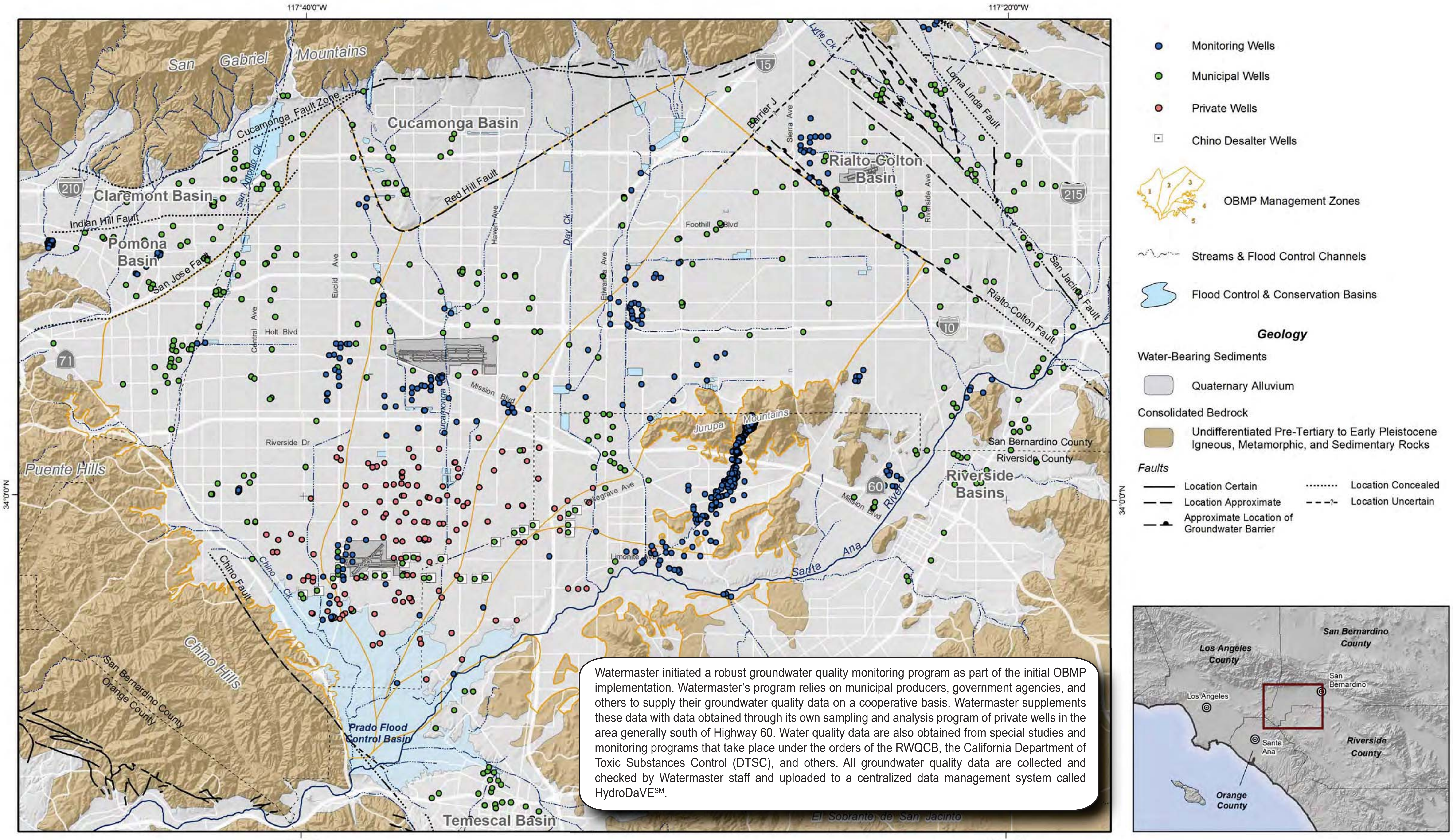
- **Plume:** Alger Manufacturing Co.
  Constituents of Concern: VOCs
  Order: Voluntary Cleanup and Monitoring

Groundwater quality data collected from Watermaster's sampling programs, from other special studies, and from monitoring in the Basin under the orders of the RWQCB or DTSC are used by Watermaster to delineate plumes associated with VOC contamination every two years. Exhibit 44 shows the extent of contamination associated with the VOC plumes as of July 2012. The VOC plumes illustrate the estimated spatial extent of TCE or PCE, depending on the main constituent of concern. The methods employed to create these depictions are described on each exhibit. Exhibits 45 and 46 show more detailed delineations of the Chino Airport plume and the Archibald South plume, respectively. Because the extensive multi-depth groundwater quality monitoring completed over the last five years in the Chino Airport region, Exhibit 45 shows Chino Airport plume delineation in the shallow and deep aquifers.

Exhibit 47 shows the VOC plumes and features pie charts that display the relative percent of TCE, PCE, and other VOCs detected at groundwater wells within the plume impacted areas. The pie charts demonstrate the chemical differentiation between the VOC plumes in the southern portion of Chino Basin.

The remaining exhibits in this section display the overall state of groundwater quality in the Basin with respect to TDS and nitrate concentrations. Exhibits 48 and 49 show trends in the ambient water quality determinations for TDS and NO_3-N by management zone and the associated anti-degradation and maximum benefit water quality objectives. The maximum benefit objectives established in the 2004 Basin Plan Amendment (RWQCB, 2004) raised the TDS and NO_3-N objectives for the Chino-North Management Zone (combined MZ1, MZ2, and MZ3). These "maximum benefit" water quality objectives were based on the additional consideration of factors specified in California Water Code Section 13241 and the requirements of the State's Antidegradation Policy (SWRCB Resolution No. 68-16), which requires a demonstration that the change in the objective will be "[…] consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies." The application of the maximum-benefit objectives is contingent upon the implementation of specific projects and programs by Watermaster and IEUA. These projects and programs, termed the "Chino Basin maximum-benefit commitments," are described in the Maximum Benefit Implementation Plan for Salt Management in the Basin Plan. The maximum benefit objectives have allowed for more efficient and pragmatic water supply planning and salt/nutrient management.

Exhibits 50 through Exhibit 57 show TDS and NO_3-N time histories for selected wells from 1970 to 2012. These time histories illustrate water quality variations and trends within each management zone and the current state of water quality compared to those historical trends. The wells were selected based on location, length of record, quality of data, geographical distribution, and screened intervals. Wells are identified by their local name (usually owner abbreviation and well number) or X Reference ID (XRef) if privately owned. The time histories also display the CDPH MCL.



Watermaster initiated a robust groundwater quality monitoring program as part of the initial OBMP implementation. Watermaster's program relies on municipal producers, government agencies, and others to supply their groundwater quality data on a cooperative basis. Watermaster supplements these data with data obtained through its own sampling and analysis program of private wells in the area generally south of Highway 60. Water quality data are also obtained from special studies and monitoring programs that take place under the orders of the RWQCB, the California Department of Toxic Substances Control (DTSC), and others. All groundwater quality data are collected and checked by Watermaster staff and uploaded to a centralized data management system called HydroDaVE^{SM}.

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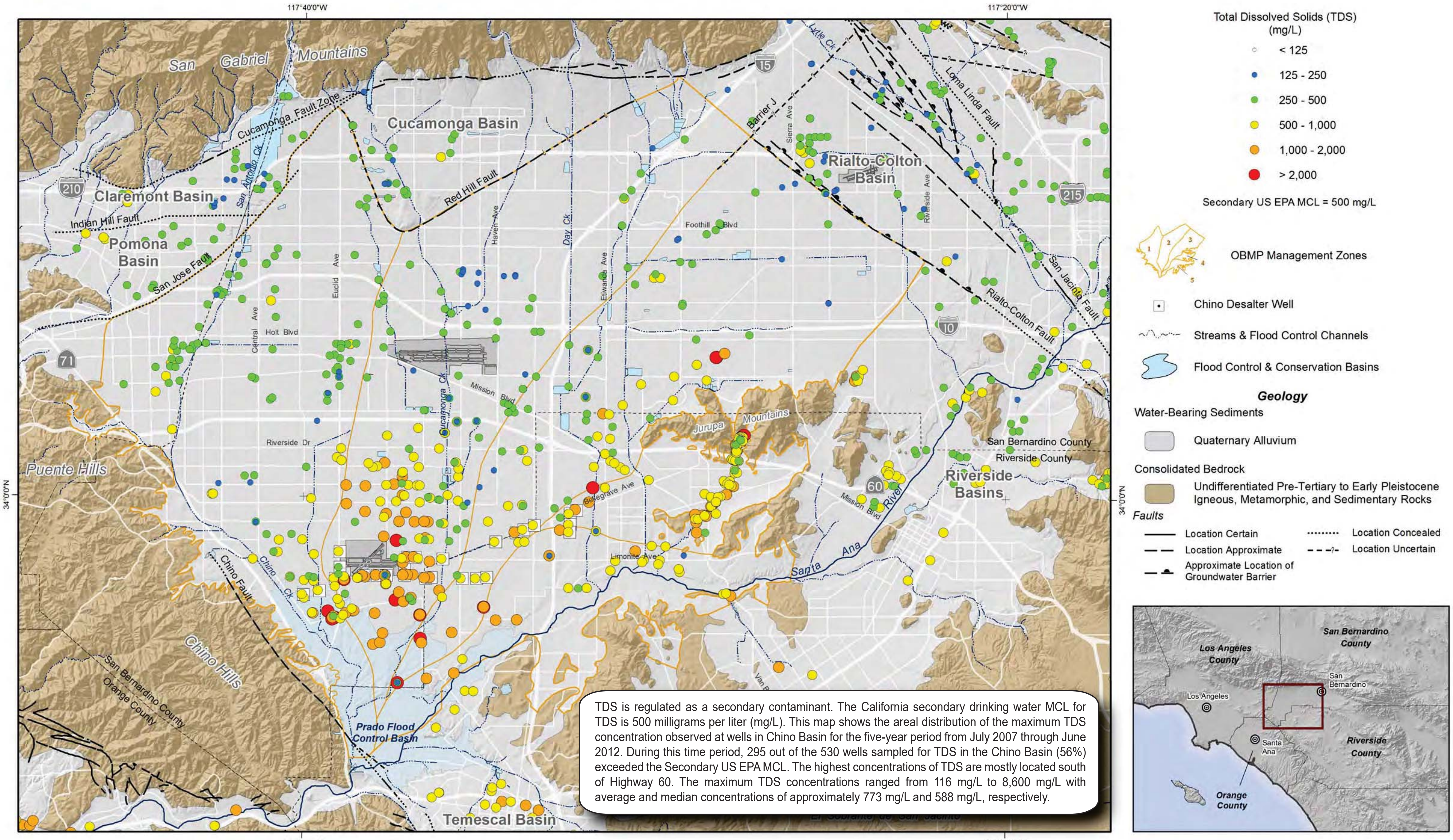
File: Exhibit_31.mxd

2012 State of the Basin
Groundwater Quality

Wells with Groundwater Quality Data

July 2007 to June 2012

Exhibit 31



TDS is regulated as a secondary contaminant. The California secondary drinking water MCL for TDS is 500 milligrams per liter (mg/L). This map shows the areal distribution of the maximum TDS concentration observed at wells in Chino Basin for the five-year period from July 2007 through June 2012. During this time period, 295 out of the 530 wells sampled for TDS in the Chino Basin (56%) exceeded the Secondary US EPA MCL. The highest concentrations of TDS are mostly located south of Highway 60. The maximum TDS concentrations ranged from 116 mg/L to 8,600 mg/L with average and median concentrations of approximately 773 mg/L and 588 mg/L, respectively.

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Date: 20121005
File: Exhibit_32.mxd

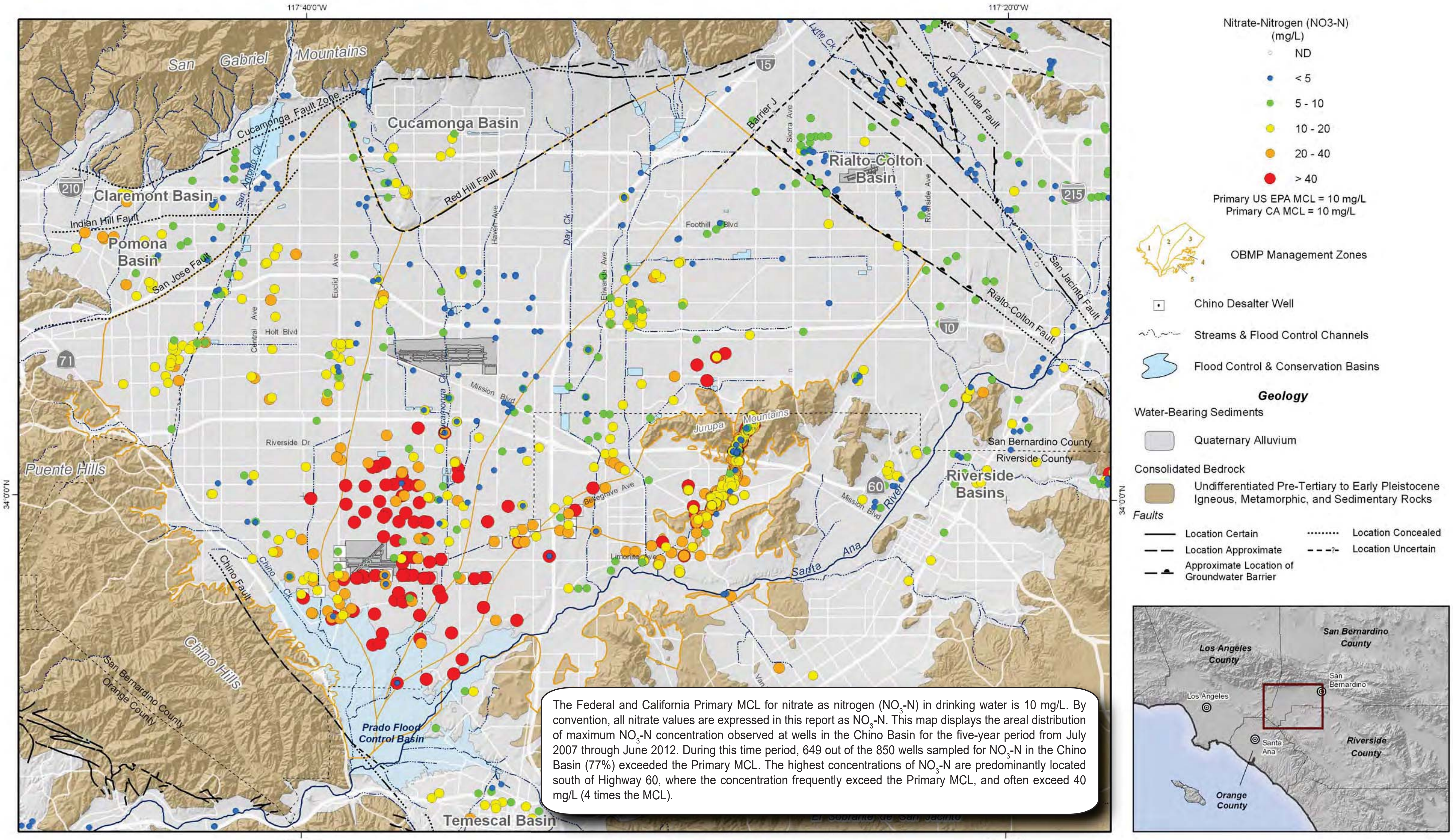
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

Total Dissolved Solids (TDS) in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 32



The Federal and California Primary MCL for nitrate as nitrogen (NO_3-N) in drinking water is 10 mg/L. By convention, all nitrate values are expressed in this report as NO_3-N. This map displays the areal distribution of maximum NO_3-N concentration observed at wells in the Chino Basin for the five-year period from July 2007 through June 2012. During this time period, 649 out of the 850 wells sampled for NO_3-N in the Chino Basin (77%) exceeded the Primary MCL. The highest concentrations of NO_3-N are predominantly located south of Highway 60, where the concentration frequently exceed the Primary MCL, and often exceed 40 mg/L (4 times the MCL).

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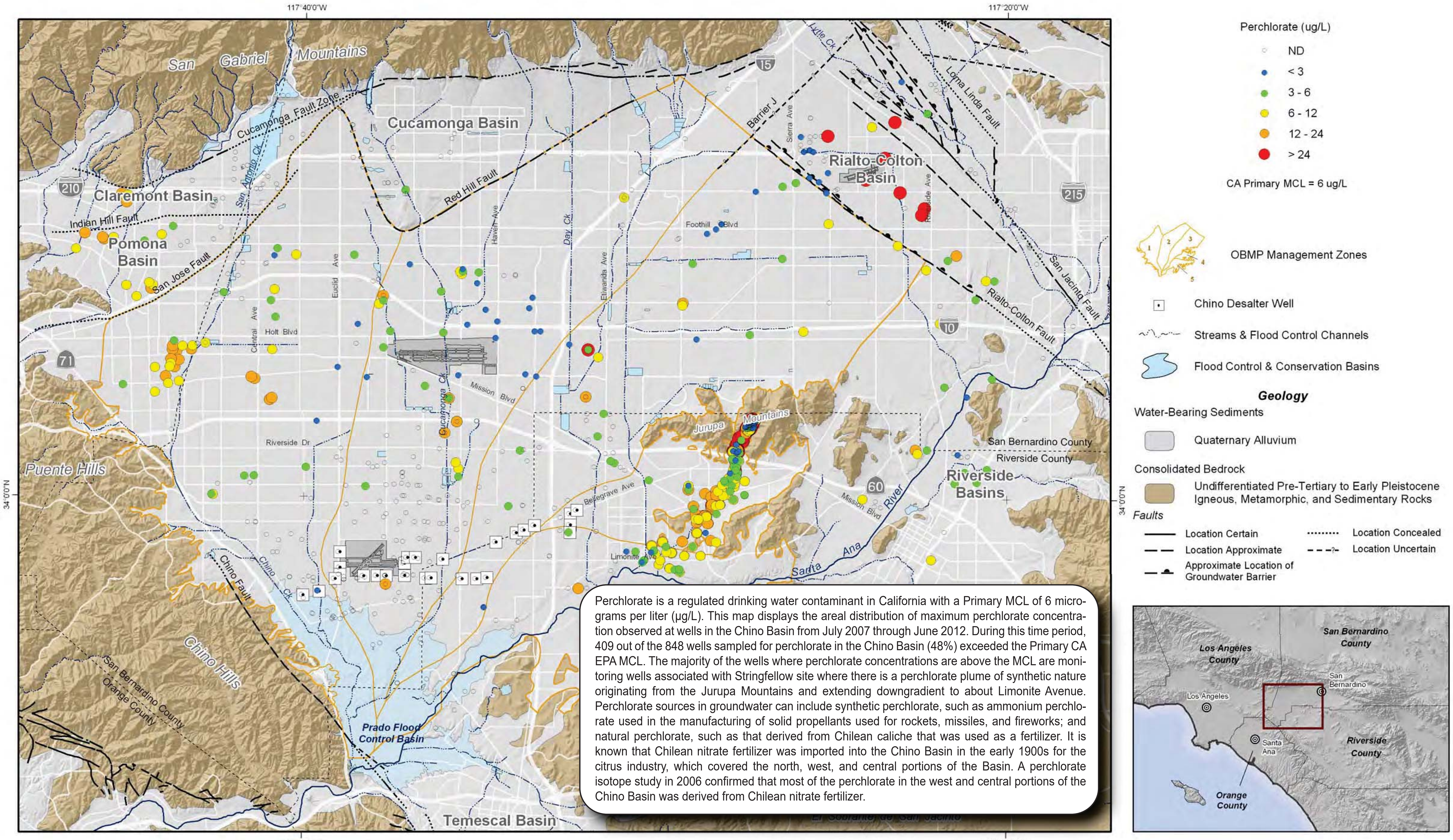
2012 State of the Basin
Groundwater Quality

Nitrate as Nitrogen in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 33



Perchlorate is a regulated drinking water contaminant in California with a Primary MCL of 6 micrograms per liter (µg/L). This map displays the areal distribution of maximum perchlorate concentration observed at wells in the Chino Basin from July 2007 through June 2012. During this time period, 409 out of the 848 wells sampled for perchlorate in the Chino Basin (48%) exceeded the Primary CA EPA MCL. The majority of the wells where perchlorate concentrations are above the MCL are monitoring wells associated with Stringfellow site where there is a perchlorate plume of synthetic nature originating from the Jurupa Mountains and extending downgradient to about Limonite Avenue. Perchlorate sources in groundwater can include synthetic perchlorate, such as ammonium perchlorate used in the manufacturing of solid propellants used for rockets, missiles, and fireworks; and natural perchlorate, such as that derived from Chilean caliche that was used as a fertilizer. It is known that Chilean nitrate fertilizer was imported into the Chino Basin in the early 1900s for the citrus industry, which covered the north, west, and central portions of the Basin. A perchlorate isotope study in 2006 confirmed that most of the perchlorate in the west and central portions of the Chino Basin was derived from Chilean nitrate fertilizer.

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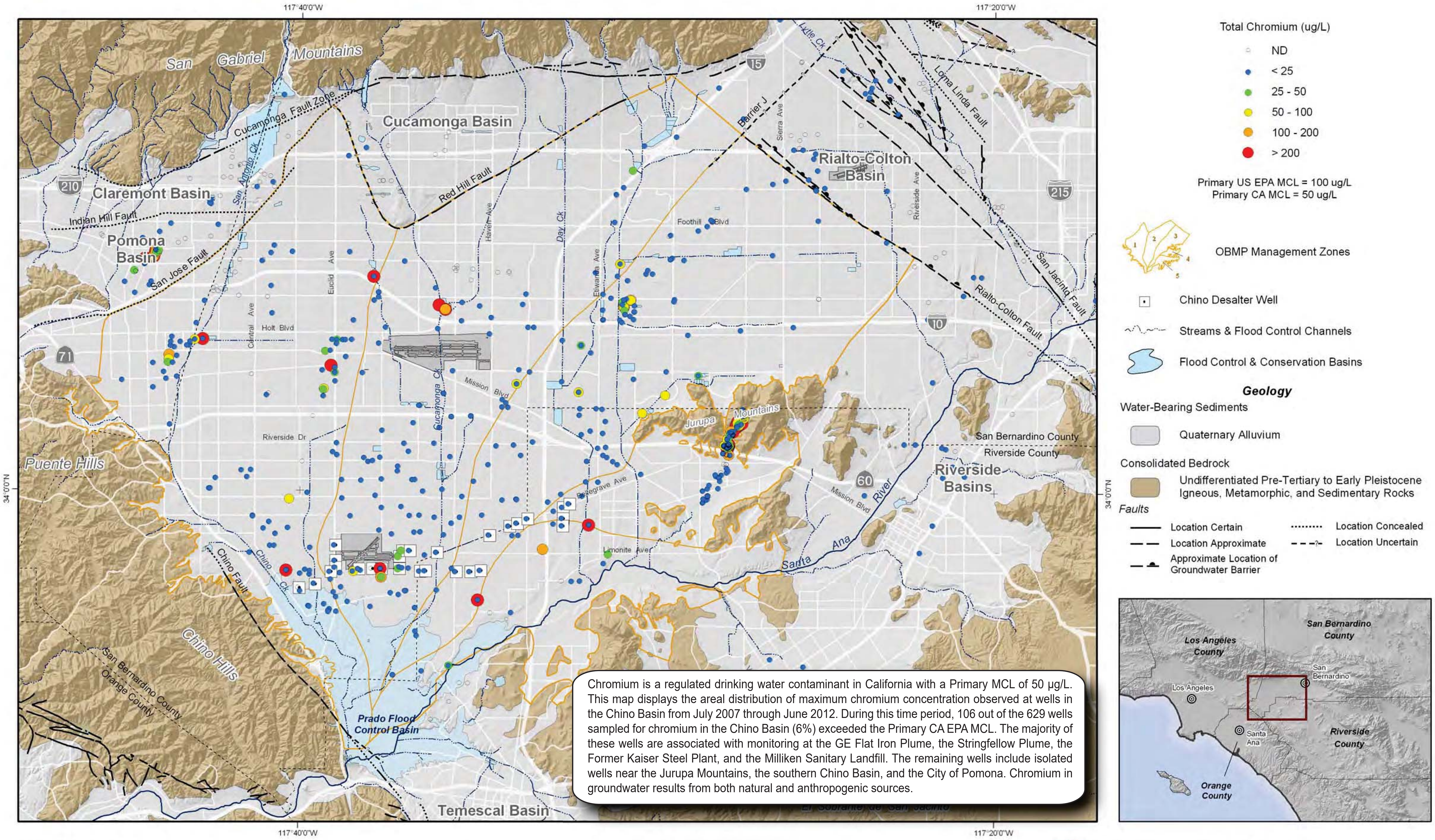
2012 State of the Basin
Groundwater Quality

Perchlorate in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 34



Chromium is a regulated drinking water contaminant in California with a Primary MCL of 50 µg/L. This map displays the areal distribution of maximum chromium concentration observed at wells in the Chino Basin from July 2007 through June 2012. During this time period, 106 out of the 629 wells sampled for chromium in the Chino Basin (6%) exceeded the Primary CA EPA MCL. The majority of these wells are associated with monitoring at the GE Flat Iron Plume, the Stringfellow Plume, the Former Kaiser Steel Plant, and the Milliken Sanitary Landfill. The remaining wells include isolated wells near the Jurupa Mountains, the southern Chino Basin, and the City of Pomona. Chromium in groundwater results from both natural and anthropogenic sources.

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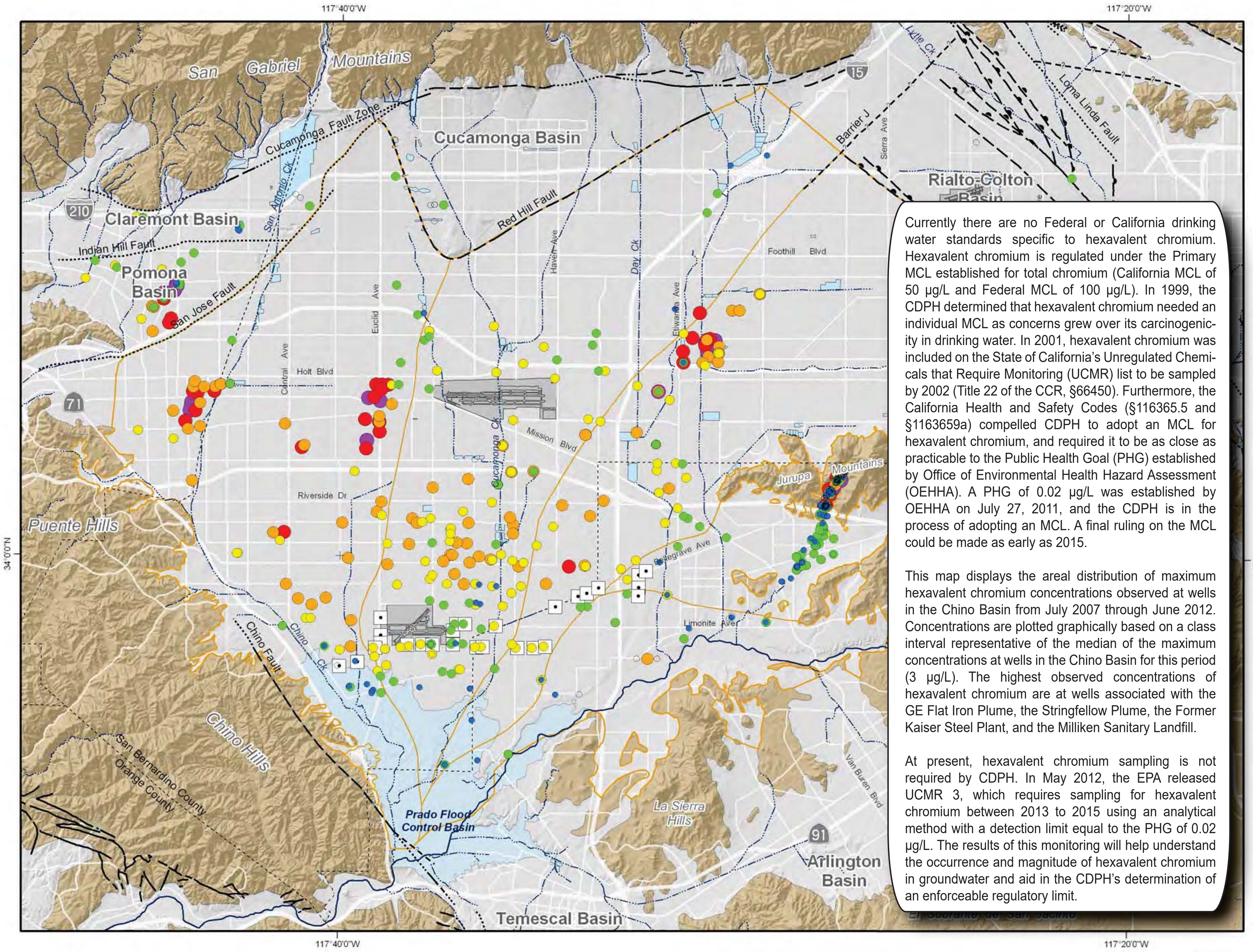
2012 State of the Basin
Groundwater Quality

Total Chromium in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 35



Currently there are no Federal or California drinking water standards specific to hexavalent chromium. Hexavalent chromium is regulated under the Primary MCL established for total chromium (California MCL of 50 µg/L and Federal MCL of 100 µg/L). In 1999, the CDPH determined that hexavalent chromium needed an individual MCL as concerns grew over its carcinogenicity in drinking water. In 2001, hexavalent chromium was included on the State of California's Unregulated Chemicals that Require Monitoring (UCMR) list to be sampled by 2002 (Title 22 of the CCR, §66450). Furthermore, the California Health and Safety Codes (§116365.5 and §1163659a) compelled CDPH to adopt an MCL for hexavalent chromium, and required it to be as close as practicable to the Public Health Goal (PHG) established by Office of Environmental Health Hazard Assessment (OEHHA). A PHG of 0.02 µg/L was established by OEHHA on July 27, 2011, and the CDPH is in the process of adopting an MCL. A final ruling on the MCL could be made as early as 2015.

This map displays the areal distribution of maximum hexavalent chromium concentrations observed at wells in the Chino Basin from July 2007 through June 2012. Concentrations are plotted graphically based on a class interval representative of the median of the maximum concentrations at wells in the Chino Basin for this period (3 µg/L). The highest observed concentrations of hexavalent chromium are at wells associated with the GE Flat Iron Plume, the Stringfellow Plume, the Former Kaiser Steel Plant, and the Milliken Sanitary Landfill.

At present, hexavalent chromium sampling is not required by CDPH. In May 2012, the EPA released UCMR 3, which requires sampling for hexavalent chromium between 2013 to 2015 using an analytical method with a detection limit equal to the PHG of 0.02 µg/L. The results of this monitoring will help understand the occurrence and magnitude of hexavalent chromium in groundwater and aid in the CDPH's determination of an enforceable regulatory limit.

Hexavalent Chromium (ug/L)

- ○ ND
- ● < 1
- ● 2 - 3
- ● 3 - 6
- ● 6 - 12
- ● 12 - 24
- ● > 24

Median Detected Concentration in Chino Basin = 3 ug/L.

Currently there is no US or CA EPA MCL; hexavalent Chromium is regulated as total chromium which has a CA EPA MCL of 50 ug/L

A CA Public Health Goal of 0.02 ug/L was established in July 2011.

OBMP Management Zones

⊡ Chino Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Faults

Location Certain

Location Approximate

Approximate Location of Groundwater Barrier

Location Concealed

Location Uncertain

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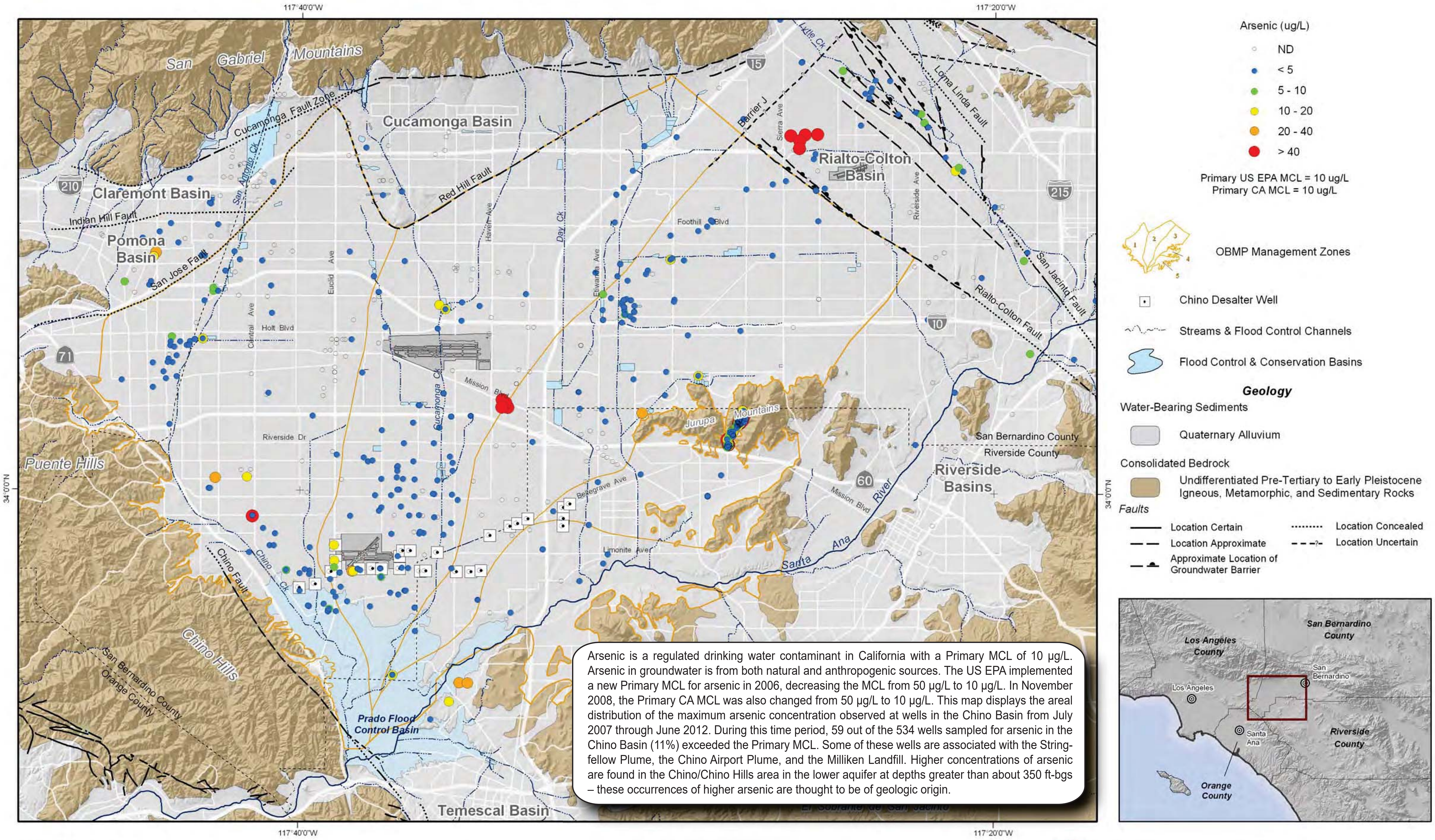
2012 State of the Basin
Groundwater Quality

Hexavalent Chromium in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 36



Arsenic is a regulated drinking water contaminant in California with a Primary MCL of 10 µg/L. Arsenic in groundwater is from both natural and anthropogenic sources. The US EPA implemented a new Primary MCL for arsenic in 2006, decreasing the MCL from 50 µg/L to 10 µg/L. In November 2008, the Primary CA MCL was also changed from 50 µg/L to 10 µg/L. This map displays the areal distribution of the maximum arsenic concentration observed at wells in the Chino Basin from July 2007 through June 2012. During this time period, 59 out of the 534 wells sampled for arsenic in the Chino Basin (11%) exceeded the Primary MCL. Some of these wells are associated with the Stringfellow Plume, the Chino Airport Plume, and the Milliken Landfill. Higher concentrations of arsenic are found in the Chino/Chino Hills area in the lower aquifer at depths greater than about 350 ft-bgs – these occurrences of higher arsenic are thought to be of geologic origin.

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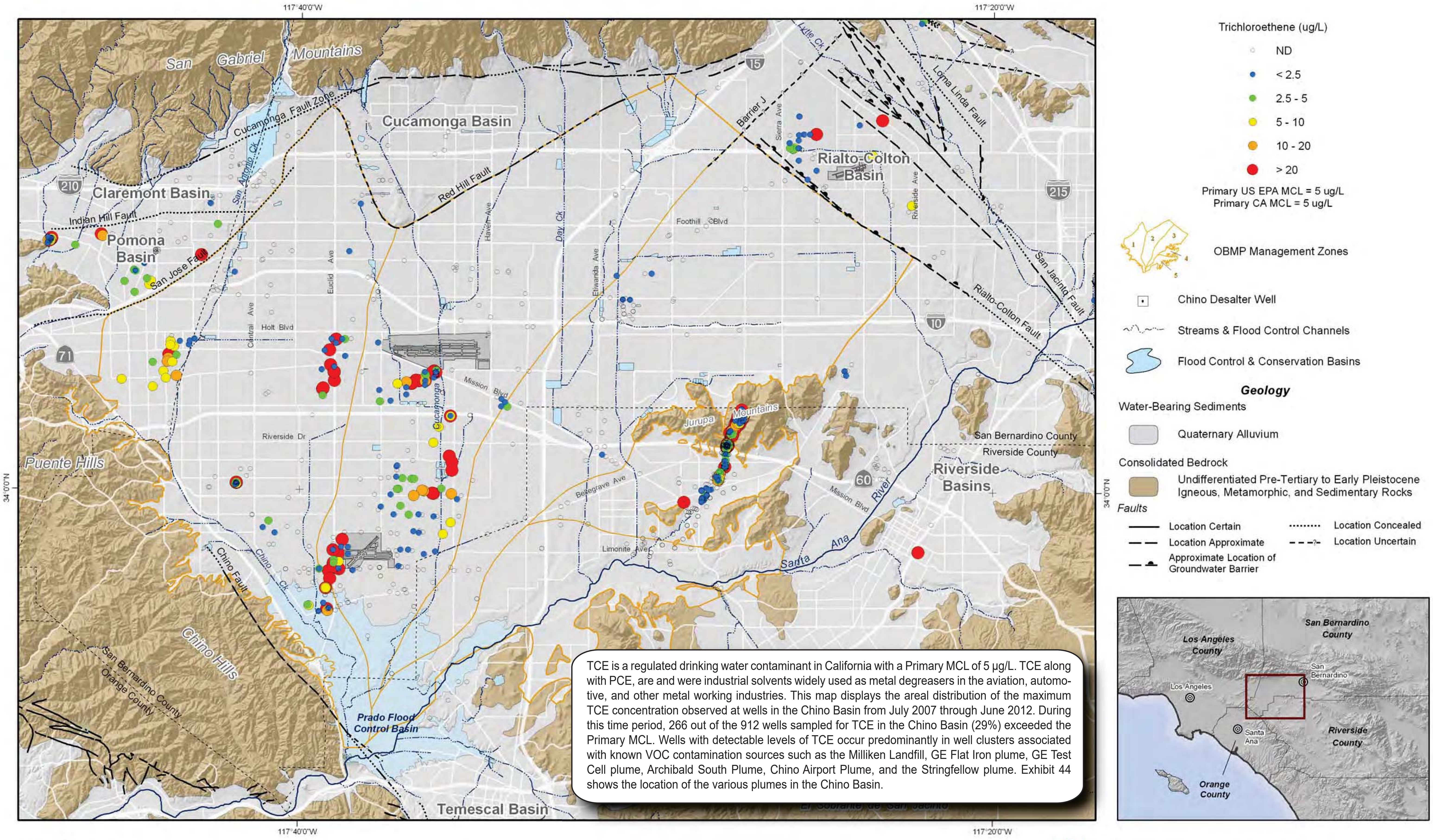
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

Arsenic in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 37



TCE is a regulated drinking water contaminant in California with a Primary MCL of 5 µg/L. TCE along with PCE, are and were industrial solvents widely used as metal degreasers in the aviation, automotive, and other metal working industries. This map displays the areal distribution of the maximum TCE concentration observed at wells in the Chino Basin from July 2007 through June 2012. During this time period, 266 out of the 912 wells sampled for TCE in the Chino Basin (29%) exceeded the Primary MCL. Wells with detectable levels of TCE occur predominantly in well clusters associated with known VOC contamination sources such as the Milliken Landfill, GE Flat Iron plume, GE Test Cell plume, Archibald South Plume, Chino Airport Plume, and the Stringfellow plume. Exhibit 44 shows the location of the various plumes in the Chino Basin.

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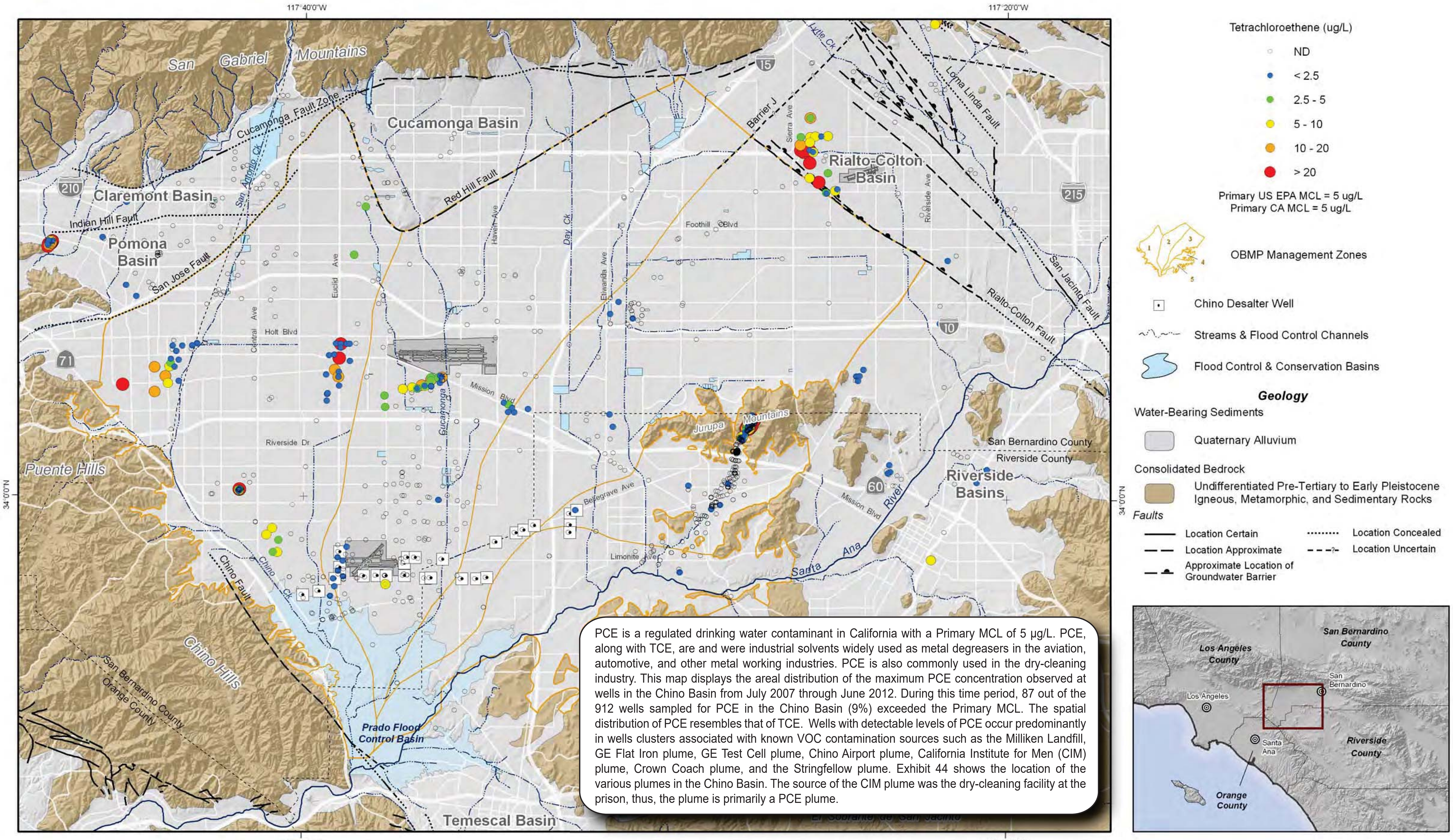
0	1	2	3	4	5 Miles
0	2	4	6	8 KM	

2012 State of the Basin
Groundwater Quality

Trichloroethene (TCE) in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 38



PCE is a regulated drinking water contaminant in California with a Primary MCL of 5 µg/L. PCE, along with TCE, are and were industrial solvents widely used as metal degreasers in the aviation, automotive, and other metal working industries. PCE is also commonly used in the dry-cleaning industry. This map displays the areal distribution of the maximum PCE concentration observed at wells in the Chino Basin from July 2007 through June 2012. During this time period, 87 out of the 912 wells sampled for PCE in the Chino Basin (9%) exceeded the Primary MCL. The spatial distribution of PCE resembles that of TCE. Wells with detectable levels of PCE occur predominantly in wells clusters associated with known VOC contamination sources such as the Milliken Landfill, GE Flat Iron plume, GE Test Cell plume, Chino Airport plume, California Institute for Men (CIM) plume, Crown Coach plume, and the Stringfellow plume. Exhibit 44 shows the location of the various plumes in the Chino Basin. The source of the CIM plume was the dry-cleaning facility at the prison, thus, the plume is primarily a PCE plume.

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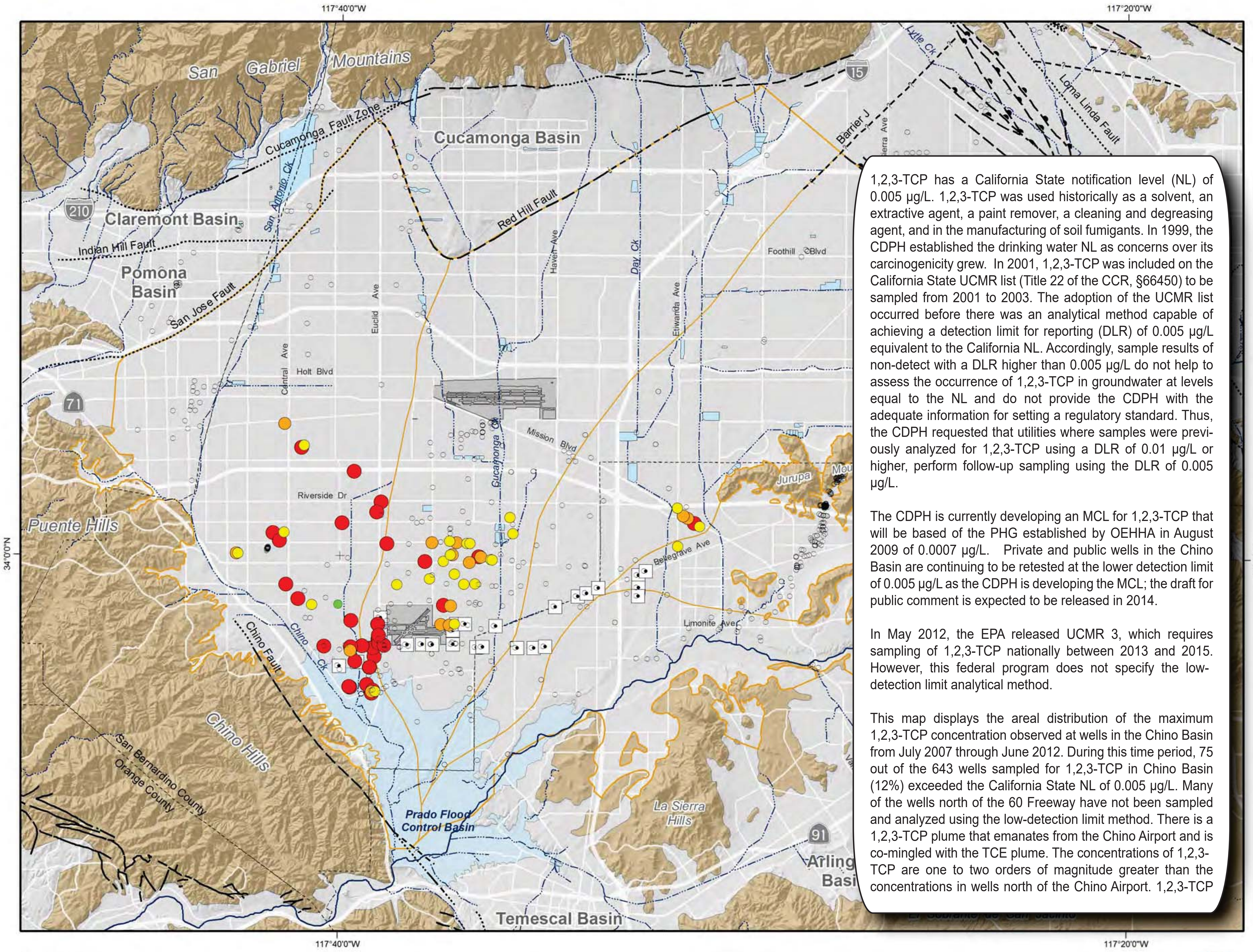
2012 State of the Basin
Groundwater Quality

Tetrachloroethene (PCE) in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 39



1,2,3-TCP has a California State notification level (NL) of 0.005 µg/L. 1,2,3-TCP was used historically as a solvent, an extractive agent, a paint remover, a cleaning and degreasing agent, and in the manufacturing of soil fumigants. In 1999, the CDPH established the drinking water NL as concerns over its carcinogenicity grew. In 2001, 1,2,3-TCP was included on the California State UCMR list (Title 22 of the CCR, §66450) to be sampled from 2001 to 2003. The adoption of the UCMR list occurred before there was an analytical method capable of achieving a detection limit for reporting (DLR) of 0.005 µg/L equivalent to the California NL. Accordingly, sample results of non-detect with a DLR higher than 0.005 µg/L do not help to assess the occurrence of 1,2,3-TCP in groundwater at levels equal to the NL and do not provide the CDPH with the adequate information for setting a regulatory standard. Thus, the CDPH requested that utilities where samples were previously analyzed for 1,2,3-TCP using a DLR of 0.01 µg/L or higher, perform follow-up sampling using the DLR of 0.005 µg/L.

The CDPH is currently developing an MCL for 1,2,3-TCP that will be based of the PHG established by OEHHA in August 2009 of 0.0007 µg/L. Private and public wells in the Chino Basin are continuing to be retested at the lower detection limit of 0.005 µg/L as the CDPH is developing the MCL; the draft for public comment is expected to be released in 2014.

In May 2012, the EPA released UCMR 3, which requires sampling of 1,2,3-TCP nationally between 2013 and 2015. However, this federal program does not specify the low-detection limit analytical method.

This map displays the areal distribution of the maximum 1,2,3-TCP concentration observed at wells in the Chino Basin from July 2007 through June 2012. During this time period, 75 out of the 643 wells sampled for 1,2,3-TCP in Chino Basin (12%) exceeded the California State NL of 0.005 µg/L. Many of the wells north of the 60 Freeway have not been sampled and analyzed using the low-detection limit method. There is a 1,2,3-TCP plume that emanates from the Chino Airport and is co-mingled with the TCE plume. The concentrations of 1,2,3-TCP are one to two orders of magnitude greater than the concentrations in wells north of the Chino Airport. 1,2,3-TCP

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

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

California Notification Level = 0.005 ug/L

OBMP Management Zones

⊡ Chino Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Faults

Location Certain
Location Approximate
Approximate Location of Groundwater Barrier
Location Concealed
Location Uncertain

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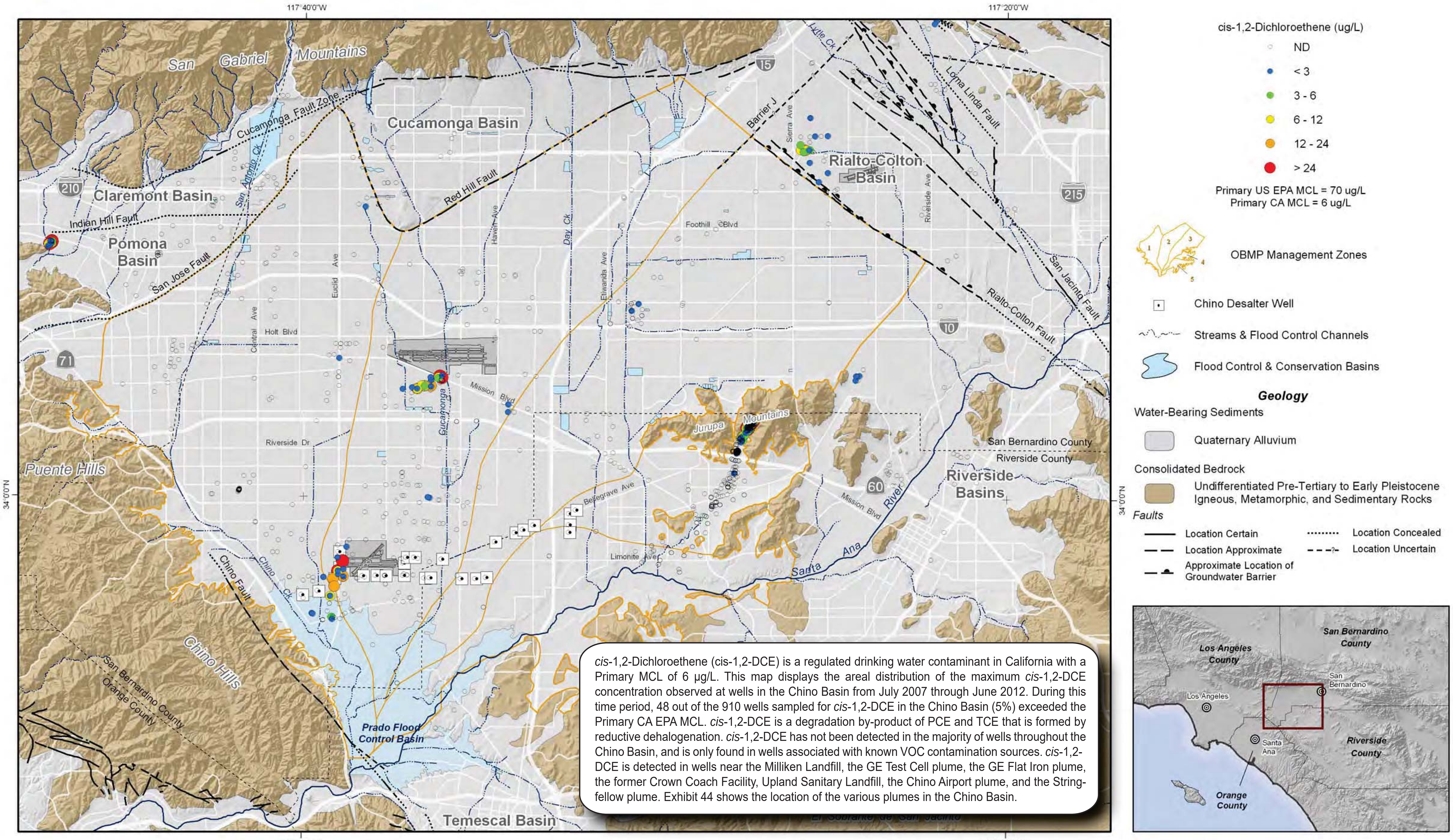
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

1,2,3-Trichloropropane (1,2,3-TCP) in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 40



cis-1,2-Dichloroethene (cis-1,2-DCE) is a regulated drinking water contaminant in California with a Primary MCL of 6 µg/L. This map displays the areal distribution of the maximum *cis*-1,2-DCE concentration observed at wells in the Chino Basin from July 2007 through June 2012. During this time period, 48 out of the 910 wells sampled for *cis*-1,2-DCE in the Chino Basin (5%) exceeded the Primary CA EPA MCL. *cis*-1,2-DCE is a degradation by-product of PCE and TCE that is formed by reductive dehalogenation. *cis*-1,2-DCE has not been detected in the majority of wells throughout the Chino Basin, and is only found in wells associated with known VOC contamination sources. *cis*-1,2-DCE is detected in wells near the Milliken Landfill, the GE Test Cell plume, the GE Flat Iron plume, the former Crown Coach Facility, Upland Sanitary Landfill, the Chino Airport plume, and the Stringfellow plume. Exhibit 44 shows the location of the various plumes in the Chino Basin.

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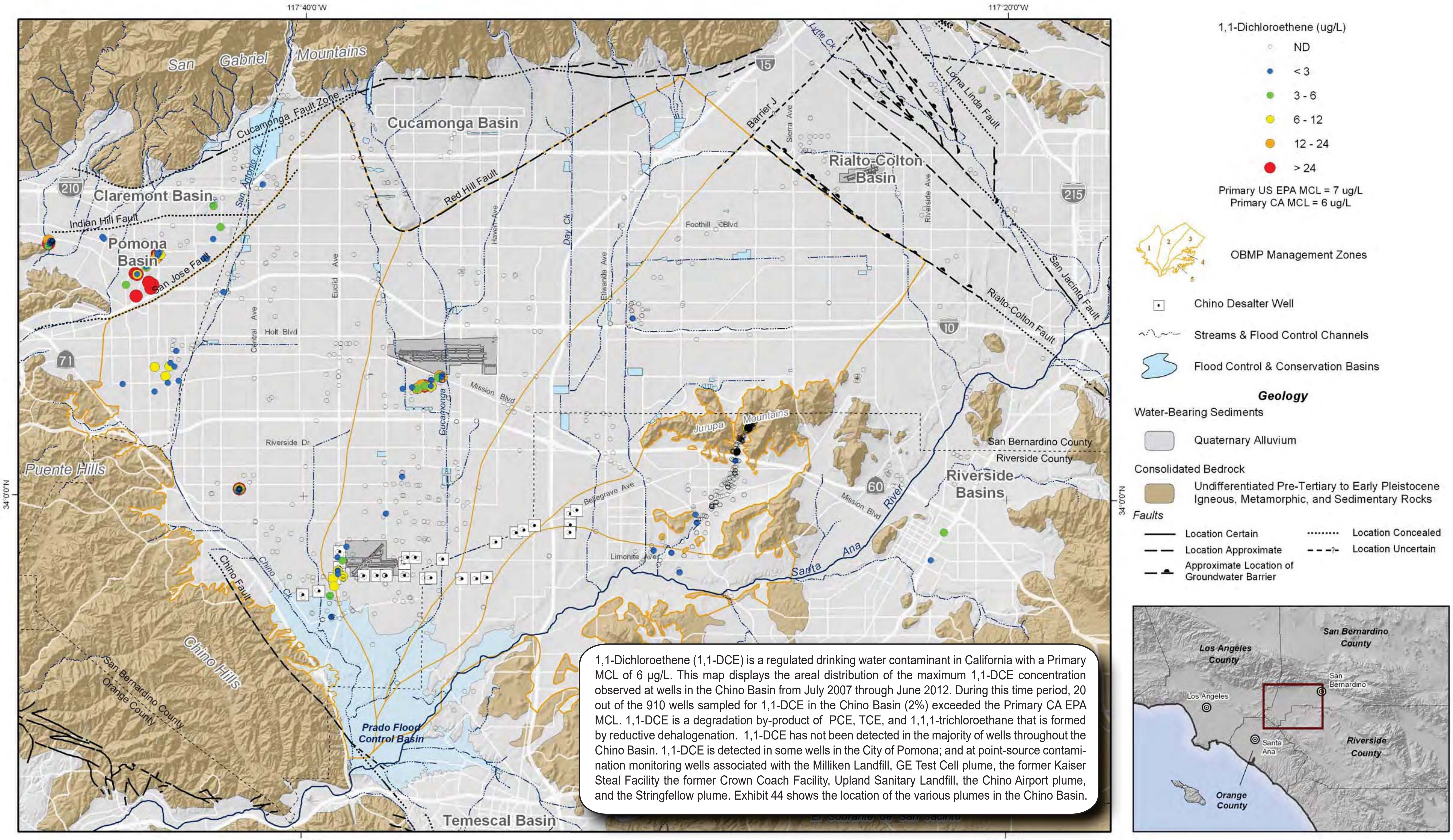
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

cis-1,2-Dichloroethene in Groundwater
Maximum Concentration (July 2007 to June 2012)

Exhibit 41



1,1-Dichloroethene (1,1-DCE) is a regulated drinking water contaminant in California with a Primary MCL of 6 µg/L. This map displays the areal distribution of the maximum 1,1-DCE concentration observed at wells in the Chino Basin from July 2007 through June 2012. During this time period, 20 out of the 910 wells sampled for 1,1-DCE in the Chino Basin (2%) exceeded the Primary CA EPA MCL. 1,1-DCE is a degradation by-product of PCE, TCE, and 1,1,1-trichloroethane that is formed by reductive dehalogenation. 1,1-DCE has not been detected in the majority of wells throughout the Chino Basin. 1,1-DCE is detected in some wells in the City of Pomona; and at point-source contamination monitoring wells associated with the Milliken Landfill, GE Test Cell plume, the former Kaiser Steal Facility the former Crown Coach Facility, Upland Sanitary Landfill, the Chino Airport plume, and the Stringfellow plume. Exhibit 44 shows the location of the various plumes in the Chino Basin.

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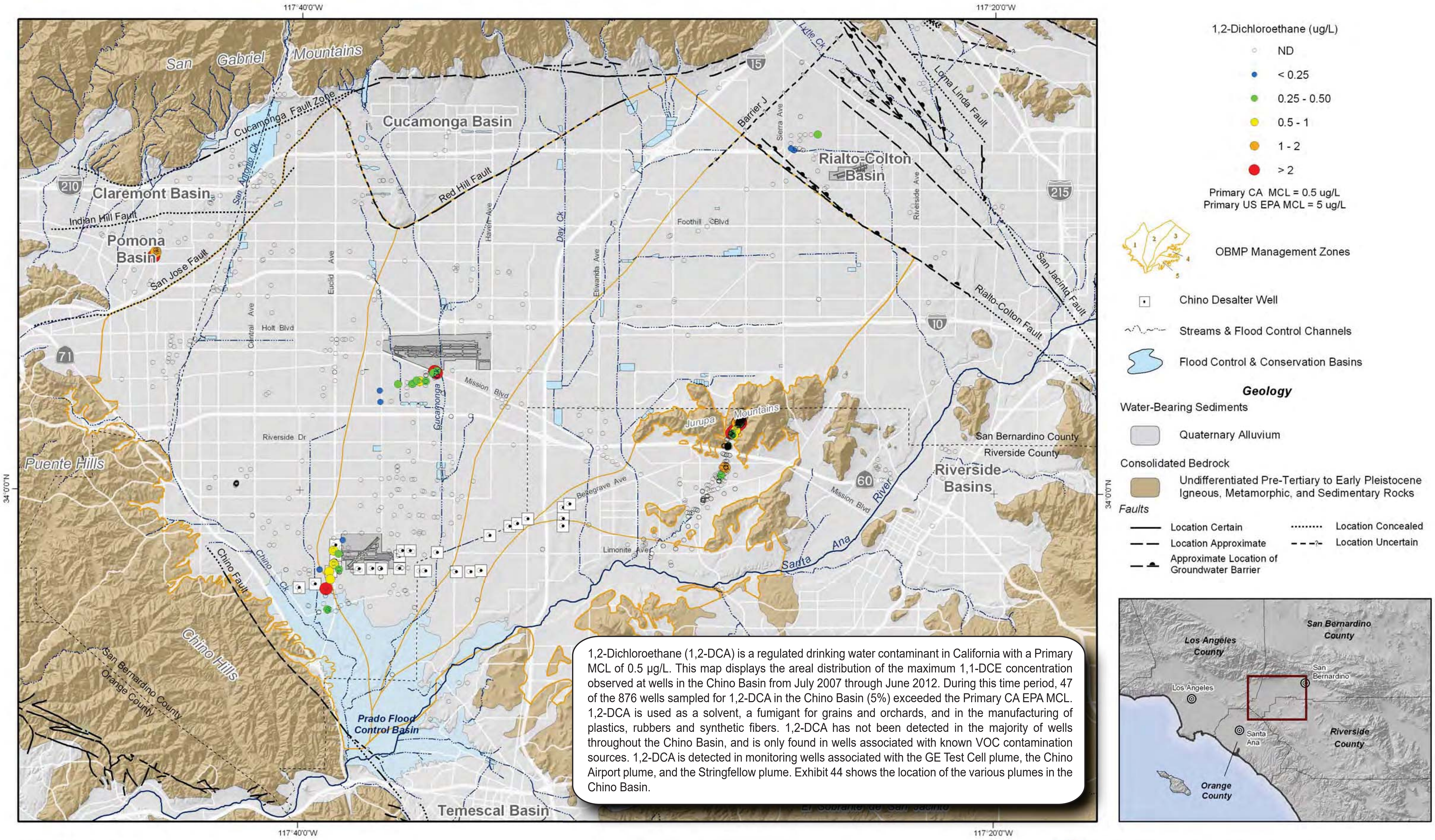
2012 State of the Basin
Groundwater Quality

1,1-Dichloroethene in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 42



1,2-Dichloroethane (1,2-DCA) is a regulated drinking water contaminant in California with a Primary MCL of 0.5 µg/L. This map displays the areal distribution of the maximum 1,1-DCE concentration observed at wells in the Chino Basin from July 2007 through June 2012. During this time period, 47 of the 876 wells sampled for 1,2-DCA in the Chino Basin (5%) exceeded the Primary CA EPA MCL. 1,2-DCA is used as a solvent, a fumigant for grains and orchards, and in the manufacturing of plastics, rubbers and synthetic fibers. 1,2-DCA has not been detected in the majority of wells throughout the Chino Basin, and is only found in wells associated with known VOC contamination sources. 1,2-DCA is detected in monitoring wells associated with the GE Test Cell plume, the Chino Airport plume, and the Stringfellow plume. Exhibit 44 shows the location of the various plumes in the Chino Basin.

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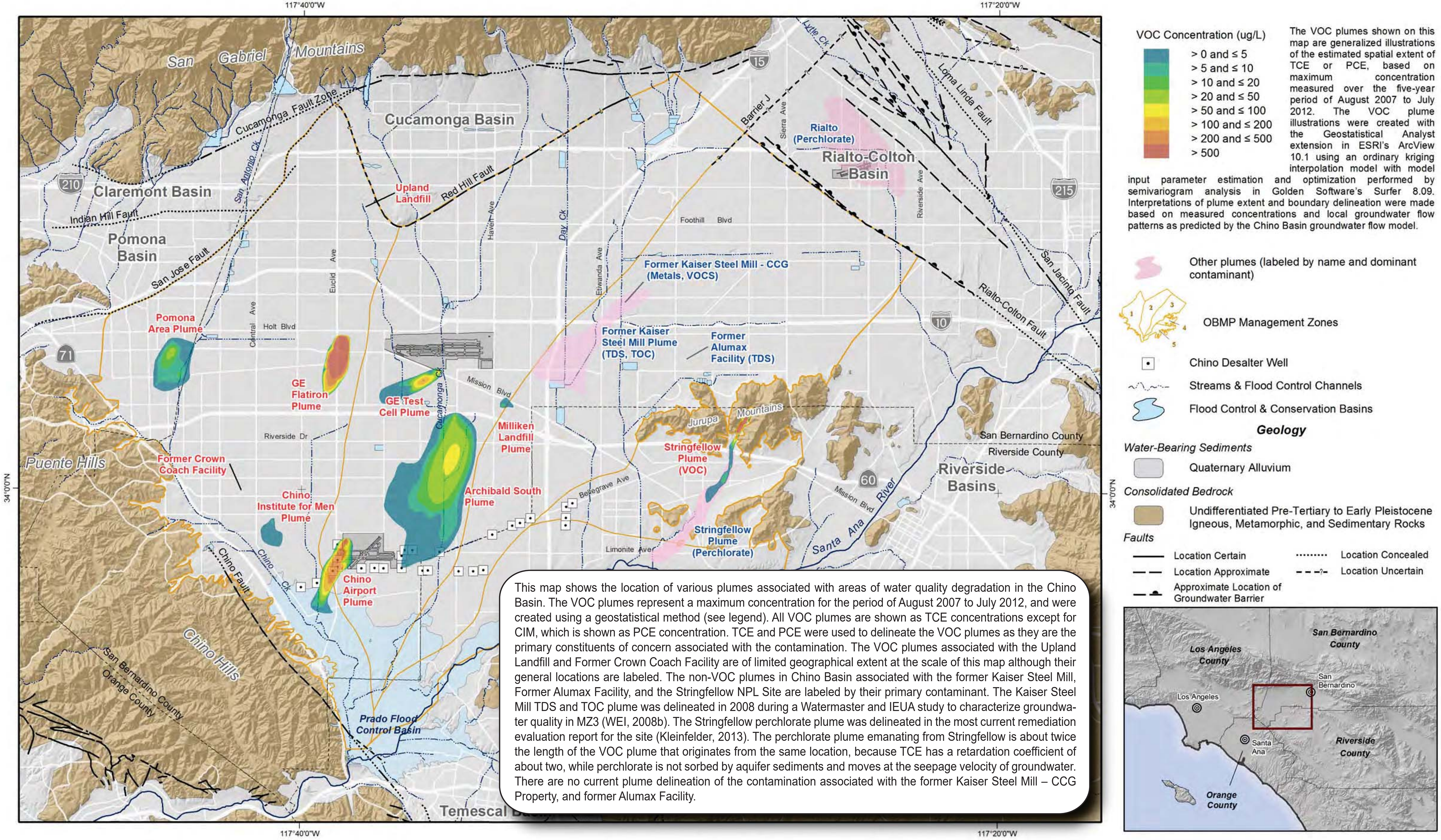
2012 State of the Basin
Groundwater Quality

1,2-Dichloroethane in Groundwater

Maximum Concentration (July 2007 to June 2012)

Exhibit 43



The VOC plumes shown on this map are generalized illustrations of the estimated spatial extent of TCE or PCE, based on maximum concentration measured over the five-year period of August 2007 to July 2012. The VOC plume illustrations were created with the Geostatistical Analyst extension in ESRI's ArcView 10.1 using an ordinary kriging interpolation model with model input parameter estimation and optimization performed by semivariogram analysis in Golden Software's Surfer 8.09. Interpretations of plume extent and boundary delineation were made based on measured concentrations and local groundwater flow patterns as predicted by the Chino Basin groundwater flow model.

This map shows the location of various plumes associated with areas of water quality degradation in the Chino Basin. The VOC plumes represent a maximum concentration for the period of August 2007 to July 2012, and were created using a geostatistical method (see legend). All VOC plumes are shown as TCE concentrations except for CIM, which is shown as PCE concentration. TCE and PCE were used to delineate the VOC plumes as they are the primary constituents of concern associated with the contamination. The VOC plumes associated with the Upland Landfill and Former Crown Coach Facility are of limited geographical extent at the scale of this map although their general locations are labeled. The non-VOC plumes in Chino Basin associated with the former Kaiser Steel Mill, Former Alumax Facility, and the Stringfellow NPL Site are labeled by their primary contaminant. The Kaiser Steel Mill TDS and TOC plume was delineated in 2008 during a Watermaster and IEUA study to characterize groundwater quality in MZ3 (WEI, 2008b). The Stringfellow perchlorate plume was delineated in the most current remediation evaluation report for the site (Kleinfelder, 2013). The perchlorate plume emanating from Stringfellow is about twice the length of the VOC plume that originates from the same location, because TCE has a retardation coefficient of about two, while perchlorate is not sorbed by aquifer sediments and moves at the seepage velocity of groundwater. There are no current plume delineation of the contamination associated with the former Kaiser Steel Mill – CCG Property, and former Alumax Facility.

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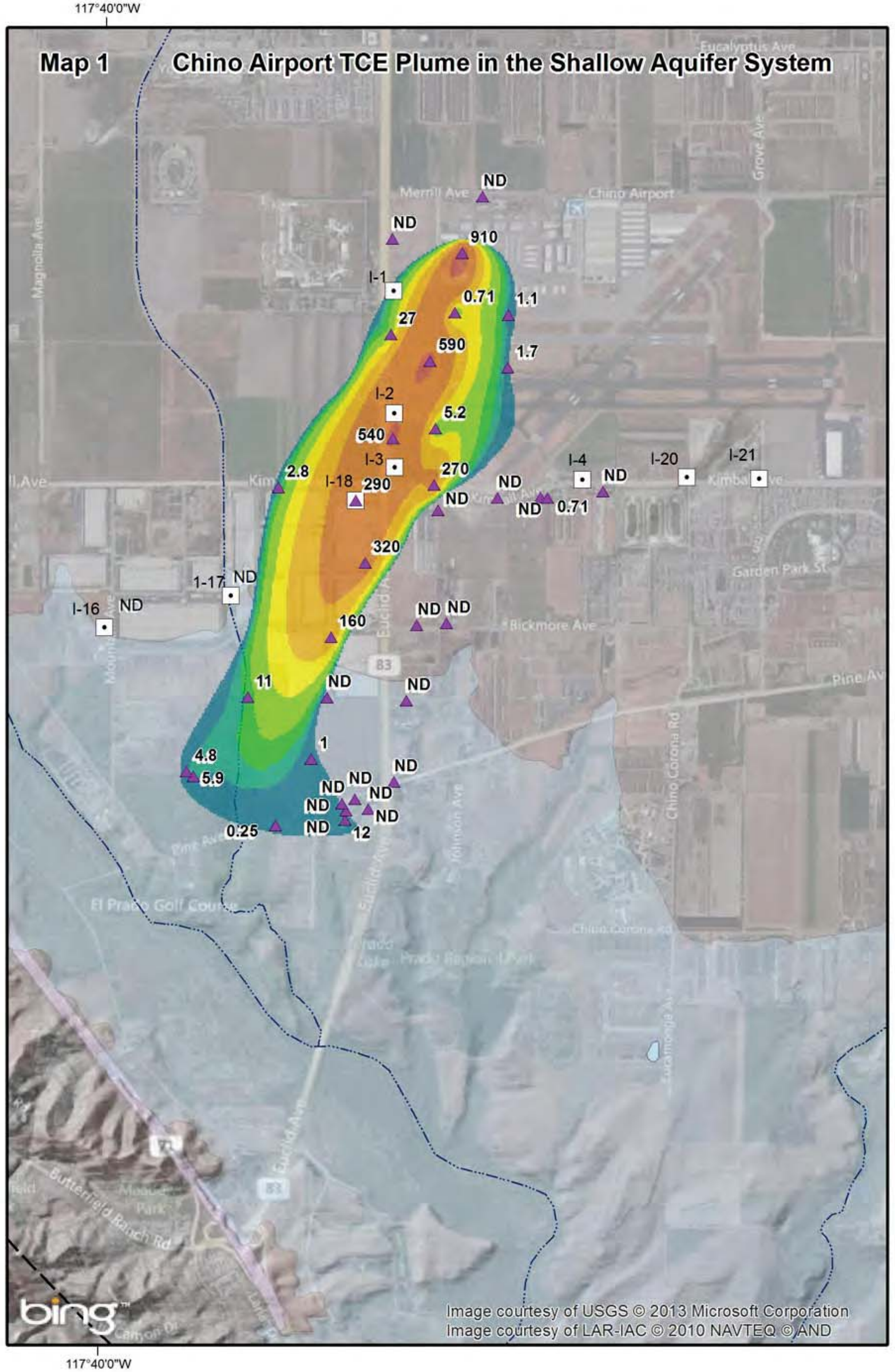
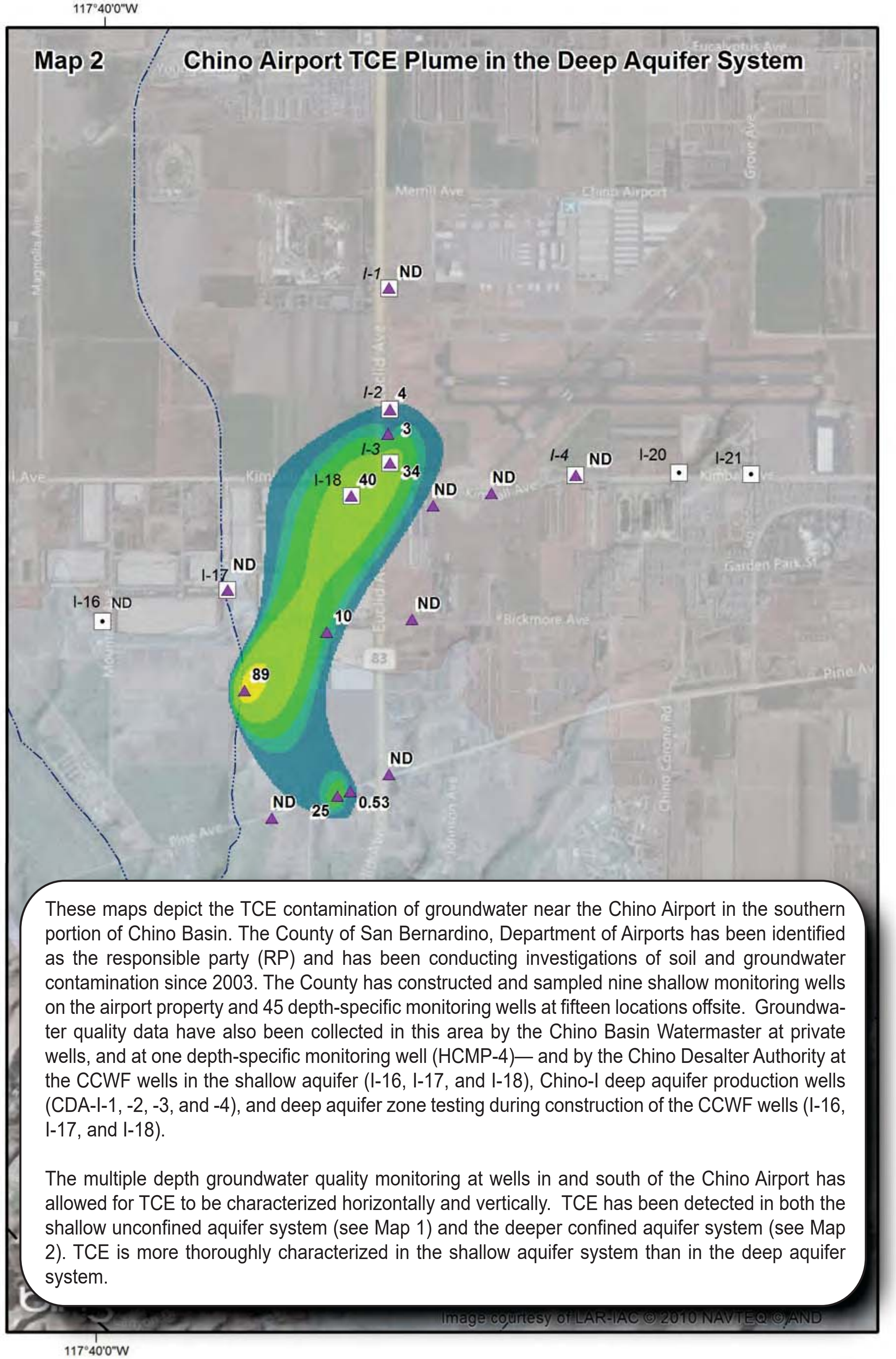
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

Delineation of Groundwater Contamination Plumes and Point Sources of Concern

Exhibit 44





These maps depict the TCE contamination of groundwater near the Chino Airport in the southern portion of Chino Basin. The County of San Bernardino, Department of Airports has been identified as the responsible party (RP) and has been conducting investigations of soil and groundwater contamination since 2003. The County has constructed and sampled nine shallow monitoring wells on the airport property and 45 depth-specific monitoring wells at fifteen locations offsite. Groundwater quality data have also been collected in this area by the Chino Basin Watermaster at private wells, and at one depth-specific monitoring well (HCMP-4)— and by the Chino Desalter Authority at the CCWF wells in the shallow aquifer (I-16, I-17, and I-18), Chino-I deep aquifer production wells (CDA-I-1, -2, -3, and -4), and deep aquifer zone testing during construction of the CCWF wells (I-16, I-17, and I-18).

The multiple depth groundwater quality monitoring at wells in and south of the Chino Airport has allowed for TCE to be characterized horizontally and vertically. TCE has been detected in both the shallow unconfined aquifer system (see Map 1) and the deeper confined aquifer system (see Map 2). TCE is more thoroughly characterized in the shallow aquifer system than in the deep aquifer system.

TCE Concentration (ug/L)

- > 0 and ≤ 5
- > 5 and ≤ 10
- > 10 and ≤ 20
- > 20 and ≤ 50
- > 50 and ≤ 100
- > 100 and ≤ 200
- > 200 and ≤ 500
- > 500

The VOC plumes shown on this map are generalized illustrations of the estimated spatial extent of TCE, based on maximum concentration measured over the five-year period of August 2007 to July 2012. The VOC plume illustrations were created with the Geostatistical Analyst extension in ESRI's ArcView 10.1 using an ordinary kriging interpolation model with model input parameter estimation and optimization performed by semivariogram analysis in Golden Software's Surfer 8.09. Interpretations of plume extent and boundary delineation were made based on measured concentrations and local groundwater flow patterns as predicted by the Chino Basin groundwater flow model.

▲ 5 Wells & Maximum TCE Concentration (ug/L) for August 2007 to July 2012.

⊡ Chino Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

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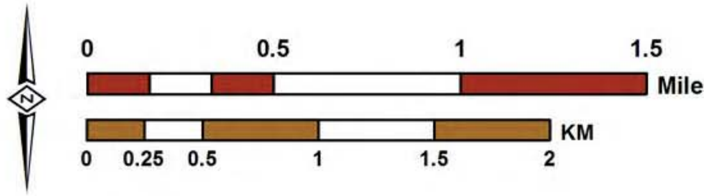
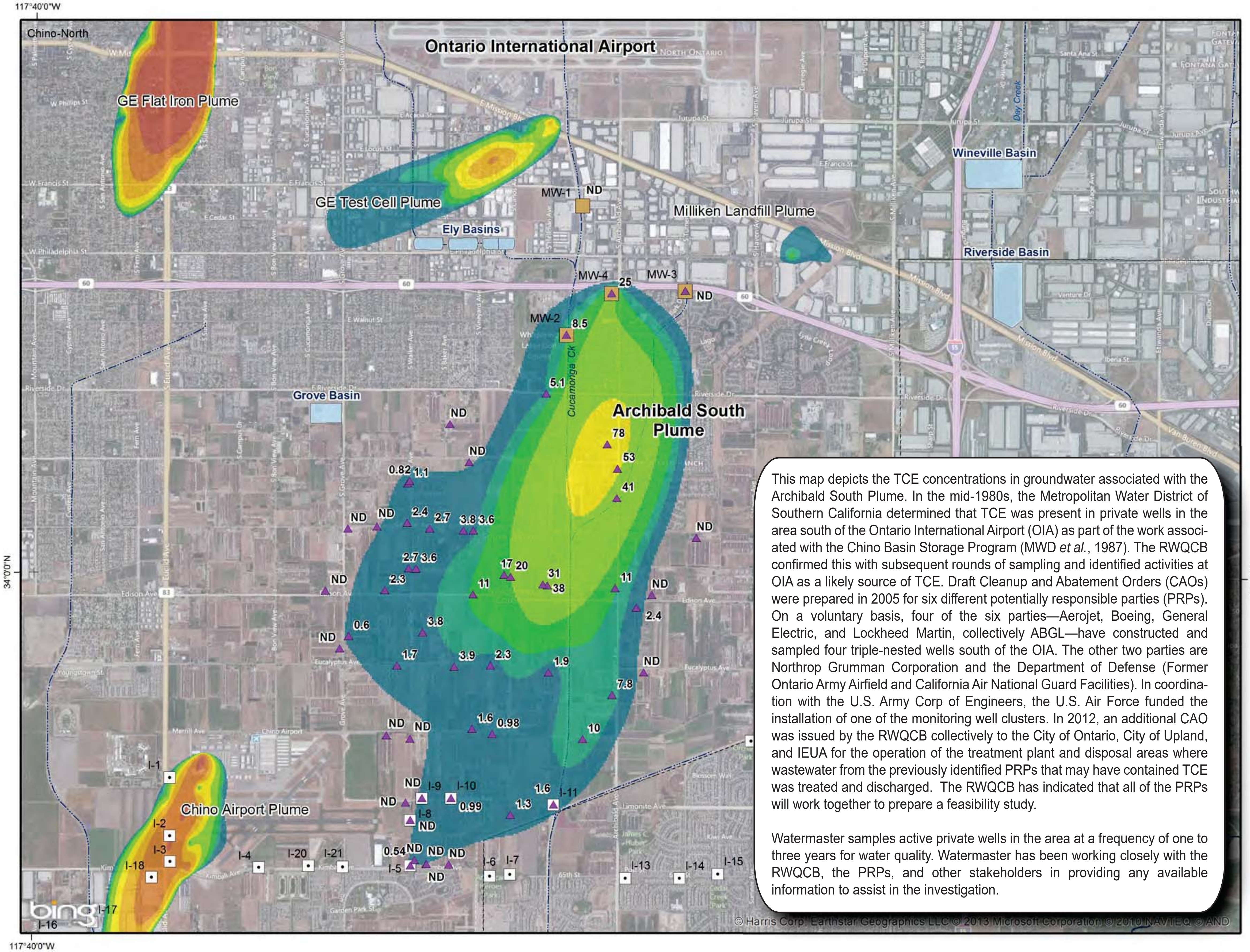


2012 State of the Basin
Groundwater Quality

Chino Airport TCE Plume
Shallow and Deep Aquifers

Exhibit 45



This map depicts the TCE concentrations in groundwater associated with the Archibald South Plume. In the mid-1980s, the Metropolitan Water District of Southern California determined that TCE was present in private wells in the area south of the Ontario International Airport (OIA) as part of the work associated with the Chino Basin Storage Program (MWD *et al.*, 1987). The RWQCB confirmed this with subsequent rounds of sampling and identified activities at OIA as a likely source of TCE. Draft Cleanup and Abatement Orders (CAOs) were prepared in 2005 for six different potentially responsible parties (PRPs). On a voluntary basis, four of the six parties—Aerojet, Boeing, General Electric, and Lockheed Martin, collectively ABGL—have constructed and sampled four triple-nested wells south of the OIA. The other two parties are Northrop Grumman Corporation and the Department of Defense (Former Ontario Army Airfield and California Air National Guard Facilities). In coordination with the U.S. Army Corp of Engineers, the U.S. Air Force funded the installation of one of the monitoring well clusters. In 2012, an additional CAO was issued by the RWQCB collectively to the City of Ontario, City of Upland, and IEUA for the operation of the treatment plant and disposal areas where wastewater from the previously identified PRPs that may have contained TCE was treated and discharged. The RWQCB has indicated that all of the PRPs will work together to prepare a feasibility study.

Watermaster samples active private wells in the area at a frequency of one to three years for water quality. Watermaster has been working closely with the RWQCB, the PRPs, and other stakeholders in providing any available information to assist in the investigation.

TCE Concentration (ug/L)

- 🟦 > 0 and ≤ 5
- 🟦 > 5 and ≤ 10
- 🟩 > 10 and ≤ 20
- 🟩 > 20 and ≤ 50
- 🟨 > 50 and ≤ 100
- 🟧 > 100 and ≤ 200
- 🟧 > 200 and ≤ 500
- 🟥 > 500

The VOC plumes shown on this map are generalized illustrations of the estimated spatial extent of TCE, based on maximum concentration measured over the five-year period of August 2007 to July 2012. The VOC plume illustrations were created with the Geostatistical Analyst extension in ESRI's ArcView 10.1 using an ordinary kriging interpolation model with model input parameter estimation and optimization performed by semivariogram analysis in Golden Software's Surfer 8.09. Interpretations of plume extent and boundary delineation were made based on measured concentrations and local groundwater flow patterns as predicted by the Chino Basin groundwater flow model.

- 🟧 ABGL Monitoring Wells
- ▲ 5 Wells & TCE Concentration (ug/L)
- ⊡ Chino Desalter Well
- 〰 Streams & Flood Control Channels
- Flood Control & Conservation Basins

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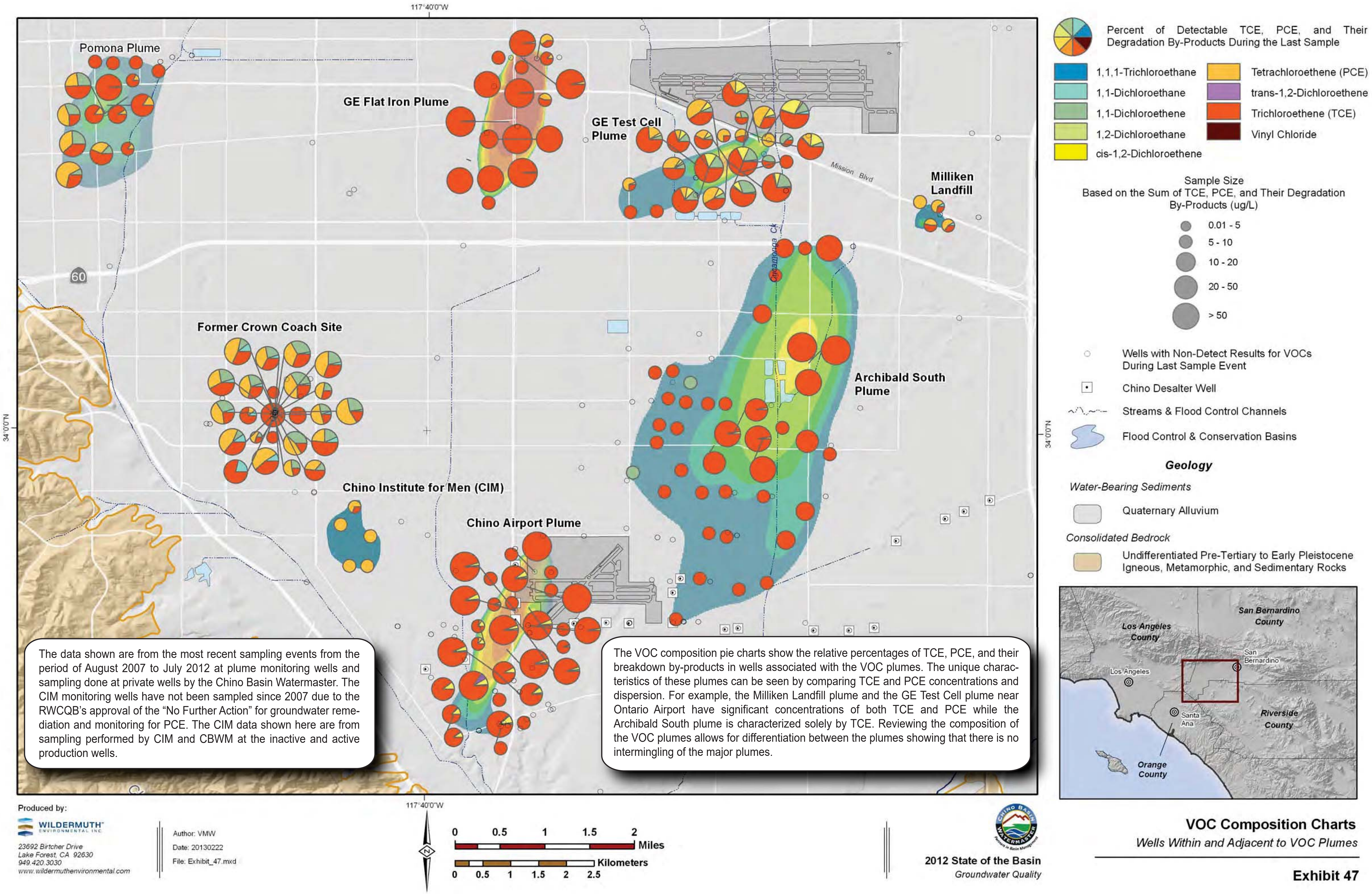
0 0.5 1 1.5 Miles
0 0.25 0.5 1 1.5 2 KM

2012 State of the Basin
Groundwater Quality

Archibald South TCE Plume

Exhibit 46



The data shown are from the most recent sampling events from the period of August 2007 to July 2012 at plume monitoring wells and sampling done at private wells by the Chino Basin Watermaster. The CIM monitoring wells have not been sampled since 2007 due to the RWCQB's approval of the "No Further Action" for groundwater remediation and monitoring for PCE. The CIM data shown here are from sampling performed by CIM and CBWM at the inactive and active production wells.

The VOC composition pie charts show the relative percentages of TCE, PCE, and their breakdown by-products in wells associated with the VOC plumes. The unique characteristics of these plumes can be seen by comparing TCE and PCE concentrations and dispersion. For example, the Milliken Landfill plume and the GE Test Cell plume near Ontario Airport have significant concentrations of both TCE and PCE while the Archibald South plume is characterized solely by TCE. Reviewing the composition of the VOC plumes allows for differentiation between the plumes showing that there is no intermingling of the major plumes.

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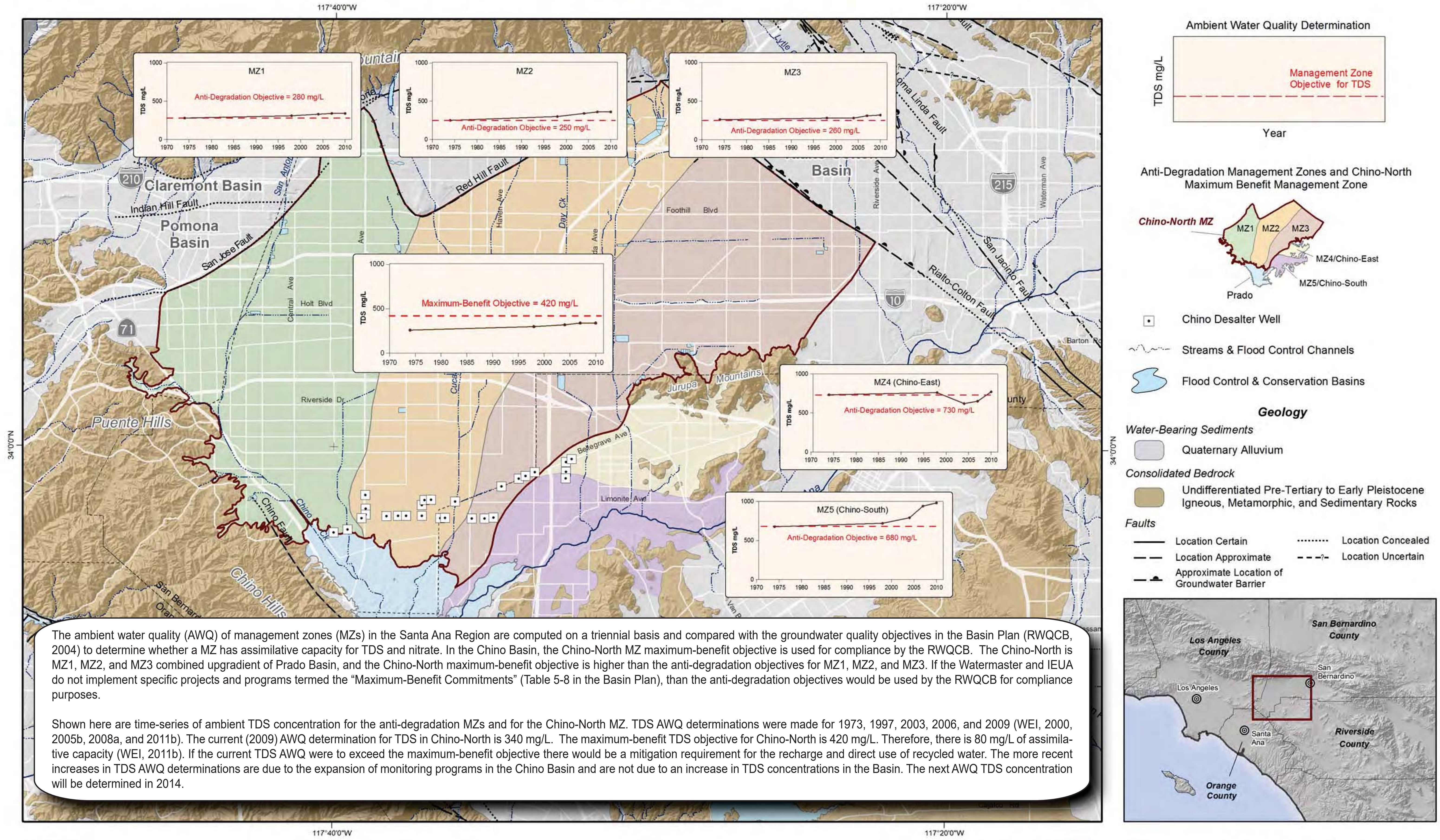
Groundwater Quality

VOC Composition Charts

Wells Within and Adjacent to VOC Plumes

Exhibit 47



The ambient water quality (AWQ) of management zones (MZs) in the Santa Ana Region are computed on a triennial basis and compared with the groundwater quality objectives in the Basin Plan (RWQCB, 2004) to determine whether a MZ has assimilative capacity for TDS and nitrate. In the Chino Basin, the Chino-North MZ maximum-benefit objective is used for compliance by the RWQCB. The Chino-North is MZ1, MZ2, and MZ3 combined upgradient of Prado Basin, and the Chino-North maximum-benefit objective is higher than the anti-degradation objectives for MZ1, MZ2, and MZ3. If the Watermaster and IEUA do not implement specific projects and programs termed the "Maximum-Benefit Commitments" (Table 5-8 in the Basin Plan), than the anti-degradation objectives would be used by the RWQCB for compliance purposes.

Shown here are time-series of ambient TDS concentration for the anti-degradation MZs and for the Chino-North MZ. TDS AWQ determinations were made for 1973, 1997, 2003, 2006, and 2009 (WEI, 2000, 2005b, 2008a, and 2011b). The current (2009) AWQ determination for TDS in Chino-North is 340 mg/L. The maximum-benefit TDS objective for Chino-North is 420 mg/L. Therefore, there is 80 mg/L of assimilative capacity (WEI, 2011b). If the current TDS AWQ were to exceed the maximum-benefit objective there would be a mitigation requirement for the recharge and direct use of recycled water. The more recent increases in TDS AWQ determinations are due to the expansion of monitoring programs in the Chino Basin and are not due to an increase in TDS concentrations in the Basin. The next AWQ TDS concentration will be determined in 2014.

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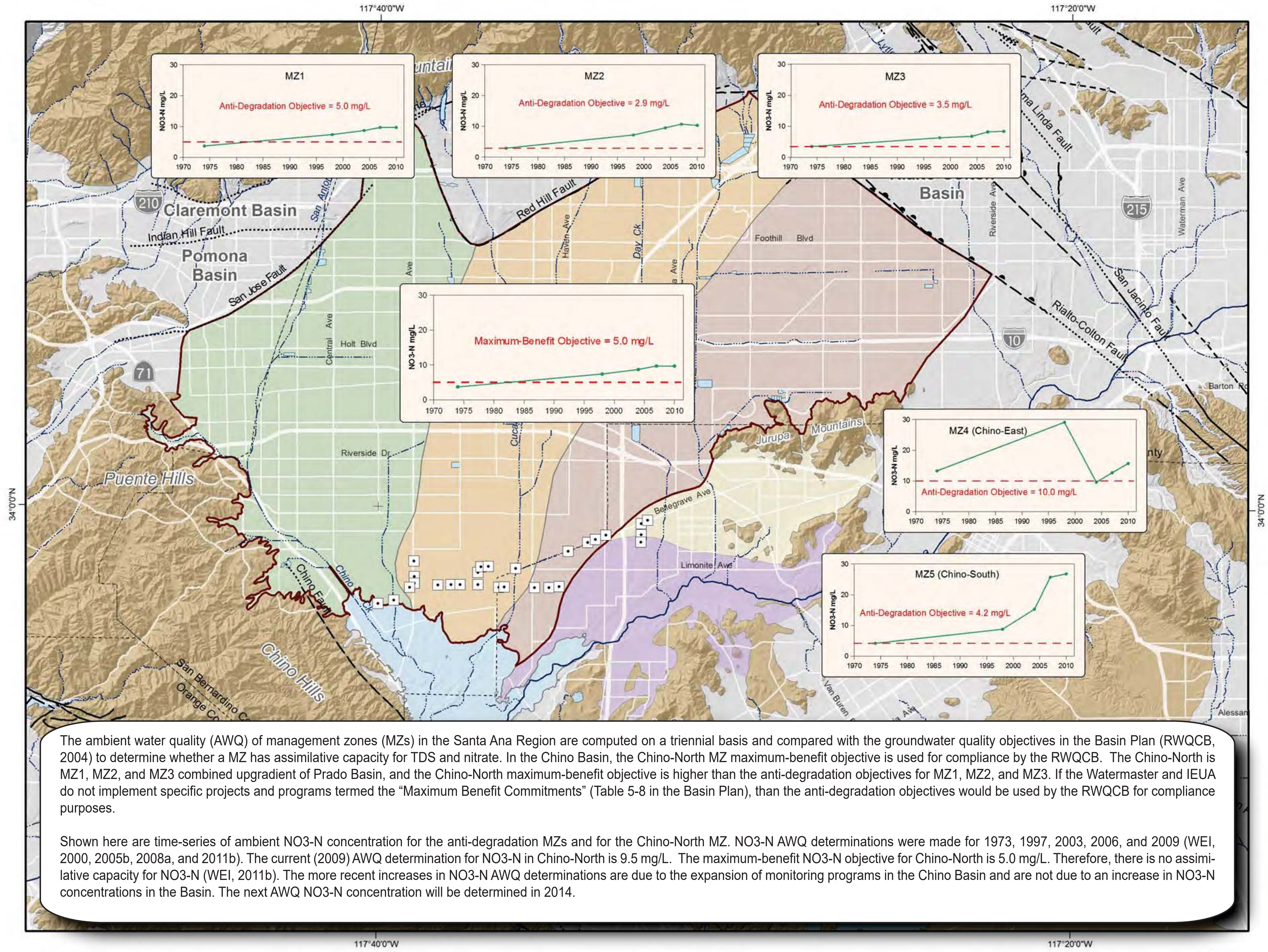
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

Trends in Ambient Water Quality Determinations for Total Dissolved Solids (TDS) By Management Zone

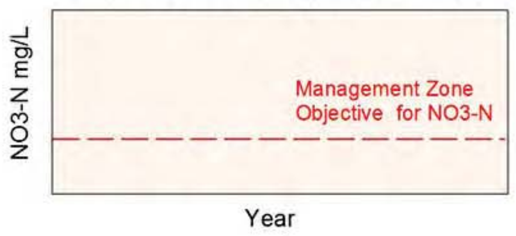
Exhibit 48



The ambient water quality (AWQ) of management zones (MZs) in the Santa Ana Region are computed on a triennial basis and compared with the groundwater quality objectives in the Basin Plan (RWQCB, 2004) to determine whether a MZ has assimilative capacity for TDS and nitrate. In the Chino Basin, the Chino-North MZ maximum-benefit objective is used for compliance by the RWQCB. The Chino-North is MZ1, MZ2, and MZ3 combined upgradient of Prado Basin, and the Chino-North maximum-benefit objective is higher than the anti-degradation objectives for MZ1, MZ2, and MZ3. If the Watermaster and IEUA do not implement specific projects and programs termed the "Maximum Benefit Commitments" (Table 5-8 in the Basin Plan), than the anti-degradation objectives would be used by the RWQCB for compliance purposes.

Shown here are time-series of ambient NO3-N concentration for the anti-degradation MZs and for the Chino-North MZ. NO3-N AWQ determinations were made for 1973, 1997, 2003, 2006, and 2009 (WEI, 2000, 2005b, 2008a, and 2011b). The current (2009) AWQ determination for NO3-N in Chino-North is 9.5 mg/L. The maximum-benefit NO3-N objective for Chino-North is 5.0 mg/L. Therefore, there is no assimilative capacity for NO3-N (WEI, 2011b). The more recent increases in NO3-N AWQ determinations are due to the expansion of monitoring programs in the Chino Basin and are not due to an increase in NO3-N concentrations in the Basin. The next AWQ NO3-N concentration will be determined in 2014.

Ambient Water Quality Determination



Anti-Degradation Management Zones and Chino-North Maximum Benefit Management Zone

⊡ Chino Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Faults

Location Certain	Location Concealed
Location Approximate	Location Uncertain
Approximate Location of Groundwater Barrier	

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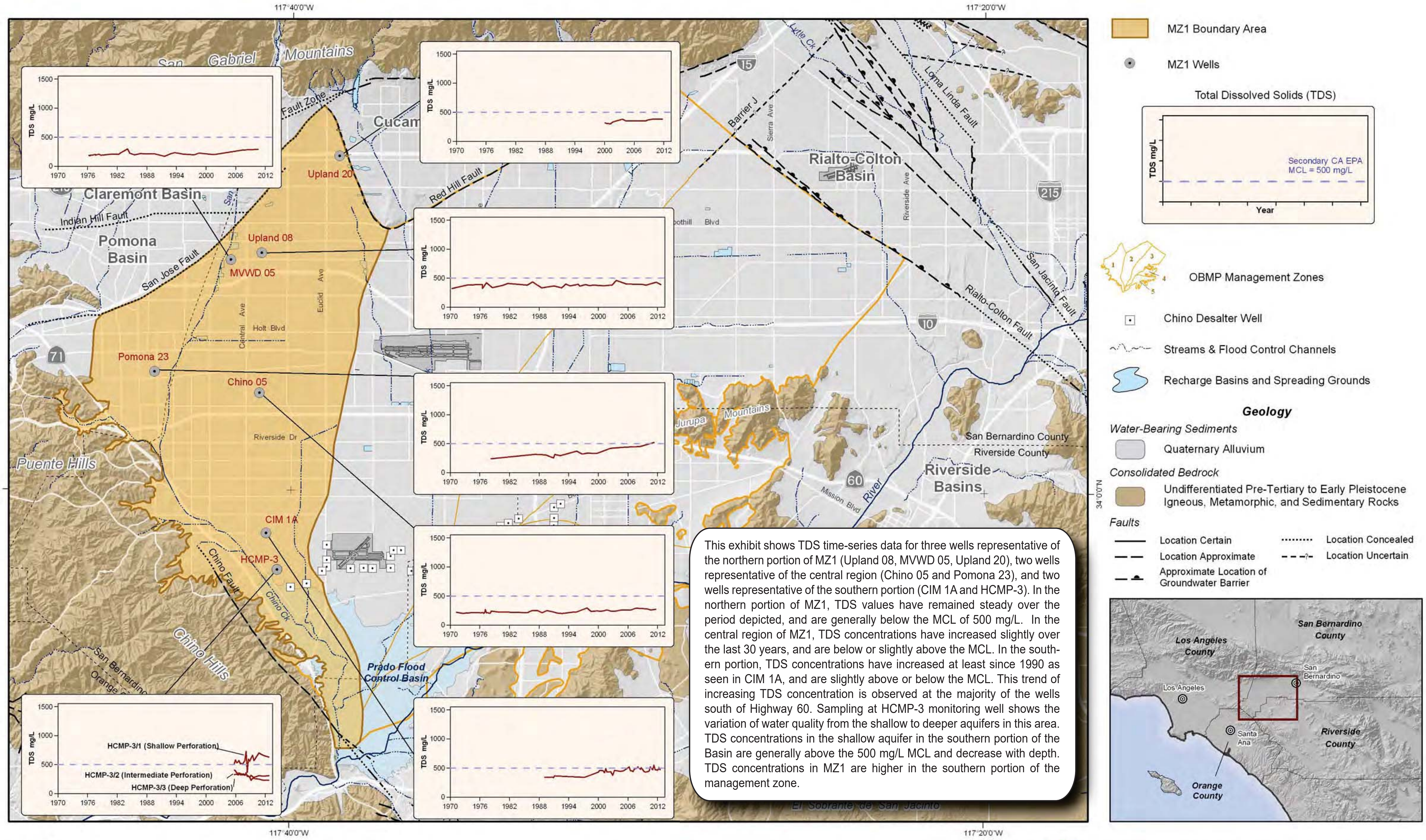
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

Trends in Ambient Water Quality Determinations for Nitrate as Nitrogen (NO3-N) By Management Zone

Exhibit 49



This exhibit shows TDS time-series data for three wells representative of the northern portion of MZ1 (Upland 08, MVWD 05, Upland 20), two wells representative of the central region (Chino 05 and Pomona 23), and two wells representative of the southern portion (CIM 1A and HCMP-3). In the northern portion of MZ1, TDS values have remained steady over the period depicted, and are generally below the MCL of 500 mg/L. In the central region of MZ1, TDS concentrations have increased slightly over the last 30 years, and are below or slightly above the MCL. In the southern portion, TDS concentrations have increased at least since 1990 as seen in CIM 1A, and are slightly above or below the MCL. This trend of increasing TDS concentration is observed at the majority of the wells south of Highway 60. Sampling at HCMP-3 monitoring well shows the variation of water quality from the shallow to deeper aquifers in this area. TDS concentrations in the shallow aquifer in the southern portion of the Basin are generally above the 500 mg/L MCL and decrease with depth. TDS concentrations in MZ1 are higher in the southern portion of the management zone.

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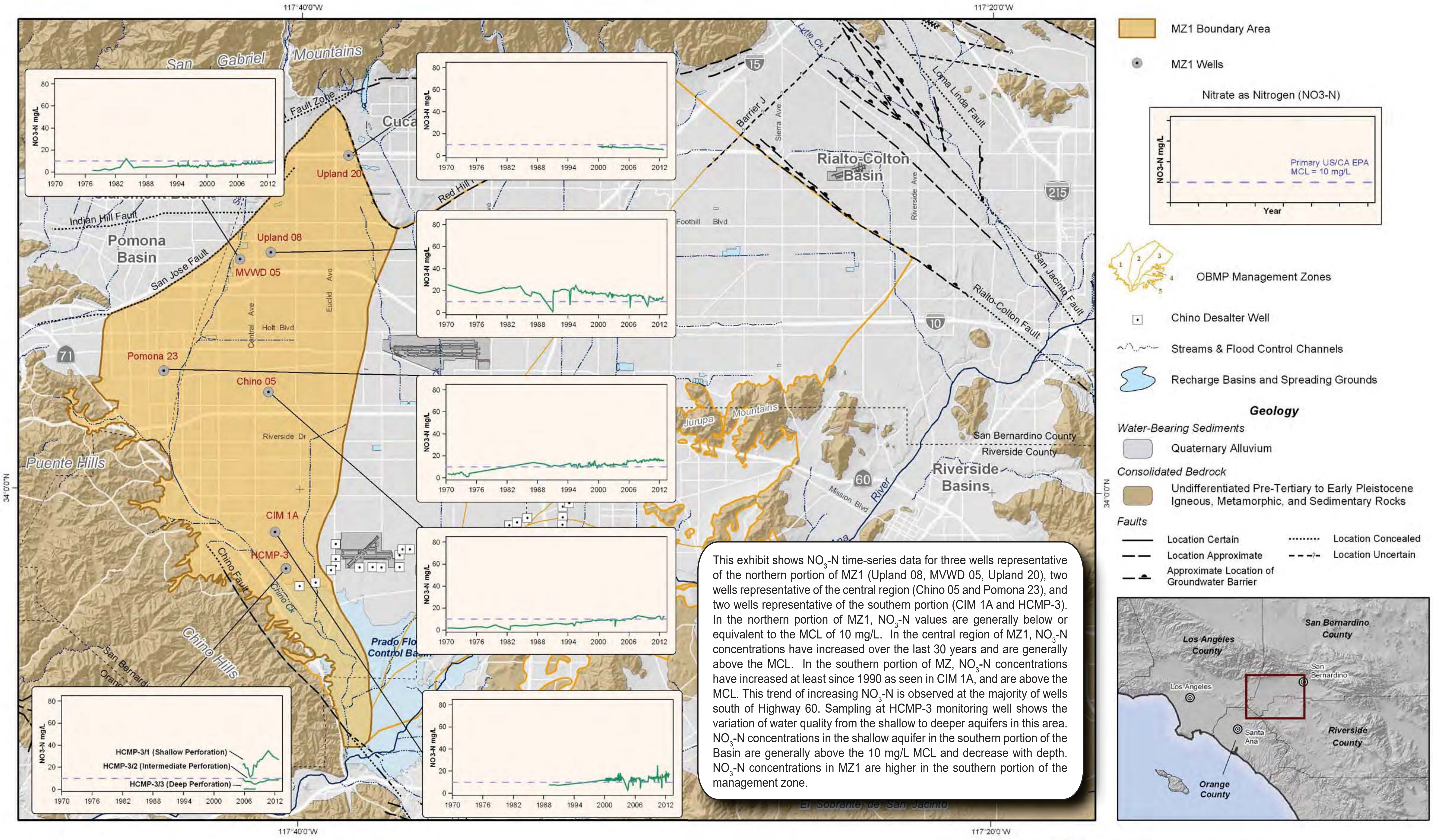
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

Chino Basin Management Zone 1

Trends in Total Dissolved Solids Concentrations

Exhibit 50



This exhibit shows NO_3-N time-series data for three wells representative of the northern portion of MZ1 (Upland 08, MVWD 05, Upland 20), two wells representative of the central region (Chino 05 and Pomona 23), and two wells representative of the southern portion (CIM 1A and HCMP-3). In the northern portion of MZ1, NO_3-N values are generally below or equivalent to the MCL of 10 mg/L. In the central region of MZ1, NO_3-N concentrations have increased over the last 30 years and are generally above the MCL. In the southern portion of MZ, NO_3-N concentrations have increased at least since 1990 as seen in CIM 1A, and are above the MCL. This trend of increasing NO_3-N is observed at the majority of wells south of Highway 60. Sampling at HCMP-3 monitoring well shows the variation of water quality from the shallow to deeper aquifers in this area. NO_3-N concentrations in the shallow aquifer in the southern portion of the Basin are generally above the 10 mg/L MCL and decrease with depth. NO_3-N concentrations in MZ1 are higher in the southern portion of the management zone.

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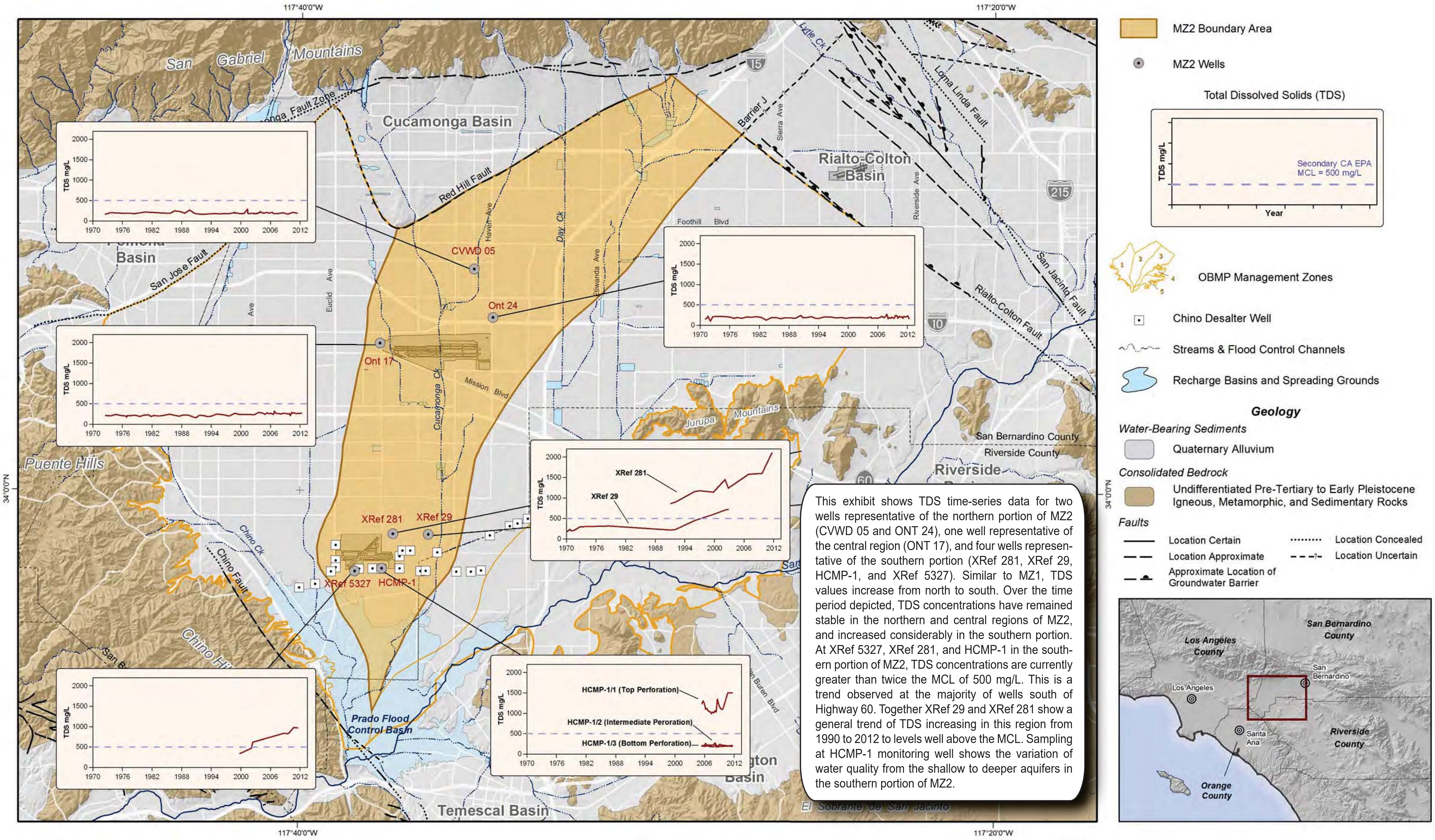
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

Chino Basin Management Zone 1

Trends in Nitrate as Nitrogen Concentrations

Exhibit 51



This exhibit shows TDS time-series data for two wells representative of the northern portion of MZ2 (CVWD 05 and ONT 24), one well representative of the central region (ONT 17), and four wells representative of the southern portion (XRef 281, XRef 29, HCMP-1, and XRef 5327). Similar to MZ1, TDS values increase from north to south. Over the time period depicted, TDS concentrations have remained stable in the northern and central regions of MZ2, and increased considerably in the southern portion. At XRef 5327, XRef 281, and HCMP-1 in the southern portion of MZ2, TDS concentrations are currently greater than twice the MCL of 500 mg/L. This is a trend observed at the majority of wells south of Highway 60. Together XRef 29 and XRef 281 show a general trend of TDS increasing in this region from 1990 to 2012 to levels well above the MCL. Sampling at HCMP-1 monitoring well shows the variation of water quality from the shallow to deeper aquifers in the southern portion of MZ2.

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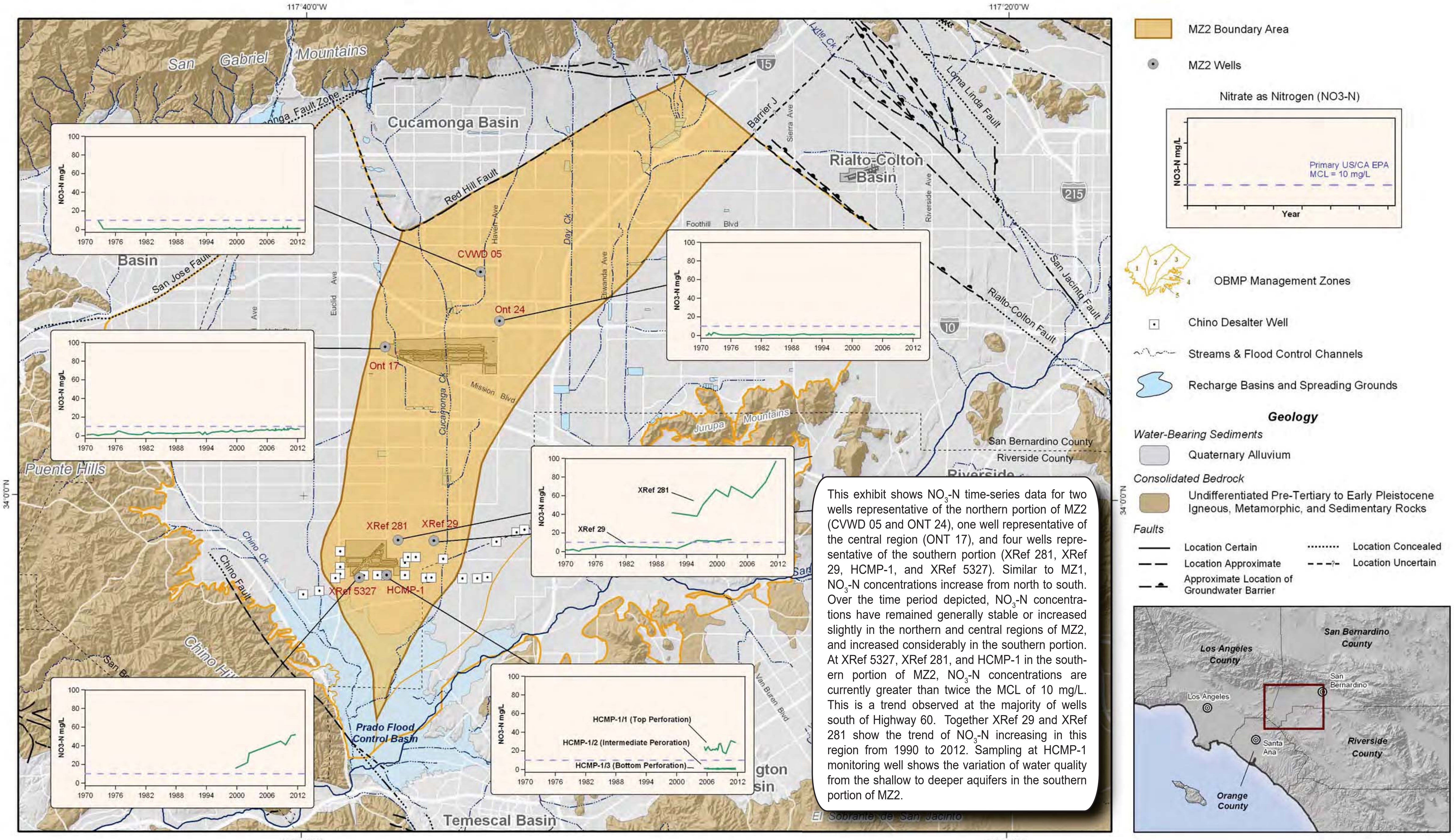
2012 State of the Basin
Groundwater Quality

Chino Basin Management Zone 2

Trends in Total Dissolved Solids Concentrations

Exhibit 52



This exhibit shows NO_3-N time-series data for two wells representative of the northern portion of MZ2 (CVWD 05 and ONT 24), one well representative of the central region (ONT 17), and four wells representative of the southern portion (XRef 281, XRef 29, HCMP-1, and XRef 5327). Similar to MZ1, NO_3-N concentrations increase from north to south. Over the time period depicted, NO_3-N concentrations have remained generally stable or increased slightly in the northern and central regions of MZ2, and increased considerably in the southern portion. At XRef 5327, XRef 281, and HCMP-1 in the southern portion of MZ2, NO_3-N concentrations are currently greater than twice the MCL of 10 mg/L. This is a trend observed at the majority of wells south of Highway 60. Together XRef 29 and XRef 281 show the trend of NO_3-N increasing in this region from 1990 to 2012. Sampling at HCMP-1 monitoring well shows the variation of water quality from the shallow to deeper aquifers in the southern portion of MZ2.

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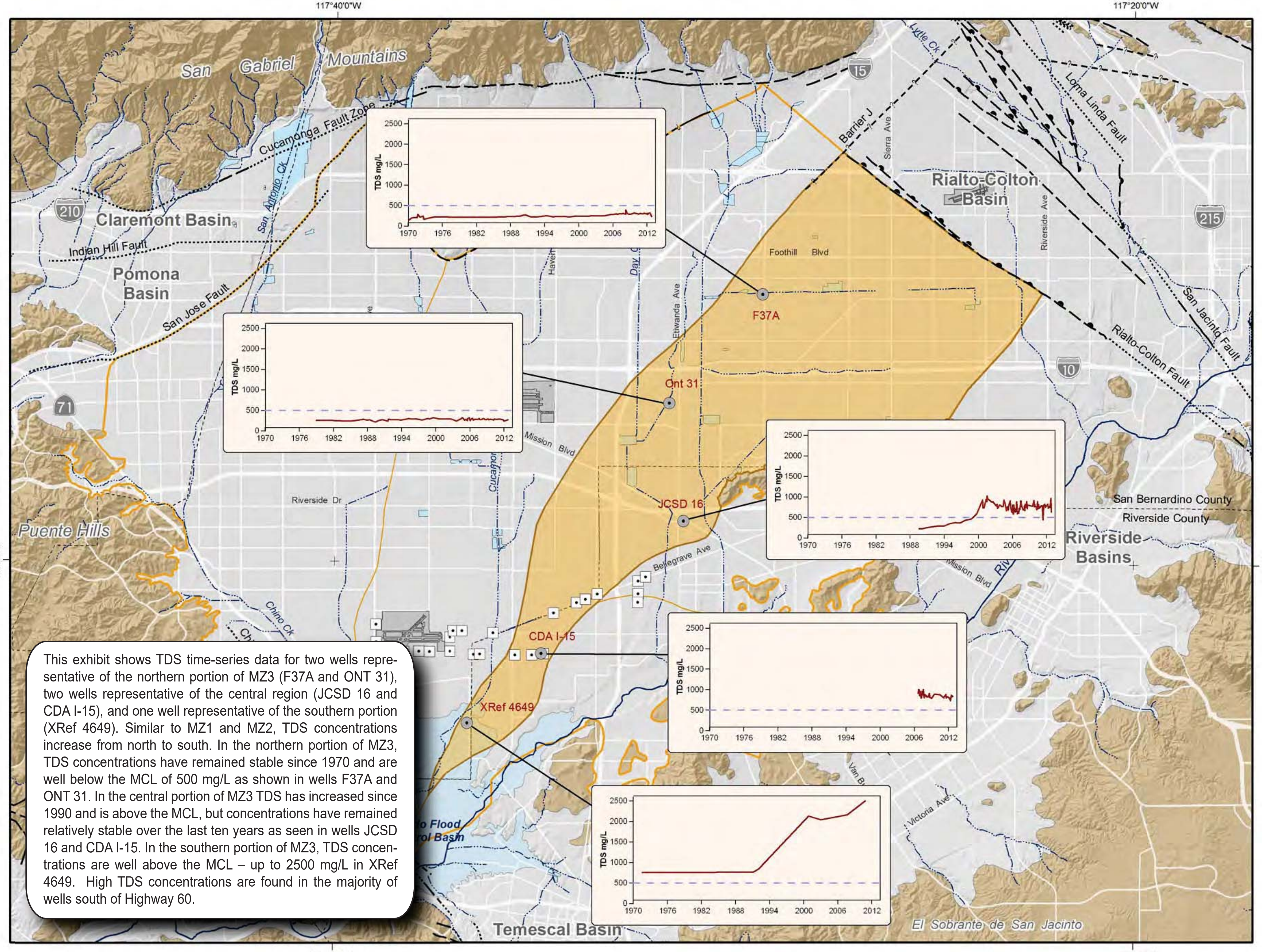
2012 State of the Basin
Groundwater Quality

Chino Basin Management Zone 2

Trends in Nitrate as Nitrogen Concentrations

Exhibit 53

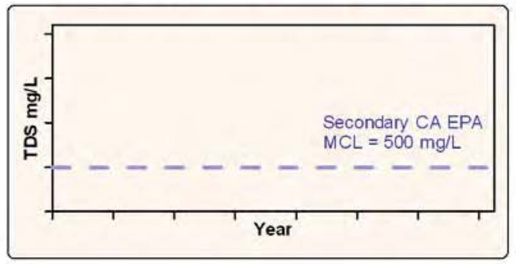


This exhibit shows TDS time-series data for two wells representative of the northern portion of MZ3 (F37A and ONT 31), two wells representative of the central region (JCSD 16 and CDA I-15), and one well representative of the southern portion (XRef 4649). Similar to MZ1 and MZ2, TDS concentrations increase from north to south. In the northern portion of MZ3, TDS concentrations have remained stable since 1970 and are well below the MCL of 500 mg/L as shown in wells F37A and ONT 31. In the central portion of MZ3 TDS has increased since 1990 and is above the MCL, but concentrations have remained relatively stable over the last ten years as seen in wells JCSD 16 and CDA I-15. In the southern portion of MZ3, TDS concentrations are well above the MCL – up to 2500 mg/L in XRef 4649. High TDS concentrations are found in the majority of wells south of Highway 60.

MZ3 Boundary Area

MZ3 Wells

Total Dissolved Solids (TDS)



OBMP Management Zones

Chino Desalter Well

Streams & Flood Control Channels

Recharge Basins and Spreading Grounds

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Faults

Location Certain

Location Approximate

Approximate Location of Groundwater Barrier

Location Concealed

Location Uncertain

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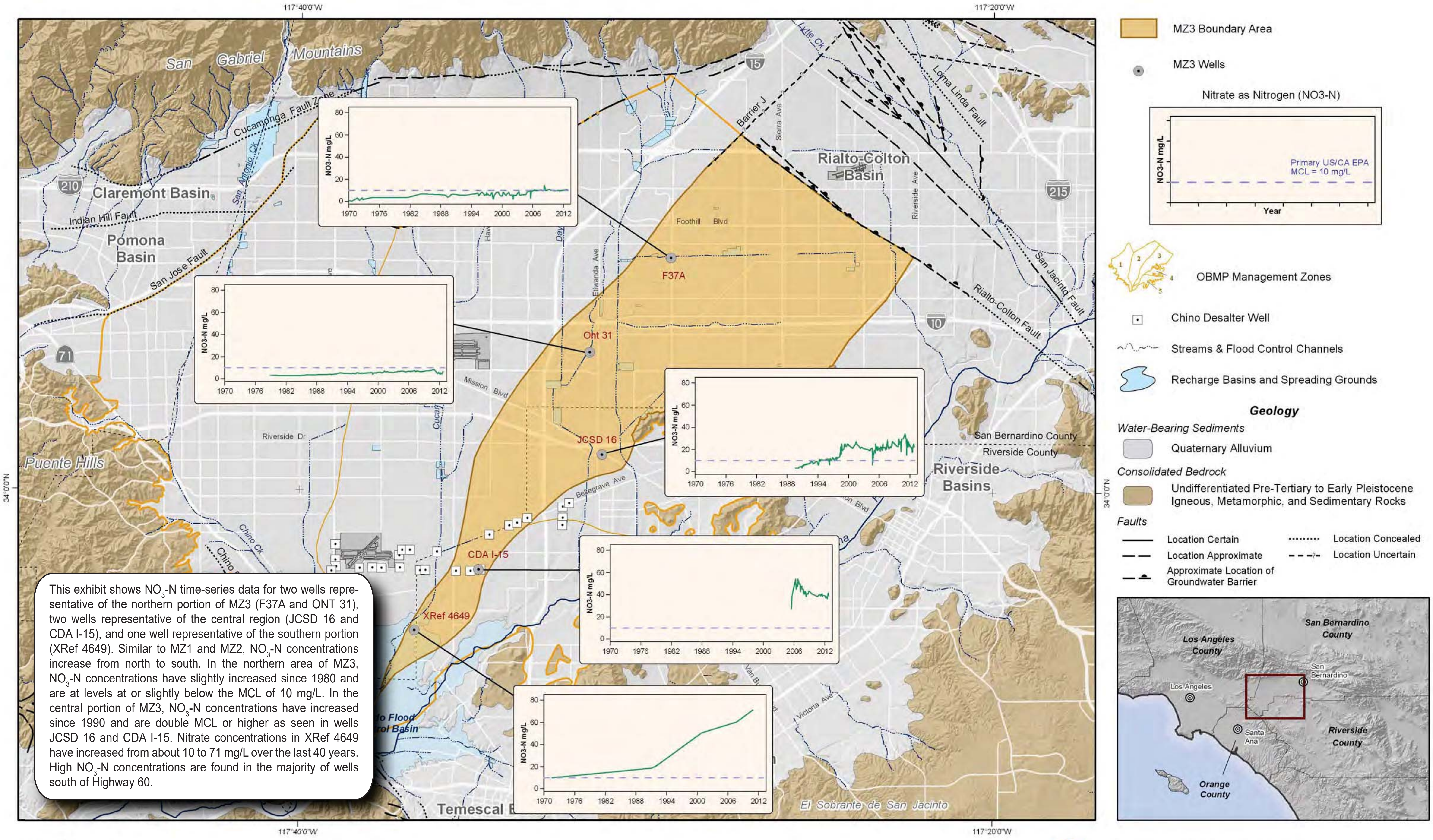
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

Chino Basin Management Zone 3

Trends in Total Dissolved Solids Concentrations

Exhibit 54



This exhibit shows NO_3-N time-series data for two wells representative of the northern portion of MZ3 (F37A and ONT 31), two wells representative of the central region (JCSD 16 and CDA I-15), and one well representative of the southern portion (XRef 4649). Similar to MZ1 and MZ2, NO_3-N concentrations increase from north to south. In the northern area of MZ3, NO_3-N concentrations have slightly increased since 1980 and are at levels at or slightly below the MCL of 10 mg/L. In the central portion of MZ3, NO_3-N concentrations have increased since 1990 and are double MCL or higher as seen in wells JCSD 16 and CDA I-15. Nitrate concentrations in XRef 4649 have increased from about 10 to 71 mg/L over the last 40 years. High NO_3-N concentrations are found in the majority of wells south of Highway 60.

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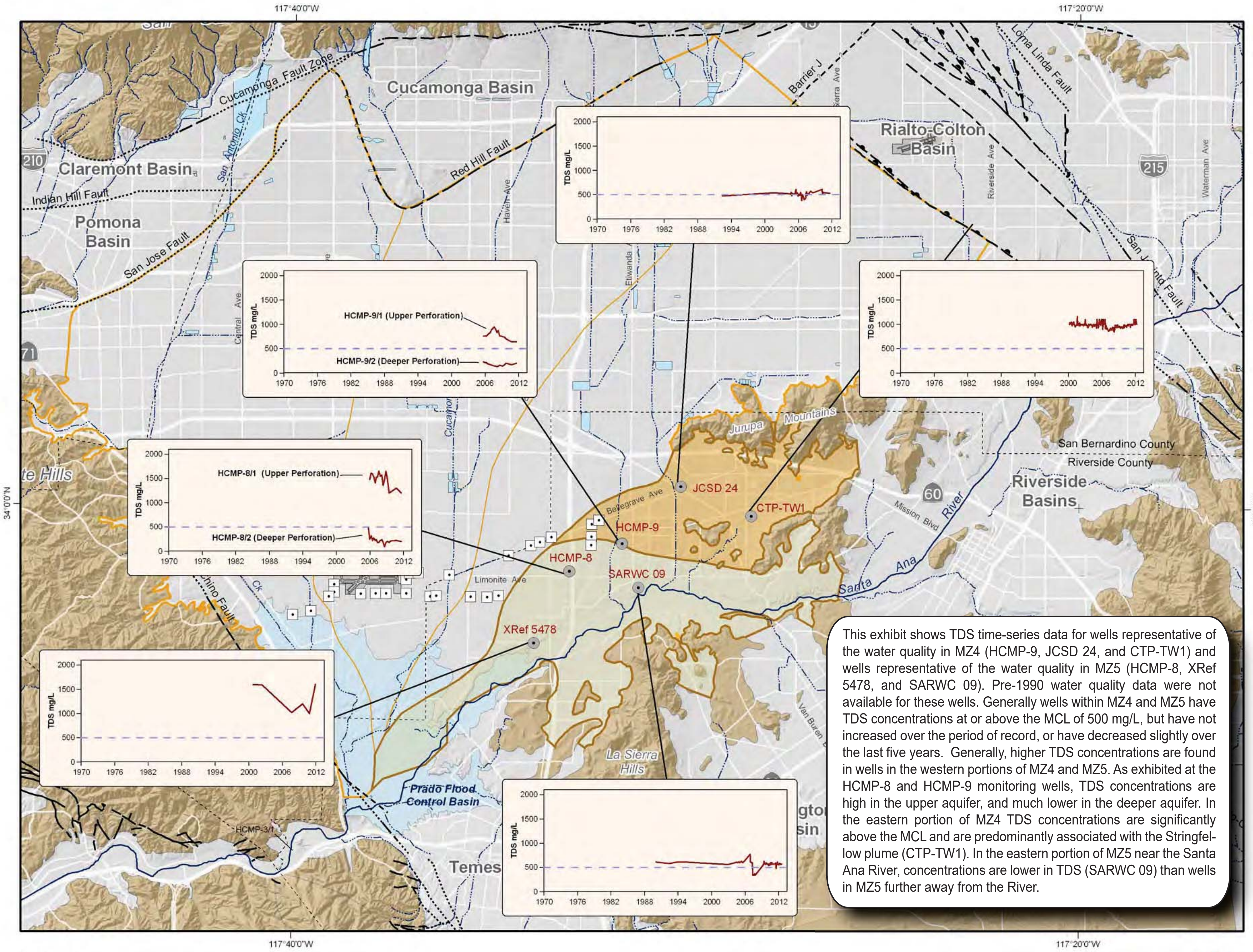
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2012 State of the Basin
Groundwater Quality

Chino Basin Management Zone 3

Trends in Nitrate as Nitrogen Concentrations

Exhibit 55



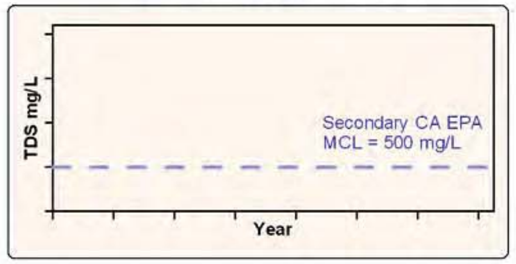
This exhibit shows TDS time-series data for wells representative of the water quality in MZ4 (HCMP-9, JCSD 24, and CTP-TW1) and wells representative of the water quality in MZ5 (HCMP-8, XRef 5478, and SARWC 09). Pre-1990 water quality data were not available for these wells. Generally wells within MZ4 and MZ5 have TDS concentrations at or above the MCL of 500 mg/L, but have not increased over the period of record, or have decreased slightly over the last five years. Generally, higher TDS concentrations are found in wells in the western portions of MZ4 and MZ5. As exhibited at the HCMP-8 and HCMP-9 monitoring wells, TDS concentrations are high in the upper aquifer, and much lower in the deeper aquifer. In the eastern portion of MZ4 TDS concentrations are significantly above the MCL and are predominantly associated with the Stringfellow plume (CTP-TW1). In the eastern portion of MZ5 near the Santa Ana River, concentrations are lower in TDS (SARWC 09) than wells in MZ5 further away from the River.

🟧 MZ4 Boundary Area

🟩 MZ5 Boundary Area

● MZ4 and MZ5 Wells

Total Dissolved Solids (TDS)



OBMP Management Zones

▣ Chino Desalter Well

Streams & Flood Control Channels

Recharge Basins and Spreading Grounds

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
Approximate Location of Groundwater Barrier	

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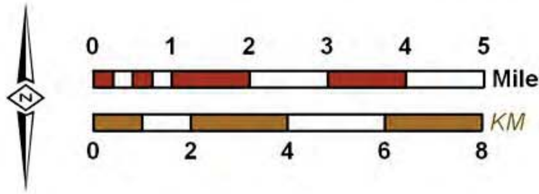
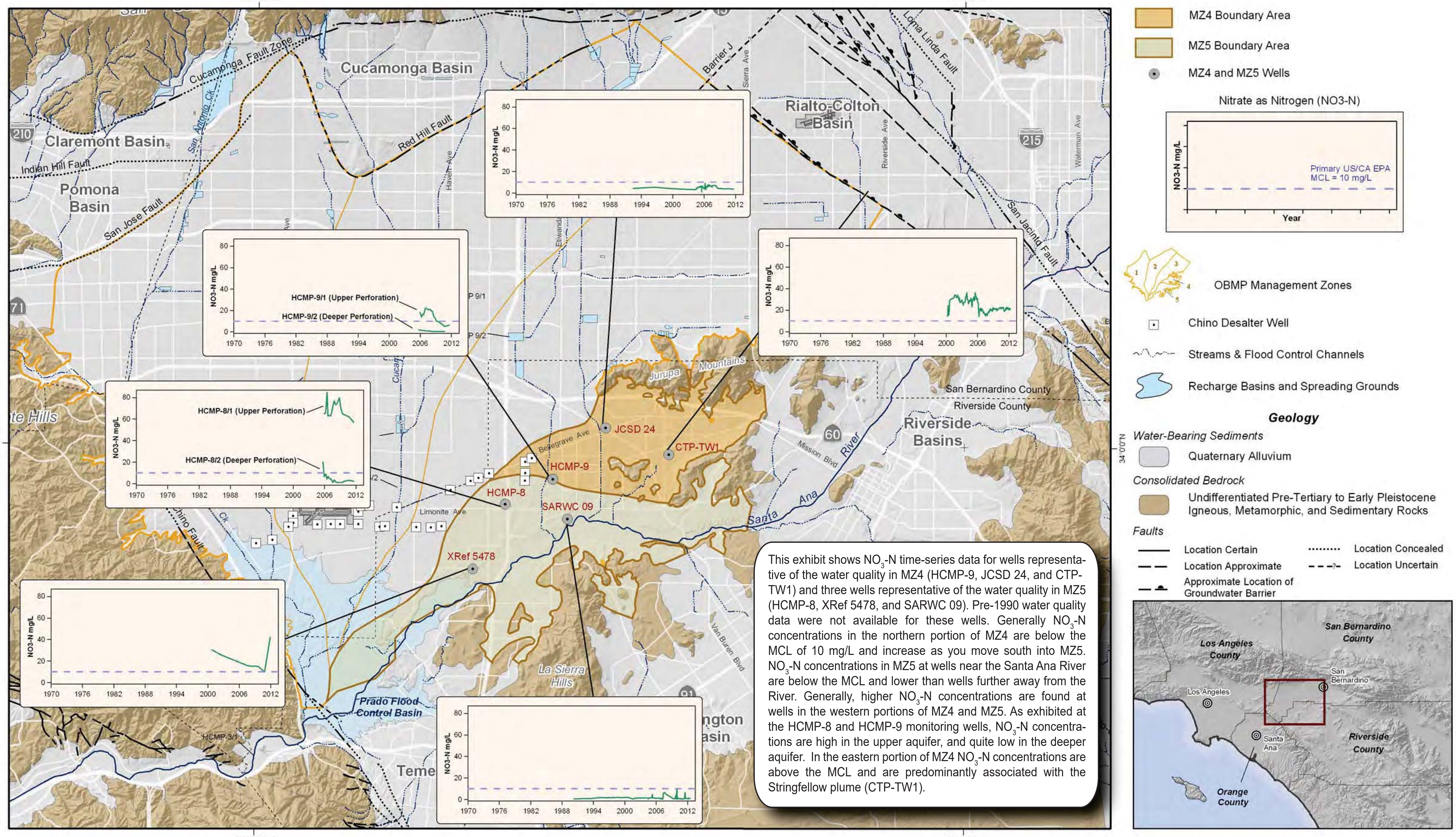


2012 State of the Basin
Groundwater Quality

Chino Basin Management Zone 4 and Zone 5

Trends in Total Dissolved Solids Concentrations

Exhibit 56



This exhibit shows NO$_3$-N time-series data for wells representative of the water quality in MZ4 (HCMP-9, JCSD 24, and CTP-TW1) and three wells representative of the water quality in MZ5 (HCMP-8, XRef 5478, and SARWC 09). Pre-1990 water quality data were not available for these wells. Generally NO$_3$-N concentrations in the northern portion of MZ4 are below the MCL of 10 mg/L and increase as you move south into MZ5. NO$_3$-N concentrations in MZ5 at wells near the Santa Ana River are below the MCL and lower than wells further away from the River. Generally, higher NO$_3$-N concentrations are found at wells in the western portions of MZ4 and MZ5. As exhibited at the HCMP-8 and HCMP-9 monitoring wells, NO$_3$-N concentrations are high in the upper aquifer, and quite low in the deeper aquifer. In the eastern portion of MZ4 NO$_3$-N concentrations are above the MCL and are predominantly associated with the Stringfellow plume (CTP-TW1).

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2012 State of the Basin
Groundwater Quality

Chino Basin Management Zone 4 and Zone 5

Trends in Nitrate as Nitrogen Concentrations

Exhibit 57

The exhibits in this section characterize the history and current state of land subsidence and ground fissuring in the Chino Basin using data from Watermaster's land-subsidence monitoring program.

One of the earliest indications of land subsidence in Chino Basin was the appearance of ground fissures in the City of Chino. These fissures appeared as early as 1973, but an accelerated occurrence of ground fissuring ensued after 1991 and resulted in damaged infrastructure.

In 1999, the OBMP Phase I Report (WEI, 1999) identified pumping-induced drawdown and subsequent aquifer-system compaction as the most likely cause of land subsidence and ground fissuring observed in MZ1. Program Element 1 – *Develop and Implement a Comprehensive Monitoring Program*, called for basin-wide analysis of land subsidence via ground-level surveys and remote sensing (InSAR) and ongoing monitoring based on the analysis of the subsidence data. Program Element 4 of the OBMP, *Develop and Implement a Comprehensive Groundwater Management Plan for Management Zone 1*, called for the development and implementation of an interim management plan for MZ1 that would:

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

In 2000, the Implementation Plan in the Peace Agreement called for an aquifer system and land subsidence investigation in the southwestern portion of MZ1 to support the development of a management plan for MZ1 (second and third bullets above). This investigation was titled the MZ1 Interim Monitoring Program (IMP). From 2001-2005, Watermaster developed, coordinated, and conducted the IMP under the guidance of the MZ1 Technical Committee, which was composed of representatives from all major producers in MZ1 and their technical consultants. The investigation methods, results, and conclusions are described in detail in the MZ1 Summary Report (WEI, 2006). The investigation provided enough information for Watermaster to develop Guidance Criteria for MZ1 that if followed, would minimize the potential for subsidence and fissuring in the investigation area. The Guidance Criteria also formed the basis for the MZ1 Subsidence Management Plan (WEI, 2007b).

The Subsidence Management Plan was developed by the MZ1 Technical Committee and approved by Watermaster in October 2007. In November 2007, the California Superior Court, which retains continuing jurisdiction over the Chino Basin Adjudication, approved the Subsidence Management Plan and ordered its implementation. The Subsidence Management Plan calls for (1) the continued scope and frequency of monitoring implemented during the IMP within the MZ1 Managed Area (see Exhibit 59) and (2) expanded monitoring of the aquifer system and land subsidence in other areas of the Chino Basin where the IMP indicated concern for future subsidence and ground fissuring.

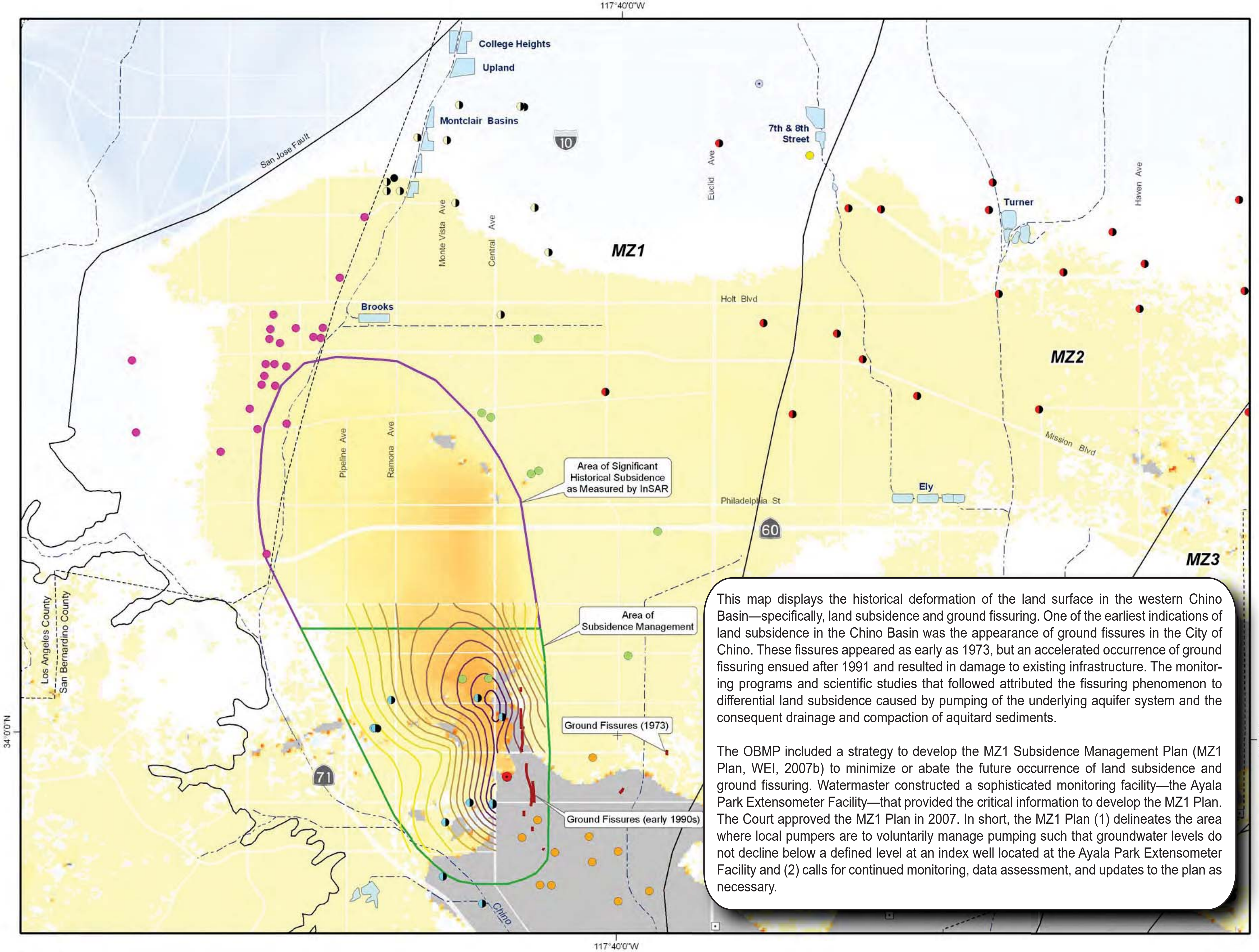
Watermaster's current subsidence monitoring program includes:

- *Piezometric Levels*. Piezometric levels are an important part of the ground-level monitoring program because piezometric changes are the mechanism for aquifer-system deformation and land subsidence. Watermaster monitors piezometric levels at about 33 wells in MZ1. Currently, a pressure-transducer/data-logger is installed at each of these wells and records one water-level reading every 15 minutes. Watermaster also records depth-specific water levels at the piezometers located at the Ayala Park Extensometer Facility every 15 minutes.
- *Aquifer-System Deformation*. Watermaster records aquifer-system deformation at the Ayala Park Extensometer Facility (see Exhibit 59). At this facility, two extensometers, completed at 550 ft-bgs (Shallow Extensometer) and 1,400 ft-bgs (Deep Extensometer). In 2012, Watermaster installed another extensometer facility, the Chino Creek Extensometer Facility (CCX), in the Southeast Area south of the Chino Airport. The CCX also consists of two extensometers: one completed to 140 ft-bgs (CCX-1) and the other to 610 ft-bgs (CCX-2). These facilities record the vertical component of aquifer-system compression and/or expansion once every 15 minutes which is synchronized with the piezometric measurements.
- *Vertical Ground-Surface Deformation*. Watermaster monitors vertical ground-surface deformation via the ground-level surveying and remote sensing (InSAR) techniques established during the IMP. Currently, ground-level surveys are being conducted in the MZ1 Managed Area and the Southeast Area once per year. InSAR is the only monitoring technique being employed outside of these two areas. InSAR data are collected and analyzed once per year.
- *Horizontal Ground-Surface Deformation*. Watermaster monitors horizontal ground-surface displacement across the historical zone of ground fissuring. These data are obtained by electronic distance measurements (EDMs) between benchmark monuments and by a horizontal extensometer, and are used to characterize the horizontal component of ground motion caused by groundwater production on either side of the fissure zone.

Exhibits 58 through 60 illustrate the historical occurrence of land subsidence in the Chino Basin as interpreted from InSAR and ground-level surveys. Historical ground-motion data (shown in Exhibit 58) and recent ground-motion data (shown in Exhibits 59 and 60) indicate that land subsidence concerns are primarily confined to the west side of Chino Basin.

Watermaster has determined from its studies that land subsidence that has occurred in the Chino Basin was mainly controlled by changes in groundwater levels, which, in turn, were mainly controlled by pumping and recharge. Exhibits 61 through 65 show the relationships between groundwater pumping, recharge, recycled water reuse, groundwater levels, and vertical ground motion. These graphics reveal cause and effect relationships, the current state of vertical ground motion, and the nature of the land subsidence (e.g. elastic, inelastic, differential, etc.).

Watermaster convenes a Land Subsidence Committee annually to review and interpret the data from the subsidence monitoring program. The committee can evaluate the appropriateness of the Guidance Criteria in the MZ1 Plan and recommend changes, if appropriate. The committee also recommends appropriate changes to the monitoring program. Watermaster's Subsidence Management Plan is a prime example of the success of the OBMP, and strategic basin management.



This map displays the historical deformation of the land surface in the western Chino Basin—specifically, land subsidence and ground fissuring. One of the earliest indications of land subsidence in the Chino Basin was the appearance of ground fissures in the City of Chino. These fissures appeared as early as 1973, but an accelerated occurrence of ground fissuring ensued after 1991 and resulted in damage to existing infrastructure. The monitoring programs and scientific studies that followed attributed the fissuring phenomenon to differential land subsidence caused by pumping of the underlying aquifer system and the consequent drainage and compaction of aquitard sediments.

The OBMP included a strategy to develop the MZ1 Subsidence Management Plan (MZ1 Plan, WEI, 2007b) to minimize or abate the future occurrence of land subsidence and ground fissuring. Watermaster constructed a sophisticated monitoring facility—the Ayala Park Extensometer Facility—that provided the critical information to develop the MZ1 Plan. The Court approved the MZ1 Plan in 2007. In short, the MZ1 Plan (1) delineates the area where local pumpers are to voluntarily manage pumping such that groundwater levels do not decline below a defined level at an index well located at the Ayala Park Extensometer Facility and (2) calls for continued monitoring, data assessment, and updates to the plan as necessary.

Contours of Relative Change in Land Surface Altitude as Measured by Leveling Surveys 1987 to 1999

0.0 ft

-2.2 ft

Relative Change in Land Surface Altitude as Measured by InSAR Oct. 1993 to Dec. 1995

+ 1 ft

0

- 1 ft

▨ InSAR data absent (incoherent)

Active Production Wells by Owner

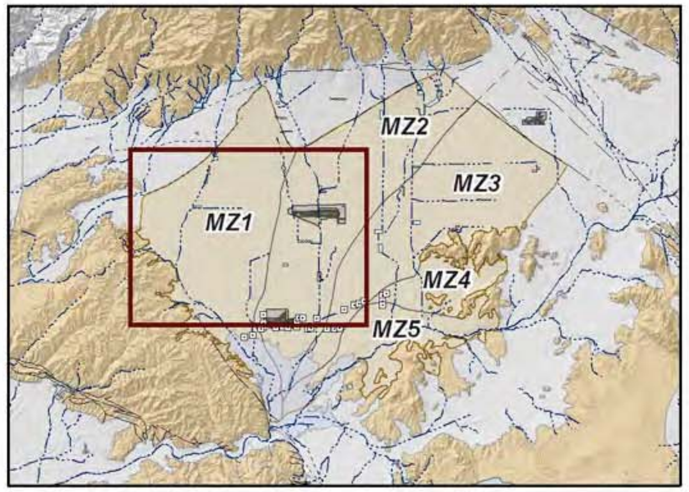
● Ontario	⊙ Upland	◐ Chino Hills
● Pomona	● GSWC	● Chino
● SAWC	● CIM	◐ MVWD

⊡ Chino Basin Desalter Authority

ʃ Ground Fissures

● Ayala Park Extensometer Facility

Flood Control & Conservation Basins



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File: Exhibit_58.mxd

0 1 2 3 Miles

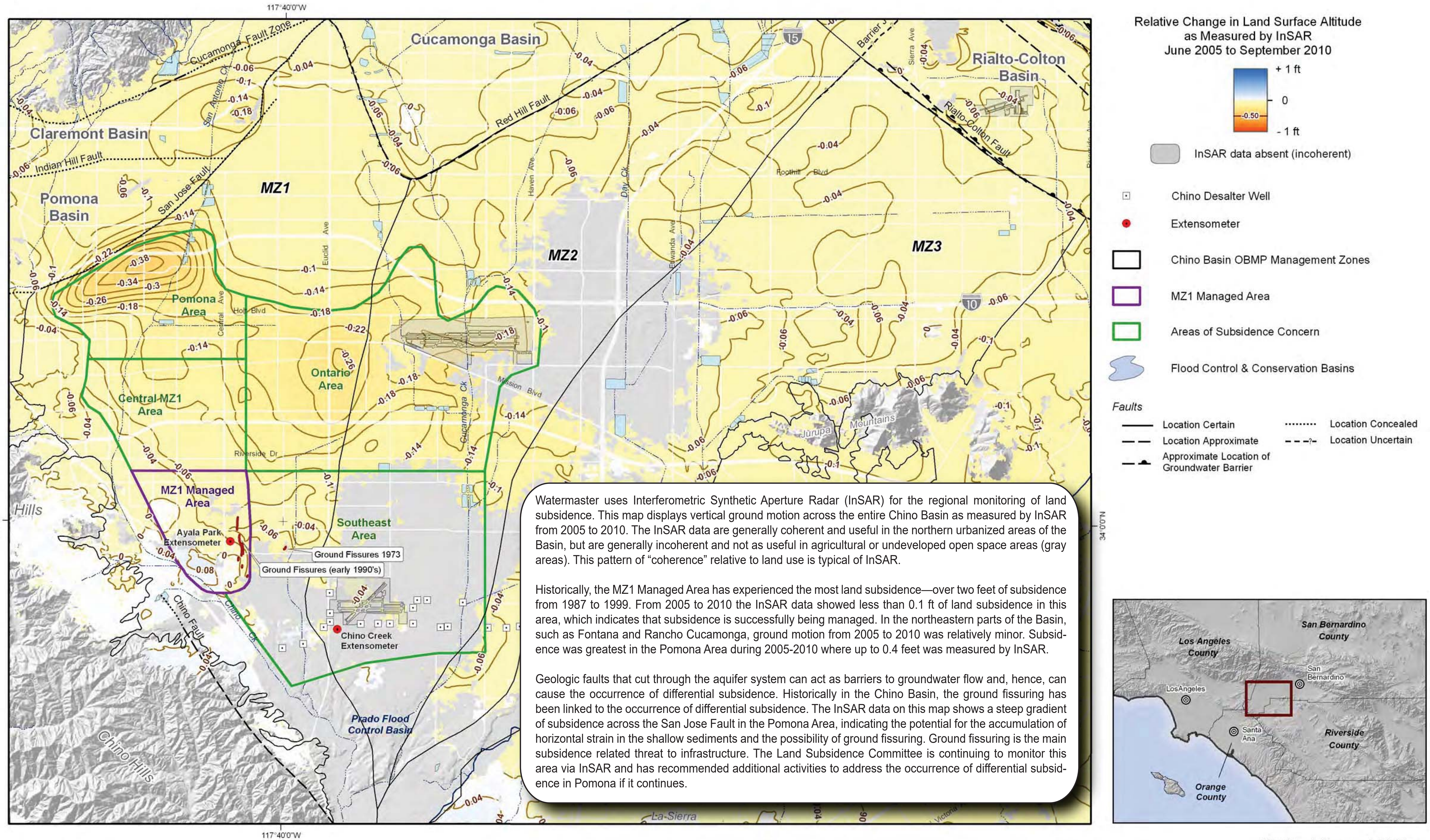
0 1 2 3 4 KM

2012 State of the Basin
Land Subsidence Monitoring

Historical Land Surface Deformation in Management Zone 1

Leveling Surveys (1987 to 1999) and InSAR (1993 to 1995)

Exhibit 58



Watermaster uses Interferometric Synthetic Aperture Radar (InSAR) for the regional monitoring of land subsidence. This map displays vertical ground motion across the entire Chino Basin as measured by InSAR from 2005 to 2010. The InSAR data are generally coherent and useful in the northern urbanized areas of the Basin, but are generally incoherent and not as useful in agricultural or undeveloped open space areas (gray areas). This pattern of "coherence" relative to land use is typical of InSAR.

Historically, the MZ1 Managed Area has experienced the most land subsidence—over two feet of subsidence from 1987 to 1999. From 2005 to 2010 the InSAR data showed less than 0.1 ft of land subsidence in this area, which indicates that subsidence is successfully being managed. In the northeastern parts of the Basin, such as Fontana and Rancho Cucamonga, ground motion from 2005 to 2010 was relatively minor. Subsidence was greatest in the Pomona Area during 2005-2010 where up to 0.4 feet was measured by InSAR.

Geologic faults that cut through the aquifer system can act as barriers to groundwater flow and, hence, can cause the occurrence of differential subsidence. Historically in the Chino Basin, the ground fissuring has been linked to the occurrence of differential subsidence. The InSAR data on this map shows a steep gradient of subsidence across the San Jose Fault in the Pomona Area, indicating the potential for the accumulation of horizontal strain in the shallow sediments and the possibility of ground fissuring. Ground fissuring is the main subsidence related threat to infrastructure. The Land Subsidence Committee is continuing to monitor this area via InSAR and has recommended additional activities to address the occurrence of differential subsidence in Pomona if it continues.

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2012 State of the Basin
Land Subsidence Monitoring

Vertical Ground Motion as Measured by InSAR

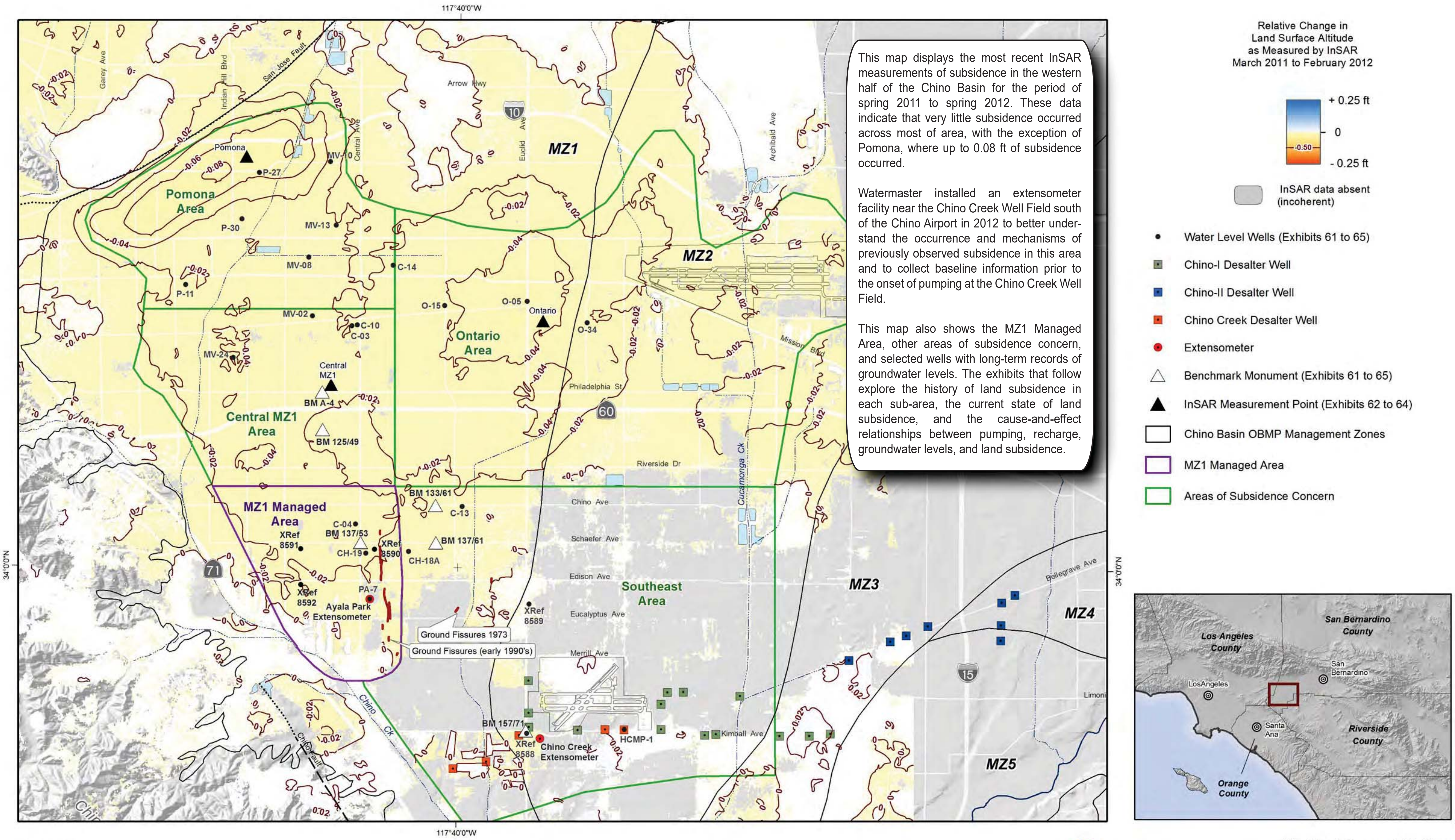
2005 to 2010

Exhibit 59

Vertical Ground Motion as Measured by InSAR

2011 to 2012

Exhibit 60



This map displays the most recent InSAR measurements of subsidence in the western half of the Chino Basin for the period of spring 2011 to spring 2012. These data indicate that very little subsidence occurred across most of area, with the exception of Pomona, where up to 0.08 ft of subsidence occurred.

Watermaster installed an extensometer facility near the Chino Creek Well Field south of the Chino Airport in 2012 to better understand the occurrence and mechanisms of previously observed subsidence in this area and to collect baseline information prior to the onset of pumping at the Chino Creek Well Field.

This map also shows the MZ1 Managed Area, other areas of subsidence concern, and selected wells with long-term records of groundwater levels. The exhibits that follow explore the history of land subsidence in each sub-area, the current state of land subsidence, and the cause-and-effect relationships between pumping, recharge, groundwater levels, and land subsidence.

0 1 2 3 Miles

0 1 2 3 4 KM

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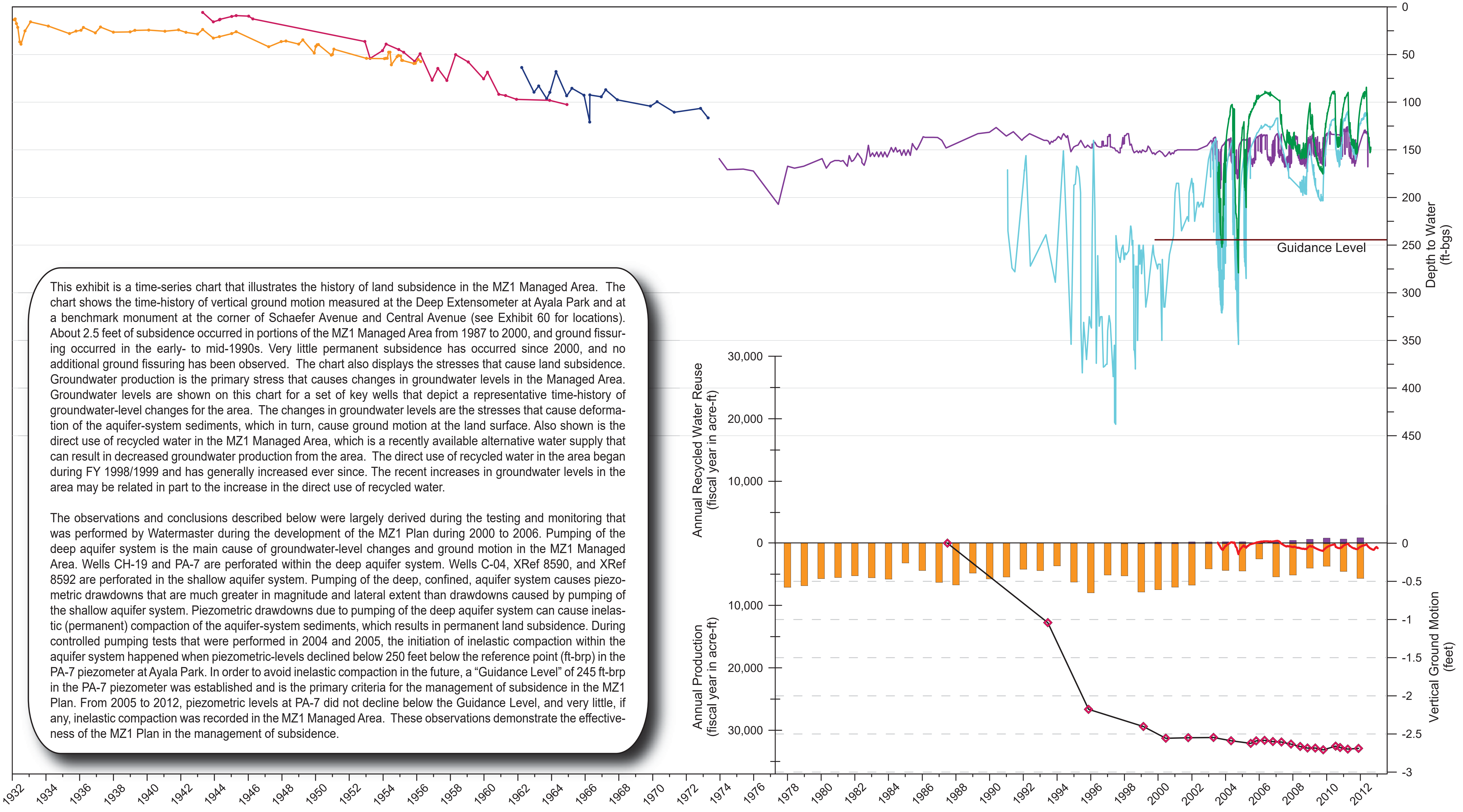
2012 State of the Basin
Land Subsidence Monitoring



This exhibit is a time-series chart that illustrates the history of land subsidence in the MZ1 Managed Area. The chart shows the time-history of vertical ground motion measured at the Deep Extensometer at Ayala Park and at a benchmark monument at the corner of Schaefer Avenue and Central Avenue (see Exhibit 60 for locations). About 2.5 feet of subsidence occurred in portions of the MZ1 Managed Area from 1987 to 2000, and ground fissuring occurred in the early- to mid-1990s. Very little permanent subsidence has occurred since 2000, and no additional ground fissuring has been observed. The chart also displays the stresses that cause land subsidence. Groundwater production is the primary stress that causes changes in groundwater levels in the Managed Area. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which in turn, cause ground motion at the land surface. Also shown is the direct use of recycled water in the MZ1 Managed Area, which is a recently available alternative water supply that can result in decreased groundwater production from the area. The direct use of recycled water in the area began during FY 1998/1999 and has generally increased ever since. The recent increases in groundwater levels in the area may be related in part to the increase in the direct use of recycled water.

The observations and conclusions described below were largely derived during the testing and monitoring that was performed by Watermaster during the development of the MZ1 Plan during 2000 to 2006. Pumping of the deep aquifer system is the main cause of groundwater-level changes and ground motion in the MZ1 Managed Area. Wells CH-19 and PA-7 are perforated within the deep aquifer system. Wells C-04, XRef 8590, and XRef 8592 are perforated in the shallow aquifer system. Pumping of the deep, confined, aquifer system causes piezometric drawdowns that are much greater in magnitude and lateral extent than drawdowns caused by pumping of the shallow aquifer system. Piezometric drawdowns due to pumping of the deep aquifer system can cause inelastic (permanent) compaction of the aquifer-system sediments, which results in permanent land subsidence. During controlled pumping tests that were performed in 2004 and 2005, the initiation of inelastic compaction within the aquifer system happened when piezometric-levels declined below 250 feet below the reference point (ft-brp) in the PA-7 piezometer at Ayala Park. In order to avoid inelastic compaction in the future, a "Guidance Level" of 245 ft-brp in the PA-7 piezometer was established and is the primary criteria for the management of subsidence in the MZ1 Plan. From 2005 to 2012, piezometric levels at PA-7 did not decline below the Guidance Level, and very little, if any, inelastic compaction was recorded in the MZ1 Managed Area. These observations demonstrate the effectiveness of the MZ1 Plan in the management of subsidence.

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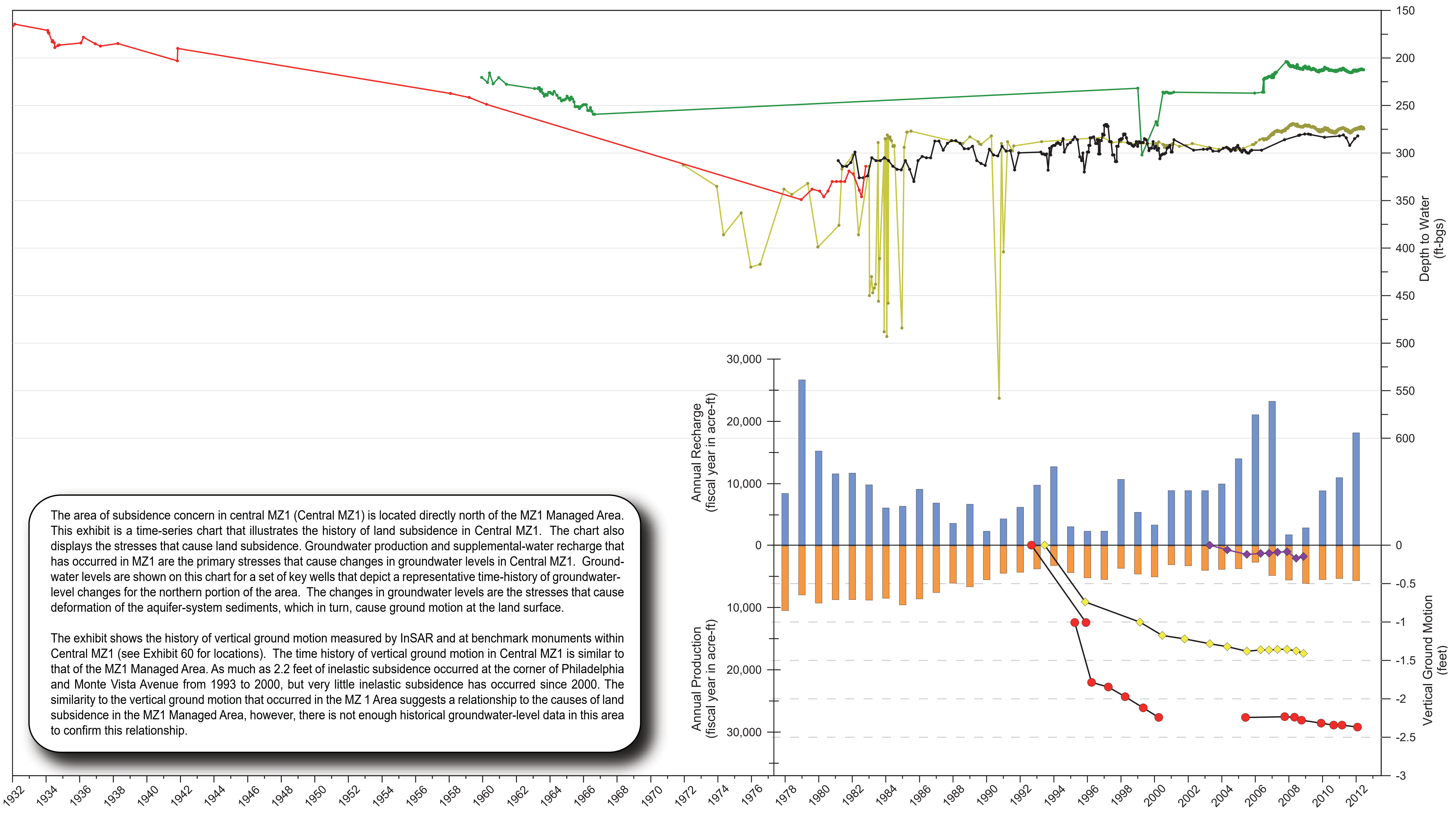
2012 State of the Basin
Land Subsidence Monitoring

The History of Land Subsidence in the MZ1 Managed Area

Exhibit 61



The area of subsidence concern in central MZ1 (Central MZ1) is located directly north of the MZ1 Managed Area. This exhibit is a time-series chart that illustrates the history of land subsidence in Central MZ1. The chart also displays the stresses that cause land subsidence. Groundwater production and supplemental-water recharge that has occurred in MZ1 are the primary stresses that cause changes in groundwater levels in Central MZ1. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the northern portion of the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which in turn, cause ground motion at the land surface.

The exhibit shows the history of vertical ground motion measured by InSAR and at benchmark monuments within Central MZ1 (see Exhibit 60 for locations). The time history of vertical ground motion in Central MZ1 is similar to that of the MZ1 Managed Area. As much as 2.2 feet of inelastic subsidence occurred at the corner of Philadelphia and Monte Vista Avenue from 1993 to 2000, but very little inelastic subsidence has occurred since 2000. The similarity to the vertical ground motion that occurred in the MZ 1 Area suggests a relationship to the causes of land subsidence in the MZ1 Managed Area, however, there is not enough historical groundwater-level data in this area to confirm this relationship.

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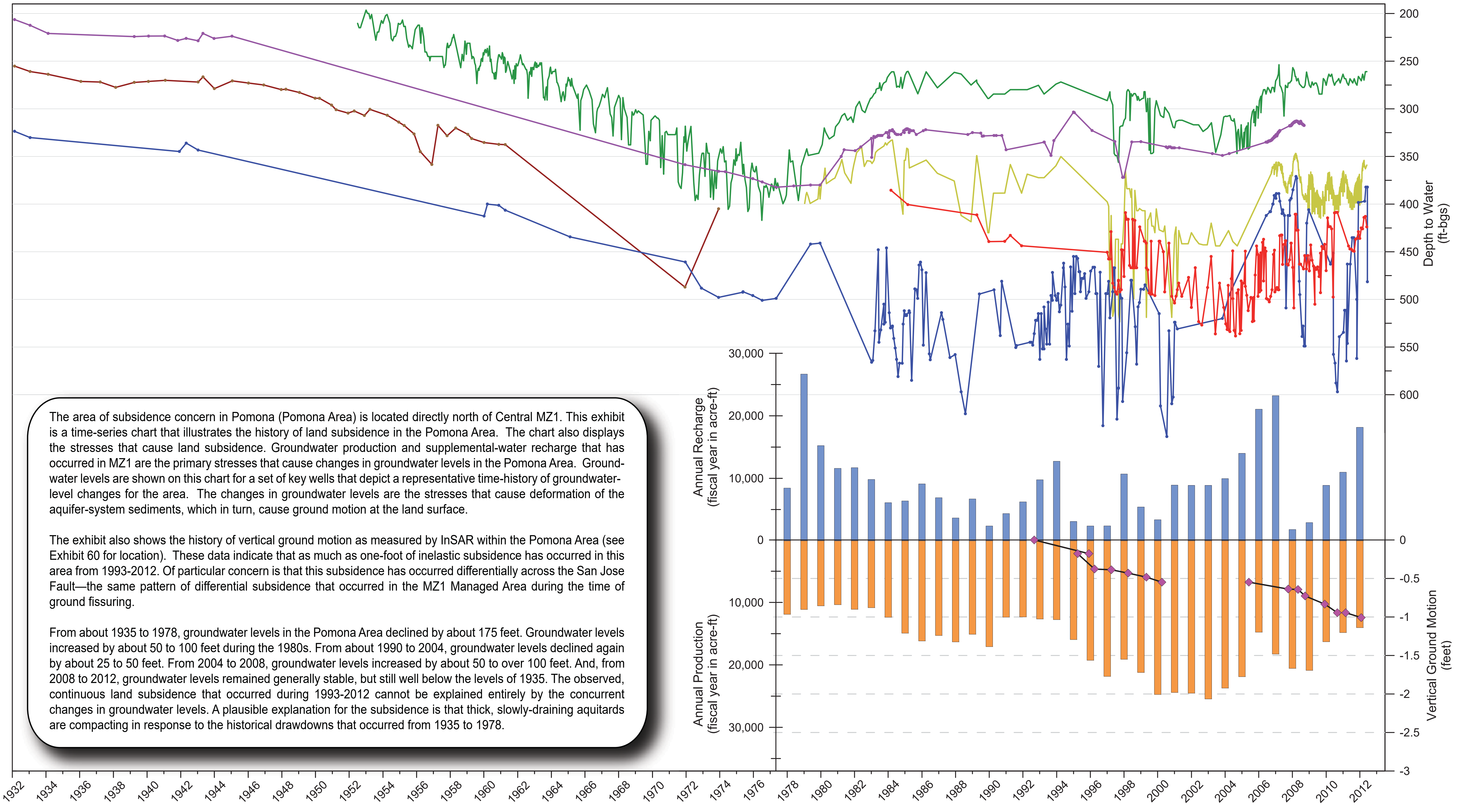
2012 State of the Basin
Land Subsidence Monitoring

The History of Land Subsidence in the Central MZ1 Area

Exhibit 62



The area of subsidence concern in Pomona (Pomona Area) is located directly north of Central MZ1. This exhibit is a time-series chart that illustrates the history of land subsidence in the Pomona Area. The chart also displays the stresses that cause land subsidence. Groundwater production and supplemental-water recharge that has occurred in MZ1 are the primary stresses that cause changes in groundwater levels in the Pomona Area. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which in turn, cause ground motion at the land surface.

The exhibit also shows the history of vertical ground motion as measured by InSAR within the Pomona Area (see Exhibit 60 for location). These data indicate that as much as one-foot of inelastic subsidence has occurred in this area from 1993-2012. Of particular concern is that this subsidence has occurred differentially across the San Jose Fault—the same pattern of differential subsidence that occurred in the MZ1 Managed Area during the time of ground fissuring.

From about 1935 to 1978, groundwater levels in the Pomona Area declined by about 175 feet. Groundwater levels increased by about 50 to 100 feet during the 1980s. From about 1990 to 2004, groundwater levels declined again by about 25 to 50 feet. From 2004 to 2008, groundwater levels increased by about 50 to over 100 feet. And, from 2008 to 2012, groundwater levels remained generally stable, but still well below the levels of 1935. The observed, continuous land subsidence that occurred during 1993-2012 cannot be explained entirely by the concurrent changes in groundwater levels. A plausible explanation for the subsidence is that thick, slowly-draining aquitards are compacting in response to the historical drawdowns that occurred from 1935 to 1978.

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Groundwater Levels at Wells (Perforated Interval Depth)

- P-11(168-550 ft-bgs)
- MV-08 (225-447 ft-bgs)
- MV-13 (203-475 ft-bgs)
- P-30 (565-875 ft-bgs)
- P-27 (472-849 ft-bgs)
- MV-10 (520-1084 ft-bgs)

Vertical Ground Motion

- Pomona Area InSAR Cumulative Displacement

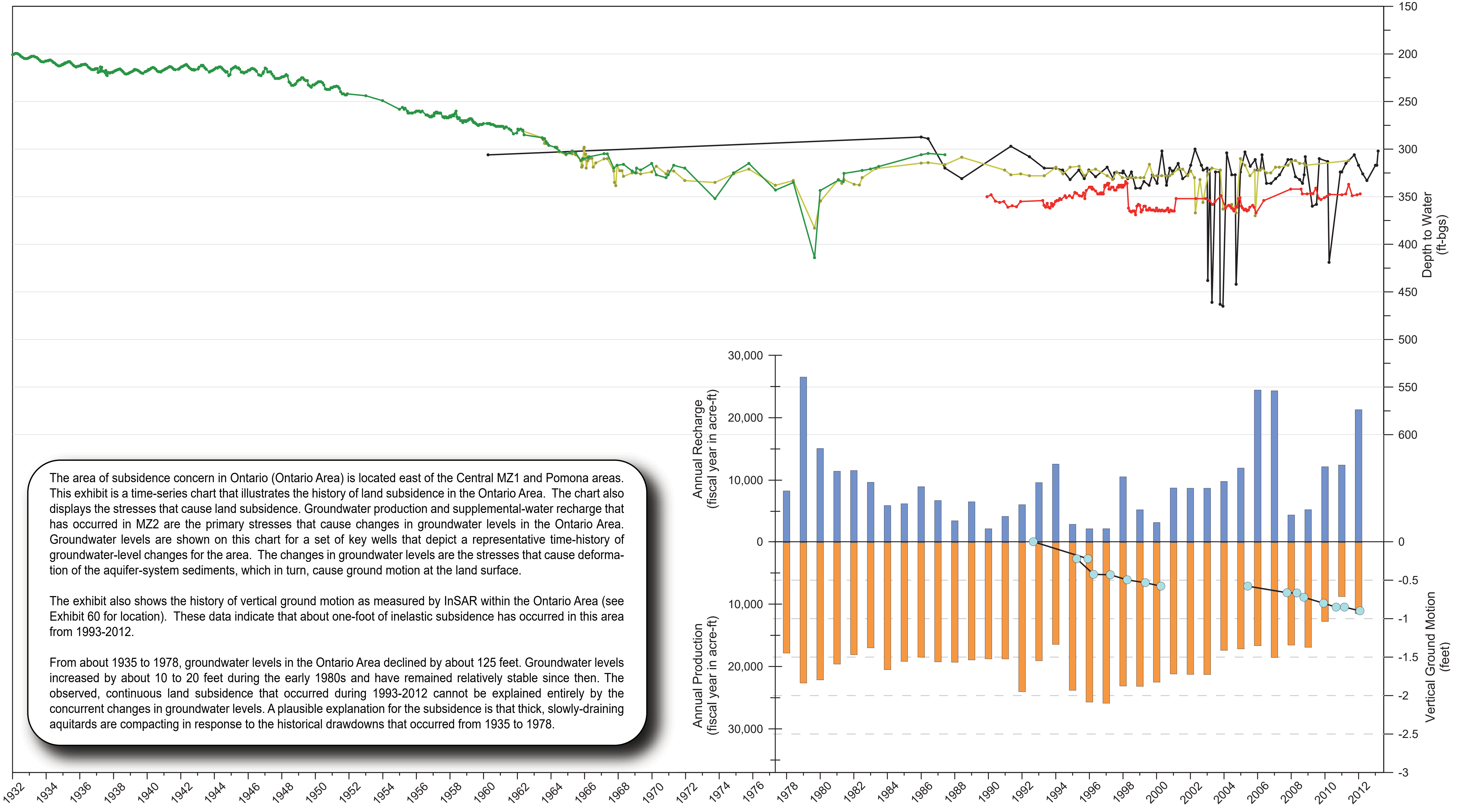
Recharge and Production

- Recharge of Recycled Water, Storm Water*, and Imported Water at the College Heights, Upland, Montclair, and Brooks Basins; and at MVWD ASR Wells
  *Storm Water is an estimated amount prior to Fiscal Year 04/05
- Groundwater Production from Wells in Pomona Area

2012 State of the Basin
Land Subsidence Monitoring

The History of Land Subsidence in the Pomona Area

Exhibit 63



The area of subsidence concern in Ontario (Ontario Area) is located east of the Central MZ1 and Pomona areas. This exhibit is a time-series chart that illustrates the history of land subsidence in the Ontario Area. The chart also displays the stresses that cause land subsidence. Groundwater production and supplemental-water recharge that has occurred in MZ2 are the primary stresses that cause changes in groundwater levels in the Ontario Area. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which in turn, cause ground motion at the land surface.

The exhibit also shows the history of vertical ground motion as measured by InSAR within the Ontario Area (see Exhibit 60 for location). These data indicate that about one-foot of inelastic subsidence has occurred in this area from 1993-2012.

From about 1935 to 1978, groundwater levels in the Ontario Area declined by about 125 feet. Groundwater levels increased by about 10 to 20 feet during the early 1980s and have remained relatively stable since then. The observed, continuous land subsidence that occurred during 1993-2012 cannot be explained entirely by the concurrent changes in groundwater levels. A plausible explanation for the subsidence is that thick, slowly-draining aquitards are compacting in response to the historical drawdowns that occurred from 1935 to 1978.

Groundwater Levels at Wells (Perforated Interval Depth)

- C-14 (480-1200 ft-bgs)
- O-05 (360-470 ft-bgs)
- O-15 (474-966 ft-bgs)
- O-34 (522-1092 ft-bgs)

Vertical Ground Motion

- Ontario Area InSAR Cumulative Displacement

Recharge and Production

- Recharge of Recycled, Storm Water*, and Imported Water at Basins in MZ2 and the 7th and 8th Street Basins
  *Storm Water is an estimated amount prior to Fiscal Year 04/05
- Groundwater Production from Wells in Ontario Area

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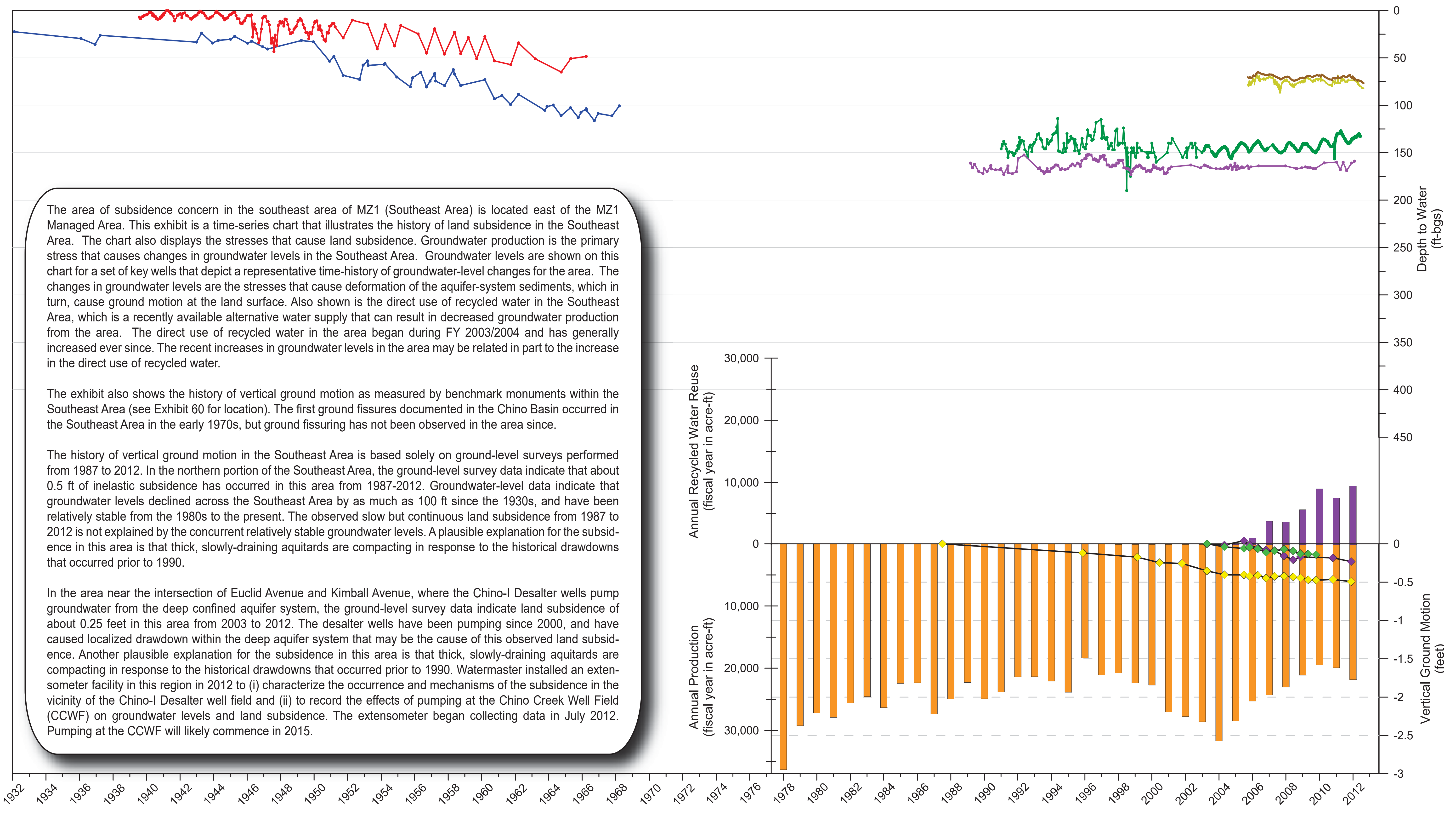
2012 State of the Basin
Land Subsidence Monitoring

The History of Land Subsidence in the Ontario Area

Exhibit 64



The area of subsidence concern in the southeast area of MZ1 (Southeast Area) is located east of the MZ1 Managed Area. This exhibit is a time-series chart that illustrates the history of land subsidence in the Southeast Area. The chart also displays the stresses that cause land subsidence. Groundwater production is the primary stress that causes changes in groundwater levels in the Southeast Area. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which in turn, cause ground motion at the land surface. Also shown is the direct use of recycled water in the Southeast Area, which is a recently available alternative water supply that can result in decreased groundwater production from the area. The direct use of recycled water in the area began during FY 2003/2004 and has generally increased ever since. The recent increases in groundwater levels in the area may be related in part to the increase in the direct use of recycled water.

The exhibit also shows the history of vertical ground motion as measured by benchmark monuments within the Southeast Area (see Exhibit 60 for location). The first ground fissures documented in the Chino Basin occurred in the Southeast Area in the early 1970s, but ground fissuring has not been observed in the area since.

The history of vertical ground motion in the Southeast Area is based solely on ground-level surveys performed from 1987 to 2012. In the northern portion of the Southeast Area, the ground-level survey data indicate that about 0.5 ft of inelastic subsidence has occurred in this area from 1987-2012. Groundwater-level data indicate that groundwater levels declined across the Southeast Area by as much as 100 ft since the 1930s, and have been relatively stable from the 1980s to the present. The observed slow but continuous land subsidence from 1987 to 2012 is not explained by the concurrent relatively stable groundwater levels. A plausible explanation for the subsidence in this area is that thick, slowly-draining aquitards are compacting in response to the historical drawdowns that occurred prior to 1990.

In the area near the intersection of Euclid Avenue and Kimball Avenue, where the Chino-I Desalter wells pump groundwater from the deep confined aquifer system, the ground-level survey data indicate land subsidence of about 0.25 feet in this area from 2003 to 2012. The desalter wells have been pumping since 2000, and have caused localized drawdown within the deep aquifer system that may be the cause of this observed land subsidence. Another plausible explanation for the subsidence in this area is that thick, slowly-draining aquitards are compacting in response to the historical drawdowns that occurred prior to 1990. Watermaster installed an extensometer facility in this region in 2012 to (i) characterize the occurrence and mechanisms of the subsidence in the vicinity of the Chino-I Desalter well field and (ii) to record the effects of pumping at the Chino Creek Well Field (CCWF) on groundwater levels and land subsidence. The extensometer began collecting data in July 2012. Pumping at the CCWF will likely commence in 2015.

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Groundwater Levels at Wells (Perforated Interval Depth)

- CH-18A (420-980 ft-bgs)
- C-13 (290-720 ft-bgs)
- HCMP-1/1 (135-175 ft-bgs)
- HCMP-1/2 (300-320 ft-bgs)
- XRef 8588 (unknown)
- XRef 8589 (unknown)

Vertical Ground Motion

- ◆ BM 133/61 Cumulative Displacement
- ◆ BM 137/61 Cumulative Displacement
- ◆ BM 157/71 Cumulative Displacement

Recharge and Production

- ■ Recycled Water Reuse Applied in the Southeast Area
- ■ Groundwater Production from Wells in Southeast Area

2012 State of the Basin
Land Subsidence Monitoring

The History of Land Subsidence in the Southeast Area

Exhibit 65

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