# Strategic Plan for the Six Basins

*Phase I Draft Report January 2013*
*Draft Strategic Plan December 2015*
*Final Strategic Plan November 2017*

Prepared for:

Six Basins Watermaster

Prepared by:


WEI
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## Acronyms, Abbreviations, and Initialisms

| | |
|---|---|
| µg/kg | micrograms per kilogram |
| 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 |
| acre-ft | acre feet |
| acre-ft/yr | acre feet per year |
| bgs | below ground surface |
| CAO | Cleanup and Abatement Order |
| CBWM | Chino Basin Watermaster |
| CCR | Consumer Confidence Report |
| CDFM | cumulative departure from mean |
| cfs | cubic feet per second |
| COPCs | constituents of potential concern |
| CRA | Colorado River Aqueduct |
| CUP | conjunctive use program |
| CVP | Central Valley Project |
| CVWD | Cucamonga Valley Water District |
| DDW | California Department of Drinking Water |
| DLR | detection limit for reporting |
| DTSC | California Department of Toxic Substances Control |
| DWR | California Department of Water Resources |
| EAR | Environmental Assessment Report |
| EC | electrical conductivity |
| ft-bgs | feet below ground surface |
| ft-msl | feet above mean sea level |
| gpm | gallons per minute |
| IEUA | Inland Empire Utilities Agency |
| InSAR | Interferometric Synthetic Aperture Radar |
| IPR | indirect potable reuse |
| Judgment | Six Basins Stipulated Judgment |
| LACFCD | Los Angeles County Flood Control District |
| LACPWD | Los Angeles County Public Works Department |
| LACSD | Los Angeles County Sanitation District |
| LOSG | Live Oak Spreading Grounds |
| MCL | maximum contaminant level |
| meq/L | milliequivalents per liter |
| mg/L | milligrams per liter |
| mgd | million gallons per day |
| MOU | Memorandum of Understanding |
| MWDSC | Metropolitan Water District of Southern California |
| NL | Notification Level |
| OBMP | Optimum Basin Management Program |
| OEHHA | Office of Environmental Health Hazard Assessment |

## Acronyms, Abbreviations, and Initialisms

| | |
|---|---|
| ORC | Occidental Research Corporation |
| OSY | operating safe yield |
| PCE | tetrachloroethene |
| PFP | Pedley Filtration Plant |
| PHG | public health goal |
| PMCL | primary maximum contaminant level |
| PRP | Potentially Responsible Party |
| PSG | Pedley Spreading Grounds |
| PVPA | Pomona Valley Protective Association |
| QA/QC | quality assurance/quality control |
| RAP | Remedial Action Plan |
| RWQCB | Regional Water Quality Control Board |
| SASG | San Antonio Spreading Grounds |
| SAWCo | San Antonio Water Company |
| SCAG | Southern California Association of Governments |
| SMCL | secondary maximum contaminant level |
| SNMP | salt/nutrient management plans |
| Strategic Plan | Strategic Plan for the Six Basins |
| SWP | State Water Project |
| TCE | trichloroethene |
| TCSG | Thompson Creek Spreading Grounds |
| TDS | total dissolved solids |
| TVMWD | Three Valleys Municipal Water District |
| UCMR | Unregulated Chemicals that Require Monitoring (State of California) |
| UCMR 3 | Unregulated Contaminant Monitoring Rule 3 (USEPA) |
| USACE | U.S. Army Corps of Engineers |
| USBR | U.S. Bureau of Reclamation |
| USEPA | US Environmental Protection Agency |
| USGS | US Geological Survey |
| UST | underground storage tanks |
| UWMP | Urban Water Management Plan |
| VOCs | volatile organic compounds |
| Watermaster | Six Basins Watermaster |
| WCI | water character index |
| WEI | Wildermuth Environmental, Inc. |
| WQS | water quality standard |
| WRP | Water Reclamation Plant |
| WSE | water surface elevation |

## 1.1 Background

The Six Basins are a group of adjacent groundwater basins, located just south of the San Gabriel Mountains in eastern Los Angeles and western San Bernardino Counties. Figure 1-1 shows the location of the Six Basins and the boundaries of the regional and local water purveyors in the area. Groundwater is pumped from the Six Basins primarily by public water agencies and mutual water companies that supply water for municipal uses. Figure 1-2 is a map that shows the locations of the existing municipal production wells within the Six Basins.

The main source of groundwater replenishment to the Six Basins is surface-water runoff from precipitation that falls on the San Gabriel Mountains and recharges at spreading grounds located along the foot of the mountain range—predominantly at the San Antonio Spreading Grounds (SASG). The water-supply agencies also use imported surface water from the Metropolitan Water District of Southern California (MWDSC) for artificial recharge at the spreading grounds (and for direct consumptive uses).

The pumping and storage rights for the Six Basins were adjudicated in 1998 through a stipulated judgment (Judgment) titled "Southern California Water Company vs. City of La Verne, et al." in the Superior Court of California for the County of Los Angeles (Case No. KC029152). The Judgment prescribes a physical solution for the coordinated management of the Six Basins with the objective that the Parties to the Judgment can reliably pump their respective rights and maximize the beneficial use of groundwater. The Judgment also established the Six Basins Watermaster (Watermaster) to implement the physical solution. The Court maintains continuing jurisdiction over the Judgment.

The Judgment is the current groundwater management plan for the Six Basins. The main components of the Judgment include the establishment of:

- a Safe Yield of 19,300 acre-feet per year (acre-ft/yr) of annual groundwater pumping
- the allocation of base annual production rights to the individual Watermaster Parties, expressed as a percentage of the Safe Yield
- an Operating Safe Yield (OSY) that is determined annually by the Watermaster, which is based on the Safe Yield and the current and expected recharge, pumping, and groundwater levels; and is allocated in proportion to the base annual production rights
- Carryover Rights, which allow up to 25 percent of a Party's unused annual OSY to be carried over for use in the subsequent operating year
- the rules and methods for "replacing" groundwater pumped in excess of a Party's share of the OSY
- the rules and responsibilities for the continued replenishment of the Six Basins with native surface water from the San Gabriel Mountains
- monitoring and mitigation measures to protect against the threat of rising groundwater
- guidelines for entering into Storage and Recovery Agreements
- the governance structure and rules to conduct and fund Watermaster activities

The Watermaster is a committee of representatives of the Parties to the Judgment, which include:

> *City of Claremont* – a City that overlies the Six Basins and is served water by the Golden State Water Company
>
> *City of La Verne* – a municipal water purveyor in the Six Basins
>
> *City of Pomona* – a municipal water purveyor in the Six Basins
>
> *City of Upland* – a municipal water purveyor in the Six Basins
>
> *Golden State Water Company* – an investor-owned public utility that serves water in the Six Basins to the City of Claremont
>
> *Pomona College* – an educational corporation in the Six Basins that has executed an agreement with Golden State Water Company with regard to its groundwater rights
>
> *Pomona Valley Protective Association* – a California corporation that is responsible for conducting replenishment activities in the Six Basins at the direction of the Watermaster
>
> *San Antonio Water Company* – a mutual water corporation that pumps groundwater from the Six Basins, and other basins, for use by its shareholders
>
> *Three Valleys Municipal Water District* – the main imported water wholesaler to the Six Basins agencies
>
> *West End Consolidated Water Company* – a mutual water corporation that pumps groundwater from the Six Basins, and other basins, for use by its shareholders (the two shareholders are the City of Upland and the Golden State Water Company)

The Watermaster convenes monthly to conduct its business and prepares an annual budget and assessment to fund its operations and activities. The Watermaster maintains a website to disseminate important documents and data (*e.g.*, meeting agendas and minutes, production and groundwater elevation data, guiding documents, Watermaster forms) to the Parties, other stakeholders, and the interested public at www.6bwm.com.

## 1.2 Objective of the Strategic Plan

The Watermaster Parties have about 17 years of experience with the Judgment and implementing its physical solution. Some Parties have raised questions and concerns about the current operating rules, regulations, agreements, and practices of the Watermaster. Some Parties desire a better technical approach to the management of the Six Basins. Because of these and other issues, the Watermaster Parties collectively agreed to enhance the management of the Six Basins beyond the execution of the Judgment, and in 2012, initiated the development of a *Strategic Plan for the Six Basins* (Strategic Plan). The Watermaster Parties envision that the Strategic Plan will be a new integrated management program for the Six Basins, and that it may require amendments to the Judgment.

Through the development of the Strategic Plan, the Parties of the Six Basins Watermaster have defined a paradigm from which to view their collective goals for sustainable water management, the current and anticipated challenges in the Six Basins, and the approaches and potential solutions to those problems. This paradigm is described in the following Mission Statement:

> *The objective of the Strategic Plan is to develop a water-resources management program that sustains and enhances the water supplies available to the Six Basins in a cost-effective manner and in accordance with the Judgment.*

## 1.3 Core Values of the Watermaster Parties

The Watermaster Parties adopted the following Core Values associated with their efforts to develop the Strategic Plan:

**Increase Local Supplies**. Most water purveyors in the Six Basins will – for an undetermined time into the future – be partly dependent on imported water for direct uses. Because imported supplies may not always be available, the Parties will work together and strive to minimize dependency on imported water and to maximize the use of local supplies when economically justified.

**Groundwater Storage**. Unused groundwater storage capacity is a precious natural resource. The Parties will manage the unused storage capacity to improve the water quality and reliability of Six Basins groundwater, and minimize the cost of water. The Strategic Plan will encourage the development of regional conjunctive-use programs.

**Stormwater Recharge**. The Parties will strive to increase stormwater recharge and thereby maintain and enhance the sustainable yield and water quality of the Six Basins.

**Water Quality**. The Parties desire to improve groundwater quality in the Six Basins and deliver water that is safe and suitable for the intended beneficial use and meets all applicable regulatory standards.

**Cost of Water**. The Parties desire to minimize the cost of water for their customers.

**Funding Mechanisms**. The Parties are committed to finding external funding sources (grants, *etc.*) to subsidize the cost to implement the Strategic Plan.

**The Long View**. The Parties desire a long-term, stable planning environment to develop local water-resources management projects. The Parties, independently and through Watermaster, will strive to take the long view in their planning assumptions and decisions to ensure a stable and cost-effective management program.

## 1.4 Process to Develop the Strategic Plan

The development of the Strategic Plan included two parallel processes: an institutional process and an engineering process, which were carried out by Wildermuth Environmental, Inc. (WEI) from 2012 to 2017. The institutional process defines the management agenda, directs the engineering process, and builds the institutional consensus to implement the Strategic Plan. The engineering process develops a consensus on the technical understanding of the basin, develops planning data, and evaluates the technical performance of the Strategic Plan activities.

The institutional process included the following tasks:

- Identify the issues, needs and interests of the Parties (2012)
- Develop a mission statement and goals for the Strategic Plan (2012)
- Develop a clear statement of the impediments to achieving the goals (2012)
- Develop and refine a list of potential projects and programs to remove the impediments, achieve the goals, and balance the needs and interests of the Parties (2014-2017)
- Develop a scope of work to refine the Strategic Plan projects, identify early implementation actions, and develop a recommended management program and implementation plan (2017)

The engineering process included the following tasks:

- Assess the current physical state of the Six Basins (2012)
- Describe the water demands and water-supply plans of the Parties—individually and as a group (2012; 2013)
- Develop planning criteria and assumptions (2013)
- Develop modeling tools to evaluate the physical response to Strategic Plan projects (2013-2015)
- Develop and evaluate a set of conceptual Strategic Plan projects and refine them based on the modeling assessment and the outcomes of the institutional process (2015-2017)

These two processes were iterative and provided feedback to each other. Stakeholder input and buy-in during the process were obtained through Strategic Plan workshops held during regularly scheduled meetings of the Six Basins Watermaster, and through the release of draft results as work was being completed.

This report was developed in phases: the first draft was published in January 2013 and the second in December 2015. This report is the final *Strategic Plan for the Six Basins*, and documents the work completed from 2012 to 2017, including an implementation plan to guide the activities of the Watermaster in the coming years.

## 1.5 Organization of the Report

*Section 1 Introduction*. This section describes background information, summarizes the objectives of the Strategic Plan, describes the core values of the Parties, and describes the process to develop the Strategic Plan. Section 1 was published in January 2013 with updates published in December 2015 and October 2017.

*Section 2 Physical State of the Six Basins*. Section 2 describes the physical characteristics and dynamics of the Six Basins with regard to surface water and groundwater based on historical data through 2011. Section 2 was published in January 2013 with updates published in December 2015.

*Section 3 Development and Evaluation of the Baseline Alternative*. Section 3 describes the development and evaluation of the Baseline Alternative. The Baseline Alternative represents the independent water-supply plans of the Six Basins Parties in the absence of a Strategic Plan and was evaluated in two ways: (1) the 2015 Six Basins Groundwater-Flow Model was used to evaluate the impact of the Baseline Alternative on the groundwater basin and production sustainability and (2) the cost of the water-supply plans by individual Party and in aggregate. This evaluation serves as a "baseline" for comparison to the groundwater impacts, production sustainability, and costs of the Strategic Plan project alternatives. The water supply plans characterized in this section were published in January 2013 with updates in December 2015; the evaluation of the Baseline Alternative was published in December 2015.

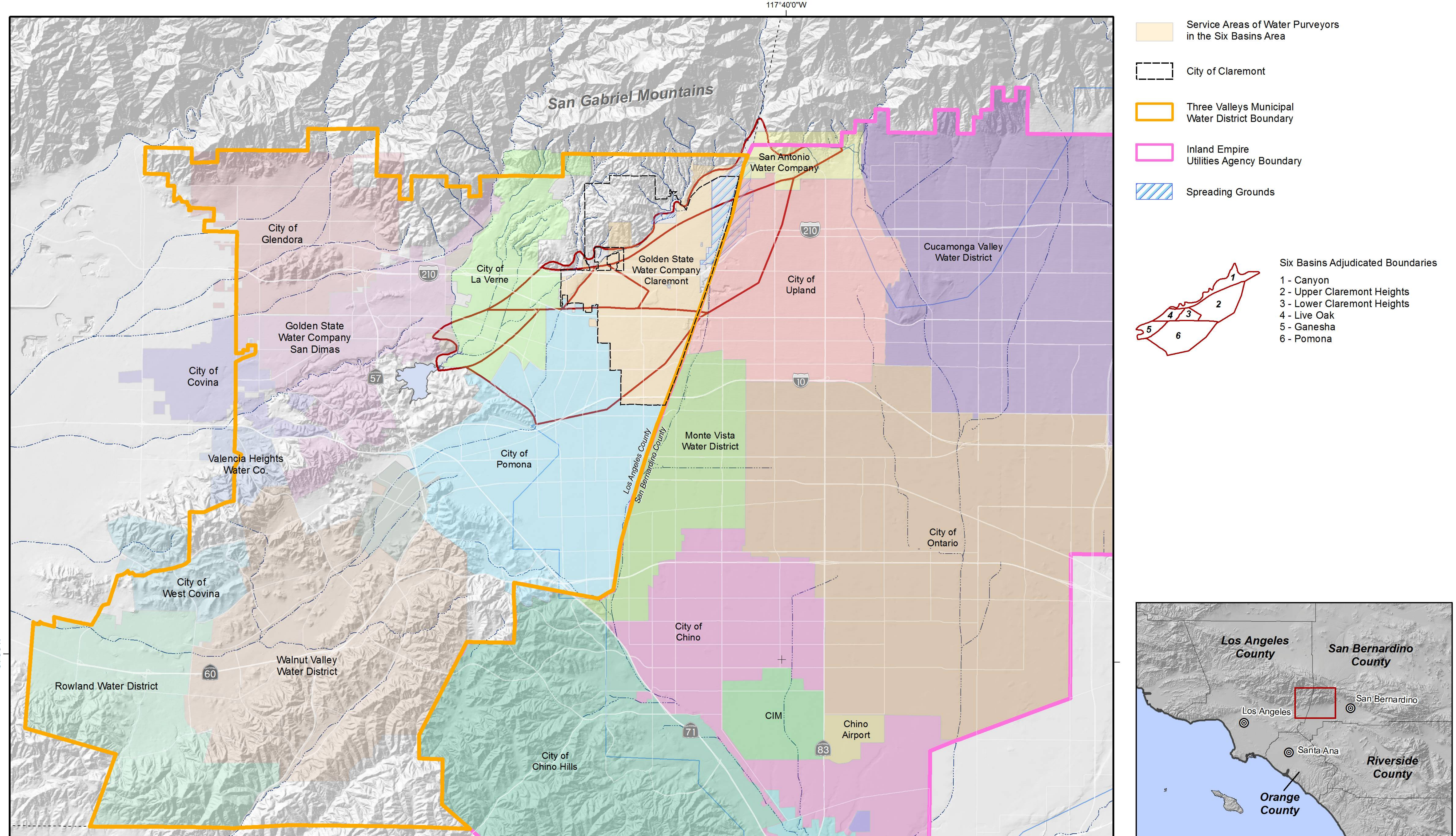
*Section 4 Stakeholder Goals & Concepts for Basin Management*. Section 4 describes the goals of the Strategic Plan as defined by the Parties in 2012, and includes a description of impediments to achieving the goals. Also described are the projects conceptualized for improving basin management that will remove the impediments to achieve the goals of the Parties. Section 4 was published in January 2013 with updates published in December 2015.

*Section 5 Development and Evaluation of Conceptual Strategic Plan Projects*. Section 5 describes the development of various projects conceptualized to remove the impediments to the Strategic Plan goals, and the evaluation of these projects based on the projected physical response of the Six Basins, the operational and facility requirements, and the yield and cost. For each project, institutional issues and implementation steps were identified. Section 5 was published in December 2015 with updates published in October 2017.

*Section 6 Refinement of Strategic Plan: 2016-2017*. Section 6 describes the work to (1) develop a final framework for defining projects that are consistent with the Strategic Plan goals and (2) refine the conceptual projects based on the evaluation documented in Section 5 and the interests of the Parties. In this section, each project is described in terms of its current operation (if applicable), facility requirements, and operating scheme(s). Section 6 was published in October 2017.

*Section 7 Implementing the Strategic Plan: 2018 and Beyond*. Section 7 describes the role of the Watermaster in implementing the Strategic Plan and the activities that will be performed to fulfill this role. Section 7 was published in October 2017 and replaces the implementation plan contained in Section 6 of the December 2015 draft report.

*Section 8 Bibliography*. This section is a comprehensive bibliography of all publications reviewed or cited in the development of the Strategic Plan. Section 8 was published in January 2013 with updates published in December 2015 and October 2017.

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Date: 20151214

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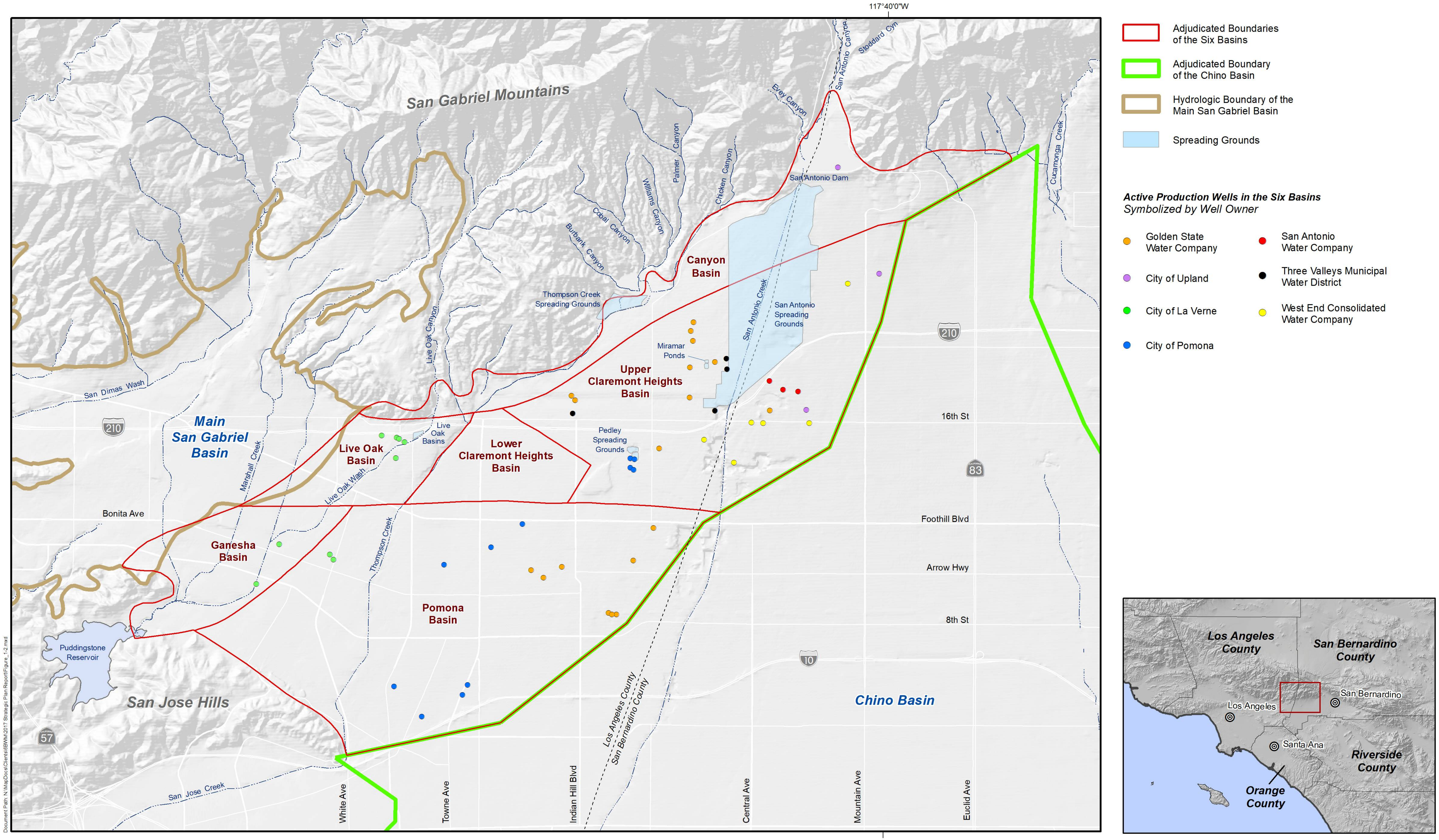
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**The Six Basins and the Water Purveyors in the Area**

**Figure 1-1**

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**Six Basins Watermaster**
**Strategic Plan for the Six Basins**

## Production Wells in the Six Basins

**Figure 1-2**

# Section 2 – Physical State of the Six Basins

This section describes the physical characteristics and dynamics of the Six Basins with regard to surface water and groundwater, including a characterization of the problems that have limited the beneficial use of water. It is important that the stakeholders understand and reach consensus on the physical characteristics and problems in the Six Basins so that effective strategies for basin management can be developed and, subsequently, implemented by the Parties.

The information in the section was used to describe a "conceptual model" of the Six Basins. The conceptual model was used to construct and calibrate a numerical, computer-simulation model of the Six Basins. The numerical model was used to develop and evaluate the Baseline Alternative and Strategic Plan project alternatives.

Herein, the physical description of the surface-water and groundwater resources of the Six Basins includes:

- Native surface water
- Hydrogeology
- Groundwater production
- Groundwater levels and storage
- Groundwater quality
- Land subsidence and rebound

Each sub-section concludes with a summary of the major issues for basin management that are associated with the topic of that section, and will include a description of physical problems and/or significant data gaps and unanswered questions. The information in this section is used to identify impediments to achieving the goals of the Parties and to develop concepts for improved basin management in Section 4.

This section was developed through (i) a review and analysis of prior work performed in the Six Basins and (ii) an analysis of all available geologic and water-resources data available through 2011. The data have been collected and compiled into a relational database which is maintained by WEI and made available to the Parties through a web-enabled software system called HydroDaVE℠. This section was originally published in January 2013 draft report with updates published in December 2015.

## 2.1 Surface Water Resources

This section describes the native surface-water resources that are tributary to the Six Basins, their temporal and spatial variability, and how they have been put to beneficial use. This understanding will aid in the development of basin-management programs to sustain or enhance the use of native surface waters for the benefit of the Parties. This section concludes with a description of the major issues for basin management that are associated with surface-water resources.

### 2.1.1 Precipitation

The climate of the Six Basins area is characteristic of a semi-arid Mediterranean climate with generally dry summers and comparatively wet winters. Runoff from precipitation is an important source of groundwater recharge in the Six Basins. This source of recharge can be understood by analyzing long-term records of precipitation. Figure 2-1 shows the location of precipitation gages in the Six Basins area with long-term historical records of daily precipitation. Of the seven stations shown, five are currently maintained and four of these five have complete records: La Verne Fire Station (1924-2011), Claremont Police Station (1928-2011), Claremont-Slaughter (1939-2011), and San Antonio Dam (1957-2011). All active stations, except for San Antonio Dam, are operated and maintained by the Los Angeles County Flood Control District (LACFCD), which is a division of the County of Los Angeles Department of Public Works. The San Antonio Dam gage is maintained by the U.S. Army Corps of Engineers (USACE).

Table 2-1 summarizes the period of record and minimum, maximum, and average precipitation for each gage with a long-term continuous record. Precipitation totals are shown based on a water year (October 1 through September 30)[1]. Note that the minimum, maximum, median, and average precipitation increases with increasing elevation of the gaging stations. The two driest years on record occurred in the last ten years during 2002 and 2007. The wettest years were 1978 and 2005.

Figures 2-2a through 2-2d show the annual precipitation time-history and the cumulative departure from mean (CDFM) precipitation for each gage station. When the slope of the CDFM curve trends downward from left to right, the annual precipitation is less than the average precipitation. When the slope continues downward for more than one year, then the CDFM is indicating a dry period. When the slope of the CDFM curve trends upward from left to right, the annual precipitation is greater than the average precipitation. When the slope continues upward for more than one year, then the CDFM is indicating a wet period. Figures 2-2a through 2-2d all display the same trend and indicate that the region experienced:

- a long dry period from 1945 through 1977,
- a wet period from 1978 through 1983,
- a dry period from 1984 through 1991,
- a wet period from 1992 through 1998, and
- a dry period from 1999 through 2010.

The records show that precipitation is highly variable, and that there are generally three to five years of consecutive, below-average precipitation before an average or above-average year occurs.

Monthly variation in precipitation is also important to understand the availability of surface water throughout the year. Figures 2-3a through 2-3d are statistical characterizations of monthly precipitation at each station in the form of a Box and Whisker Plot. The Box and

[1] For example, water year 2011 is the period from October 1, 2010 through September 30, 2011.

Whisker Plot shows the minimum, lower quartile[2], median, upper quartile[3], and maximum, values for each station. The plots show that significant precipitation (median greater than about one inch per month) generally occurs during the period of November through April, with the greatest monthly precipitation occurring in January and February. A minor amount of precipitation (median less than one-half an inch per month) occurs during the period of June through September. Over the period of record, the minimum monthly precipitation total was zero inches in every month of the year at all stations.

### 2.1.2 Tributary Watersheds

Figure 2-1 identifies the three primary watersheds that are tributary to the Six Basins. From west to east, these watersheds are Live Oak Wash, Thompson Creek, and San Antonio Creek. These watersheds originate in the San Gabriel Mountains and generally flow from north to south across the Six Basins. The Live Oak Wash and Thompson Creek watersheds are part of the San Gabriel River watershed. The San Antonio Creek watershed is part of the Santa Ana River watershed.

All three creeks are dammed for flood-control and water-conservation purposes, and spreading grounds have been constructed downstream of each dam to recharge water released from the dams. All three creek systems are concrete-lined for their entire course across the Six Basins. Thus, any surface-water discharge that by-passes the spreading grounds is a water resource that is lost from the Six Basins.

### 2.1.3 Beneficial Use of Native Surface-Water Resources

Surface-water runoff generated in the three watersheds described above is diverted and used in the Six Basins for two purposes: direct potable and non-potable uses and groundwater recharge. Figures 2-4, 2-5a, 2-5b, and 2-5c show the facilities used to control, divert, and monitor the surface-water discharge on Live Oak Wash, Thompson Creek, and San Antonio Creek. The following sections describe the operations of these facilities.

#### 2.1.3.1 Live Oak Wash

Figure 2-5a is a map of the facilities on Live Oak Wash used for flood control, monitoring of surface-water discharge, and diversion of surface water for recharge. The northern-most feature is Live Oak Dam which was constructed in 1932 by the LACFCD for flood-control purposes. The drainage area above the dam is approximately 2.3 square miles. The total storage capacity behind the dam is about 250 acre-ft. Runoff generated in Live Oak Canyon is captured behind Live Oak Dam and is released by the LACFCD to an unlined portion of Live Oak Wash. The total daily inflow to Live Oak Dam is computed by the LACFCD based on the water surface elevation (WSE) behind the dam and outflow that is recorded by a flow gage located along Live Oak Wash just downstream of the dam. For this report, all available records of daily inflow and outflow were collected from the LACFCD.

Water released from the dam flows down Live Oak Wash and into the Live Oak Debris Basin to capture sediment and debris. The debris basin is located just north of the headworks of the

[2] The lower quartile represents the 25th percentile: 25 percent of the observed values are less than the upper quartile.

[3] The upper quartile represents the 75th percentile: 25 percent of the observed values are greater than the upper quartile.

Live Oak Spreading Grounds (LOSG). The debris basin and the LOSG are maintained and operated by the LACFCD. Water that flows out of the debris basin is either diverted into the LOSG and recharged, or is discharged to the concrete-lined Live Oak Wash Channel and subsequently flows to Puddingstone Reservoir without recharging the Six Basins.

The LOSG was first used to recharge surface water in water year 1962. The LOSG consists of five basins. Basin 1 is located on the west side of Live Oak Wash just north of Baseline Road. Basins 2 through 5 are located south of the 210 freeway. Surface water is diverted out of the Live Oak Debris Basin to Basin 1 through a flashboard structure at a maximum rate of 15 cubic feet per second (cfs). Water then flows by gravity through an underground culvert to Basins 2 through 5. The LOSG has an estimated percolation rate of 13 cfs and a total storage capacity of 12 acre-ft (LACFCD, 2012). A spillway at the southern end of Basin 5 diverts water back to the Live Oak Channel if the inflow to the LOSG exceeds the percolation rate.

Figure 2-6a shows the surface water that was captured and recharge or lost on Live Oak Wash for water years 1997 through 2011, the period for which complete, continuous records from the LACFCD are available. During this 15-year period, 23 percent of the total runoff available on Live Oak Wash was captured for recharge[4]: a total of 1,920 acre-ft of runoff was captured and recharged and 6,594 acre-ft was not. The majority of losses occurred during wet years—57 percent of the total runoff lost to Live Oak Wash Channel occurred in 1998, 2005, and 2011. Because the percolation rate and storage capacity of the basins at the LOSG are small, all of the water available in wet years cannot be captured. That said, Figure 2-6a shows that a significant amount of runoff is also lost in dry and average years. The average annual runoff lost as a percent of total runoff available was 72 percent. This suggests that the LOSG has not been operated consistently to maximize recharge of runoff. Currently, the LACFCD is looking for funding partners to improve the LOSG facilities and increase capture of surface-water runoff.

In addition to spreading of native flows from Live Oak Wash, the LOSG is used by the Three Valleys Municipal Water District (TVMWD) for recharge of imported water as part of a conjunctive-use program with the MWDSC. The source of the imported water is State Water Project water from the San Gabriel Valley pipeline. The location of the turnout from the San Gabriel Valley pipeline to the LOSG is shown on Figure 2-5a. The turnout was constructed in 2005. Imported water was recharged during three of the last seven years. To date, a total of 1,060 acre-ft of imported water has been spread at the LOSG.

Currently, there are no monitoring programs to collect surface-water-quality data on Live Oak Wash and no historical data were available to characterize the quality of the runoff diverted for recharge. Imported State Water Project water recharged at the LOSG is of high quality. Between 2006 and 2011, total dissolved solids (TDS) concentrations of imported water in the San Gabriel Valley pipeline ranged between 124 milligrams per liter (mg/L) and 324 mg/L and nitrate (as nitrogen) ranged between 0.1 mg/L and 1.3 mg/L.[5]

#### 2.1.3.2 Thompson Creek

Figure 2-5b shows the facilities on Thompson Creek used for flood control, monitoring of surface-water discharge, and diversion of surface water for recharge. The blue boundary delineates the property boundary of the PVPA's Thompson Creek Spreading Grounds (TCSG).

[4] Runoff available is calculated as the total flow measured at the flow gage located south of Live Oak Dam (shown on Figure 2-5a).

[5] State Water Project water quality is measured by MWDSC at Silverwood Lake.

After the Pomona Valley Protective Association (PVPA) was formed in 1910, this land was purchased to enhance recharge of the Six Basins by capturing surface-water runoff generated in the Thompson Creek watershed. In 1931, the LACFCD obtained easements in the TCSG for the construction of Thompson Creek Dam and its associated facilities for flood-control purposes. The PVPA and the LACFCD have worked together since this time to operate the TCSG. The drainage area above Thompson Creek Dam is about 3.7 square miles.

Runoff generated above the dam—with the exception of Chicken Creek to the east—enters the PVPA property at the diversion structure at the north end of the property. The diversion structure is operated by the LACFCD in cooperation with the PVPA. The diversion structure controls where the surface water is directed: to behind the dam and/or to the PVPA's conveyance ditch. All flow from Chicken Creek discharges directly into the conveyance ditch. In the interest of flood protection, the LACFCD controls the diversion structure such that during storms the majority of the runoff is diverted to behind the dam rather than to the PVPA conveyance ditch.

Currently, the LACFCD's standard operating procedure at the dam is to store the water behind the dam up to a WSE of 1,620 feet and allow it to percolate or evaporate. The reservoir storage behind the dam at a WSE of 1,620 feet is about 217 acre-ft. When the WSE behind the dam exceeds 1,620 feet, water is released to the wasteway channel at a rate of up to 260 cfs. Water discharged to the wasteway channel flows into the concrete-lined Thompson Creek Channel where it eventually flows to San Jose Creek without recharging the Six Basins. Water discharged to the wasteway channel is recorded by a flow gage located along the wasteway channel just downstream from the dam. The total daily inflow to Thompson Creek Dam is computed by the LACFCD using measurements of WSE behind the dam to compute change in reservoir storage plus any recorded outflow. During periods of inflow, the LACFCD assumes that evaporation and percolation at the reservoir behind the dam are negligible.

Runoff that is diverted at the diversion structure to the PVPA conveyance ditch, or enters the ditch from Chicken Creek, flows south into a tunnel under the dam and is discharged into two recharge pits located just south of the dam: East Pit and West Pit. To prevent overflow of the pits, a spillway on the conveyance ditch diverts water to behind the dam if the flow in the conveyance ditch is too high. A recorder station at the end of the tunnel records the flow entering the pits. Currently, PVPA records spreading totals on a monthly basis. Historical data (prior to 1999), are available as water-year totals.

For this report, all available records of flow at the recorder station were collected from PVPA, and all available records of daily inflow and outflow from the dam were collected from the LACFCD. These data were used to prepare Figure 2-6b which shows the annual volumes of surface water that was captured and recharge or lost from the Thompson Creek Dam and the TCSG for water year 2000 through 2011, the period for which complete records from both the PVPA and the LACFCD are available. During this 12-year period, 44 percent of the runoff from the Thompson Creek watershed was captured for recharge: 556 acre-ft was diverted and recharged by the PVPA, 1,019 acre-ft was captured behind Thompson Creek Dam[6], and 1,978 acre-ft was lost to the concrete-lined Thompson Creek Channel. Figure 2-6b shows that the majority of water is lost during wet years: 83 percent of the total water lost to the Thompson Creek Channel occurred in the very-wet water year of 2005.

[6] The volume of water captured behind the dam was calculated as *Total Inflow – Total Outflow*.

The LACFCD assumes that evaporation from the reservoir behind the dam is negligible, and that water stored behind the dam recharges. However, the volume of water recharged is likely to be minimal, since the area behind the dam is not maintained to optimize recharge. The relative volumes of recharge and evapotranspiration of water that was captured behind Thompson Creek Dam has not been quantified, thus, the losses associated with the LACFCD's diversion protocols are not known. In addition, note on Figure 2-5b that only a small area of the PVPA property south of the dam is utilized for recharge. There are no studies that quantify the percolation rates or recharge capacity of the TCSG or estimate how much additional runoff could be captured and recharged at the TCSG.

Currently, there are no monitoring programs to collect surface-water-quality data at the TCSG and no historical data were available to characterize the quality of the runoff diverted for recharge.

#### 2.1.3.3 San Antonio Creek

Surface water rights in the San Antonio Canyon were assigned in the early 1900s. Many of the entities with rights were water and irrigation companies that were later purchased by the San Antonio Water Company (SAWCo), also an original owner of water rights in San Antonio Canyon) or the City of Pomona. The historical water rights are described in detail by James M. Montgomery (1985a). The rights as they are exercised today are described in SAWCo's *2010 Urban Water Management Plan – Volume 1 Report* (Civiltec Engineering, 2011b). The water rights can generally be described as:

- About 60 percent of the flow in San Antonio Creek is diverted by SAWCo
- About 40 percent of the flow in San Antonio Creek is diverted by the City of Pomona
- All flow in the San Antonio Creek that is not diverted by SAWCo or the City of Pomona is available to the PVPA for diversion and recharge at the San Antonio Spreading Grounds (SASG).

After the PVPA was formed in 1910, the San Antonio Spreading Grounds (SASG) land was purchased to enhance recharge of the Six Basins by diverting and spreading surface water from San Antonio Creek that are in excess of the needs of the water rights holders. The total area of the SASG is about 1.4 square miles or 980 acres. In 1956, in response to flood events in 1937 and 1938, the USACE completed construction of the San Antonio Dam, including facilities to convey water captured behind the dam to the SASG. The San Antonio Channel below the Dam was concrete-lined by 1960. The drainage area behind the dam is about 26 square miles. Figures 2-4 and 2-5c are maps that show the facilities on San Antonio Creek used for flood control, monitoring of surface-water discharge, and diversion of surface water for recharge. How the runoff is diverted and put to beneficial use by the SAWCo, the City of Pomona and the PVPA is described below.

**San Antonio Water Company**

Runoff generated in the San Antonio Creek watershed—with the exception of Evey Canyon to the south—enters the Edison Box, or the "60/40" splitter box, at the Edison power house on Mountain Avenue about one mile upstream of San Antonio Dam (see Figure 2-4). This is the last of several power houses used to generate electricity from water flowing in San Antonio Creek. The 60/40 splitter box splits San Antonio Creek flows and diverts them to the conveyance facilities of SAWCo and the City of Pomona.

Water diverted by SAWCo is delivered to its shareholders for potable and non-potable uses and is also used for recharge at the SASG and/or at spreading grounds in the Cucamonga Basin. Surface flows diverted at the 60/40 splitter box are directed to the San Antonio Tunnel Ponds (see Figure 2-4) or south of the dam to the distribution systems of the San Antonio Canyon Water Company and the City of Upland (the majority shareholder of SAWCo). Water diverted to the Tunnel Ponds percolates into underground "tunnels" that direct flow under the dam and are discharged into the San Antonio's potable distribution system. Surface flows that bypass the Tunnel Ponds are either sent to SAWCo's non-potable distribution system or to the San Antonio Canyon Treatment Plant where flows are treated before entering the City of Upland's potable distribution system. Backwash from the treatment plant can be diverted to SAWCo's Reservoir 9, where it is combined with excess water from the non-potable system and then discharged to the SASG for recharge—the discharge location is shown on Figure 2-5c. Water recharged at the SASG from this turnout is credited to SAWCo's Storage and Recovery Account.

**City of Pomona**

Water diverted by the City of Pomona at the 60/40 splitter box, combined with surface-water flows diverted from Evey Canyon, flows by gravity in a shallow underground pipeline called the Canon Pipeline. The Canon Pipeline conveys the water to the City of Pomona's Pedley Treatment Plant where the water is treated and served for direct potable use. The Pedley Treatment Plant is located adjacent to the Pedley Spreading Grounds (PSG) shown in Figure 2-4. The surface water diverted to the Canon Pipeline generally exceeds the treatment capacity of the Pedley treatment plant, so surplus water is recharged at the SASG or the PSG. The location of the City's turnout to the SASG is shown on Figure 2-5c. At the end of the Canon Pipeline, water can be spread at the PSG either before it enters the treatment plant or as backwash from the treatment plant.

**Pomona Valley Protective Association**

Runoff from the San Antonio Creek watershed that is in excess of what can be used by SAWCo and the City of Pomona is captured behind the San Antonio Dam. The PVPA works with the USACE to coordinate releases from the dam for diversion and recharge at the SASG. Release gates at the dam discharge water to a large concrete chamber beneath the dam. The USACE computes daily outflow from the dam based on the position of the release gates and the WSE of the reservoir behind the dam. Within the chamber, the PVPA has six diversion gates to direct water into the SASG. At the end of the chamber is an outlet where water not diverted by the PVPA discharges to the concrete-lined San Antonio Creek Channel. The elevation of the PVPA's diversion gates is lower than elevation of the outlet to San Antonio Creek Channel in order to maximize the diversion of water to the SASG. The approximate capacity of each diversion gate is 200 cfs when completely open (CDM, 2001). Two gates on the west side of the chamber direct water to the Los Angeles County side of the SASG through a 72-inch diameter concrete pipeline. Four gates on the east side of the chamber direct water to the San Bernardino County side of the SASG through two 72-inch diameter concrete pipelines. Flow meters are installed in each 72-inch pipeline to record the diversions to the SASG. Currently during spreading operations, the meters are read and recorded by PVPA staff monthly. Monthly totals for diversions are available from PVPA from 1999 to the present. Annual totals for diversions to the SASG are available from the PVPA from 1961-1998. Diversions to the SASG prior to 1999 are available as water-year totals.

There are no recent studies on the percolation rates at the SASG, but a 1937 study showed that after initial saturation, percolation rates ranged from 0.8 cfs/acre to 6.7 cfs/acre depending on the level of improvement (CDM, 2001).

Figure 2-5c shows how water diverted and spread at the SASG. Currently, on the Los Angeles County side of the SASG, water is diverted to either (i) a series of five basins located at the northern boundary of the SASG and/or (ii) to an unlined channel that runs parallel to the west side of the San Antonio Creek Channel. The five basins were re-constructed in the fall of 2008 to increase the amount of water that could be recharged in the northern portion of the SASG. Water on the Los Angeles County side is preferentially diverted to the five basins. Water that is diverted to the unlined channel that parallels San Antonio Creek encounters a total of 39 drop structures that were constructed to slow the flow and minimize erosion of the channel (CDM, 2001). Six of the drop structures have turnout gates to direct the water southwest across the SASG for recharge.

Water discharged to the San Bernardino side of the SASG is first discharged to the Hog Wallow basin just south of the dam. There are two gates to release water from Hog Wallow to the SASG. The western gate discharges water to a series of three large berms. The berms were constructed in the fall of 2009 to increase the amount of water that could be recharged in the northern portion of the SASG. The eastern gate directs water around the berms where it flows south across the spreading grounds. Flow is generally only diverted around the berms when they are filled to capacity. During periods of high flow, water that flows south of the berms can be diverted in into Vulcan's sand and gravel pits No. 5 and No. 6. In the December 2010, an extreme three-day precipitation event damaged the berms. Flow diverted to the San Bernardino County side of the SASG had to be reduced and the use of the sand and gravel pits was necessary to capture all the runoff diverted to the San Bernardino side of the SASG. The berms were repaired and re-constructed in the spring of 2012 with the help of a grant from the Federal Emergency Management Agency.

Water discharged to the concrete-lined San Antonio Creek Channel has one more opportunity to be diverted to the SASG via the Lower San Bernardino Turnout. The turnout is a drop-inlet structure that diverts water to the San Bernardino County side of the SASG. When the gate is fully open, this turnout can divert water at a maximum rate of approximately 300 cfs. The Lower San Bernardino Turnout is not metered by the PVPA.

Table 2-2 shows annual outflow from the dam as reported by the USACE, annual diversions to the SASG as reported by the PVPA, and the difference between the two which should equal the water lost to the San Antonio Creek Channel for water years 1961-2011. Since water year 1961, a total of 552,015 acre-ft of surface water was discharged from San Antonio Dam. Of this, 309,166 acre-ft, or 56 percent of the total discharge, was diverted to the SASG for recharge; 245,203 acre-ft was not. About 67 percent of the water discharged to San Antonio Creek Channel was discharged in seven of the eight most extreme wet years since 1961: 1969, 1978, 1980, 1983, 1993, 1995, and 2005. The year 1998 was the only wet year where 100 percent of water discharged from the dam was diverted for recharge at the SASG. Table 2-2 also shows that in many years, very little water is discharged from the dam. In 28 of the last 51 years, diversions to the SASG totaled less than 1,000 acre-ft and in 11 of those years, there were no diversions.

Figure 2-6c shows the recent time-history of surface-water runoff from the San Antonio Creek watershed that was either diverted or lost for water year 2001 through 2011. This is the period for which complete, continuous records from SAWCo, the City of Pomona, the PVPA, and the

USACE are available. During this 11-year period, a total of 166,317 acre-ft of water was diverted for use: 88,354 acre-ft by SAWCo, 33,526 acre-ft by the City of Pomona, and 46,437 acre-ft by the PVPA. During this same period, 51,425 acre-ft of water was lost to the San Antonio Creek Channel. In seven of the last eleven years, less than 1,000 acre-ft diverted for recharge by PVPA at the SASG, and in five of those years, diversions were zero. In six of the seven years with minimal to no diversions by PVPA, the annual precipitation was below average as measured at the San Antonio Dam precipitation gage (see Figure 2-2d). This observation suggests that runoff in excess of the needs of SAWCo and the City of Pomona is only available in years with above average precipitation.

Analyzing data collected from the USACE and the PVPA, Figure 2-6c shows that the PVPA diverted 47 percent of the flow discharged from San Antonio Dam since 2001. The figure indicates that the majority of the losses occurred during wet years: 43 percent of total losses occurred during the very-wet water year 2005. Another 31 percent was lost in wet water year of 2011. Figure 2-6c suggests that the PVPA may not be operating the SASG in a manner that maximizes the diversion of runoff when it is available.

Figure 2-6d shows the monthly time-history of diversions and losses for water years 2007 through 2010. Water years 2006 through 2010 were relatively dry with only one year of above-average precipitation in 2010 (see Figure 2-2d). During this dry period, a total of 10,809 acre-ft was released from San Antonio Dam as recorded by the USACE, but only 1,837 acre-ft, or 17 percent, was diverted to the SASG as recorded by the PVPA. Figure 2-6d illustrates that the surface water was not lost as the result of one or two high-volume runoff events. Instead it suggests that there was a steady loss of water throughout the winter months when runoff occurs. The maximum daily discharge from the dam during this period was 54 cfs between March 9 and March 17, 2010. This flow rate is less than the maximum capacity of just one PVPA diversion gate (200 cfs). Anecdotal information from PVPA staff suggests that all of the water released from the dam was diverted to the SASG in water year 2010. If the observations of PVPA staff are correct, then the data reported by the USACE, the PVPA, or both could be erroneous. Additional research and analysis of the data sources and the monitoring methods of the USACE and PVPA is needed to determine if the characterization as presented herein of the water discharged, diverted and lost is accurate. Correct characterization of these terms is critical to understanding the groundwater response to recharge and for developing management strategies to maximize the diversion and recharge of runoff in the future.

San Antonio Creek water is of high quality. TDS concentration in San Antonio Creek water ranged between 170 mg/L and 190 mg/L and nitrate (as nitrogen) was 0.5 mg/L or less.[7]

In addition to spreading of native runoff, the SASG is used by TVMWD to recharge imported water when it is available. The turnout off the Miramar pipeline, shown on Figure 2-5c, was constructed in 2006. To date, a total of 3,446 acre-ft of imported water has been spread by TVMWD at the SASG. Between 2006 and 2011, TDS concentrations ranged between 124 and 324 mg/L and nitrate (as nitrogen) ranged between 0.1 and 1.3 mg/L.[8]

[7] San Antonio Creek water is sampled at the San Antonio Canyon Treatment Plant by the City of Upland prior to being treated. Data ranges state herein are from the period 2006-2011.

[8] State Water Project water quality is measured by MWDSC at Silverwood Lake.

### 2.1.4 Summary of Basin Management Issues

The following is a summary of the major issues for basin management that are associated with surface-water resources in the Six Basins:

- The climate of the region is such that the Six Basins area is subject to prolonged dry periods. In years when precipitation is below average, the volumes of surface-water runoff that are available for artificial recharge at spreading grounds in the Six Basins are small, so the facilities for artificial recharge go largely un-utilized.
- The facilities to divert and recharge stormwater runoff do not capture all of the runoff that is available. Stormwater runoff that bypasses the spreading grounds is a loss of a low-cost, high-quality water resource.
- The current methods and protocols being employed by the USACE, LACFCD, and the PVPA to monitor the surface-water resources may not be returning accurate data for surface-water discharges and diversions. The completeness and accuracy of these data are crucial to the development and implementation of programs to improve basin management.

## 2.2 Hydrogeology

This section describes the groundwater reservoirs of the Six Basins, their evolution, structure, and composition, and how groundwater occurs and moves through these reservoirs. An understanding of the hydrogeology is fundamental to the development of basin management programs because the groundwater basin is the storage reservoir. This section concludes with a description of the major issues for basin management that are associated with the hydrogeology of the Six Basins.

The hydrogeology of the Six Basins area has been studied by various entities and authors in the past (Mendenhall, 1908; Eckis and Gross, 1932; Eckis, 1934; LACFCD, 1937; California DWR, 1970a; Bean, 1980; Fox and Slade, 1983; James M. Montgomery, 1985a, MWH, 1993; Richard C. Slade & Associates, 1998; Layne GeoSciences, 2006; Haley & Aldrich, 2011). The hydrogeologic description below was prepared from a review of prior studies and from original work performed for this effort.

### 2.2.1 Geologic Setting

Figure 2-7 is a geologic map of the Six Basins and the surrounding area. The Six Basins are part of a large, broad, alluvial plain located south of the San Gabriel Mountains and atop a depressed portion of the Perris Block of the Peninsular Ranges (California DWR, 1970a). This alluvial plain is sometimes referred to as the Chino Plain. The Chino Plain was formed during the Quaternary Period[9]. The surrounding mountains and hills were uplifted by tectonic compression and faulting, and sediments were eroded and washed out of the mountains by streams and deposited in the low-lying depressions on the Perris Block. These Quaternary sediments are today's groundwater reservoirs that underlie the Chino Plain.

The Six Basins underlie the northwestern corner of the Chino Plain between the San Gabriel Mountains and the San Jose Hills. A major fault in this area—the San Jose Fault—is a known

[9] Approximately 2 million ago to the present.

barrier to groundwater flow that separates the Six Basins from the larger Chino Basin to the southeast. Faulting and folding within the Six Basins uplifted bedrock or created low-permeability zones within the sediments to create groundwater sub-basins.

The Six Basins are located across a major watershed divide that separates the San Gabriel River watershed to the west from the Santa Ana River watershed to the east. The stream systems that exit the San Gabriel Mountains have been the main source of sediments and water that contributed to the formation of the Six Basins. The largest of these stream systems is San Antonio Creek which deposited a broad alluvial fan that emanates from the mouth of San Antonio Canyon. Today, San Antonio Creek flows south to the Santa Ana River. Other major stream systems located to the west of San Antonio Creek include Thompson Creek, which turns into San Jose Creek, and Live Oak Wash. Both of these creeks are within the San Gabriel River watershed.

### 2.2.2 Stratigraphy

In this report, the stratigraphy of the Six Basins is divided into two natural divisions: (1) pervious formations that comprise the groundwater reservoir are termed "water-bearing sediments" and (2) impermeable formations that bound the groundwater reservoirs in places are termed "consolidated bedrock." Water-bearing sediments overlie consolidated bedrock, with bedrock formations coming to the surface in the surrounding hills and mountains. These geologic formations are described below in stratigraphic order, beginning with the oldest formations.

The terms used in this report to describe bedrock, such as "consolidated," "non-water-bearing," and "impermeable," are used in a relative sense. The water content and permeability of these bedrock formations is, in fact, not zero. However, the primary point is that the permeability of the bedrock formations flanking and underlying the groundwater basin is much less than that of the aquifer sediments in the basin.

#### 2.2.2.1 Consolidated Bedrock

The consolidated bedrock formations that flank and underlie the Six Basins consist of very old crystalline rocks of the Basement Complex (Eckis and Gross, 1932) and younger sedimentary and volcanic rocks of the Puente Group (English, 1926).

The Basement Complex consists of deformed and recrystallized metamorphic rocks (*e.g.*, banded gneisses) that have been intruded by masses of igneous rocks (*e.g.* granite). As shown in Figure 2-7, the Basement Complex outcrops in the San Gabriel Mountains along the northern boundary of the Six Basins and in the eastern San Jose Hills along the southern boundary of the Six Basins. Weathering and erosion of the Basement Complex in the San Gabriel Mountains is the major sediment source for the younger sedimentary formations—in particular, the water-bearing sediments of Six Basins.

The Puente Group, where present, overlies the Basement Complex and consists of interbedded shales, sandstones, conglomerates, lava flows, volcanic ash, and volcanic breccia (English, 1926). Figure 2-7 shows, the Puente Group outcrops in the western San Jose Hills. Some well boreholes in the western portion of the Six Basins encountered the Puente Group at depth (Eckis and Gross, 1932; Eckis, 1934).

#### 2.2.2.2 Water-Bearing Sediments

During the Quaternary Period, an intense episode of faulting depressed the Six Basins area and uplifted the surrounding mountains and hills. Sediments that eroded from the mountains were transported to the Six Basins area by flooding and deposited atop the consolidated bedrock formations as interbedded, discontinuous layers of gravel, sand, silt, and clay to form the water-bearing sediments.

The water-bearing sediments are over 1,000 feet thick in places, but pinch-out to zero thickness along the northern and southern basin boundaries at the surface contact with the consolidated bedrock. Most water wells have their screens completed within the water-bearing sediments. Some of these wells can pump over 1,000 gallons per minute (gpm).

The water-bearing sediments are typically composed of gneissic and granitic debris from the San Gabriel Mountains, and can be differentiated into the Older Alluvium of Pleistocene age[10] and Younger Alluvium of Holocene age[11]. The general character of these formations is known from driller's logs and surface outcrops.

The Older Alluvium was deposited on top of the bedrock formations under conditions similar to today's depositional environments. Indian Hill is a surface outcrop of the Older Alluvium that was displaced upward by movement along the Indian Hill Fault. The Older Alluvium is commonly distinguishable in surface outcrop by its red-brown or brick-red color. The red color comes from secondary clays that formed from the weathering and oxidation of sediments that were deposited in areas where the water table was deep and where the sediments were not disturbed by stream erosion over long periods. The Older Alluvium contains many local unconformities because of the nature of the alluvial fan deposition process. It is typically thicker than the Younger Alluvium, especially in the central and deeper portions of the Six Basins, and is the main source of groundwater for today's wells. In the Pomona Basin, the Older Alluvium is composed of thick sediment sequences that contain layers of clay-rich, fine-grained sediments interstratified with coarser-grained sediments. These fine-grained layers are of low permeability and can cause confining conditions in the aquifer system and flowing-artesian conditions at wells that penetrate them.

The Younger Alluvium was deposited on top of the Older Alluvium after a period of weathering and erosion of the Older Alluvium. The Younger Alluvium is typically a fresh, un-weathered, grey or brown color, and occupies stream beds, washes, and other areas of recent sedimentation. The Younger Alluvium is absent in places and is typically thin compared to the Older Alluvium (<150 feet thick). Where it exists, it is commonly unsaturated and lies above the regional water table.

The Younger Alluvium is typically more permeable than the Older Alluvium. Surface water percolates readily in the Younger Alluvium. Figure 2-8 is a map of the hydrologic soils types across the Six Basins as mapped by the Soil Conservation Service. Note that the soils mapped as having rapid infiltration rates coincide with the Younger Alluvium on the geologic map on Figure 2-7, and that soils mapped as having moderate to low infiltration rates coincide with the Older Alluvium on the geologic map. Also note on Figures 2-7 and 2-8 that the spreading

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[10] Approximately 2 million to 12,000 years ago.

[11] Approximately 12,000 years ago to the present.

grounds in the Six Basins are located in areas that overlie the Younger Alluvium and soils with relatively high infiltration rates.

### 2.2.3 Effective Base of the Freshwater Aquifer

The consolidated bedrock formations occur at depth underlying the water-bearing sediments of the Six Basins and act as the effective base of the freshwater aquifer. Herein, the effective base of the freshwater aquifer is referred to as the "bottom of the aquifer." Fracture zones in the bedrock formations may yield water to wells locally, but the storage capacity is typically inadequate for sustained production.

Figure 2-9 is a map of the bottom of the aquifer in the Six Basins. The map shows contours of equal depth to the buried contact between the water-bearing sediments and the consolidated bedrock. The units of depth are in feet below ground surface (ft-bgs). These contours were drawn from lithologic descriptions of borehole cuttings that were recorded on well driller's reports and from bedrock "signatures" on borehole geophysical logs.

Figure 2-10 is another map of the bottom of the aquifer; however, depth has been converted to elevation in feet above mean sea level (ft-amsl). The following steps were executed in ArcGIS Geostatistical Analyst to complete this conversion: (i) create a raster of the depth to the bottom of the aquifer from the contours and data shown in Figure 2-9, (ii) subtract the depth raster from the USGS 10-meter digital elevation model of the ground-surface elevation to create a raster of the elevation of the bottom of the aquifer, and (iii) create contours from the elevation raster.

Figures 2-9 and 2-10 show that the bottom of the aquifer is a network of troughs and ridges. The main topographic features of the bottom of the aquifer are:

- A deep trough in the Upper Claremont Heights Basin that slopes from west to east.
- A west-to-east trending ridge located just north of the Indian Hill Fault in the Upper Claremont Heights Basin.
- A ridge that trends southwest from the Indian Hill Fault just north of the Intermediate Fault.
- A deep trough in the central portions of the Pomona Basin that slopes to the southeast.

The ridges appear to be related to fault movement. The troughs appear to be related to faulting and/or erosion by ancestral streams. Eckis (1934) speculated that the contact between the consolidated bedrock and the water-bearing sediments is unconformable, as indicated by an ever-present weathered zone in the consolidated bedrock directly underlying the contact with the water-bearing sediments. This observed relationship suggests that the consolidated bedrock in the Six Basins area was undergoing erosion prior to deposition of the water-bearing sediments. Eckis (1934) reported that the weathered zone is about 50-feet thick, and that beneath the weathered zone the bedrock is hard.

### 2.2.4 Occurrence and Movement of Groundwater

The physical nature of the Six Basins as a groundwater reservoir is described below, including: the thickness of the water-bearing sediments, basin boundaries, recharge, groundwater flow, internal barriers to groundwater flow, discharge, distinct aquifer systems, and aquifer properties. Moreover, this section describes (i) where groundwater occurs in the Six Basins, (ii) how groundwater recharges and moves through the Six Basins, and (iii) where groundwater discharges from the Six Basins.

#### 2.2.4.1 Thickness of the Water-Bearing Sediments

The depth to the bottom of the aquifer shown in Figure 2-9 is equivalent to the thickness of the water-bearing sediments. The water-bearing sediments are thickest in the central portions of the Upper Claremont Heights and Pomona Basins.

Figure 2-10 shows the locations of four hydrogeologic cross-sections that transect the Six Basins. Figures 2-11a, 2-11b, and 2-11c, and 2-11d show these cross-sections in profile view and show borehole and well information. The cross-sections show the variation in thickness of the water-bearing sediments across the troughs and ridges in the bedrock and the faults that offset the bedrock. In the Upper Claremont Heights Basin, the water-bearing sediments are up to 900 feet thick. In the Pomona Basin, the water-bearing sediments are over 1,000 feet thick. Some of the most productive wells in the Six Basins are located within these thickest portions.

#### 2.2.4.2 Basin Boundaries

The physical boundaries of the Six Basins, such as faults and the geologic contacts between bedrock and the water-bearing sediments, are described below and are shown in Figure 2-7. The physical boundaries do not coincide exactly with the adjudicated boundaries, which are also shown in Figure 2-7 for comparison. The physical boundaries described herein were derived from prior studies (Eckis and Gross, 1932; James M. Montgomery, 1985a; CDM, 2006b) and original work performed for this study. Hereafter, the physical boundaries that enclose the Six Basins are referred to as the “hydrologic boundary” of the Six Basins.

*San Gabriel Mountain Front.* The northern boundary of the Six Basins is the impermeable Basement Complex that outcrops along the front of the San Gabriel Mountains, as depicted by Figure 2-7. The Cucamonga Fault strikes along front of the San Gabriel Mountains and is described by Eckis and Gross (1932) as a steep reverse fault that dips 84 degrees to the north. Vertical movement on this fault has been upthrow on the north side which is, in part, responsible for the uplift of the Basement Complex in the San Gabriel Mountains and the depression of the Six Basins area.

*San Jose Fault.* The eastern boundary of the Six Basins is the San Jose Fault. Although the surface of the alluvial fan that emanates from the mouth of San Antonio Canyon does not appear to be offset by movement along the San Jose Fault, the fault offsets bedrock at depth and acts as a distinct barrier to groundwater flow between the Six Basins and the Chino Basin (see Figures 2-11b through 2-11d, cross-sections B-B’, C-C’ and D-D’). Note that in Figure 2-11c, cross-section C-C’, groundwater elevations can be more than 600 feet higher in the Six Basins compared to groundwater elevations in the Chino Basin.

The location of the San Jose Fault was refined in this study using remote-sensing of ground-surface elevation changes. Figure 2-12 shows vertical ground motion across the Six Basins and the northwestern portion of the Chino Basin during 2011-12 as measured with a remote-sensing technique known as InSAR (Interferometric Synthetic Aperture Radar). InSAR has been used extensively in the Chino Basin to monitor vertical ground motion associated with changes in groundwater elevations (WEI, 2006). Typically, as groundwater elevations increase the ground surface moves upward, and vice versa.

Figure 2-12 shows that changes in groundwater elevations in the Six Basins during 2011-12 caused uplift and subsidence of the ground surface. Since the San Jose Fault is a barrier to groundwater flow, groundwater levels respond to pumping and recharge differently on either side of the fault, and hence, the vertical ground motion on either side of the fault is differential. This differential vertical movement of the ground surface helped identify the San Jose Fault at certain locations within the aquifer system—particularly along the southeastern boundaries of the Pomona Basin and Upper Claremont Heights Basin.

*Contact with the Main San Gabriel Basin*. The western boundary of the Six Basins is the contact with the Main San Gabriel Basin. This boundary is somewhat arbitrary in that the water-bearing sediments are continuous across it. The boundary is approximately aligned with a bedrock "shelf" as defined by a limited number of boreholes that have penetrated bedrock in this area (Eckis and Gross, 1932; Eckis, 1934). Eckis (1934) reported that during periods of low groundwater elevations, the water-bearing sediments are drained above the bedrock shelf, which then completely separates the Six Basins from the Main San Gabriel Basin. During periods of higher groundwater elevations, a flattened mound of groundwater exists above the bedrock divide, and acts as a groundwater divide between the Six Basins and the Main San Gabriel Basin. Groundwater west of this divide flows southwest within the Main San Gabriel Basin, and groundwater east of the divide flows south and east within the Six Basins. In this report, the contact with Main San Gabriel Basin is the same as the adjudicated boundary of the Six Basins.

*San Jose Hills*. The southern boundary of the Six Basins is the contact with impermeable Basement Complex and the Puente Group that outcrops along the northern front of the San Jose Hills, as depicted by Figure 2-7. Eckis and Gross (1932) speculated that an unnamed fault may exist along the northern front of the San Jose Hills that uplifted the hills and depressed the Pomona Basin.

#### 2.2.4.3 Internal Barriers to Groundwater Flow

The differential vertical motion of the ground surface shown by InSAR on Figure 2-12 helped identify the locations of other internal faults in the Six Basins that act as barriers to groundwater flow, such as the Indian Hill Fault and the Intermediate Fault.

The Indian Hill Fault separates the northern forebay areas of the Six Basins from the southern areas of groundwater discharge. This fault has been identified by others based on offsets in bedrock, offsets in groundwater elevations, and differences in the behavior of groundwater elevations on either side of the fault (Eckis and Gross, 1932; Eckis, 1934; LACFCD, 1937; California DWR, 1970a). For this report, the InSAR data was studied for indications of differential vertical motion of the ground surface to more accurately locate the Indian Hill Fault within the aquifer system. Although the evidence is not robust, the InSAR data for the period of March 2011 to February 2012 suggests that the fault, near its intersection with the San Jose Fault, is located about 900 feet north of the adjudicated boundary. Figure 2-7 supports this more northern position of the fault because it better aligns with the southern boundary of Indian Hill, which was uplifted by movement along the fault. West of Indian Hill, the Indian Hill Fault is not apparent in the InSAR data, nor does it appear to be a competent barrier to groundwater flow in the west (see section on Groundwater Flow for this discussion).

The Intermediate Fault in the Pomona Basin parallels the San Jose Fault. Offsets in groundwater elevations across this fault indicate its effectiveness as a barrier to groundwater flow (see section on Groundwater Flow for this discussion). The InSAR data for the period

March 2011 to February 2012 suggests that the Intermediate Fault is located in a different position than that mapped by others, such as Haley & Aldrich (2011).

Other faults have been mapped in the Six Basins in the past and have been used to delineate the sub-basins as defined in the Judgment, including the Cucamonga Fault, the Claremont Heights Barrier, the Thompson Wash Barrier, and the San Antonio Fault. The InSAR data evaluated for this report do not show differential vertical ground motion across these faults, indicating that these faults may not be effective barriers to groundwater flow. The barrier effect of these faults, or lack thereof, is discussed further below.

#### 2.2.4.4 Groundwater Recharge

Groundwater recharge to the Six Basins primarily occurs by the following general mechanisms:

- Infiltration of native and imported surface waters at the spreading grounds that overlie the Six Basins (San Antonio, Thompson Creek, Live Oak, Pedley, and Miramar)
- Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills and mountains
- Deep infiltration of precipitation and applied water.
- Deep infiltration of septic tank discharge
- Streambed infiltration in unlined channels

A major source of recharge to the Six Basins is surface-water runoff from San Antonio Canyon. This recharge occurs by spreading the runoff at the SASG or as underflow beneath the San Antonio Dam. It is episodic, variable in magnitude, and dependent on precipitation.

Recharge also occurs by spreading and underflow along the mountain front west of San Antonio Canyon, specifically at the mouths of Thompson Creek and Live Oak Wash, and in smaller amounts relative to recharge from San Antonio Canyon.

The deep infiltration of precipitation and applied water (DIPAW) includes the combination of precipitation that falls directly on a pervious land surface and precipitation that falls on impermeable land surface that subsequently flows onto pervious surface, and irrigation water applied to the land surface, all of which when combined is surplus to the evapotranspiration demand and soil water storage capacity. DIPAW migrates through the root zone and subsequently reaches the underlying groundwater reservoir. DIPAW is affected by soil type. Figure 2-8 shows the hydrologic soil types across the Six Basins, as mapped by the Soil Conservation Service, as well as runoff potential and infiltration capabilities. Note that soils mapped as having rapid infiltration rates coincide with the Younger Alluvium shown in Figure 2-7 and soils mapped as having moderate to low infiltration rates coincide with the Older Alluvium. Also note that in Figures 2-7 and 2-8, the spreading grounds in the Six Basins are located in areas that overlie the Younger Alluvium and soils with relatively high infiltration rates.

DIPAW is an important source of recharge from a water quality standpoint because it is typically high in TDS and nitrogen from land application of fertilizers and from consumptive use by vegetation. Figure 2-30 illustrates land use in the Six Basins area in 1949, 1963, 1990, and 2005. The land-use maps were developed from DWR land use surveys for 1949 through 1984 and Southern California Association of Governments (SCAG) surveys for 1990 and 2005. These maps show a change over time from mainly agricultural citrus in 1949 to mainly urban land uses today. Urbanization encroached from the south to the north. By 1963, almost all of the City of Pomona had converted to urban land uses as did the southern portions of Claremont, La Verne, and Upland. By 1990, most citrus groves had been converted to urban uses..

#### 2.2.4.5 Groundwater Discharge

Groundwater discharge from the Six Basins occurs primarily as:

- Groundwater production from wells.
- Sub-surface outflow to the Chino Basin and the Spadra Basin.
- Shallow groundwater discharge to surface water, and subsequent outflow of this water from the basin in storm drains and stream channels.

Sub-surface outflow to the Chino Basin and Spadra Basin occurs across the San Jose Fault. The San Jose Fault is proven to be a barrier to groundwater flow as evidenced by groundwater levels that are approximately 300 to 600 feet higher in the Six Basins than in the Chino Basin. These offsets in groundwater levels across the San Jose Fault are depicted on the hydrogeologic cross-sections on Figure 2-11b and Figure 2-11d. Rates of subsurface discharge across the San Jose Fault are likely to vary depending on groundwater elevations in the Six Basins—rates being higher during periods of high groundwater elevations when subsurface discharge can occur within the shallower, less-deformed sediments.

The barrier effect of the San Jose Fault north of its intersection with the Indian Hill Fault is also evidenced by the absence of production wells in the Chino Basin directly to the east. The City of Upland was unsuccessful in attempts to pump groundwater from this part of the Chino Basin (James M. Montgomery, 1989). That said, it is likely that as groundwater mounds north of the Indian Hill Fault, some groundwater flows across the San Jose Fault into the Chino Basin—especially within the shallower, less-deformed sediments. Groundwater flow across the San Jose Fault is evidenced in Figure 2-12 by a slight rise in the ground surface in the Chino Basin to the east of the Upper Claremont Heights Basin—probably in response to an increase in groundwater levels due to sub-surface outflow from the Upper Claremont Heights Basin and the Cucamonga Basin. This sub-surface outflow is likely episodic and occurs only during years when recharge and groundwater mounding are high in the Upper Claremont Heights Basin and the Cucamonga Basins. That said, any subsurface outflow that occurs does not provide enough recharge to support sustained groundwater production in this part of the Chino Basin. Note however that there are no wells in, nor groundwater elevation data for, this part of the Chino Basin to confirm these interpretations.

The numerous production wells owned by the City of Pomona and Monte Vista Water District that are located in the Chino Basin east of the Pomona Basin suggests that subsurface outflow from the Pomona Basin may be a significant source of recharge to the Chino Basin. The groundwater divide that separates the Spadra Basin from the Chino Basin is likely caused by subsurface outflow exiting the southern tip of the Pomona Basin (California DWR, 1970a).

During periods of extremely high groundwater levels in the Six Basins, groundwater discharge has also occurred as rising groundwater that exits the basin in storm drains and stream channels. This phenomena of rising groundwater outflow is a natural condition that formed historical cienegas (marshy areas) and has been observed, documented, and estimated by various authors in the more recent times (Mendenhall, 1908; Eckis, 1934; Bean, 1980; Bean, 1982; MWH, 1985; Richard C. Slade & Associates, 2001; CDM, 2006a).

Rising groundwater is not occurring today, but groundwater has approached the ground surface as recently as 2006. Figure 2-13 shows several areas where groundwater was very close to the ground surface following the wet winter of 2004-05. Figure 2-13 also shows previously mapped areas of historical rising groundwater (Mendenhall, 1908; CDM, 2006a), including:

- Claremont Cienegas—located south of the SASG and north of the Indian Hill Fault
- Martin Cienegas—located northwest of the Intermediate Fault
- Del Monte Cienegas—located northwest of the San Jose Fault
- Palomares Cienegas—located north of the San Jose Hills and the San Jose Fault

The occurrence and patterns of rising groundwater are controlled by (i) precipitation and recharge, (ii) hydrogeologic conditions, and (iii) man-made water works and their operations. Above average precipitation and recharge create a high pressure head in the up-gradient areas of the Six Basins that forces groundwater flow to the south. Geologic faulting and folding has created groundwater barriers within the water-bearing sediments and/or uplifted the lower-permeability Older Alluvium to shallower depths. The southward flowing groundwater encounters the lower-permeability zones and barriers, which can force the groundwater to rise to the ground surface. Without sufficient pumping by wells, the groundwater will preferentially rise to the ground surface through higher permeable zones, including shallow sandy sediments, abandoned wells, and/or buried pipes. From the near surface, the rising groundwater flows (or is pumped) into curbs, storm drains, and channels and exits the Six Basins.

The occurrence of rising groundwater is infrequent, typically of short duration, and does not occur at all of the locations shown on Figure 2-13 at the same time. Rising groundwater has been documented within the Six Basins during the late-1880s, 1907-12, 1922, 1937-38, 1940-41, 1968-69, 1978-81, 1983-84, and 1999-2001. Rates of rising groundwater, when it occurs, have not been measured completely or accurately. Bean (1982) estimated about 1,200 gpm of rising groundwater discharge to storm drains from the Martin Cienegas in Claremont during the 1978-81. Richard C. Slade & Associates (2001) estimated at least 70 acre-ft of rising groundwater discharge from the Palomares Cienegas in Pomona during August 2000 through June 2001.

Although not quantified, groundwater discharge from the Six Basins via rising groundwater is relatively small compared to groundwater production and sub-surface outflow across the San Jose Fault. That said, rising groundwater has been a periodic inconvenience to the residents, businesses, and institutions within the cities of Claremont and Pomona, and has reportedly flooded basements and caused settling of foundations.

#### 2.2.4.6 Groundwater Flow

In general, the groundwater flow mimics the surface-water drainage patterns: from areas of recharge in the north towards the southwest. Along this general flow path, groundwater encounters bedrock ridges and barriers to flow that deflect and retard it. As groundwater mounds behind bedrock ridges and/or fault barriers, it flows within the shallower sediments over and across these obstructions into down-gradient basins.

Figure 2-14a is a groundwater-elevation contour map for fall 2011 that depicts the general groundwater-flow patterns across the Six Basins. Flow direction is perpendicular to the contours from higher elevation to lower elevation. Figures 2-14b, 2-14c, and 2-14d are groundwater-elevation contour maps for: fall 1999, which represents the start of Six Basins adjudication; fall 1983, which represents a period of relatively high groundwater elevations; and fall 1965, which represents a period of low groundwater elevations. Although groundwater elevations are quite different on these maps, the shape and orientation of the contours are similar, demonstrating that the groundwater-flow patterns within the Six Basins have been generally consistent over time and under different hydrologic conditions.

The groundwater-elevation maps show recharge that occurs along the mountain front, from San Antonio Canyon to the Thompson Creek Spreading Grounds, flows south and southwest. Groundwater that encounters the San Jose Fault barrier mounds and deflects groundwater flow to the southwest.

The deflection of groundwater flow to the southwest is especially evident after years of plentiful recharge at the SASG, which is clearly demonstrated by comparing the groundwater flow systems in Figure 2-14a during 2011, following a wet winter, to Figure 2-14d during 1965, following a dry period. During the wet winter of 2010-11, a groundwater mound formed beneath the SASG. The mound flowed south, encountered groundwater-flow barriers—including the San Jose Fault, the bedrock ridge north of the Indian Hill Fault, and the Indian Hill Fault itself—and the groundwater-flow system was deflected further to the southwest compared to the flow system in 1965. Figure 2-12 is further evidence of this process: it shows that groundwater elevations increased in MW-2 during early 2011 and caused a simultaneous rise in the ground surface in this area due to the rising groundwater elevations. The rise in the ground surface gradually dissipated and propagated to the southwest later in 2011, which indicates that the groundwater mound dissipated and flowed to the southwest.

The bedrock ridge north of the Indian Hill Fault, and the Indian Hill Fault itself, impede the southward flow of groundwater, but do not stop it altogether. As groundwater elevations rise behind the Indian Hill Fault, groundwater flows across the fault into the Pomona Basin through preferential paths within the shallow water-bearing sediments. Figure 2-15 shows changes in groundwater elevations following the very wet winter of 2004-05, which illustrates the preferential flow of groundwater across the Indian Hill Fault into the Pomona Basin:

1. More than 30,000 acre-ft of surface water was recharged at the SASG during water year 2004-05. From December 2004 to June 2005, a groundwater mound developed beneath the SASG and flowed south.
2. Groundwater flow was impeded by barriers—including the San Jose Fault, the bedrock ridge north of the Indian Hill Fault, and the Indian Hill Fault—and groundwater mounding spread to the southwest.
3. The San Jose Fault and the Indian Hill Fault appeared to be significant barriers near their intersection: groundwater first flowed across the Indian Hill Fault west of its intersection with the Intermediate Fault.
4. The Intermediate Fault appeared to be a groundwater barrier in the Pomona Basin, as evidenced by groundwater elevations at MW-3, which did not increase until August 2005.
5. By January 2006, the recharge event of 2004-05 had caused increases in groundwater elevations across the entire northeast portion of the Pomona Basin.

Figures 2-14a, 2-14b, 2-14c, and 2-14d corroborate this description of preferential groundwater flow across the Indian Hill Fault, showing:

1. Large differences in groundwater elevations at wells on either side of the Indian Hill Fault east of its intersection with the Intermediate Fault—differences are typically greater than 300 feet.
2. A relatively constant hydraulic gradient across the Indian Hill Fault west of its intersection with the Intermediate Fault.
3. In the Pomona Basin, groundwater flows to the southwest on both sides of the Intermediate Fault.

The InSAR data, shown in Figure 2-12, corroborates this description of preferential groundwater flow across the Indian Hill Fault: it shows a differential rise in the ground surface west of the Intermediate Fault caused by increases in groundwater elevations following the wet winter of 2010-11.

As groundwater flows south toward the southern portion of the Pomona Basin, the barrier effect of the Intermediate Fault appears to diminish as indicated by (i) a lack of groundwater elevation offsets across it and (ii) a lack of differential vertical ground motion, as shown by the InSAR data. In the southern portion of the Pomona Basin, groundwater discharges as rising groundwater, groundwater production, or subsurface outflow to the down-gradient Chino Basin and Spadra Basin. Figure 2-13, which depicts depth-to-groundwater for January 2006, a period of relatively high groundwater elevations in the Six Basins, shows relatively shallow depths to groundwater at the southern tip of the Pomona Basin (<50 feet), the area where groundwater flows across the San Jose Fault to recharge the Chino Basin and Spadra Basin (DWR, 1970).

In the western portion of the Six Basins, Figures 2-14a to 2-14d show that recharge that occurs along the mountain front in the vicinity of the mouth of Live Oak Wash flows south toward the Indian Hill Fault. The western boundary of the Six Basins is drawn as a “no-flow” boundary with the contours perpendicular to the boundary. This boundary is approximately aligned with a bedrock ridge, and the water-bearing sediments are relatively thin along the boundary. There are very few wells along the boundary, and hence, very little groundwater-elevation data available to characterize groundwater flow directions. The Indian Hill Fault does not appear to be a significant barrier to groundwater flow in the western portion of the Six Basins because (i) groundwater does not mound behind it, (ii) the interpretation of InSAR data does not indicate differential vertical ground motion across it, and (iii) there is not a noticeable offset in groundwater elevations across it (also see LACFCD, 1936).

#### 2.2.4.7 Aquifer Systems and Hydrostratigraphy

The Six Basins is an alluvial groundwater reservoir composed of interbedded layers of gravel, sand, silt and clay, or layers that are a combination of one or more of these sediment types. The layers that are composed mainly of gravel and sand are permeable and groundwater flows through the interconnected pore space within these layers towards pumping wells. These layers of gravel and sand are referred to as “aquifers.” The layers that are composed mainly of silt and clay are poorly permeable, and impede groundwater flow to pumping wells. Layers of silt and clay are referred to as “aquitards.” Aquitards store groundwater and can transmit appreciable amounts of groundwater to the adjacent aquifers through vertical drainage.

Groundwater can exist within an aquifer system under two different physical conditions: unconfined and confined. Where the groundwater table is exposed to the atmosphere through the overlying unsaturated zone, the aquifer system is unconfined, and the groundwater table can rise and fall freely under the stresses of recharge and pumping. Where deeper groundwater is separated from the atmosphere by significant thicknesses of aquitards, the aquifer system is confined, and the groundwater can be under a pressure head that is higher than the top of the aquifer. Depending on the spatial distribution of the aquitards, and their effectiveness as "confining layers," a groundwater reservoir can be vertically stratified into multiple aquifer systems that have different physical and chemical characteristics.

In the Six Basins north of the Indian Hill Fault, groundwater generally exists under unconfined conditions. Hydrogeologic cross-section A-A' (Figure 2-11a) shows that the water-bearing sediments in these northern forebay areas of the Six Basins are relatively coarse-grained throughout their total thickness, and do not contain thick, laterally-continuous, aquitards that create confined conditions and a multiple aquifer system. Flowing-artesian wells—an indication of confined aquifer conditions—have never been observed or mapped in this area.

South of the Indian Hill Fault in the Pomona Basin, groundwater exists within at least two aquifer systems: a shallow aquifer system and a deep aquifer system. The shallow aquifer system is generally characterized by unconfined conditions, higher permeability within its sand and gravel units, and high concentrations of dissolved solids and any groundwater contaminants that were released at the ground surface. The deep aquifer system is generally characterized by confined groundwater conditions, lower permeability within its sand and gravel units, and lower concentrations of dissolved solids and groundwater contaminants. Groundwater elevations tend to be higher in the shallow aquifer system, indicating a downward vertical hydraulic gradient.

This multiple aquifer system is most distinct and best characterized in the central and southern portions of the Pomona Basin, but may also exist in the northern and western portions of the basin. Evidence of this multiple aquifer system includes:

Figure 2-16 shows historical areas of flowing-artesian wells in the Six Basins at the Martin and Del Monte Cienegas in Claremont and at the larger Palomares Cienega in Pomona (Mendenhall, 1905; 1908). Flowing-artesian wells indicate the presence of laterally-continuous aquitards that cause confined conditions within a deeper aquifer system.

Investigations of groundwater contamination associated with the Xerox Site in the Pomona Basin are discussed below in the section on Groundwater Quality. These investigations involved the drilling, construction, and sampling of numerous, multi-depth, monitoring wells across the central portion of the Pomona Basin. Analysis of the geologic and water-quality data collected from these wells indicate the presence of at least two aquifer systems—a shallow unconfined system and a deep confined system—separated by about 50 feet of fine-grained sedimentary layers at a depth of about 400 to 450 feet below the ground surface (Haley & Aldrich, 2011). Figure 2-11b is a hydrogeologic cross-section that includes one of these monitoring wells (MW-14), and shows how groundwater-quality changes with depth. The main differences in groundwater quality between the aquifer systems are (i) that electrical conductivity (EC) is about 300 uS/cm in the deep aquifer system and about 800 uS/cm in the shallow aquifer system, and (ii) that concentrations of the contaminants associated with the site, including 1,1-DCE and hexavalent chromium, are highest in the shallow aquifer system. Haley & Aldrich (2011) speculated that the differences in groundwater quality indicate the existence of the confining, fine-grained, sedimentary layers that separate the shallow and deep aquifers.

The City of Pomona owns and operates a number of production wells within the historical area of the Palomares Cienega. Figure 2-16 shows the locations of two of these wells: P-01B is an inactive well that was generally screened across the shallow aquifer system from 160-450 ft-bgs; P-07 is an active well that is generally screened across the deep aquifer system from 385-982 ft-bgs.

These two wells are physically located about 1,000 feet from each other, but their water-level time histories are different. Figure 2-17 is a groundwater-elevation time-series chart from 2007-2011 for both wells. Note that groundwater elevations at Well P-01B, which is perforated within the shallow aquifer system, fluctuated annually by about 50 feet—probably in response to seasonal production at nearby wells. Most of these nearby wells pump from the deep aquifer system, including Well P-07. Note that when Well P-07 turns on, its water levels decline by about 200 feet, which is typical of confined groundwater conditions where relatively small changes in storage can generate large changes in piezometric levels. Note that groundwater elevation in P-07 are always lower than in P-01B—even when P-07 is not pumping—which indicates a downward hydraulic gradient. Also note that groundwater elevations in P-01B appear to respond to the pumping cycles at P-07, which suggests (i) that the shallow and deep aquifer systems are not completely isolated from each other and (ii) that groundwater within the shallow aquifer system, and its dissolved constituents, have flowed downward into the deep aquifer system.

Wells P-01B and P-07 also display significant differences in water quality. Figure 2-18 is a time-series chart of TDS and 1,1-DCE concentrations at both wells, and shows that TDS and 1,1-DCE concentrations are higher in the shallow aquifer system—and at some times, much higher.

Monitoring of the vertical ground motion overlying a groundwater basin can provide information on the extent and aggregate thickness of fine-grained sedimentary layers within a groundwater basin. This is because the drawdown of groundwater elevations causes pore water to drain out of the pore space within the fine-grained sediments, causing compression of the sediments and land subsidence. Recovery of groundwater elevations causes the opposite process and results in rebound of the land surface. Vertical ground motion has been monitored in the Six Basins area by the Chino Basin Watermaster using InSAR since 1993. Figure 2-16 shows a subset of the ground-motion data from this monitoring program for the period 1996-2000. The data demonstrate that the maximum vertical ground motion in the Six Basins occurs within the southern portion of the Pomona Basin underlying the Palomares Cienega, which suggests the presence of fine-grained sedimentary layers and a confined aquifer system.

Based on the observations and analyses described above, the aquifer systems of the Six Basins were sub-divided into two hydrostratigraphic units—Layer 1 and Layer 2. Figures 2-11a, 2-11b, 2-11c, and 2-11d show the division between Layer 1 and Layer 2. The delineation of these layers in three dimensions was drawn from a holistic analysis of all data. In other words, the layer boundaries do not always match specific observations at every well on every cross-section, but do honor the general patterns within the hydrostratigraphy of the Six Basins.

In general, Layer 1 coincides with the shallow aquifer system, which is characterized by unconfined conditions, higher permeability within its sand and gravel units, and high concentrations of dissolved solids and any groundwater contaminants that were released at the ground surface. Layer 2 coincides with the deep aquifer system, which is generally characterized by confined to semi-confined groundwater conditions, lower permeability within its sand and gravel units, and lower concentrations of dissolved solids and groundwater contaminants.

The bottom of each Layer was contoured based on the hydrogeologic cross-sections to describe the three-dimensional geometry of both layers. Figure 2-19 shows equal elevation contours of the bottom of Layer 1. Figure 2-20 shows equal elevation contours of the bottom of Layer 2. Figure 2-20 also shows that Layer 2 only exists within the deeper portions of the Six Basins.

#### 2.2.4.8 Initial Estimates of Aquifer Properties

The properties that characterize the ability of the water-bearing sediments of the Six Basins to store and transmit groundwater are specific yield (effective porosity) and hydraulic conductivity. The specific yield of the water-bearing sediments is a measure of its capacity to store water. Specific yield is the ratio of the volume of water that a given mass of saturated sediments will yield by gravity drainage to the volume of that mass. The ratio is typically stated as a percentage. The hydraulic conductivity of the water-bearing sediments is a measure of its capacity to transmit water. Hydraulic conductivity is the rate of flow of groundwater in gallons per day through a cross section of one square foot of sediment under a unit hydraulic gradient. The English units for hydraulic conductivity are feet per day (ft/day).

Hydraulic conductivity and specific yield are closely related to the texture of the sediments (McCuen et al., 1981). For example, the values of hydraulic conductivity and specific yield are generally higher in sands and gravels as compared to silts and clays. Several databases and publications have estimated values of hydraulic conductivity and specific yield based on sediment texture (Rawls et al., 1982; Schaap and Leij, 1998; Carsel and Parrish, 1988; Bouwer, 1978; Prudic, 1991; Reese and Cunningham, 2000; Kuniansky and Hamrick, 1998; Domenico and Schwartz, 1990; Freeze and Cherry, 1979, Johnson, 1967). These estimates of hydraulic conductivity and specific yield were assigned to each sediment description on every well driller's report for boreholes drilled in the Six Basins.

Thickness-weighted estimates of horizontal hydraulic conductivity and specific yield were computed at each borehole within each hydrostratigraphic units (Layer 1 and Layer 2) in 1983, a time of relatively high groundwater elevations, using the following formulas:

$$K_h = \sum_{i=1}^{n} \frac{K_i b_i}{b}$$

$$S_y = \sum_{i=1}^{n} \frac{S_{yi} b_i}{b}$$

*Where,*

$K_h$ is the average horizontal hydraulic conductivity in the Layer,

$K_i$ is the hydraulic conductivity of *i* bed,

$b_i$ is the saturated thickness of bed *i*,

*b* is the total thickness of the saturated portion of the Layer

$S_y$ is average specific yield in the Layer

$S_{yi}$ is the specific yield for bed *i*.

Figures 2-21 and 2-22 show the thickness-weighted, initial estimates for specific yield at boreholes for Layers 1 and 2, respectively. These figures also show interpolated estimates of specific yield between boreholes to depict their spatial and vertical distribution. Generally, specific yield is (i) higher in the northern and eastern portions of the Six Basins and (ii) higher in in Layer 1 compared to Layer 2. Specific yield is lower in the Pomona Basin because of the greater number and thickness of fine-grained sedimentary layers. Specific yield also is low in the area overlying the bedrock ridge north of the Indian Hill Fault—probably a result of uplift of the Older Alluvium.

Figures 2-23 and 2-24 show the thickness-weighted, initial estimates for horizontal hydraulic conductivity at boreholes for Layers 1 and 2, respectively. These figures also show interpolated estimates of horizontal hydraulic conductivity between boreholes to depict their spatial and vertical distribution. As with effective porosity, hydraulic conductivities are (i) higher in the northern and eastern portions of the Six Basins and (ii) higher in Layer 1 compared to Layer 2. Hydraulic conductivities typically decrease with depth because deeper sediments, such as the Older Alluvium, have experienced a greater degree of secondary alteration, such as weathering of feldspars to clay minerals and cementation of pore space.

The initial estimates of vertical hydraulic conductivity for each Layer are assumed to be ten percent of the horizontal hydraulic conductivity.

### 2.2.5 Summary of Basin Management Issues

The hydrogeology of the Six Basins places certain limits on the utilization of groundwater. In addition, the hydrogeology is imperfectly understood. The physical limits and the gaps in the current understanding of the hydrogeology are summarized below, and they pose specific challenges to basin management.

- The Six Basins are situated in an area that can receive and recharge large volumes of surface water, but they are a relatively small series of groundwater sub-basins with limited storage capacity.
- The recharge of surface water is unbalanced across the Six Basins. The areas where most recharge occurs are located in San Antonio Canyon and at the SASG. The Thompson Creek and Live Oak Creek watersheds, and the spreading grounds at the mouths of these watersheds, are much smaller in comparison, and hence, the recharge of storm water is much less in these areas.
- Areas of greatest recharge capacity do not overlie the areas with greatest groundwater-storage capacity, but in fact, are separated by distance and barriers to groundwater flow. The groundwater-storage capacity in the forebay areas north of the Indian Hill Fault, where most of the surface-water recharge occurs, is small compared to the storage capacity in areas south of the Indian Hill Fault in the Pomona Basin. The storage capacity is greatest in the Pomona Basin, but there are no spreading grounds that overlie the Pomona Basin, and it is separated from the areas of surface-water recharge by groundwater barriers.

- Currently, groundwater levels are relatively high in the Pomona Basin which (i) means that losses via sub-surface outflow to the Chino Basin and Spadra Basin are higher than they would be if groundwater levels were lower and (ii) limits its ability to "take" water in a storage program.
- Faulting and folding have created barriers to groundwater flow and, in places, have uplifted the consolidated bedrock formations and the lower-permeability sediments of the Older Alluvium to shallow depths. These geologic conditions have created:
  - Areas that are susceptible to rising groundwater during wet periods.
  - Preferential flow paths for groundwater across the groundwater barriers that is not fully understood and characterized, including (i) flow across the Indian Hill Fault, which is a source of recharge to the Pomona Basin; (ii) flow across the Intermediate Fault, which has impacted groundwater levels at wells and the transport and distribution of groundwater contaminants in the Pomona Basin; and (iii) flow across the San Jose Fault, which is a component of groundwater discharge from the Six Basins.
  - A partially-closed groundwater basin—the Pomona Basin—which can lead to the concentration of dissolved salts and other contaminants in groundwater.
- The aquifer-system in the Pomona Basin is multi-layered and the groundwater-flow system is complex and not well characterized. This is problematic because the most serious groundwater-quality problems are within the Pomona Basin. Effective remediation of these problems will require a better understanding of the hydrogeology and the groundwater-flow system.
- The thickness, effective porosity, and permeability of the water-bearing sediments are variable across the Six Basins, which makes some areas more productive for groundwater pumping than others. In general, the production characteristics of wells are best where the water-bearing sediments are thickest. The production characteristics of wells are poorest in areas where the water-bearing sediments are relatively thin and/or of low porosity and permeability.

## 2.3 Groundwater Production

This section describes historical and current groundwater production patterns in the Six Basins, and identifies how and why groundwater production has been constrained in the past. This understanding will aid in the development of basin-management programs to address those constraints and develop a higher and more sustainable yield from the Six Basins.

### 2.3.1 Groundwater-Production Monitoring

Historically, groundwater production has been monitored by the Parties in the Six Basins that own and operate wells. In general, the completeness and quality of the recent data is better than historical data maintained by the Parties. Prior to the adjudication in December 1998, there were no coordinated and on-going efforts to collect and compile groundwater-production data from all of the Parties in the Six Basins area. Historical groundwater-production data were compiled by various consultants for the development of groundwater models and other hydrogeologic studies (MWH, 1993; CDM, 1995, CDM 1996; CDM, 1999;

CDM, 2006a). Since the adjudication in 1998, Watermaster staff has collected monthly flow-meter reads from each Party for each of its wells in the Six Basins and has compiled and stored these data.

### 2.3.2 Historical Groundwater Production

For this report, the production data from all available sources were compiled and reviewed. Production data set spans the period from 1960 through 2011. Data from 1960 through 1996 were obtained from CDM and their model-input files (CDM, 2006a). Data from 1978 through 1998 were collected from the Watermaster Parties. Data from 1999 through 2011 were available from Watermaster's database.

Table 2-3a summarizes annual groundwater production data set for 1960 through 1998[12]. Much of the production data on this table for the early period of 1960-1977 is based on information from model-input files (CDM, 2006a). The table shows that for some sub-basins annual production is constant year after year, and some of the values are significantly different compared to the more recent measured data that was collected directly from the Parties or obtained from Watermaster's database. These early data appear to be rough estimates, and we were unable to locate or decipher the supporting references for these estimates. For these reasons, we have less confidence in the accuracy of the production data from 1960-1977 than for after 1977, so the analysis presented herein focuses on the period 1978-2011.

Table 2-3b and Figure 2-25 summarize annual groundwater production by sub-basin for the period 1978 to 2011. Since 1978, annual production from the Six Basins ranged from about 13,600 acre-ft/yr to 23,500 acre-ft/yr and averaged 18,600 acre-ft/yr. For the period prior to the adjudication (1978-1998) production averaged about 19,100 acre-ft/yr. For the period since the adjudication (1999-2011) production averaged about 17,900 acre-ft/yr. The average production for each time period is shown on Figure 2-25.

Table 2-3b and Figure 2-25 show that the majority of groundwater production in the Six Basins occurred in the Upper Claremont Heights Basin and the Pomona Basin. Prior to the adjudication, 87 percent of total production was in these two basins. Since the adjudication, this percentage of total production increased to 95 percent. This was largely due to decreased production in the Lower Claremont Heights Basin and Canyon Basin. Currently, there are no wells pumping groundwater from the Lower Claremont Heights Basin and pumping in the Canyon Basin is about half of what it was prior to the adjudication.

Figure 2-25 also shows that groundwater production from the Six Basins increased following wet years or periods, and decreased during prolonged dry periods. This observation was particularly true for the Upper Claremont Heights Basin and the Canyon Basin. On Figure 2-25, the wet years or periods are indicated by an upward slope of the CDFM curve, such as during 1978 to 1983, 1992 to 1998, and 2004 to 2006. The dry periods are indicated by a downward slope of the CDFM curve, such as during 1984 to 1991, 1999 to 2004, and 2007 to 2010. Groundwater production in the Upper Claremont Heights Basin was about 9,400 acre-ft/yr during the dry period from 1984-1991, and was about 12,500 acre-ft/yr during the wet period from 1992-1998—an increase of over 3,000 acre-ft/yr.

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[12] Data are reported herein based on a calendar year. Watermaster performs annual production accounting based on a calendar year. Additionally, some agencies only provided annual production values based on the calendar year for pre-1999 production.

Groundwater production in the Pomona Basin has varied between about 5,100 to 9,400 acre-ft/yr during 1978 to 2011, but on average, production has remained relatively constant at about 6,500 acre-ft/yr. Poor groundwater quality—including high concentrations of nitrate, perchlorate, and volatile organic compounds (VOCs)—has limited production in the Pomona Basin. Construction and operation of treatment facilities has eased some of those constraints, but poor groundwater quality continues to be a factor that limits production in the Pomona Basin.

Production from the Live Oak Basin and Ganesha Basin has always been relatively minor—on average about 3 percent of total production in the Six Basins. From about 1993 to 2001, production declined to almost zero due to poor groundwater quality, including high concentrations of nitrate, perchlorate, and VOCs. Construction of treatment facilities in the Live Oak Basin has allowed production to increase back up to and above historical levels.

### 2.3.3 Groundwater Production and Water Rights

The Judgment states that the safe yield of the Six Basins is 19,300 acre-ft/yr and established a base annual production right for each Party, which is essentially a percentage of the safe yield. However, the physical solution in the Judgment states that Watermaster will determine an operating safe yield (OSY) for the Four Basins area (Canyon Basin, Upper Claremont Heights Basin, Lower Claremont Heights Basin, and Pomona Basin), and the Parties can produce their share of the OSY from the Four Basins without incurring a replacement obligation. Each year, the Watermaster determines the OSY based on recent and expected recharge, pumping, and groundwater levels. The OSY is allocated to each Party based on their base annual production right. Production in the Two Basins is reserved for the City of La Verne, and is not subject to any limitations provided that production does not substantially injure the rights of any other Party.

Table 2-4 and Figure 2-26 show the annual OSY established by the Watermaster for the Four Basins versus the annual groundwater production in the Four Basins from 1999-2011. Production from the Four Basins has almost always been less than or equal to the OSY, which suggests that there are factors that have limited production, such as poor groundwater quality and/or low groundwater levels. Since 2008, the OSY and production have been relatively stable at about 17,500 acre-ft/yr which is about 1,800 acre-ft less than the safe yield, and groundwater production has gradually shifted from the Pomona Basin to the Upper Claremont Heights Basin. Moreover, some Parties are installing or planning for new well construction in the Upper Claremont Heights Basin because of the generally excellent groundwater quality and higher elevation.

The management implication here is that the current practice of setting a single OSY for the Four Basins allows for production patterns that do not optimize the yield of the Four Basins and may lead to other basin-management problems. For example, preferential production of the OSY from the Upper Claremont Heights Basin may lead to higher groundwater levels in the Pomona Basin, increased sub-surface losses to the Chino Basin, and/or rising groundwater in the Pomona Basin.

### 2.3.4 Summary of Basin Management Issues

The following is a summary of the major issues for basin management that are associated with groundwater production in the Six Basins:

- Low groundwater elevations following dry periods can significantly constrain groundwater production. This has been particularly true in the Canyon Basin and Upper Claremont Heights Basin.
- Poor groundwater quality has constrained some Parties' ability to produce groundwater—particularly in the Pomona Basin, Lower Claremont Heights Basin, and the Two Basins.
- The current practice of setting a single OSY for the Four Basins allows for production patterns that do not optimize the yield and may lead to other basin-management problems, such as rising groundwater. Changing the current practice may require an amendment to the Judgment, Operating Plan, or both.

## 2.4 Groundwater Levels and Storage

This section describes (i) how groundwater levels are monitored in the Six Basins, (ii) how groundwater levels and storage have changed over time across the Six Basins, (iii) why those changes occurred, and (iv) what effect those changes had on the yield of the groundwater basin and the water purveyors that pump groundwater. This understanding will aid in the development of basin management programs that include the control of groundwater levels and storage for the maximum benefit of the water purveyors.

### 2.4.1 Groundwater-Level Monitoring

Various entities have collected groundwater-level data in the past. Municipal, governmental, and other entities have historically collected groundwater-level data in programs that range from irregular, study-oriented measurements to long-term periodic measurements. The USGS and the DWR collected groundwater-level measurements at wells prior to about 1980. Most of the municipal water purveyors have conducted long-term monitoring programs of periodic measurements on a monthly or semi-annual interval. The Watermaster has installed nine transducers and data-loggers in wells across the Six Basins to continually measure and record groundwater levels. The Watermaster collects, compiles, and checks groundwater-level measurements from all sources and stores the data in a relational database that is accessible online through the HydroDaVE software system.

Figure 2-27 is a map that displays all wells that are currently monitored for groundwater levels in the Six Basins. The map also shows the wells that are equipped with transducers, and the wells used in this section to analyze trends in groundwater levels over time but are no longer monitored.

### 2.4.2 Historical Groundwater Levels

Figure 2-27 shows the location of wells that are used herein to characterize the time history of groundwater-levels in different areas of the Six Basins. The wells were selected based on length of record, completeness of record, and geographical distribution. The wells are labeled on the map by their local name designation.

The time series of groundwater-elevations at these wells are shown on:

> Figure 2-28a illustrates groundwater-elevation trends in the Upper Claremont Heights Basin.

Figure 2-28b illustrates groundwater-elevation trends in the northeastern portion of the Pomona Basin.

Figure 2-28c illustrates groundwater-elevation trends in the southern portion of the Pomona Basin.

Figure 2-28d illustrates groundwater-elevation trends in the Live Oak Basin, Ganesha Basin, and the western portion of the Pomona Basin.

To illustrate cause-and-effect relationships on the charts, the behavior of groundwater elevations is compared to:

- Annual groundwater production from wells within the area that pertains to the chart.
- Annual recharge of native and imported waters that occurred at the spreading grounds.
- Precipitation as illustrated by the CDFM curve for the precipitation station located at the Claremont Police Station (No. 93A-C). Upward sloping lines on the CDFM curve indicate wet years or wet periods. Downward sloping lines indicate dry years or dry periods.

Each time-series chart covers the period 1930 to 2011, but only includes the recharge and groundwater-production data from 1965 to 2011, which is the period of record that will be used to estimate developed yield later in this section.

The short-term groundwater-elevation fluctuations at some of wells shown on the charts are caused by pumping and non-pumping observations at the wells.

#### 2.4.2.1 Upper Claremont Heights Basin

Figure 2-28a is the groundwater-elevation time-series chart for wells located in the Upper Claremont Heights Basin. Groundwater elevations in this area increased immediately during wet years or wet periods that were associated with large volumes of recharge. During some of these years, groundwater elevations increased by as much as 200 feet. Groundwater production from the area increased immediately following the rise in groundwater elevations to volumes well above 10,000 acre-ft/yr. During dry years or periods, groundwater elevations declined, and it appears that as groundwater elevations declined, groundwater production also declined. During extended dry periods, groundwater production declined to volumes of less than 10,000 acre-ft/yr, and groundwater elevations became more stable. Although groundwater elevations fluctuated in this area by about 200 feet between wet and dry periods, there was no long-term trend of decline in groundwater elevations that would suggest overdraft.

These observations suggest that recharge and production have an immediate influence on groundwater elevations in the Upper Claremont Heights Basin, and that the groundwater pumpers in this area have the capacity and desire to increase production when groundwater elevations are high. These conclusions are significant because they indicate that management programs that enhance recharge in this area will increase groundwater elevations and allow for increased groundwater production.

#### 2.4.2.2 Pomona Basin

Figure 2-28b and Figure 2-28c are the groundwater-elevation time-series charts for wells located in the eastern portion of the Pomona Basin. Two charts are needed to describe this area because the hydrogeology and groundwater-flow systems are complex, and hence, groundwater elevations have followed different trends in different areas.

Figure 2-28b shows the groundwater elevations at wells located immediately south of the Indian Hill Fault on either site of the Intermediate Fault:

- P-13 is west of the Intermediate Fault.
- College-2 and Green-1 are east of the Intermediate Fault.

The period from 1945 to 1977 was dry, as indicated by the downward slope of the CDFM curve, and by 1977 groundwater elevations were at or near historical lows. Groundwater elevations were higher west of the Intermediate Fault during this period of relatively low groundwater levels.

During the 1978 to 1983 wet period, recharge at the spreading grounds exceeded 20,000 acre-ft for three of the six years. Groundwater elevations increased at all wells in this area during this wet period, but more so in the area east of the Intermediate Fault. By 1980, groundwater elevations were higher in the area east of the Intermediate Fault than west of the fault. Similarly, over 30,000 acre-ft of water was recharged at the spreading grounds during 2006, and groundwater elevations east of the Intermediate Fault increased by more than groundwater elevations west of the fault.

These observations suggest that during wet periods when groundwater elevations are relatively high in the Upper Claremont Heights Basin, the Pomona Basin east of the Intermediate Fault receives preferential recharge via sub-surface inflow across the Indian Hill Fault. This is significant because sub-surface inflow is a major source of recharge to the Pomona Basin. Understanding how sub-surface inflow occurs across the Indian Hill Fault will be important to the development of basin management programs.

Figure 2-28c shows the groundwater elevations from wells P-08 and P-07 located in the southern downgradient portion of the Pomona Basin. The 1936 to 1944 period was relatively wet, and groundwater elevations increased by about 150 feet in this area. The 1945 to 1968 period was dry, and groundwater elevations gradually declined by more than 300 feet in this same area to historical lows. Groundwater production data are not complete during this period, but it is likely that groundwater production increased during the dry period as the availability of surface water declined.

From 1968-1998, there were a number of wet years or periods (1969, 1978 to 83, and 1992 to 98) and groundwater production from the area was relatively low because of poor groundwater quality. By 1999, groundwater elevations had increased by more than 400 feet to historical highs, and rising groundwater was documented in the City of Pomona (Richard C. Slade & Associates, 2001). The recent period of 1999 to 2011 has been relatively dry and groundwater production from this area has increased during some years because of the installation of groundwater treatment facilities. Since 1999, groundwater elevations in this area gradually declined by about 40 feet. As of 2012, rising groundwater no longer occurs in Pomona, but groundwater elevations in this area remain near historical highs.

The current state of relatively high groundwater elevations in the southern Pomona Basin is undesirable because (i) sub-surface outflow to the Chino Basin and Spadra Basin is greater than would be if groundwater elevations were lower, (ii) the threat of rising groundwater is high in the event of an increase in recharge or a decrease in production, and (iii) it limits the basin's ability to "take" water in a storage program.

#### 2.4.2.3 Live Oak Basin and Ganesha Basin

Figure 2-28d is the groundwater-elevation time-series chart for wells located in the Live Oak Basin and the western portion of the Pomona Basin. The groundwater-elevation data on this chart are from the La Verne Heights 3 well and an un-named well, which are located directly downgradient from Live Oak Canyon and the Live Oak Spreading Grounds, and from the Lincoln well, which is located further downgradient near the boundary between the Ganesha Basin and Pomona Basin. There is no evidence that the boundary between the Ganesha and Pomona basins is a barrier to groundwater flow, so the Lincoln well is representative of groundwater conditions in the Ganesha Basin.

Figure 2-28d shows that recharge and pumping in these subbasins are small compared to the subbasins. Recharge at the Live Oak Spreading Grounds has never exceeded 500 acre-ft/yr, while recharge at the SASG has at times exceeded 30,000 acre-ft/yr. Pumping from the combined Live Oak and Ganesha basins has never exceeded 1,600 acre-ft/yr, while pumping from the combined Canyon, Upper Claremont Heights, Lower Claremont Heights, and Pomona basins has at times exceeded 23,000 acre-ft/yr.

At the La Verne Heights 3 well and the un-named well, groundwater elevations were at historical lows in the mid-1960s. During the wet year of 1969 and the wet period of 1978-83, groundwater elevations increased. By 1984, groundwater elevations in the Live Oak Basin had increased by about 150 feet compared to 1967 elevations to historical highs. During the subsequent dry period of 1984 to 1992, groundwater elevations declined by about 40 feet. There is an absence of groundwater-elevation data in this area from about 1996 to 2003, but after the wet year of 2005, groundwater elevations had recovered again to near historical highs. From about 1986 to 2005, groundwater production from the area declined, so it is likely that groundwater elevations remained relatively high during the period with no data (1996 to 2003). From 2006 to 2011, groundwater production has steadily increased, the climate has been relatively dry, and groundwater elevations have declined in the Live Oak Basin by about 70 feet.

These observations indicate that groundwater elevations in the Live Oak Basin respond directly and immediately to recharge and production. These responses of groundwater elevations are logical given the relatively coarse-grained nature of the shallow sediments, the shallow depth-to-groundwater that is typically between 100 to 200 ft-bgs, and the small volume of groundwater storage that is typically between 40,000 to 50,000 acre-ft.

At the downgradient Lincoln well, groundwater elevations displayed a similar trend compared to the La Verne Heights well and the un-named well, but follow more closely with the groundwater-elevation time histories of wells in the southern Pomona Basin shown on Figure 2-28c. This suggests that the aquifer system from the Ganesha Basin and the southern Pomona Basin is connected.

### 2.4.3 Groundwater Storage

The changes in groundwater levels described above resulted in changes in groundwater storage. This section describes the time series of storage and storage change in the Six Basins from 1965 to 2011.

The following figures illustrate how and where groundwater elevation and storage changed within the Six Basins between key points in time since 1965:

- Figure 2-29a shows changes in groundwater levels from 1965, which was a time of low groundwater levels, to 1983, which was a time of relatively high groundwater levels. Groundwater levels increased by more than 100 feet across most of the Six Basins, and in some areas by more than 300 feet.
- Figure 2-29b shows changes in groundwater levels over the period 1983 (relatively high groundwater levels) to 1999 (start of the adjudication). Note that groundwater levels declined north of the Indian Hill Fault and in the western Pomona Basin, but continued to increase across most of the central and southern Pomona Basin.
- Figure 2-29c shows changes in groundwater levels over the period 1999 (start of the adjudication) to 2011 (current groundwater levels). Note that groundwater levels generally increased in areas north of the Indian Hill Fault, and generally decreased in areas south of the Indian Hill Fault.

The methods used to compute storage and storage changes are describe below:

> The data used to estimate groundwater storage for a specific year included bedrock elevation which is shown on Figure 2-10, the groundwater elevations for the year which are shown on Figures 2-14a, 2-14b, 2-14c, and 2-14d, and the thickness-weighted average effective porosity of the saturated water-bearing sediments which is shown on Figure 2-21 and Figure 2-22 as an example for 1983. Within ArcGIS, bedrock elevation, groundwater-level elevation, and effective porosity were assigned to each cell of a 200 x 200-foot grid across the Six Basins. In Microsoft Excel, volumes of groundwater in storage within each grid cell were added and summarized by sub-basin.

Table 2-5 shows total groundwater in storage by sub-basin for 1965, 1983, 1999, and 2011. Change in storage was computed for logical groups of sub-basins. The observations and interpretations from Table 2-5 are:

1. Total storage in the Six Basins has ranged from a low of about 470,000 acre-ft in 1965 to a high of about 720,000 acre-ft in 1983—a storage increase of about 250,000 acre-ft over 18 years.
2. Total storage in the Six Basins declined slightly since 1983, but has remained relatively high compared to 1965. In 2011, total storage was about 650,000 acre-ft.
3. Storage capacity is greatest in the Pomona Basin.
4. Storage changes do not occur in parallel across the Six Basins. Different areas have experienced different magnitudes and time-histories of storage change.

These findings reveal significant challenges to basin management. Specifically, the areas of greatest recharge capacity do not overlie the areas with greatest groundwater-storage capacity, but in fact, are separated by distance and barriers to groundwater flow. The groundwater-storage capacity in the forebay areas north of the Indian Hill Fault, where most of the surface-water recharge occurs, is small compared to the storage capacity in areas south of the Indian Hill Fault in the Pomona Basin. Storage capacity is greatest in the Pomona Basin, but there are no spreading grounds that overlie the Pomona Basin, and it is separated from the areas of surface-water recharge by groundwater barriers.

### 2.4.4 Developed Yield

As defined herein, the "developed yield" is the annual average yield that was pumped from a groundwater sub-basin(s) over a finite period of time, but is corrected for the change in groundwater storage and the volume of supplemental water recharge that occurred during the period. The developed yield is reflective of the hydrology and water management practices of that period. It is not necessarily the "safe yield" of the basin unless the period is long enough and meets the criteria for a safe yield estimate. Herein, the estimates of develop yield are used to reveal (i) how the Six Basins responded under varying hydrologic conditions and water management practices and (ii) the implications for basin management.

The developed yield can be estimated using a pragmatic approach that has sometimes been used to estimate safe yield:

$$\text{Developed Yield} = (O_p - I_{ar} + \Delta S)/\Delta t$$

Where:

$\Delta t$ is the time period over which the developed yield is being estimated

$O_p$ is the total groundwater pumped from the basin(s) during $\Delta t$

$I_{ar}$ is the total supplemental water recharged to the basin(s) during $\Delta t$

$\Delta S$ is the change in groundwater storage within the basin(s) during $\Delta t$

Table 2-6 shows the developed yield estimates for the various sub-basins and groups of sub-basins within the Six Basins from 1966 to 1983, 1984 to 1999, 2000 to 2011, and 1966 to 2011. These periods were chosen because they will show how developed yield changed over time and under different hydrologic and groundwater-elevation conditions:

**1966 to 1983**. This was generally a wet period, especially at the end of the period. During the period, groundwater elevations increased by more than 100 feet across most of the Six Basins, and in some areas by more than 300 feet.

**1984 to 1999**. This period was generally dry during the first half of the period and generally wet during the second half of the period. During the period, groundwater elevations declined north of the Indian Hill Fault and in the western Pomona Basin, but continued to increase across most of the central and southern Pomona Basin.

**2000 to 2011**. This was generally a dry period. During the period, groundwater elevations generally increased in areas north of the Indian Hill Fault, and generally decreased in areas south of the Indian Hill Fault.

**1966 to 2011**. This is the entire period of record. This period was generally wet compared to the long-term historical record of precipitation shown on Figures 2-2a through 2-2d. The implication here is that the develop yield estimates during a dryer period would be lower than the estimates for 1966 to 2011.

For the combined Canyon, Upper Claremont Heights, and Lower Claremont Heights basins, the developed yield is higher after wet years or periods when groundwater elevations are relatively high, and is lower after dry years or periods when groundwater elevations are lower. The management implication here is that operating this area at higher groundwater elevations will increase the yield and allow the pumpers in this area to produce more groundwater.

In the Pomona Basin, the opposite is true. Groundwater elevations rose by up to 400 feet in the Pomona Basin from 1966 to 1999 and stayed relatively high during the 2000 to 2011 period. The developed yield declined from about 12,000 acre-ft/yr during the 1966 to 1983 period to about 4,100 acre-ft/yr during 2000 to 2011 period. This decline in developed yield suggests that sub-surface outflow to the Chino Basin and Spadra Basin increased as groundwater elevations rose. The management implication here is that operating the Pomona Basin at lower groundwater elevations will decrease outflow and increase the yield.

For the combined Four Basins during the 1966 to 2011 period, the developed yield was about 20,700 acre-ft/yr. The established safe yield of the Four Basins in the Judgment is 19,300 acre-ft/yr. Although the 1966 to 2011 period is a relatively long, this estimate of developed yield should not be viewed as an alternate estimate of safe yield, because the 1966 to 2011 period was a relatively wet. The develop yield estimates during a dryer period would likely be lower than the estimates for the 1966 to 2011 period.

For the Two Basins, the production estimates for the 1966 to 1983 period were derived from model input files (CDM, 2012) and the values for production are much higher than for the periods 1984 to 1999 and 2000 to 2011. This suggests that the production estimates for 1966 to 1983 are likely incorrect and too high, which indicates that the estimates of developed yield for the period 1966 to 1983 are incorrect and too high. For the period 1984 to 1999, the developed yield from the Two Basins was less than 1,000 acre-ft/yr. During the relatively dry period of 2000 to 2011, groundwater elevations declined and the developed yield declined to less than 500 acre-ft/yr. The management implications here are that the long-term sustainable yield of the Two Basins is relatively small—probably less than 1,000 acre-ft/yr. Enhancing recharge and operating the Two Basins at higher groundwater elevations will increase the yield.

### 2.4.5 Summary of Basin Management Issues

The following is a summary of the major issues for basin management that are associated with groundwater elevations and storage in the Six Basins:

- Recharge has an immediate and positive influence on groundwater elevations and the developed yield in the Upper Claremont Heights Basin. Groundwater pumpers in this area have the capacity and desire to increase production when groundwater elevations are high. The management implication here is that enhanced recharge in this area will increase groundwater elevations and allow for increased groundwater production.
- When groundwater elevations are relatively high in the Upper Claremont Heights Basin, the Pomona Basin east of the Intermediate Fault receives preferential recharge via sub-surface inflow across the Indian Hill Fault. The management implication here is that maintaining high groundwater elevations in the Upper Claremont Heights Basin will enhance recharge to the Pomona Basin and enhance its yield.

- Sub-surface flow across the Indian Hill Fault is an important source of recharge to the Pomona Basin, but is not adequately understood and characterized. Understanding how sub-surface flow occurs across the Indian Hill Fault is important to the development of basin management programs.
- The areas of greatest recharge capacity, such as the Upper Claremont Heights Basin, do not overlie the areas with greatest groundwater-storage capacity, such as the Pomona Basin. In fact, these areas are separated by distance and barriers to groundwater flow.
- The current state of relatively high groundwater elevations in the southern Pomona Basin is undesirable. Managing the Pomona Basin at lower groundwater elevations will (i) reduce sub-surface outflow to the Chino Basin and Spadra Basin and increase the yield of the basin, (ii) reduce the threat of rising groundwater in the event of an increase in recharge or a decrease in production, and (iii) improve the ability of the Pomona Basin to participate in storage programs without causing undesirable consequences such as reduced yield or rising groundwater.
- The long-term sustainable yield of the Two Basins is relatively small—probably less than 1,000 acre-ft/yr. Enhancing recharge and operating the Two Basins at higher groundwater elevations will increase the yield.

## 2.5 Historical Land Use, Water Use, and Disposal

This section describes the historical and current land use, water use, and disposal of water in the Six Basins. It is important to understand land use, water use, and disposal for three main reasons. First, water use and disposal on lands that overlie a groundwater basin are important components of the water budget. This is true because different land uses have different imperviousness, irrigation practices, and disposal practices that affect the volume of return flows to the groundwater basin. Second, water use and disposal are an important influence on groundwater quality. This is true because the concentration of dissolved constituents in the return flows is higher relative to the groundwater, which causes degradation of groundwater quality. Third, the municipal wastewater that originates in the Six Basins, and is currently exported from the Six Basins, is a potential supplemental water supply for the water purveyors in the Six Basins.

### 2.5.1 Land Use and Source Waters

Figure 2-30 illustrates the land use in the Six Basins area in 1949, 1963, 1975, and 2005. The land-use changes shown on these maps are quantified by acreage on Figure 2-31. The land-use maps were developed from DWR land use surveys for 1949 through 1984, and from Southern California Association of Governments (SCAG) surveys for 1990 and 2005. The maps show a change over time from mainly agricultural citrus in 1949 to mainly urban land uses today. The urbanization encroached from the south to the north. By 1963, almost all of the City of Pomona had converted to urban land uses, as well as the southern portions of Claremont, La Verne, and Upland. By 1990, the remainder of most citrus groves had converted to urban uses.

The early sources of water for domestic use and irrigated agriculture were surface-waters diverted from San Antonio Canyon, other tributary canyons, and the marshes and springs at the cienegas. These surface waters were conveyed to the areas of use by channels and pipelines. In the late 1880s, wells and tunnels were constructed at the cienegas to augment the surface water with groundwater. By 1950, wells had been constructed across the entire Six Basins area to supply the agriculture and the drinking-water demands of the growing urban population, and imported water supplies were available from the Colorado River via the Upper Feeder. By the 1970s, imported water supplies were available from the State Water Project via the Foothill Feeder.

### 2.5.2 Water Use and Return Flows

With few exceptions, as land use converts from irrigated agriculture to urban uses, it becomes more impervious with less irrigated area. Historically, when land use was converted from natural or agricultural uses to urban uses, the imperviousness increased from near zero to between 60 and 100 percent depending on the specific land use. The Los Angeles County Public Works Department assumes about a 2% impervious area for orchards and vineyards in their hydrology manual (LACPWD, 2006). In contrast, urbanized areas have a much higher fraction of imperviousness, typically from about 20% for very low-density residential areas to 90% or more for apartments, mobile home courts, and high-rise offices.

For their respective irrigated areas, citrus and urban land uses have different irrigation efficiencies. Irrigation efficiency is defined as the ratio of the use of the applied water by the plants to the total water applied (UCCE, 2000). The lower the efficiency, the more applied water is lost. The main component of loss is infiltration of the applied water past the root zone to the aquifer system. The typical efficiency of flood irrigation is 60 percent or less. Modern irrigation methods, such as trickle irrigation, can achieve 90 percent efficiency (Pier, 2006).

The combination of higher imperviousness and higher irrigation efficiency associated with urban land uses can reduce the return flows of applied water to the groundwater basin by up to 90 percent compared to the same area of flood-irrigated citrus groves. In short, the change from citrus to urban land uses has resulted in reduced return flows, and hence, reduced basin yield.

Irrigation return flows degrade groundwater quality. Citrus farming, and to a lesser degree urban landscape irrigation, is associated with application of fertilizers and pesticides that dissolve in the applied water. Plant uptake of the water concentrates the return flows. The return flows are a non-point-source of contaminant loading to the groundwater basin that has affected, and continues to affect, the temporal and spatial distribution of groundwater-quality in the Six Basins. This is particularly true for nitrate and perchlorate. Groundwater quality in the Six Basins is described and discussed in Section 2.6.

### 2.5.3 Disposal of Water

Surface waters that have not infiltrated or been diverted for use in the Six Basins have exited the Six Basins in the stream channels. These channels were concrete-lined for flood-control purposes in the late-1950s and early-1960s, which eliminated infiltration of water in these channels as a source of recharge. In addition, as the area converted from citrus to urban land uses, the imperviousness urbanized areas were connected to the storm-drain systems to export runoff from the area. The surface water that exits the Six Basins in the channels either flows to the ocean or is put to beneficial use by downstream entities mainly for recreational uses and/or groundwater recharge.

Prior to the 1920s, all domestic and commercial wastewaters were disposed of in cesspools or septic-tanks/leach-fields. Subsequently, population growth led to the construction of pipelines and treatment plants to collect and treat wastewater at regional facilities. Currently, the municipal wastewaters that originate in the Six Basins are treated to tertiary standards at regional treatment facilities that are located outside of the Six Basins. Almost none of the treated municipal wastewater is reused in the Six Basins, and therefore, it is a potential water resource to the Six Basins.

Figure 2-32 shows the current wastewater disposal and recycling facilities in the Six Basins area. The domestic and commercial wastewater originating in the Six Basins is either treated by the Los Angeles County Sanitation District at the Pomona Water Reclamation Plant (Pomona WRP) for Los Angeles County areas, or by the Inland Empire Utilities Agency (IEUA) at Regional Plant #1 for the San Bernardino County areas. Currently, the tertiary-treated wastewaters from these plants are either (i) discharged to streams, (ii) reused for irrigation or commercial processes, or (iii) directly recharged to groundwater at spreading grounds in the Chino Basin.

Figure 2-32 also shows that some urbanized areas are not sewered, and dispose of wastewaters with on-site waste disposal (septic) systems. These areas are mainly located in Live Oak Canyon and vicinity, and could be having an adverse impact on groundwater quality in downgradient areas—particularly for nitrate.

### 2.5.4 Summary of Basin Management Issues

The following is a summary of basin management issues associated with land use, water use, and water disposal in the Six Basins:

- The change from citrus to urban land uses in the Six Basins has resulted in reduced return flows and recharge, which has reduced basin yield.
- Concentrated return flows from irrigation are a non-point source of contaminant loading to the groundwater basin which has affected, and continues to affect, the temporal and spatial distribution of groundwater-quality in the Six Basins.
- Currently, the municipal wastewaters that originate in the Six Basins are treated to tertiary standards at regional treatment facilities that are located outside of the Six Basins. Almost none of the treated municipal wastewater is reused in the Six Basins, and therefore, it is a potential water resource to the Six Basins.
- Some urbanized areas are not sewered, and dispose of wastewaters with on-site waste disposal (septic) systems. These areas are mainly located in Live Oak Canyon and vicinity, and could be having an adverse impact on groundwater quality in downgradient areas—particularly for nitrate.

## 2.6 Groundwater Quality

A characterization of groundwater quality in the Six Basins aids in the understanding of how groundwater is being put to beneficial use, and the current and future challenges that pumpers face related to groundwater quality. Groundwater quality, and how it has varied over space and time, can also be used to characterize the hydrology and hydrogeology of the Six Basins, insofar as groundwater quality is a function of source-water quality, water use and disposal, and the physical processes and chemical reactions that occur along groundwater-flow paths from areas of recharge to areas of discharge. These processes and reactions typically include dispersion/diffusion, sorption/desorption, precipitation/dissolution, and degradation/transformation.

This section describes: (1) the sources of groundwater quality data available in the Six Basins, (2) the general chemistry of groundwater in the Six Basins, (3) how groundwater quality compares to regulatory standards for drinking water, and (4) the known point sources of contamination in the Six Basins.

### 2.6.1 Groundwater-Quality Monitoring and Data Collection

In the Six Basins, groundwater quality data are available from production and monitoring wells. Groundwater quality samples from production wells are collected by well owners. In general, well owners sample their wells for the constituents and associated sample frequencies required by the California Code of Regulations for drinking water. Oftentimes additional sampling is performed that is specific to each well owner's water quality concerns and interests. Groundwater quality samples from monitoring wells in the Six Basins are collected by public entities and private companies, and their consultants, to characterize point-source contamination for which they are potentially responsible, as determined by the Los Angeles Regional Water Quality Control Board (RWQCB). The constituents and sample frequency vary by contamination site.

Available groundwater quality data for wells in the Six Basins were collected from a variety of resources. A quality assurance/quality control (QA/QC) program was conducted as part of the process to upload all groundwater quality data to HydroDaVE$^{SM}$, a software system with a centralized database and graphical user interface that allows visualization of the data through a variety of sophisticated data-analysis tools. The objective of the QA/QC program is to ensure that duplicate and erroneous data are not loaded to the database or included in the groundwater quality analysis.

Data for wells owned by the City of Pomona, West End Consolidated Water Company, City of Upland, and San Antonio Water Company were collected from the Chino Basin Watermaster, who collects the sample results directly from these agencies or from their contract laboratories and loads them into HydroDaVE. For these wells, data are available for the 1930 to 2011 period. Groundwater quality data from wells owned by the City of La Verne, Golden State Water Company, and TVMWD were obtained from the California State Water Resources Control Board's (State Board) Division of Drinking Water (DDW) water quality database for the 1990 to 2011 period, the period for which electronic data are readily available. Some supplementary groundwater quality data for the City of Pomona, West End Consolidated Water Company, City of Upland, and San Antonio Water Company were also obtained from the DDW database. Groundwater quality data from the State Board's GeoTracker[13] and EnviroStor[14] websites were obtained for monitoring efforts at the following sites with point source contamination: the former Xerox Corporation facility in the Pomona Basin, the former United Production Services

[13] GeoTracker was created by the State Water Resources Control Board to manage data for sites that may impact groundwater: underground storage tanks (UST), Department of Defense, *etc*. Permitted facilities, such as operating USTs and land disposal sites are also managed in GeoTracker.

[14] EnviroStor was created by the Department of Toxic Substances Control (DTSC) and provides access to detailed information on hazardous waste permitted and corrective action facilities, as well as existing site cleanup information.

facility, and the former Victor Graphics facility, both in the Ganesha Basin. In total, data were collected for 70 production wells and 94 monitoring wells for the period 1930 to 2011.

Data for the 2007 to 2011 period were used to characterize current groundwater quality of the Six Basins. Figure 2-33 shows the location of wells with groundwater quality sample results for the 2007 to 2011 period—symbolized by well type. In this period, there were 48 production wells and 61 monitoring wells with available data for the characterization of water quality. Figure 2-33 also shows the general location of the three point-source contamination sites identified within the Six Basins as impacting groundwater quality.

## 2.6.2 Water Character Index

The general chemistry of groundwater can be characterized using a modified version of the Piper Diagram method known as the water character index (WCI). WCI is a unitless parameter that can be used to generally characterize water sources in terms of their ratios of major cations and anions. WCI is analogous to a trilinear Piper diagram, which is a graphical means of displaying the ratios of the principal ionic constituents in water (Watson & Burnett, 1995). Water character is defined by the following equation:

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

Where Ca, Mg, *et cetera* are expressed in terms of milliequivalents per liter (meq/L) rather than milligrams per liter (mg/L). The first term on the right hand side of the equation is the ratio of divalent to monovalent cations, and the second term is the ratio of carbonate character to chloride/sulfate character. The utility of the WCI method, compared to Stiff or Piper diagrams, is that data points can be plotted on a map to show the spatial distribution of water character or as a time-series plot to assess temporal trends. Note that WCI is not a unique solution, and verifying the results with Stiff or Piper Diagrams is important. In this analysis, the water chemistry of Six Basins wells are used identify spatial variations in water character. Using HydroDaVE Explorer, the Stiff diagram tool was used to corroborate the interpretations of the computed WCI values.

The primary sources of groundwater recharge in the Six Basins include mountain front recharge, artificial recharge of native surface water from San Antonio Canyon, Thompson Creek, and Live Oak Canyon, deep infiltration of precipitation, deep infiltration of returns from use (*e.g.*, anthropogenic outdoor water use), and imported water recharge. Raw, native surface water diverted from San Antonio Canyon is sampled by the City of Upland prior to treatment at the San Antonio Canyon drinking water treatment plant. The WCI of raw San Antonio Creek surface water sampled between 2006 and 2011 ranged between 1,445 and 2,050, and averaged 1,720. These high WCI values are reflective of the calcium-bicarbonate character of the San Antonio Creek water.

Figure 2-34 is an areal representation of the average WCI of groundwater at wells for the five-year period from 2007 through 2011. Two wells located just to the north of San Antonio Dam pump groundwater that is directly under the influence of mountain front recharge from San Antonio Canyon. These two wells have similar WCI values to raw San Antonio Canyon surface water for the same period: the average WCI values for the 2007 through 2011 period are 1,415 and 2,025. Wells pumping from areas of the Six Basins where native surface water recharge is a primary source of groundwater recharge should express similarly high WCI values (>1,000). As the groundwater flows through the aquifer system the dissolution of minerals, cation exchange, or mixing with other sources of recharge—such as deep infiltration of precipitation or returns from use—results in changes in WCI.

Figure 2-34 shows that the majority of wells located in the Upper Claremont Heights Basin are producing groundwater that is recharged by San Antonio Canyon surface water. These wells are all downgradient of the forebay of the Six Basins where the vast majority of San Antonio Creek runoff water is recharging.

Wells located in the western portion of the Six Basins have WCI values that range between 400 and 800, suggesting that there is less influence from mountain-front recharge of native surface water in these areas or the that geology of the drainage area is different than that of San Antonio Creek. As discussed earlier in this report, the annual volume of water diverted for spreading at the Live Oak basins is small[15] compared with spreading at the SASG. Further downgradient, in the Ganesha Basin, WCI values are less than 400, suggesting that groundwater is mixing with other sources of lower WCI water (*e.g.*, returns from use) and/or is impacted by the ionic composition of the aquifer materials through which groundwater is flowing.

In the Pomona Basin, a wide range of WCI values are observed: from a low of 210 to a high of 1080. In the western-most end of Pomona Basin, WCI in wells is similar to Live Oak Basin. To the south, WCI area range between 200 and 400, suggesting that major ion chemistry has been altered along the flow path from the forebay area, likely from both chemical reactions with aquifer sediments (sorption/desorption, precipitation/dissolution) and from returns from use. In the northeast end of the Pomona Basin, wells in relatively close proximity to each other have a wide range of WCI values, which supports conclusions stated earlier in this report that the hydrogeology of the Pomona Basin is complex.

### 2.6.3 Comparison of Groundwater Quality with Regulatory Standards

**Drinking Water Standards.** Section 304(a)(1) of the Clean Water Act of 1972 requires the US Environmental Protection Agency (USEPA) to develop criteria for water quality that that are based solely on data and scientific judgments on chemical concentrations and human health effects. The Safe Drinking Water Act requires the USEPA to establish National Primary Drinking Water Regulations, which include maximum contaminant levels (MCL). Primary MCLs (PMCLs) are the legal threshold limits on the amount of a constituent – expressed as a concentration – that is allowable in a public drinking water system. A maximum contaminant level goal (MCLG) is the concentration of a constituent that can be present in drinking water with no adverse health effects. The MCL, then, is set as close to the MCLG as possible taking into consideration treatment technologies, analytical capabilities, and economic analyses. Secondary MCLs (SMCLs) are established by the USEPA for constituents in drinking water that do not cause adverse health effects, but may instead cause aesthetic problems, such as unpleasant taste or odors.

[15] Between 1999 and 2011, spreading a Live Oak averaged 123 acre-ft/yr, with a maximum value of 297 acre-ft/yr. At the SASG, spreading ranged averaged 3,572 acre-ft/yr, with a maximum value of 31,362 acre-ft/yr. For more details see section 2.1 of this report.

Similarly, at the state level, Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA) establishes public health goals pursuant to Health & Safety Code §116365(c), which are concentrations of constituents in drinking water that do not pose a significant human health risk based on risk assessments. Health & Safety Code §116365(a) requires DDW to set the MCL as close to the public health goal (PHG) as possible, taking into account detectability, treatability, and the cost of treatment.

DDW also establishes Notification Levels (NLs), which are health-based advisory levels for constituents in drinking water for which MCLs have not yet been established. Health & Safety Code §116455 requires that the owner of a drinking water system notify local governing bodies whenever an NL is exceeded in drinking water that is provided to consumers. DDW also recommends that the consumers are provided notice as well, perhaps through the Consumer Confidence Report (CCR).

Using HydroDaVE, a query was performed to compare all water quality data for wells in the Six Basins from 2007 through 2011 to current Federal and California MCLs, and California NLs. Table 2-7 summarizes the results of this query by listing each chemical that was detected above an MCL or NL, the number of times the MCL or NL was exceeded, and the number of wells at which the exceedances occurred.

**Basin Plan Objectives and Salt and Nutrient Management.** The responsibility for protecting water quality in California rests with the State Board and its nine RWQCBs. The State Board sets policies and develops regulations for the implementation of water quality control plans (Basin Plans) that are mandated by state and federal water quality statutes and regulations. The RWQCBs are responsible for developing and implementing water quality control plans that (1) designate the current and potential future beneficial uses for surface waters, groundwater, wetlands and coastal waters, (2) set numerical or narrative water quality objectives, referred to as basin plan objectives, that must be protective of the designated beneficial uses and conform to the State Board's Antidegradation Policy, and (3) describe the implementation programs to implement the Basin Plan.

A key element of California's water quality standards is the State Board's Antidegradation Policy. This policy restricts degradation of surface or groundwater, in particular for sources where the existing water quality is better than is necessary for the protection of its beneficial uses. When the existing water quality of a surface water or groundwater resource is better than its basin plan objective, this water is said to have "assimilative capacity" for degradation. The antidegradation policy is implemented, in part, through Waste Discharge Requirements issued by the RWQCBs. Waste discharges to groundwater are regulated as follows with respect to assimilative capacity:

- If assimilative capacity does not exist (*i.e.,* the existing groundwater quality is poorer than basin plan objective), then discharges to that the groundwater basin must have water quality that is equal to or better than the basin plan objective.
- If assimilative capacity does exist (*i.e.*, the existing groundwater quality is better than basin plan objective), then the RWQCB has the discretion to allocate assimilative capacity for discharges that have water quality that is poorer than the basin plan objective. Dischargers must demonstrate to the RWQCB that the degradation resulting from the proposed discharge will not result in an exceedance of basin plan objectives and that it is consistent with the maximum benefit to the people of the State of California.

In February 2009, the State Board adopted Resolution No. 2009-011 which establishes a statewide Recycled Water Policy (Policy). The Policy identifies an "unparalleled opportunity for California to move aggressively towards a sustainable water future" and encourages the "local and regional water agencies to move toward clean, abundant, local water for California by emphasizing appropriate water recycling, water conservation, maintenance of supply infrastructure, and the use of stormwater (including dry-weather urban runoff)". The Policy requires the State Board and the RWQCBs to exercise the authority granted to them by the Legislature to the fullest extent possible to encourage the use of recycled water, consistent with State and federal water quality laws. The Policy also recognizes that:

- Some groundwater basins in the state contain salts and nutrients that exceed or threaten to exceed the water quality objectives established in applicable Basin Plans.
- Water quality objectives in the Basin Plans are set to protect the beneficial uses of groundwater, but not all Basin Plans include adequate implementation procedures for achieving or ensuring compliance with the water quality objectives for salt or nutrients.
- Degradation of groundwater quality can be caused by a number factors, including natural soils/conditions; waste discharges; irrigation using surface water, groundwater, or recycled water; and water-supply augmentation using surface or recycled water.
- Regulation of recycled water alone does not ensure compliance with the water quality objectives for salt or nutrients or the protection of the beneficial uses of groundwater.

To address the potential for salt and nutrient degradation in groundwater from all sources, and the potential impairment of beneficial uses, the Policy requires the development of salt/nutrient management plans (SNMP) to support recycled water reuse programs. The two primary water quality constituents of concern for SNMPs are TDS and nitrate.

The Los Angeles RWQCB has jurisdiction over the coastal drainages of Ventura County and Los Angeles County, including the San Gabriel Basin, within which the Six Basins is located. In the Basin Plan for the Los Angeles Region, the Six Basins is divided into three groundwater sub-basins: Claremont Heights, which generally coincides with the adjudicated boundaries of the Upper Claremont Heights Basin and the Lower Claremont Heights Basin; Live Oak, which generally coincides with the adjudicated boundary of the Live Oak Basin; and Pomona, which generally coincides with the adjudicated boundaries of the Pomona Basin and Ganesha Basin. The designated beneficial uses for all three basins are: municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply. The TDS objectives for Claremont Heights, Live Oak, and Pomona are 450 mg/L, 450 mg/L, and 300 mg/L, respectively. The nitrate (as nitrogen) objective for all three basins is 10 mg/L.

Understanding the spatial distribution of wells with sample results greater than regulatory standards is important because it indicates areas in the basin where groundwater may be impaired from a beneficial use standpoint. A series of maps were prepared to depict the areal distribution of constituents of potential concern (COPC) in the Six Basins. COPCs are defined as follows:

- Constituents associated with salt and nutrient management planning, which are primarily TDS and nitrate.
- Other constituents where a primary or secondary MCL was exceeded in five or more wells from 2007 to 2011, which include TDS, nitrate, and perchlorate.

- Constituents associated with known point-source contamination sites, which include trichloroethene (TCE), tetrachloroethene (PCE), 1,1-dichloroethene (1,1-DCE), and hexavalent chromium.
- Constituents for which the DDW 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).

Figures 2-35 through 2-41 show the areal distribution of groundwater quality for the COPCs listed above. The maximum concentration measured at each well from 2007 to 2011 is displayed using the following standardized class intervals based on the water quality standard (WQS) for the constituent of concern:

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

#### 2.6.3.1 TDS

TDS has an SMCL of 500 mg/L. Figure 2-35 displays the areal distribution of the maximum TDS concentration at wells in the Six Basins from 2007 through 2011. During this period, 8 out of 48 wells sampled for TDS exceeded the SMCL. The maximum TDS concentrations ranged from 230 mg/L to 660 mg/L and averaged 368 mg/L. The highest TDS concentrations are located in Live Oak Basin, Ganesha Basin, and the western-most area of the Pomona Basin, where there is less recharge of low-TDS surface water to blend with high-TDS of returns from irrigation uses.

With regards to basin plan objectives for TDS, all wells in Claremont Heights are well below the objective concentration of 450 mg/L. The highest TDS concentration observed in this area is 380 mg/L, indicating that the basin has assimilative capacity for TDS. In Live Oak, only one of seven wells is below the objective of 450 mg/L. The majority of wells are above 500 mg/L, indicating that the basin may not have assimilative capacity for TDS. In Pomona, 15 of the 17 wells have TDS concentrations in excess of the objective of 300 mg/L, indicating that the basin may not have assimilative capacity for TDS. A finding of no assimilative capacity for TDS could restrict the reuse and/or recharge of recycled water in the Six Basins.

#### 2.6.3.2 Nitrate

The Federal and California PMCL for nitrate as nitrogen in drinking water is 10 mg/L. By convention, all nitrate values are expressed in this report as nitrate as nitrogen. Figure 2-36 displays the areal distribution of the maximum nitrate concentration at wells in the Six Basins from 2007 through 2011. During this period, 22 out of 58 wells sampled for nitrate exceeded the PMCL. The areas of highest nitrate concentrations—to the west and south-west of the SASG down to the Pomona Basin and Live Oak Basin—correlate with areas of historical agricultural land use, particularly citrus farming, in the Six Basins (refer to the land use maps in Figure 2-

30). Fertilizers high in nitrate were regularly applied to citrus crops in these areas for more than 30 years. Furthermore, typical irrigation practices for citrus have low irrigation efficiencies, about 60 percent. The lower the irrigation efficiency of the practice, the more applied water percolates to groundwater. These agricultural practices resulted in the high-nitrate legacy that impacts the beneficial use of groundwater by agencies in the Six Basins to this day. Both the Cities of Pomona and La Verne rely on treatment of the high-nitrate groundwater in the Live Oak, Ganesha, and Pomona Basins. High-nitrate concentrations have also threatened Golden State Water Company's ability to produce groundwater in the western-most Claremont Heights Basins. Lower concentrations of nitrate in groundwater are observed at wells in areas not overlain by historical citrus farming and that are influenced by the recharge of high-quality, low-nitrate native water at the San Antonio Dam and SASG.

With regard to the basin plan objective for nitrate, which is 10 mg/L across the whole Six Basins, Live Oak and Pomona have the greatest number of wells with concentrations above the objective. In Live Oak, all wells have nitrate concentrations greater than 10 mg/L, indicating that the basin does not have assimilative capacity for nitrate. In Pomona, all but the eight wells in the north-east corner of the basin have nitrate concentrations greater than 10 mg/L, indicating that the basin may not have assimilative capacity for nitrate. In Claremont Heights, only three wells have nitrate concentrations about equal to or greater than 10 mg/L, indicating that the basin does have assimilative capacity for nitrate. A finding of no assimilative capacity for nitrate could restrict the reuse and/or recharge of recycled water in the Six Basins.

#### 2.6.3.3 Perchlorate

Perchlorate is a regulated drinking water contaminant in California with a PMCL of 6 micrograms per liter (μg/L). Figure 2-37 displays the areal distribution of the maximum perchlorate concentration at wells in the Six Basins from 2007 through 2011. During this period, 17 out of 48 wells sampled for perchlorate exceeded the PMCL of 6 μg/L. 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 used in Southern California in the early 1900s for the citrus industry, which covered the northern and western portions of the Six Basins as shown in Figure 2-30. While citrus farming was almost non-existent in the Six Basins by the 1990s, like nitrate, the legacy of perchlorate contamination in groundwater still exists[16]. As is the case with nitrate, the Cities of Pomona and La Verne require treatment of the perchlorate-contaminated groundwater in the Live Oak, Ganesha, and Pomona Basins.

#### 2.6.3.4 TCE and PCE

TCE and PCE are regulated drinking water contaminants in California with a PMCL of 5 μg/L. Figure 2-38 and Figure 2-39 display the areal distribution of the maximum TCE and PCE concentrations at wells in the Six Basins from 2007 to 2011. During this period, 17 out of 106 wells sampled for TCE, and 18 out of 106 wells sampled for PCE, exceeded their PMCLs. TCE, and PCE are common industrial solvents used as degreasers in metal-working industries. Wells with detectable levels of TCE and PCE occur predominantly in monitoring well clusters

[16] The Chino Basin Watermaster conducted a study analyzing the stable isotopes of oxygen and chlorine from perchlorate in samples from groundwater wells in west and central Chino Basin. This study concluded that Chilean fertilizer was the source of perchlorate in those portions of Chino Basin. The results of the study were not published by the Chino Basin Watermaster.

associated with the known point-sources of contamination (see Figure 2-33) or in wells downgradient of these contamination sites. However, TCE is detected in a few wells that are not located in proximity to these contamination sites and potentially responsible parties are yet to be identified. The known point-source contamination sites in the Six Basins will be discussed in more detail in this report.

#### 2.6.3.5 1,1-DCE

1,1-DCE is a regulated drinking water contaminant in California with a PMCL of 6 µg/L. Figure 2-40 displays the areal distribution of the maximum 1,1 DCE concentration at wells in the Six Basins from 2007 – 2011. During this period, 21 out of 106 wells sampled for 1,1-DCE exceeded the PMCL. 1,1-DCE is a degradation by-product of TCE, PCE, and 1,1,1-trichloroethane (1,1,1-TCA) that is formed by reductive dehalogenation. Wells with detectable levels of 1,1-DCE occur predominantly in monitoring well clusters associated with the known point-sources of contamination (see Figure 2-33) or in wells downgradient of these contamination sites. 1,1-DCE is detected in a few wells that are not located in proximity to these contamination sites and potentially responsible parties are yet to be identified. The known point-source contamination sites in the Six Basins will be discussed in more detail in this report.

#### 2.6.3.6 Hexavalent Chromium

There are no Federal or California drinking water standards specific to hexavalent chromium. Hexavalent chromium is currently regulated under the PMCL established for total chromium (California PMCL of 50 µg/L and Federal PMCL of 100 µg/L). In 1999, the DDW 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[17] to be sampled by 2002 (Title 22 of the CCR, §66450). Furthermore, the California Health and Safety Codes (§116365.5 and §1163659a) compelled the DDW to adopt an MCL for hexavalent chromium, and required it to be as close as practicable to the PHG established by OEHHA. A PHG of 0.02 µg/L was established by OEHHA on July 27, 2011, and an MCL of 10 ug/L was established by the State Board in 2015. This MCL was later invalidated by the Superior Court of Sacramento County as economically infeasible and directed the State Board to adopt a new alternative MCL.

Hexavalent chromium in groundwater may be naturally-occurring (weathering of alluvium) and it may also be anthropogenic in origin (typically chromium plating or other industrial sources). Research is being conducted by the USGS to determine if a stable isotope method can be developed to differentiate hexavalent chromium by source. Unpublished research by the Chino Basin Watermaster suggests that hexavalent chromium concentrations up to 8 to 9 µg/L in the Chino Basin probably result from naturally-occurring sources.

Figure 2-41 displays the areal distribution of the maximum hexavalent chromium concentrations at wells in the Six Basins from 2007 through 2011. Hexavalent chromium concentrations are plotted using the standardized class interval based on the PHG of 0.02 µg/L. During this period, 42 out of 48 wells in the Six Basins sampled for hexavalent chromium exceeded the PHG. The remaining 6 wells that did not exceed the PHG were non-detect values. However, samples collected from these wells were analyzed using a detection limit for reporting (DLR) of 0.1 to 1.0 µg/L, which corresponds to 5 to 50 times than the PHG, which

[17] Information can be found at http://www.cdph.ca.gov/certlic/drinkingwater/Pages/UCMR.aspx

means that hexavalent chromium could be present at concentrations above the PHG, but that they are not detectible based on the lab methods performed.

From 2007 through 2011 the maximum detected hexavalent chromium concentrations ranged from 0.5 to 340 μg/L. The highest concentrations of hexavalent chromium are observed at monitoring wells associated with the former Xerox Corporation Facility in Pomona Basin and in wells downgradient of the contamination site. At all other wells in the Six Basins not associated with the former Xerox Corporation Facility monitoring, or downgradient of the site, maximum detected hexavalent chromium concentrations range from 0.5 to 4.5 μg/L, with an average of 2.1 μg/L, and a median of 1.5 μg/L.

At present, hexavalent chromium sampling is not required by DDW. The last required sampling event was for State UCMR program in 2001—at that time the reporting limit was 1.0 ug/L—50 times higher than the PHG. More than half of the municipal production wells in the Six Basins were not sampled for hexavalent chromium between 2007 and 2011. In May 2012, the EPA released Unregulated Contaminant Monitoring Rule 3 (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 of hexavalent chromium in drinking water at low levels and aid in the DDW's determination of an enforceable regulatory limit. As shown in Figure 2-41, sample results from wells analyzed at low detection limits indicate that an MCL at or near the PHG of 0.02 μg/L will severely limit the ability of municipal agencies to serve groundwater without treatment to reduce hexavalent chromium concentrations.

#### 2.6.3.7 1,2,3-TCP

1,2,3-TCP has a California State 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 DDW 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 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 DDW with the adequate information for setting a regulatory standard. Thus, the DDW 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 DDW is currently developing an MCL for 1,2,3-TCP.

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. As of 2011, the majority of the private and public wells in the Six Basins have not been sampled for 1,2,3-TCP using the lower detection limit of 0.005 μg/L and so the potential impact of the forthcoming MCL on the Six Basins cannot be characterized at this time.

### 2.6.4 Point-Source Contamination in the Six Basins

Using HydroDaVE Explorer, the State Board's GeoTracker and EnviroStor databases were queried interactively to determine if there are any remediation sites with open cases for monitoring and cleanup of groundwater within the Six Basins. Sites listed on GeoTracker or EnviroStor that contained no information about the contamination source, constituent, or contaminated media were not investigated for this report. The sites identified as limited to soil contamination were not investigated for this report.

Three point-source contaminant sites were identified on GeoTracker within the Six Basins as potentially impacting drinking water resources: the former Victor Graphics Facility, the former United Production Services Inc. Facility, and the former Xerox Corporation Facility. Figure 2-34 shows the general location of these three point-source contamination sites.

#### 2.6.4.1 Victor Graphics

The former Victor Graphics Facility is a 1.49 acre site located on 1330 Arrow Highway in La Verne, California. The site is owned by the Tamkin Family Trust (Tamkin), which leased the property to Victor Graphics from 1973 to 1993 for the manufacturing of rubber stamps. Victor Graphics documented the use and storage of PCE, TCE, and other solvents at the facility. In 1977 a PCE spill was reported to the County of Los Angeles to have occurred near the southwestern corner of the property (RWQCB, 2012a). At the request of the RWQCB initial site investigations began in 2001 with soil and groundwater sampling, and included the installation of four on-site monitoring wells (Gaston, 2001). PCE was detected in soils samples at concentrations ranging from 7 to 690 micrograms per kilogram (µg/kg) and in 2 of the 4 monitoring wells at 42 and 110 µg/L. During subsequent sampling in 2002, PCE was detected in the two monitoring wells at 17 and 330 µg/L (Gaston, 2002). However, since 2002 the RWQCB has not required further sampling at these four monitoring wells. In 2010, groundwater sampling was conducted during a site investigation for the neighboring Former United Production Services Facility. Two additional monitoring wells were constructed on the Victor Graphics property slightly downgradient of the other four monitoring wells (Langan, 2011). Samples collected from these two new wells had PCE concentrations of 500 and 9,100 µg/L, and TCE concentrations of 23 and 420 µg/L. Other VOCs detected above California PMCLs were *cis*-1,2-dichloroethene (*cis*-1,2-DCE) at 110 µg/L and vinyl chloride at 17 µg/L.

Figure 2-38 and Figure 2-39 display the areal distribution of the maximum TCE and PCE concentrations, respectively, from 2007 to 2011 at wells in the Six Basins. Additionally, Figure 2-42 is a map of the former Victor Graphics site and the adjacent former United Production Services cleanup site, and shows the maximum concentration of PCE in monitoring wells from 2007 to 2011 and the extent of the PCE plume as delineated during a groundwater contamination investigation at the neighboring, former United Production Services cleanup site (Langan, 2011). During this period, the maximum TCE and PCE concentrations found at onsite wells at the former Victor Graphics Facility were 420 µg/L and 9100 µg/L, respectively. Sampling has not occurred at 4 of the 6 on-site monitoring wells since 2002, and there has been no investigation as to the extent of the contaminant plume associated with the former Victor Graphics facility by the property owners.

On April 11, 2011 the Los Angeles RWQCB issued a *Requirement for Technical Reports* to Tamkin and Inmark-Victor Rubber Stamp Co. (Victor), requesting a Phase I Environmental Assessment Report (EAR), a monitoring work plan, and groundwater sampling (RWQCB, 2011a). One month later, St Paul Stamps Works, Inc. (St Paul), the parent company of Victor, petitioned the request and provided documentation that it did not acquire any of Victor's environmental liabilities. The RWQCB approved this petition from St Paul (RWQCB, 2011b), and Tamkin submitted a Phase I EAR to the RWQCB in July 2011 (CDM, 2011).

A Cleanup and Abatement Order (CAO) was issued by the RWQCB on October 2, 2012 to Tamkin (RWQCB, 2012a) as the sole Potentially Responsible Party (PRP). Tamkin is preparing a Remedial Action Plan (RAP) for cleanup and a monitoring work plan, which would include quarterly monitoring. The CAO states that the first monitoring report is due July 15, 2013.

#### 2.6.4.2 United Production Services/Former Occidental Research Corporation

The Former United Production Services site is a 3.23 acre site located at 1855 Carrion Road in the City of La Verne, currently owned by the University of La Verne. From 1966 to 1979, the Occidental Research Corporation (ORC) used the property for the research and development of various chemicals and synthetic fuels, coal gasification, municipal waste incineration, fertilizer processing, and mineral processing. Laboratory and processed waste were stored and disposed of at the facility. Storage and disposal practices included drains into the soil, evaporation ponds, septic tanks with seepage pits, underground storage tanks, and above ground tanks and drums. Records show that PCE and TCE were purchased and used on site during the ORC operations (Langan, 2011; RWQCB, 2012b).

The first site investigation conducted from 1979 to 1980 confirmed that wastes were discharged to soil and groundwater beneath the site and that TCE and PCE were detected in groundwater (James M. Montgomery, 1981). During this study TCE was detected in 14 out of the 15 monitoring wells at concentrations ranging from 0.2 to 120 μg/L, and PCE was detected in 6 of the 15 monitoring wells at concentrations ranging from 0.2 to 1.7 μg/L. In subsequent studies required by the RWQCB from 1990 to 2002, 9 additional monitoring wells were constructed and the concentrations of PCE, TCE, and other VOCs found in groundwater overall increased (Remedial Engineering, 1990; CET, 1995; The Source Group, 2002). Maximum TCE concentrations ranged from 140 to 206 μg/L, and maximum PCE concentrations ranged from 8,500 to 9,700 μg/L. At this time, the extent of the contaminant plume was not characterized.

In a November 10, 2008 letter, the Regional Board notified Glenn Springs Holding Inc., an affiliate of ORC, that it would reopen the case and require additional site assessment. In October 2009, a *Site Investigation Work Plan* was approved by the RWQCB (Langan, 2009; RWQCB 2009). The most recent investigation was conducted in 2010 pursuant to the approved Work Plan (Langan, 2011). The contaminant plume is predominantly characterized by elevated concentrations of PCE. TCE, 1,1-DCE, *cis*-1,2-DCE, and vinyl chloride were also found at concentrations above the California PMCL. Groundwater monitoring during the 2010 investigation found the following maximum concentrations at onsite wells: PCE of 6,700 μg/L, TCE of 53 μg/L, 1,1-DCE of 25 μg/L, *cis*-1,2 DCE of 290 μg/L, and vinyl chloride of 6.2 μg/L. Sampling has not occurred at the onsite monitoring wells since 2010.

Figure 2-38 and Figure 2-39 display the areal distribution of maximum concentrations of TCE and PCE, respectively, from 2007 to 2011 at wells in the Six Basins. Additionally, Figure 2-42 is a map of the former United Production Services site and the adjacent former Victor Graphics cleanup site, and shows the maximum concentration of PCE in monitoring wells from 2007 to 2011. During this period, the maximum concentration of TCE and PCE found at onsite monitoring wells at the Former United Production Services site was 110 μg/L, and 6,100 μg/L. Figure 2-42 shows the extent of the PCE plume as delineated during the most recent investigation (Langan, 2011). As discussed previously, this investigation included the construction and sampling of two monitoring wells at the neighboring, upgradient, former Victor Graphics site.

A CAO was issued to Glenn Springs Holding Inc. on October 2, 2012 (RWQCB, 2012b) to prepare a RAP for cleanup and a monitoring work plan, which includes the implementation of a quarterly monitoring program. The CAO states that the first monitoring report is due by July

15, 2013. The adjacent, upgradient Former Victor Graphics Facility is believed to be a contributor to the PCE plume at United Production Services site, and has been issued a separate CAO (RWQCB, 2012a).

#### 2.6.4.3 Xerox

The former Xerox Corporation Facility Site is a 10-acre site located on 800 East Bonita Avenue in Pomona, California. From 1971 to 1990, the former Xerox Corporation Facility was located at this site and produced printed wire boards and associated electronic components, the production of which included the use of organic solvents, acids (hydrofluoric, fluoroboric, nitric, and hydrochloric), inorganic solutions containing heavy metals (chromium, copper, lead, and nickel), and mineral salts. From 1971 to 1984, liquid storage at the Xerox Site consisted of 10 USTs located adjacent to Towne Avenue. From 1981 through 1986, Xerox removed the USTs. During UST removal and thereafter, it was determined that some of the tanks had leaked and contaminated soil and groundwater beneath the site. Elevated levels of 1,1,1-TCA, 1,1-DCE (a degradation by-product of 1,1,1-TCA), and hexavalent chromium were found in groundwater (James M. Montgomery, 1985). Upon submittal of the UST summary reports in 1986, the RWQCB directed Xerox to perform further soil and groundwater investigations. These further investigations in 1986 confirmed the presence of 1,1,1-TCA, 1,1-DCE, and hexavalent chromium at significant concentrations (James M. Montgomery, 1986a; 1986b). The maximum concentrations of 1,1,1-TCA, 1,1-DCE, and hexavalent chromium found in groundwater on-site during these initial sampling events were 13,000 μg/L, 2,800 μg/L, and 260 μg/L, respectfully (Haley and Aldrich, 2007). These investigations also determined that the contaminant plume had migrated off-site. In 1987, on-site groundwater remediation began, which consisted of groundwater extraction and granular activated carbon treatment.

On July 18, 1991, a CAO was issued by the RWQCB (RWQCB, 1991) which directed Xerox to: continue groundwater monitoring and remediation onsite; continue monitoring groundwater contamination off-site; and install and initiate operations of a well-head treatment system for off-site contamination affecting the City of Pomona's well P-3 located 1.3 miles southwest of the site. In 1994, Xerox expanded on-site remediation to include ten extraction wells located in the so-called perched zone and upper and lower aquifers. The on-site treatment system was deactivated in September 2004 and continued monitoring by Xerox demonstrated no rebound in contaminant levels. The RWQCB granted regulatory closure of the on-site remediation case in March 2008 after requirements of the CAO related to on-site contamination were satisfied. Xerox continues to monitor a group of on-site wells.

The CAO remains in effect for off-site contamination monitoring. Off-site groundwater monitoring began in 1987 and showed elevated levels of contaminants downgradient of the site to the southwest towards the City of Pomona's well P-3. Continued off-site monitoring from 1987 to 2006 showed levels of 1,1,1-TCA, 1,1-DCE, and hexavalent chromium steadily increasing. During this time, maximum concentrations found at off-site monitoring wells were 150 μg/L for 1,1,1-TCA, 2,200 μg/L for 1,1-DCE, and 500 μg/L for hexavalent chromium. However, since 2006 contaminant concentrations at the off-site monitoring wells have steadily decreased but are still well above their respective PMCLs. Figure 2-40 and Figure 2-41 display the areal distribution of the maximum concentrations of 1,1-DCE and hexavalent chromium at wells in the Six Basins from 2007 to 2011. During this period, the maximum concentration of 1,1-DCE and hexavalent chromium found at Xerox on-site monitoring wells site were 180 μg/L and 200 μg/L, and the maximum concentration of 1,1-DCE and hexavalent chromium found at Xerox off-site monitoring wells were 1,500 μg/L and 350 μg/L. At the City of Pomona well P-3, the maximum concentrations of 1,1-DCE and hexavalent chromium were 5.6 μg/L and 4.5

µg/L. High concentrations of 1,1-DCE and hexavalent chromium are also found at City of Pomona wells P-32B, P-08(old), P-08B, and P-07 to the southwest of the Xerox site. At these wells, from 2007 to 2011, the maximum concentration of 1,1-DCE ranged from 43 to 56 µg/L, and the maximum concentration of hexavalent chromium ranged from 8.3 to 17 µg/L.

In 2011, Xerox stated that the lateral transport of contaminants offsite is downgradient (southwest), in the more "permeable upper zone" of the aquifer, and only along the north side of the Intermediate Fault towards well P-3 (Haley and Aldrich, 2011). Furthermore, Xerox reports that the off-site plumes of 1,1-DCE and hexavalent chromium are stable and confined to the "shallow" and "upper zones" of the aquifer system, and are attenuating by dilution with higher-quality native water recharge and degradation processes. Xerox is not currently operating an offsite remediation program, but continues to monitor groundwater (i) on-site to evaluate the effectiveness of past clean-up efforts and (ii) off-site to monitor the natural attenuation of the 1,1-DCE and hexavalent chromium plumes.

Figure 2-43 is a location map of the former Xerox Corporation Facility site and the off-site monitoring area, and includes the approximate location of the Intermediate Fault, and 1,1-DCE plume as delineated in 2011 by Haley and Aldrich. The following is a summary of Xerox's current understanding of groundwater flow and contaminant transport in the area downgradient of the facility as described in the 2011 Groundwater Site Conceptual Model Report—Former Xerox Corporation Facility (Haley and Aldrich, 2011):

- Page 5: "The Intermediate Fault trends northeast to southwest, passing through the southeast corner of the Site…the Intermediate Fault creates a hydraulic barrier that results in groundwater elevations of between 50 to 100 feet higher on the southeast side of the fault (Xerox monitoring wells MW-3, MW-18G, and MW-17B), compared with the northwest side (Xerox monitoring wells MW-4 and MW-14B)"
- Page 5: "The Intermediate Fault is an important feature to the Site, as it restricts groundwater flow to the south and east, forcing groundwater in the vicinity of the Site to flow southwest to west"
- Page 5: "The Intermediate Fault may become less of a hydraulic barrier to the southwest, resulting in groundwater flow from the southeast side of the fault into the main basin to the northeast, or from the northwest to southeast, depending on recharge and pumping dynamics."
- Page 8: "The fact that COPC [chemicals of potential concern] were detected in City [of Pomona] wells P-7 and P-8B, which is across the Intermediate Fault from the Site, and that the Site is outside the capture zone of P-8B, indicates that there are other sources of 1,1-DCE and [hexavalent chromium] CrVI in the vicinity of P-7 and P-8B…and it indicates that additional sources of 1,1-DCE and CrVI are present in the same aquifer screened by City well P-3 and could be captured by City well P-3 from the south and east"
- Page 8: "City [of Pomona] well P-3 is the downgradient groundwater supply well in relation to the Site; however as previously described (Haley & Aldrich, 2007), it appears that there [are] other sources of 1,1-DCE and CRVI closer to City [of Pomona] well P-3 that may be impacting groundwater in City well P3."

In short, Xerox concludes that the offsite groundwater contamination is a stable and attenuating plume that is spatially confined to shallow portions of the aquifer and only to the north of their delineation of the Intermediate Fault. Xerox also concludes that well P-3 is the only well owned by the City of Pomona that has been impacted by the offsite contamination, and that other sources may be responsible for the contamination at P-3 and other wells owned by the City (P-7, P-8B, and P-32B). Xerox contends that no additional offsite monitoring wells or remediation is necessary, and that monitored natural attenuation should be investigated as the final groundwater remedy.

Based on the review of available data and the hydrogeologic characterization presented in this report, Xerox's conclusions are not fully supported. Observations and interpretations that challenge the conclusions of Xerox are described below:

- The Intermediate Fault is not located as mapped by Xerox (Haley & Aldrich, 2011). Xerox used a limited amount of data from monitoring wells to map the fault. Many of the monitoring wells used to map the fault have been destroyed. In this report, the Intermediate Fault is mapped further to the south based on InSAR data (see Figure 2-12), which would render it ineffective as a barrier to groundwater flow between the Xerox Site and City of Pomona's well field that is contaminated with 1,1-DCE and hexavalent chromium.
- Regardless of the location of the Intermediate Fault, faults that act as groundwater barriers are typically less effective barriers within the shallow, more recent aquifer sediments. Since the early 1990s, groundwater levels have been relatively high within the Pomona Basin (see Figure 2-28c), which may have reduced the effectiveness of the Intermediate Fault as a groundwater barrier.
- Pumping at the City of Pomona's wells P-3, P-7, P-8B, and P-32B establishes a hydraulic gradient from the Xerox Site to the wells. Xerox contends that groundwater flows southeast from the Xerox Site toward P-3 where the hydraulic gradient becomes relatively flat, and that in this southern portion of the Pomona Basin, pumping controls the direction of groundwater flow. Xerox also contends that the Intermediate Fault is not an effective barrier in the portion of the Pomona Basin. Pomona's wells located to the east of P-3 (P-7, P-8B, and P-32B) pump from deep, confined aquifers and cause over 100 feet of drawdown at the wells, which can cause groundwater in the vicinity of P-3 (and the dissolved contaminants) to flow eastward and downward to the well screens of P-7, P-8B, and P-32B.

While claims by Xerox of other sources of groundwater contaminants may be true, and while such claims should be investigated to identify other potential responsible parties, it is premature to absolve Xerox of the widespread groundwater contamination of 1,1-DCE and hexavalent chromium in the southern Pomona Basin.

### 2.6.5 Summary of Basin Management Issues

The following is a summary of basin management issues associated with groundwater quality in the Six Basins:

- From a water-quality standpoint, the recharge of high-quality surface water at the SASG does not benefit the Live Oak, Ganesha, and portions of the Pomona Basin.
- TDS and nitrate concentrations at wells in the Pomona Basin, Live Oak Basin, and Ganesha Basin suggest that there is no assimilative capacity for TDS or nitrate. A finding of no assimilative capacity could restrict the reuse and/or recharge of recycled water

in the Six Basins. The State Board is requiring the development and implementation of SNMPs for all groundwater basins in the state. The Watermaster should develop the SNMP for the Six Basins as part of the Strategic Plan so that salt and nutrient management dovetails with the Parties' goals for enhanced water supply.

- In the Lower Claremont Heights, Live Oak, Ganesha, and Pomona Basins, nitrate and perchlorate concentrations in groundwater exceed federal and state drinking-water standards. Treatment is required to put the groundwater to beneficial use, which has limited groundwater production in these basins.
- In parts of the Pomona Basin, concentrations of TCE and 1,1-DCE in groundwater exceed federal and state drinking-water standards. Treatment is required to put the groundwater to beneficial use, which has limited groundwater production in this basin. The source(s) of TCE in some areas of the Pomona Basin have not been identified.
- In the southern Pomona Basin, high concentrations of hexavalent chromium in groundwater require treatment to put the water to beneficial use, which has limited groundwater production in the basin.
- The extent of TCE contamination in the Ganesha Basin from the Former Victor Graphics and Former United Production Services/Former Occidental Research Corporation has not been full characterized.
- If the DDW adopts an MCL for hexavalent chromium at or near the PHG of 0.02 μg/L, the pumpers could be forced to treat groundwater, even at naturally-occurring concentrations of 8 to 9 μg/L.
- There is insufficient data on the presence of 1,2,3-TCP in the Six Basins to determine the potential impact to the Parties if DDW adopts an MCL standard.
- Based on the review of available data and the hydrogeologic characterization presented in this report, Xerox's conclusions that (1) offsite groundwater contamination from 1,1-DCE and hexavalent chromium originating from the Xerox Facility is a stable and attenuating plume that is spatially confined to shallow portions of the Pomona Basin aquifer to the north of their delineation of the Intermediate Fault and (2) the City of Pomona's well P-3 is the only municipal well that has been impacted by the offsite contamination, are not fully supported. While claims by Xerox that there must be other sources of groundwater contamination may be true, such claims should be investigated to identify the other sources as responsible parties. It is premature to absolve Xerox of the widespread groundwater contamination of 1,1-DCE and hexavalent chromium in the southern Pomona Basin.

## 2.7 Land Subsidence and Rebound

Vertical ground motion, in the form of subsidence and rebound of the land surface, occurs in all groundwater basins as groundwater levels change within the underlying aquifer system. This process has occurred in the Six Basins, as well as in the adjacent groundwater basins such as the Chino Basin. It is important to understand and monitor this process because land subsidence can cause damage to vulnerable infrastructure at the surface. This section describes the physical process of land subsidence and rebound. It also describes (i) how ground motion has been monitored in the Six Basins and the Chino Basin, (ii) how ground motion has occurred over time, (iii) why it occurred, and (iv) what effect its occurrence had on the ground surface. This understanding will aid in the development of basin management programs to monitor for and mitigate land subsidence, if necessary. This section concludes with a description of the major issues for basin management that are associated with land subsidence.

### 2.7.1 Background

Land subsidence and rebound is the vertical motion of the Earth's surface due to the rearrangement of subsurface Earth materials. In some instances, land subsidence is accompanied by adverse impacts at the land surface, such as sinkholes, ground fissures, modified drainage patterns, and others. In populated regions, these subsidence-related impacts can result in severe damage to man-made infrastructure and costly remediation measures.

Over 80 percent of all documented cases of land subsidence in the United States have been caused by groundwater extractions from the underlying aquifer system (USGS, 1999). Subsidence due to groundwater extraction is especially well-documented in the arid southwestern United States, where the aquifer systems are typically composed of unconsolidated sediments that are susceptible to permanent compaction when groundwater is extracted. Some infamous examples include the San Joaquin, Antelope, and Santa Clara Valleys in California; the Las Vegas Valley in Nevada; the Houston-Galveston area in Texas; and several basins in Arizona. In many of these regions, ground fissuring occurred in areas of differential subsidence (*i.e.*, where rates and accumulated magnitudes of subsidence vary over short horizontal distances).

Although drawdown of water levels is the driving force that causes land subsidence due to groundwater pumping, the geology of a groundwater basin also plays an important role in this process. Clay layers within the aquifer-system are relatively compressible materials. Therefore, aquifer-systems that contain thick and/or numerous clay layers are most susceptible to land subsidence or rebound when groundwater is extracted or recharged. In addition, faults that act as groundwater barriers can focus drawdown in the aquifer-system when pumping wells are located near these faults. When pumping and drawdown are concentrated on one side of a fault barrier, then differential land subsidence and ground fissuring can result.

The process that describes pumping-induced land subsidence is termed the "aquitard-drainage model." This model has been successfully applied to numerous cases of land subsidence world-wide. It has been incorporated into the industry-standard computer models of groundwater flow and is increasingly recognized as critical to the understanding of the geology, the hydraulics, and the mechanics of the aquifer system. A brief summary of the aquitard-drainage model is below:

> Simply stated, an aquifer system consists of permeable sand and gravel layers interbedded with less-permeable silt and clay layers. The sand and gravel layers are the "aquifers" and groundwater flows through the aquifers toward pumping wells. The silt and clay layers are the "aquitards." Pumping wells cause water-level drawdown in the aquifers which, in turn, cause the aquitards to slowly drain into the aquifers. The draining allows aquitard pore pressures to decay toward equilibrium with the reduced heads in the adjacent aquifers. Since the pressure of the pore water provides some internal support

for the sedimentary structure of the aquitards, this loss of internal support causes the aquitards to compress, resulting in subsidence at the land surface. When the pumping wells turn off, and water levels recover in the aquifers, groundwater migrates back into the aquitards and they expand, resulting in rebound at the land surface. Over a limited range of seasonal water-level fluctuations this process can occur in a purely elastic fashion. That is, a recovery of water levels to their original values causes the land surface to rebound to its original elevation. However, when drawdown falls below a certain "threshold" level, elastic compression transitions to a non-recoverable inelastic compaction of the aquitards, resulting in permanent land subsidence. The "threshold" water level, referred to as the "preconsolidation stress," is taken to be the maximum past stress to which the sedimentary structure had previously equilibrated under the gradually increasing load of accumulating sediments.

Drawdowns exceeding a previous threshold water level result in an increase in the value of maximum past stress, and thus the establishment of a deeper threshold, accompanied by an increment of inelastic aquitard compaction. Concomitantly, the compaction results in the one-time mining of groundwater from the aquitards. The benefits of this process include not only the obvious economic value of the water produced but also the often overlooked fact that, by establishing deeper thresholds, it increases the volume of confined groundwater storage available for cyclical drawdown and replenishment under strictly elastic conditions. The cost, of course, is the resulting deformation of the land surface and its impact on vulnerable infrastructure.

This hydro-mechanical process within the aquifer system, and the resultant deformation of the ground surface, has been well documented in the Chino Basin where ground fissures damaged overlying infrastructure in the City of Chino in the early 1990s (WEI, 2006). The Chino Basin Watermaster conducted extensive studies of the process, and based on those studies, developed a management plan to minimize or abate the occurrence of subsidence and ground fissuring.

### 2.7.2 Ground-Motion Monitoring

Part of the Chino Basin Watermaster's management plan for land subsidence is to conduct ongoing monitoring of ground motion by InSAR, which is a method that utilizes radar imagery from an Earth-orbiting satellite to map ground motion over time. The InSAR data collected and utilized in the subsidence studies in Chino Basin cover the Six Basins area as well. Currently, the Chino Basin Watermaster's efforts to monitor for ground motion by InSAR are the only coordinated efforts to monitor ground motion on a regional scale. The Chino Basin Watermaster determines the scope of its monitoring efforts annually.

### 2.7.3 Land Subsidence and Rebound in the Six Basins

This section of the report describes the history of land subsidence and rebound in the Six Basins as measured by InSAR for most of the period from 1993-2012—the only readily available data in this area to characterize historical ground motion. This section also describes the hydrologic and geologic factors that appear to control land subsidence and rebound in the Six Basins, and identifies areas in the Six Basins where ground fissuring is a potential threat to overlying infrastructure. This understanding will aid in the development of basin management programs to minimize the threat of permanent land subsidence and ground fissuring in the future.

The following figures display the InSAR data that summarize the history of land subsidence and rebound in the Six Basins from 1993-2012:

- Figure 2-44a for the period October 1993 to December 1995.
- Figure 2-44b for the period January 1996 to February 2000.
- Figure 2-44c for the period June 2005[18] to September 2010.
- Figure 2-44d for the period March 2011 to February 2012.
- In all of these figures, the maximum ground motion as subsidence and/or rebound occurs in the eastern portion of the Upper Claremont Heights Basin and in the central and southern portions of the Pomona Basin. This is because (i) the aquifer system is relatively thick underlying these areas, (ii) the aquifer system in these areas contain a greater number and aggregate thickness of aquitards, and (iii) groundwater levels significantly increased or decreased within the aquifer system during the periods. These interpretations were based on comparison of the InSAR maps on the figures listed above with (i) the thickness of the water bearing sediments as displayed on Figure 2-9, (ii) the borehole lithology descriptions as shown on the hydrogeologic cross sections on Figures 2-11a, 2-11b, 2-11c, and 2-11d, and (iii) the time-series charts of groundwater-levels at wells as shown on Figures 2-28a, 2-28b, 2-28c, and 2-28d.

Over the entire period of the InSAR data from 1993-2012, there does not appear to be any areas within the Six Basins where permanent land subsidence has occurred. The likely reason for no observed permanent subsidence is related to the fact that groundwater levels were higher during 1993-2012 compared to historical low groundwater levels that occurred in the 1960s. In other words, groundwater levels during 1993-2012 never fell below the "threshold" level where elastic deformation of the aquitards would transition to inelastic compaction and permanent land subsidence. This last statement is clearly supported by the time-series charts of groundwater-levels on Figures 2-28a, 2-28b, 2-28c, and 2-28d.

There is one area where differential subsidence has continuously occurred from 1993-2012—along the southern extent of the San Jose Fault that separates the Pomona Basin from the Chino Basin. In the Pomona Basin, ground motion from 1993-2012 has been elastic subsidence and rebound of at least 1-2 inches in response to changes in groundwater levels. In the Chino Basin, ground motion from 1993-2012 has been persistent subsidence of about one foot during 1993-2012. The consulting engineer for the Chino Basin Watermaster has speculated that the persistent subsidence in the Chino Basin is due to delayed drainage of deep aquitards underlying this area in response to long-term historical drawdown (WEI, 2011). The result has been differential subsidence along the San Jose Fault of at least one foot from 1993-2012. Additional differential subsidence may have occurred prior to 1993, but ground motion data are scarce prior to 1993. This area of differential subsidence has not been inspected closely for evidence of sinkholes or ground fissures, and none have been reported or documented.

[18] The time gap in the InSAR data from February 2000 to June 2005 is because there was no functioning radar satellite collecting InSAR data that was available to the Chino Basin Watermaster.

That said, this is an area of potential ground fissuring in the future—especially because the subsidence in the Chino Basin is continuing and likely permanent.

### 2.7.4 Summary of Basin Management Issues

The following is a summary of the major issues for basin management that are associated with ground motion in the Six Basins:

- Differential land subsidence of at least one foot has occurred along the San Jose Fault from 1993-2012. This area of differential subsidence has not been inspected closely for evidence of sinkholes or ground fissures, and none have been reported or documented. That said, this is an area of potential ground fissuring in the future—especially because the subsidence in the Chino Basin is continuing and likely permanent.
- Currently, the Chino Basin Watermaster's efforts to monitor for ground motion by InSAR are the only coordinated efforts to monitor ground motion on a regional scale. The Chino Basin Watermaster determines the scope of its monitoring efforts annually.

**Table 2-1**
**Active Daily-Precipitation Gages in the Six Basins with Complete Records**

| Station (Station ID) | Owner/Operator | Surface Elevation *(ft-amsl)* | Period of Record | | Annual Precipitation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Minimum | | Maximum | | Median *(inches)* | Average *(inches)* |
| | | | Date Range | Length of Record *(years)* | Value *(inches)* | Year Observed | Value *(inches)* | Year Observed | | |
| La Verne Fire Station (196A-C) | Los Angeles County Flood Control District | 1050 | 1924 - present | 88 | 4.51 | 2002 | 43.04 | 1978 | 15.51 | 17.96 |
| Claremont Police Station (93A-C) | Los Angeles County Flood Control District | 1170 | 1928 - present | 84 | 4.80 | 2007 | 42.61 | 1978 | 15.72 | 17.85 |
| Claremont-Slaughter (497) | Los Angeles County Flood Control District | 1350 | 1939 - present | 73 | 5.60 | 2007 | 46.45 | 2005 | 16.32 | 19.15 |
| San Antonio Dam (1115) | U.S. Army Corps of Engineers | 2120 | 1956 - present | 56 | 5.63 | 2007 | 53.53 | 2005 | 18.26 | 23.51 |

**Table 2-2**
**Surface Water Diversions by the PVPA**
**to the San Antonio Spreading Grounds**
*1961-2011*

| Water Year | Outflow from San Antonio Dam (acre-ft) | Diversions Reported by PVPA (acre-ft) | Water Lost to San Antonio Channel (acre-ft) |
|---|---|---|---|
| 1961 | 0 | 0 | 0 |
| 1962 | 11,487 | 2,525 | 8,962 |
| 1963 | 0 | 0 | 0 |
| 1964 | 0 | 0 | 0 |
| 1965 | 17 | 0 | 17 |
| 1966 | 13,774 | 13,056 | 718 |
| 1967 | 12,460 | 10,727 | 1,733 |
| 1968 | 161 | 549 | 0 |
| **1969** | **67,891** | **22,960** | **44,931** |
| 1970 | 2,086 | 365 | 1,721 |
| 1971 | 100 | 26 | 74 |
| 1972 | 247 | 45 | 202 |
| 1973 | 6,900 | 6,725 | 175 |
| 1974 | 334 | 330 | 4 |
| 1975 | 8 | 27 | 0 |
| 1976 | 595 | 153 | 442 |
| 1977 | 1,175 | 273 | 903 |
| **1978** | **64,540** | **30,152** | **34,389** |
| 1979 | 4,914 | 2,686 | 2,228 |
| **1980** | **30,224** | **23,125** | **7,099** |
| 1981 | 273 | 39 | 234 |
| 1982 | 9,866 | 7,538 | 2,328 |
| **1983** | **49,719** | **33,370** | **16,349** |
| 1984 | 14,194 | 2,449 | 11,745 |
| 1985 | 2,134 | 229 | 1,906 |
| 1986 | 10,522 | 6,521 | 4,001 |
| 1987 | 24 | 13 | 12 |
| 1988 | 2,855 | 1,500 | 1,355 |
| 1989 | 298 | 243 | 55 |
| 1990 | 0 | 1 | 0 |
| 1991 | 7,363 | 482 | 6,881 |
| 1992 | 19,630 | 14,416 | 5,214 |
| **1993** | **59,328** | **26,488** | **32,840** |
| 1994 | 67 | 11 | 56 |
| **1995** | **32,060** | **26,052** | **6,008** |
| 1996 | 4,206 | 4,241 | 0 |
| 1997 | 2,383 | 1,187 | 1,196 |
| **1998** | **22,315** | **24,227** | **0** |
| 1999 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 |
| 2001 | 46 | 0 | 46 |
| 2002 | 0 | 0 | 0 |
| 2003 | 0 | 0 | 0 |
| 2004 | 553 | 129 | 424 |
| **2005** | **52,540** | **31,362** | **21,179** |
| 2006 | 9,355 | 5,804 | 3,551 |
| 2007 | 0 | 0 | 0 |
| 2008 | 2,556 | 577 | 1,979 |
| 2009 | 0 | 0 | 0 |
| 2010 | 8,253 | 1,260 | 6,993 |
| 2011 | 24,560 | 7,306 | 17,254 |
| **Total** | **552,015** | **309,166** | **245,203** |

**Table 2-3a**
**Summary of Annual Groundwater Production in the Six Basins**
*(1960-2011)*

| Year | **Annual Groundwater Production** (acre-ft/yr) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Canyon | UCHB | LCHB | Pomona | Live Oak | Ganesha | Total |
| 1960 | 1,500 | 5,750 | 281 | 6,232 | 1,002 | 574 | 15,339 |
| 1961 | 1,500 | 5,411 | 281 | 6,604 | 988 | 574 | 15,359 |
| 1962 | 1,500 | 5,287 | 345 | 6,286 | 988 | 574 | 14,981 |
| 1963 | 1,500 | 5,247 | 848 | 6,415 | 988 | 574 | 15,573 |
| 1964 | 1,500 | 5,134 | 686 | 6,466 | 988 | 574 | 15,348 |
| 1965 | 1,500 | 5,377 | 548 | 6,161 | 988 | 574 | 15,149 |
| 1966 | 1,500 | 5,360 | 462 | 5,781 | 988 | 574 | 14,665 |
| 1967 | 1,500 | 5,658 | 863 | 5,723 | 988 | 574 | 15,307 |
| 1968 | 1,500 | 5,896 | 1,619 | 5,735 | 988 | 574 | 16,312 |
| 1969 | 1,500 | 7,029 | 1,241 | 6,560 | 988 | 574 | 17,892 |
| 1970 | 1,500 | 5,169 | 1,027 | 8,100 | 988 | 574 | 17,358 |
| 1971 | 1,500 | 4,993 | 728 | 6,908 | 988 | 574 | 15,691 |
| 1972 | 1,500 | 4,504 | 1,109 | 7,607 | 988 | 574 | 16,282 |
| 1973 | 1,500 | 4,601 | 1,405 | 6,949 | 988 | 574 | 16,017 |
| 1974 | 1,500 | 5,337 | 1,239 | 6,598 | 988 | 574 | 16,236 |
| 1975 | 1,500 | 5,052 | 1,158 | 5,967 | 988 | 574 | 15,240 |
| 1976 | 1,500 | 4,547 | 895 | 5,156 | 1,016 | 574 | 13,688 |
| 1977 | 1,500 | 4,659 | 573 | 5,091 | 984 | 574 | 13,381 |
| 1978 | 1,320 | 5,008 | 1,374 | 6,024 | 662 | 548 | 14,935 |
| 1979 | 1,680 | 8,074 | 1,452 | 6,109 | 580 | 601 | 18,495 |
| 1980 | 1,861 | 9,593 | 1,492 | 6,183 | 424 | 525 | 20,078 |
| 1981 | 1,212 | 9,236 | 1,621 | 6,533 | 533 | 526 | 19,661 |
| 1982 | 779 | 6,796 | 1,253 | 6,380 | 563 | 461 | 16,232 |
| 1983 | 882 | 8,385 | 1,435 | 6,783 | 358 | 560 | 18,404 |
| 1984 | 581 | 11,001 | 1,463 | 8,077 | 538 | 428 | 22,088 |
| 1985 | 164 | 9,520 | 1,403 | 6,212 | 459 | 440 | 18,198 |
| 1986 | 436 | 10,511 | 1,398 | 7,545 | 480 | 451 | 20,820 |
| 1987 | 265 | 10,762 | 1,323 | 7,568 | 262 | 232 | 20,413 |
| 1988 | 590 | 8,233 | 1,365 | 5,385 | 47 | 24 | 15,644 |
| 1989 | 524 | 9,894 | 1,323 | 6,083 | 292 | 70 | 18,187 |
| 1990 | 85 | 8,376 | 1,069 | 5,349 | 335 | 22 | 15,236 |
| 1991 | 904 | 8,531 | 923 | 5,513 | 350 | 12 | 16,234 |
| 1992 | 241 | 10,341 | 711 | 6,209 | 285 | 28 | 17,815 |
| 1993 | 987 | 12,530 | 558 | 5,629 | 406 | 391 | 20,500 |
| 1994 | 240 | 11,927 | 737 | 6,529 | 335 | 96 | 19,864 |
| 1995 | 530 | 13,519 | 1,069 | 7,379 | 253 | 21 | 22,771 |
| 1996 | 541 | 13,284 | 1,113 | 8,320 | 213 | 74 | 23,545 |
| 1997 | 1,290 | 12,946 | 196 | 6,145 | 119 | 19 | 20,714 |
| 1998 | 1,884 | 13,129 | 12 | 5,485 | 136 | 16 | 20,661 |
| 1999 | 241 | 14,103 | 0 | 6,187 | 3 | 4 | 20,537 |
| 2000 | 432 | 9,576 | 0 | 5,872 | 0 | 41 | 15,922 |
| 2001 | 958 | 8,877 | 0 | 5,956 | 2 | 152 | 15,945 |
| 2002 | 182 | 8,357 | 0 | 5,081 | 141 | 125 | 13,887 |
| 2003 | 1,061 | 7,693 | 1 | 5,052 | 254 | 5 | 14,065 |
| 2004 | 432 | 7,769 | 0 | 5,303 | 54 | 1 | 13,559 |
| 2005 | 276 | 12,739 | 0 | 5,891 | 221 | 1 | 19,129 |
| 2006 | 64 | 13,601 | 0 | 9,396 | 473 | 2 | 23,536 |
| 2007 | 36 | 11,223 | 0 | 9,172 | 439 | 224 | 21,095 |
| 2008 | 0 | 9,043 | 0 | 8,157 | 620 | 378 | 18,198 |
| 2009 | 523 | 9,224 | 0 | 7,737 | 804 | 594 | 18,883 |
| 2010 | 292 | 9,985 | 0 | 6,780 | 910 | 496 | 18,463 |
| 2011 | 0 | 12,050 | 0 | 5,377 | 1,002 | 401 | 18,830 |

**Table 2-3b**

**Summary of Annual Groundwater Production in the Six Basins**

*(1978-2011)*

| Year | Annual Groundwater Production (acre-ft/yr) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Canyon | UCHB | LCHB | Pomona | Live Oak | Ganesha | Total |
| 1978 | 1,320 | 5,008 | 1,374 | 6,024 | 662 | 548 | 14,935 |
| 1979 | 1,680 | 8,074 | 1,452 | 6,109 | 580 | 601 | 18,495 |
| 1980 | 1,861 | 9,593 | 1,492 | 6,183 | 424 | 525 | 20,078 |
| 1981 | 1,212 | 9,236 | 1,621 | 6,533 | 533 | 526 | 19,661 |
| 1982 | 779 | 6,796 | 1,253 | 6,380 | 563 | 461 | 16,232 |
| 1983 | 882 | 8,385 | 1,435 | 6,783 | 358 | 560 | 18,404 |
| 1984 | 581 | 11,001 | 1,463 | 8,077 | 538 | 428 | 22,088 |
| 1985 | 164 | 9,520 | 1,403 | 6,212 | 459 | 440 | 18,198 |
| 1986 | 436 | 10,511 | 1,398 | 7,545 | 480 | 451 | 20,820 |
| 1987 | 265 | 10,762 | 1,323 | 7,568 | 262 | 232 | 20,413 |
| 1988 | 590 | 8,233 | 1,365 | 5,385 | 47 | 24 | 15,644 |
| 1989 | 524 | 9,894 | 1,323 | 6,083 | 292 | 70 | 18,187 |
| 1990 | 85 | 8,376 | 1,069 | 5,349 | 335 | 22 | 15,236 |
| 1991 | 904 | 8,531 | 923 | 5,513 | 350 | 12 | 16,234 |
| 1992 | 241 | 10,341 | 711 | 6,209 | 285 | 28 | 17,815 |
| 1993 | 987 | 12,530 | 558 | 5,629 | 406 | 391 | 20,500 |
| 1994 | 240 | 11,927 | 737 | 6,529 | 335 | 96 | 19,864 |
| 1995 | 530 | 13,519 | 1,069 | 7,379 | 253 | 21 | 22,771 |
| 1996 | 541 | 13,284 | 1,113 | 8,320 | 213 | 74 | 23,545 |
| 1997 | 1,290 | 12,946 | 196 | 6,145 | 119 | 19 | 20,714 |
| 1998 | 1,884 | 13,129 | 12 | 5,485 | 136 | 16 | 20,661 |
| 1999 | 241 | 14,103 | 0 | 6,187 | 3 | 4 | 20,537 |
| 2000 | 432 | 9,576 | 0 | 5,872 | 0 | 41 | 15,922 |
| 2001 | 958 | 8,877 | 0 | 5,956 | 2 | 152 | 15,945 |
| 2002 | 182 | 8,357 | 0 | 5,081 | 141 | 125 | 13,887 |
| 2003 | 1,061 | 7,693 | 1 | 5,052 | 254 | 5 | 14,065 |
| 2004 | 432 | 7,769 | 0 | 5,303 | 54 | 1 | 13,559 |
| 2005 | 276 | 12,739 | 0 | 5,891 | 221 | 1 | 19,129 |
| 2006 | 64 | 13,601 | 0 | 9,396 | 473 | 2 | 23,536 |
| 2007 | 36 | 11,223 | 0 | 9,172 | 439 | 224 | 21,095 |
| 2008 | 0 | 9,043 | 0 | 8,157 | 620 | 378 | 18,198 |
| 2009 | 523 | 9,224 | 0 | 7,737 | 804 | 594 | 18,883 |
| 2010 | 292 | 9,985 | 0 | 6,780 | 910 | 496 | 18,463 |
| 2011 | 0 | 12,050 | 0 | 5,377 | 1,002 | 401 | 18,830 |
| **Summary of Production 1978-2011** | | | | | | | |
| Minimum | 0 | 5,008 | 0 | 5,052 | 0 | 1 | 13,559 |
| Maximum | 1,884 | 14,103 | 1,621 | 9,396 | 1,002 | 601 | 23,545 |
| Average | 632 | 10,172 | 685 | 6,512 | 369 | 234 | 18,604 |
| % of Total Average | 3% | 55% | 4% | 35% | 2% | 1% | |
| **Summary of Production 1978-1998 (Pre-Adjudication)** | | | | | | | |
| Minimum | 85 | 5,008 | 12 | 5,349 | 47 | 12 | 14,935 |
| Maximum | 1,884 | 13,519 | 1,621 | 8,320 | 662 | 601 | 23,545 |
| Average | 809 | 10,076 | 1,109 | 6,450 | 363 | 264 | 19,071 |
| % of Total Average | 4% | 53% | 6% | 34% | 2% | 1% | |
| **Summary of Production 1999-2011 (Post-Adjudication)** | | | | | | | |
| Minimum | 0 | 7,693 | 0 | 5,052 | 0 | 1 | 13,559 |
| Maximum | 1,061 | 14,103 | 1 | 9,396 | 1,002 | 594 | 23,536 |
| Average | 346 | 10,326 | 0 | 6,612 | 379 | 187 | 17,850 |
| % of Total Average | 2% | 58% | 0% | 37% | 2% | 1% | |



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## Table 2-4

## Groundwater Production in the Four Basins versus the Operating Safe Yield

*1999-2011*

| Year | OSY for the Four Basins *(acre-ft)* | Production in the Four Basins *(acre-ft)* |
|---|---|---|
| 1999 | 24,000 | 20,531 |
| 2000 | 22,000 | 15,880 |
| 2001 | 22,000 | 15,791 |
| 2002 | 19,500 | 13,621 |
| 2003 | 18,000 | 13,807 |
| 2004 | 17,000 | 13,504 |
| 2005 | 22,500 | 18,906 |
| 2006 | 18,000 | 23,061 |
| 2007 | 22,000 | 20,432 |
| 2008 | 18,500 | 17,200 |
| 2009 | 17,500 | 17,484 |
| 2010 | 17,500 | 17,056 |
| 2011 | 17,500 | 17,427 |
| **Total** | **256,000** | **224,699** |
| Minimum | 17,000 | 13,504 |
| Maximum | 24,000 | 23,061 |
| Average | 19,692 | 17,285 |

## Table 2-5
## Groundwater Storage in the Six Basins

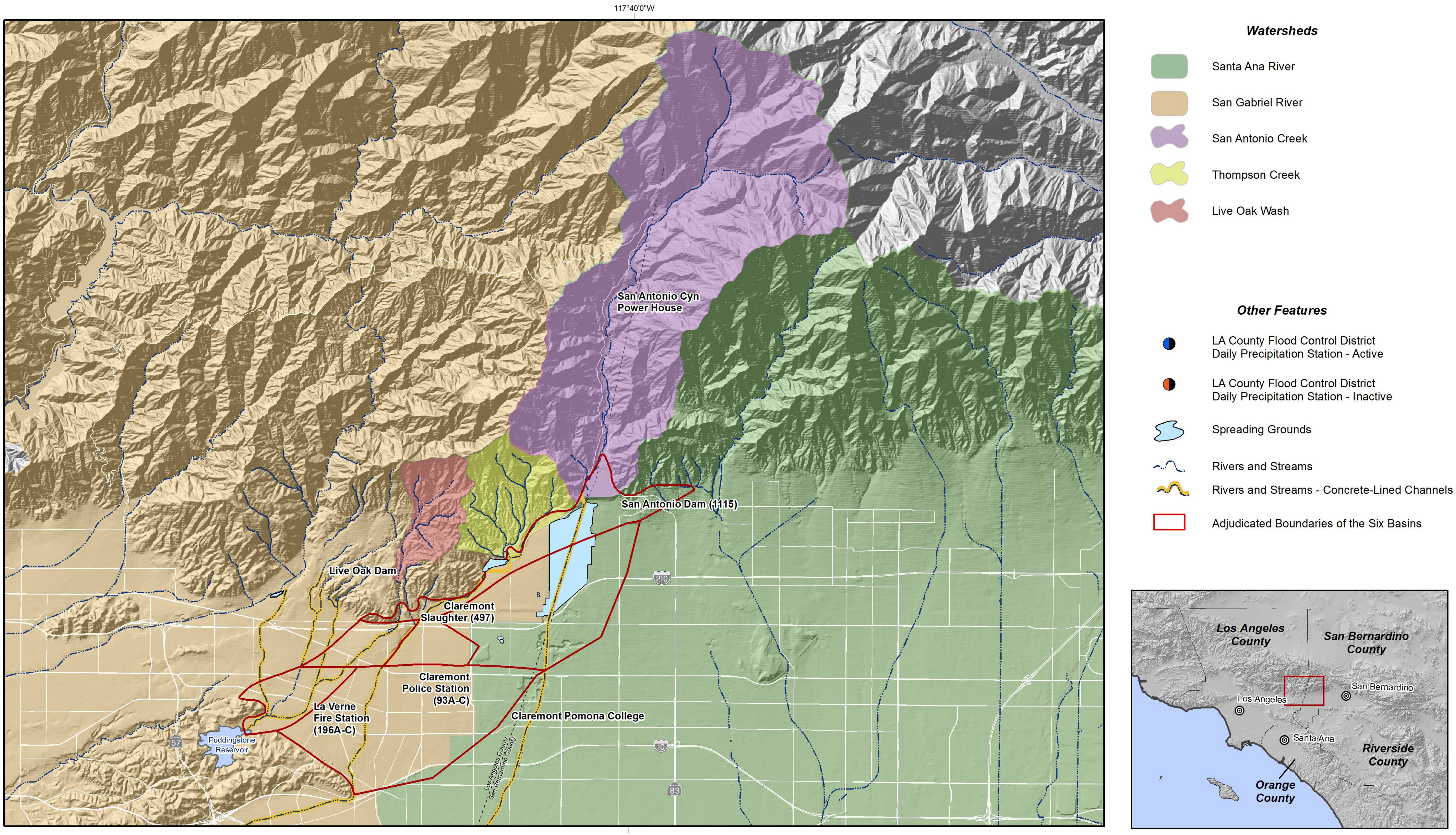
| Area or Sub-Basin | Storage *(acre-ft)* | | | |
|---|---|---|---|---|
| | 1965 | 1983 | 1999 | 2011 |
| ***Four Basins*** | | | | |
| Canyon Basin | 20,387 | 42,938 | 26,616 | 24,449 |
| Upper Claremont Heights Basin | 110,829 | 210,695 | 155,250 | 166,641 |
| Lower Claremont Heights Basin | 24,350 | 33,204 | 33,104 | 34,453 |
| ***Sub-Total*** *(north of Indian Hill Fault)* | **155,565** | **286,837** | **214,970** | **225,542** |
| Change from Prior Period | | 131,272 | -71,867 | 10,573 |
| | | | | |
| Pomona Basin | 268,463 | 371,455 | 413,893 | 383,810 |
| Change from Prior Period | | 102,992 | 42,438 | -30,083 |
| | | | | |
| ***Sub-Total for the Four Basins*** | **424,028** | **658,292** | **628,863** | **609,352** |
| Change from Prior Period | | 234,264 | -29,429 | -19,511 |
| | | | | |
| ***Two Basins*** | | | | |
| Live Oak Basin | 41,601 | 48,115 | 49,608 | 49,554 |
| Ganesha Basin | 3,556 | 12,952 | 18,469 | 17,008 |
| ***Sub-Total*** | **45,157** | **61,067** | **68,077** | **66,561** |
| Change from Prior Period | | 15,910 | 7,010 | -1,516 |
| | | | | |
| **Total for the Six Basins** | **469,185** | **719,360** | **696,940** | **675,913** |
| Change from Prior Period | | 250,174 | -22,419 | -21,027 |

**Table 2-6**
**Developed Yield from the Six Basins**
*1966-2011*

| Area | Period | # of Years | Groundwater Production | Average Annual Production | Supplemental Recharge | Storage Change | Developed Yield |
|---|---|---|---|---|---|---|---|
| | | | *acre-ft* | *acre-ft/yr* | *acre-ft* | *acre-ft* | *acre-ft/yr* |
| ***Four Basins*** | | | | | | | |
| **Canyon UCH LCH** | 1966-1983 | 18 | 156,574 | 8,699 | | 131,272 | 15,991 |
| | 1984-1999 | 16 | 202,771 | 12,673 | 404 | -71,867 | 8,156 |
| | 1999-2011 | 12 | 124,395 | 10,366 | 14,467 | 10,573 | 10,042 |
| | 1966-2011 | 46 | 483,740 | 10,516 | 14,871 | 69,977 | 11,714 |
| **Pomona** | 1966-1983 | 18 | 114,186 | 6,344 | | 102,992 | 12,065 |
| | 1984-1999 | 16 | 103,617 | 6,476 | | 42,438 | 9,128 |
| | 1999-2011 | 12 | 79,774 | 6,648 | | -30,083 | 4,141 |
| | 1966-2011 | 46 | 297,577 | 6,469 | | 115,347 | 8,977 |
| ***Sub-Totals for the Four Basins*** | 1966-1983 | 18 | 270,760 | 15,042 | 0 | 234,264 | 28,057 |
| | 1984-1999 | 16 | 306,388 | 19,149 | 404 | -29,429 | 17,285 |
| | 1999-2011 | 12 | 204,169 | 17,014 | 14,467 | -19,511 | 14,183 |
| | 1966-2011 | 46 | 781,317 | 16,985 | 14,871 | 185,324 | 20,691 |
| ***Two Basins*** | | | | | | | |
| **Live Oak** | 1966-1983 | 18 | 15,000 | 833 | | 6,515 | 1,195 |
| | 1984-1999 | 16 | 4,512 | 282 | | 1,493 | 375 |
| | 1999-2011 | 12 | 4,920 | 410 | 1,060 | -54 | 317 |
| | 1966-2011 | 46 | 24,432 | 531 | 1,060 | 7,953 | 681 |
| **Ganesha** | 1966-1983 | 18 | 10,114 | 562 | | 9,396 | 1,084 |
| | 1984-1999 | 16 | 2,326 | 145 | | 5,517 | 490 |
| | 1999-2011 | 12 | 2,421 | 202 | | -1,462 | 80 |
| | 1966-2011 | 46 | 14,862 | 323 | | 13,451 | 615 |
| ***Sub-Totals for the Two Basins*** | 1966-1983 | 18 | 25,114 | 1,395 | | 15,910 | 2,279 |
| | 1984-1999 | 16 | 6,838 | 427 | | 7,010 | 866 |
| | 1999-2011 | 12 | 7,342 | 612 | 1,060 | -1,516 | 397 |
| | 1966-2011 | 46 | 39,294 | 854 | 1,060 | 21,404 | 1,296 |

**Table 2-7**
**Exceedance of Drinking Water Maximum Contaminant Levels and Notification Levels in Raw Groundwater from 2007 to 2011**

| Analyte | Standard | Number of Samples | Number of Exceedances | Number of Wells with Exceedances |
|---|---|---|---|---|
| 1,1-Dichloroethene | US EPA and California Primary MCL | 713 | 192 | 21 |
| 1,2-Dichloroethane | US EPA and California Primary MCL | 401 | 14 | 4 |
| *cis* -1,2-Dichloroethene | US EPA and California Primary MCL | 482 | 23 | 9 |
| *trans* -1,2-Dichloroethene | California Primary MCL | 478 | 1 | 1 |
| 1,4-Dioxane | California NL | 35 | 3 | 3 |
| Aluminum | US EPA and California Secondary MCL | 97 | 1 | 1 |
| Antimony | US EPA and California Secondary MCL | 104 | 1 | 1 |
| Arsenic | US EPA and California Primary MCL | 115 | 3 | 3 |
| Benzene | US EPA and California Primary MCL | 483 | 13 | 13 |
| Carbon Tetrachloride | California Primary MCL | 401 | 2 | 2 |
| Chromium | US EPA and California Primary MCL | 375 | 42 | 10 |
| Iron | US EPA and California Secondary MCL | 97 | 3 | 2 |
| Lead | US EPA and California Primary MCL | 106 | 6 | 6 |
| Manganese | US EPA and California Secondary MCL | 134 | 8 | 3 |
| Nitrate-Nitrogen | US EPA and California Primary MCL | 1023 | 520 | 22 |
| N-Nitrosodimethylamine | California NL | 4 | 1 | 1 |
| Perchlorate | California Primary MCL | 714 | 355 | 17 |
| Selenium | US EPA and California Primary MCL | 104 | 2 | 2 |
| Styrene | US EPA and California Primary MCL | 397 | 2 | 2 |
| TDS | US EPA and California Secondary MCL | 105 | 17 | 8 |
| Tetrachloroethene | US EPA and California Primary MCL | 609 | 43 | 18 |
| Trichloroethene | US EPA and California Primary MCL | 778 | 158 | 17 |
| Turbidity | US EPA and California Secondary MCL | 256 | 49 | 24 |
| Vinyl Chloride | US EPA and California Primary MCL | 482 | 13 | 6 |
| Zinc | US EPA and California Secondary MCL | 125 | 2 | 2 |

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Updated By: csanchez

Date: 20151209

0 1 2 Miles

0 2 4 Kilometers

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Watersheds Tributary to the Six Basins**

**Figure 2-1**

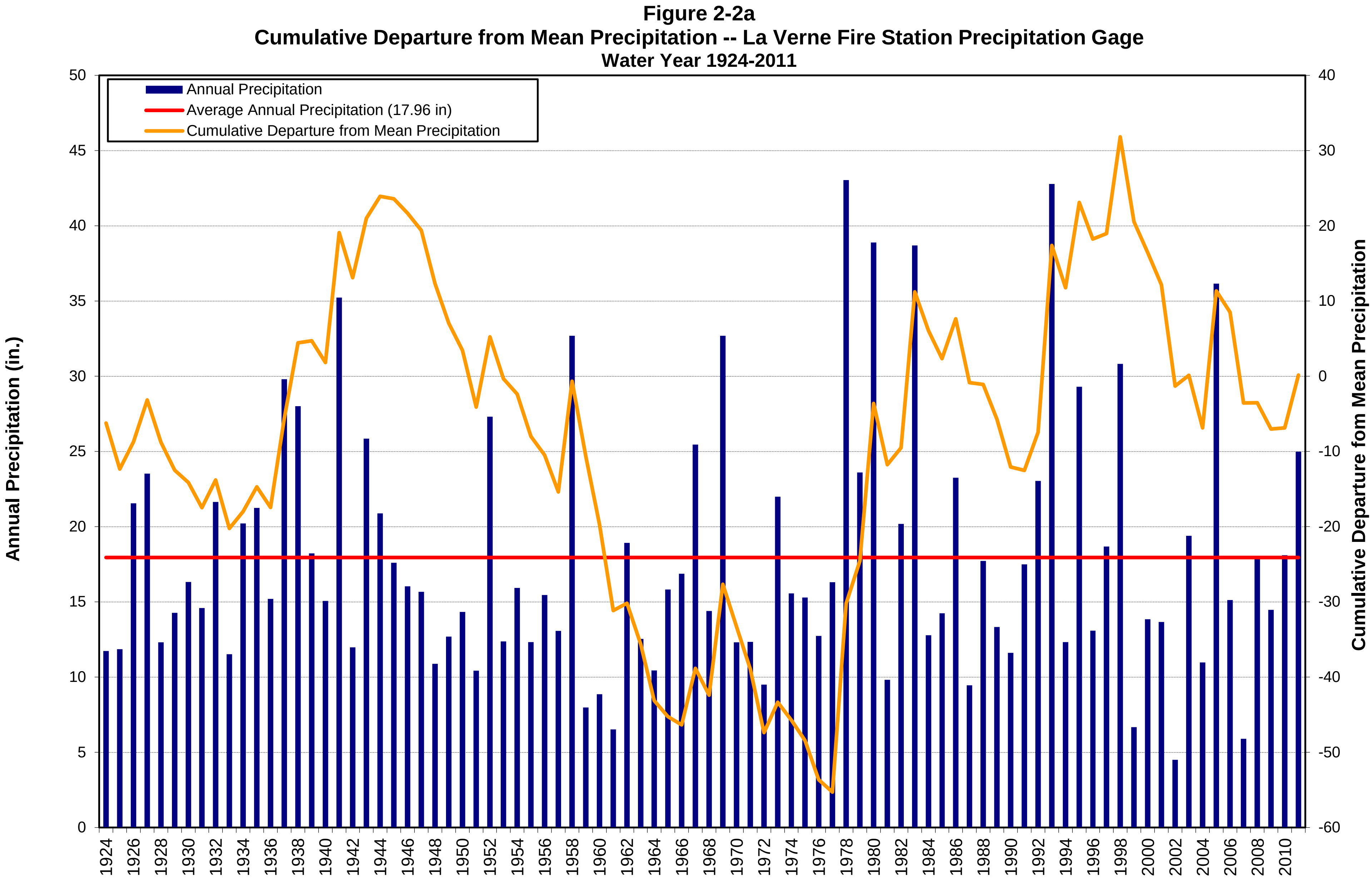


Figure 2-2a -- LaVerneFS_CDFM
5/6/2014

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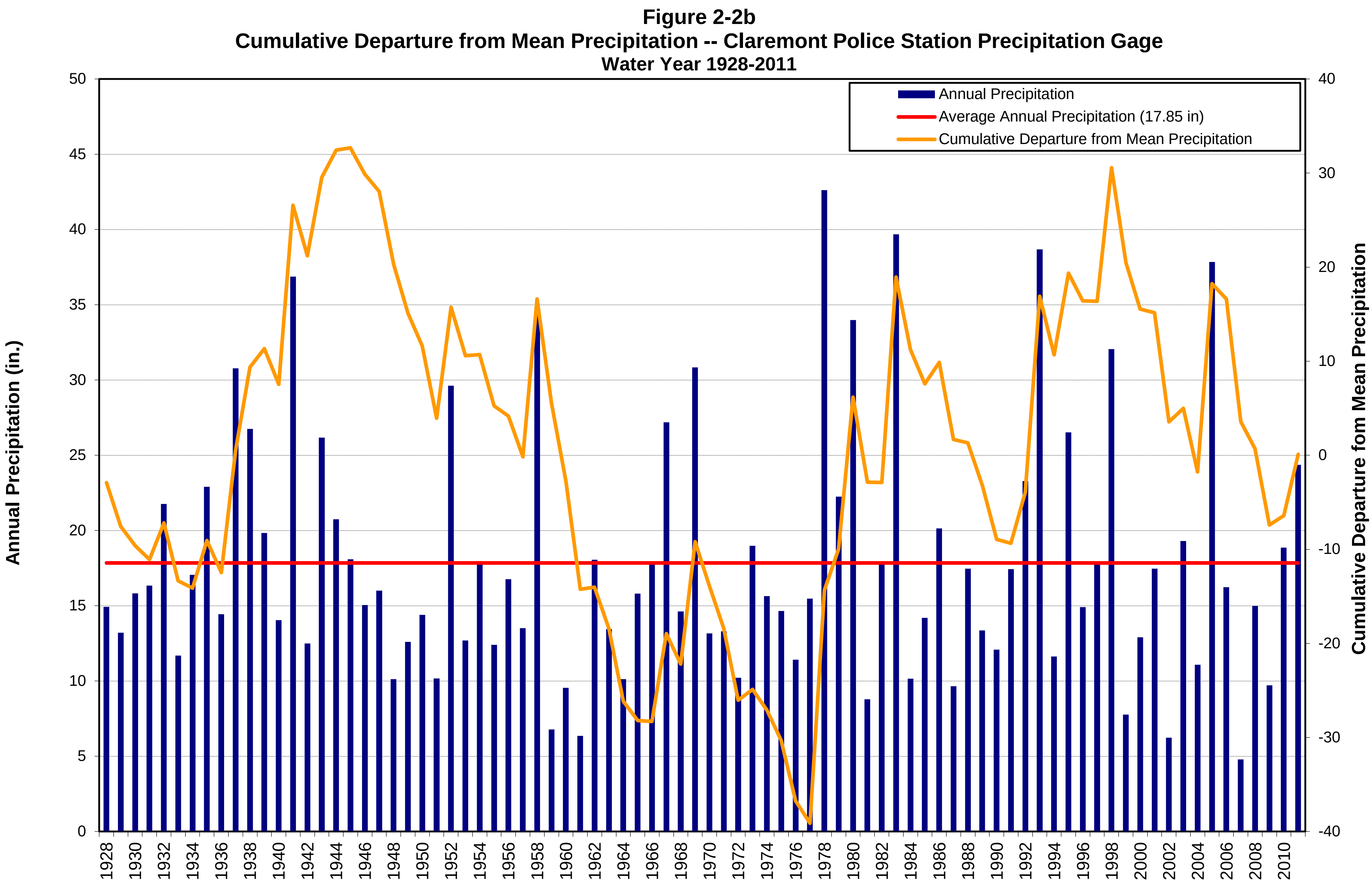



Figure 2-2b -- ClaremontPS_CDFM
5/6/2014

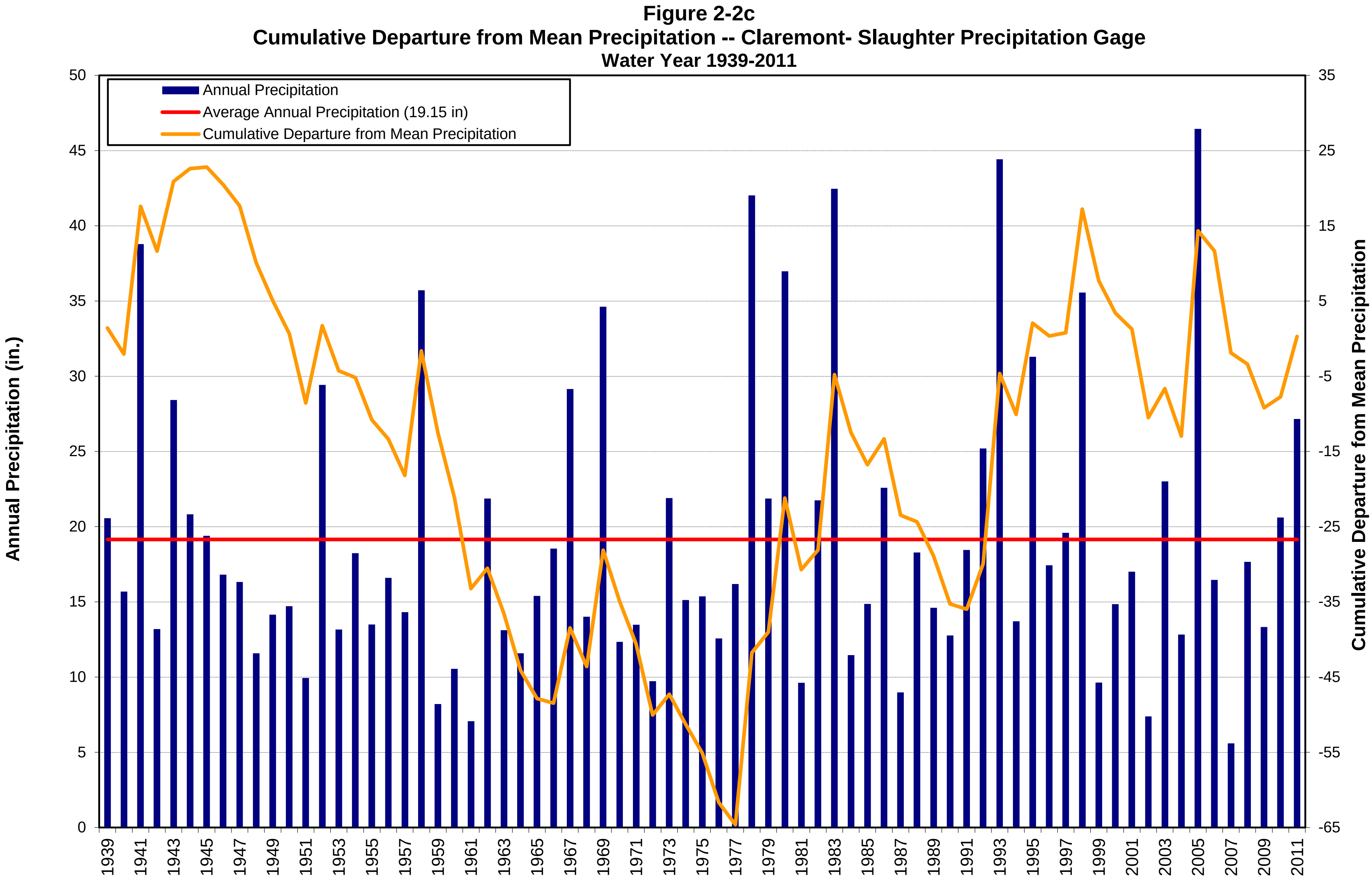



Figure 2-2c -- ClaremontSlaughter_CDFM
5/6/2014

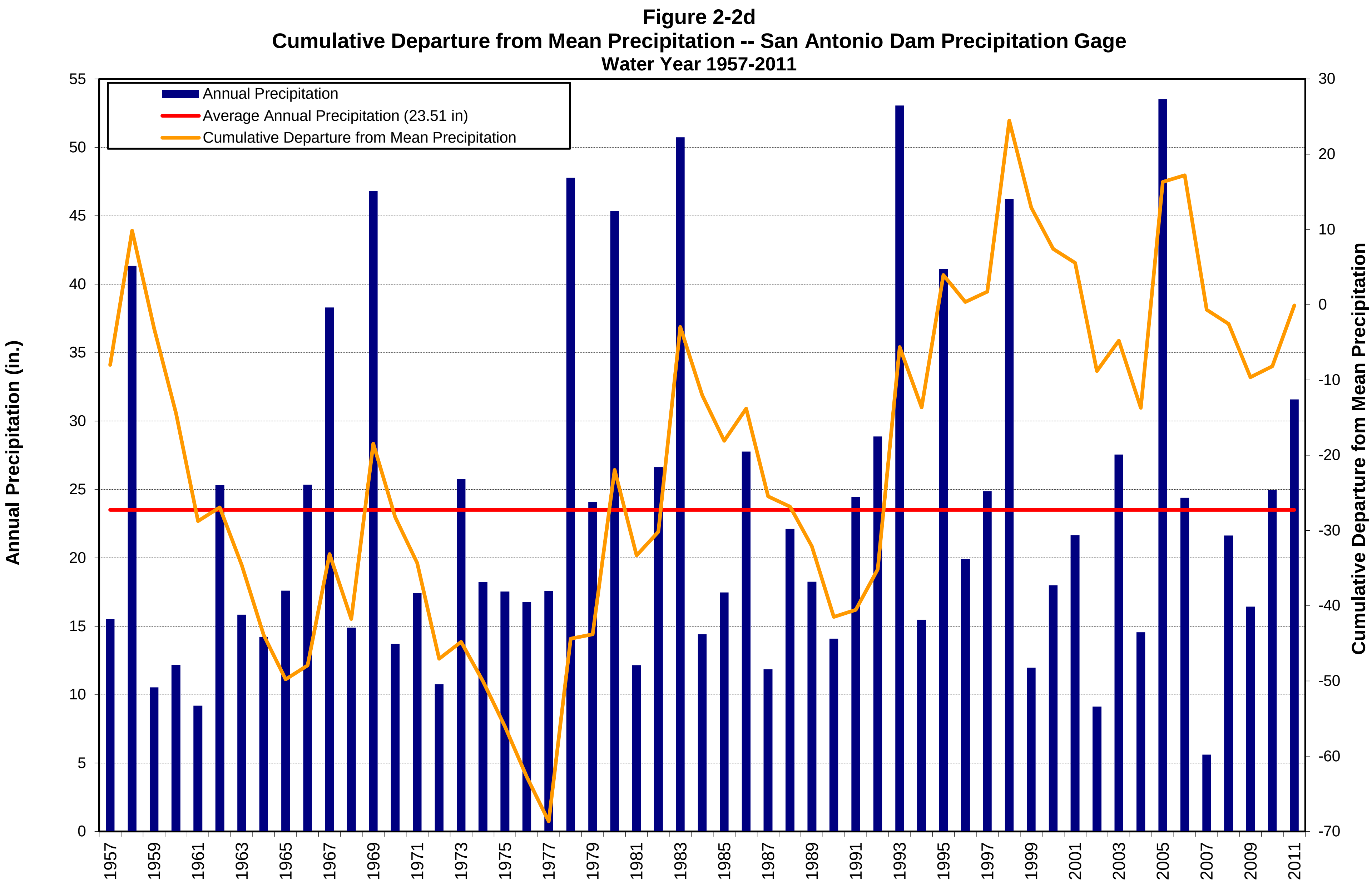



Figure 2-2d -- SanAntDam_CDFM
5/6/2014

**Figure 2-3a**
**Box Whisker Plot of Average Monthly Precipitation at the La Verne Fire Station Gage**
**Water Year 1924-2011**

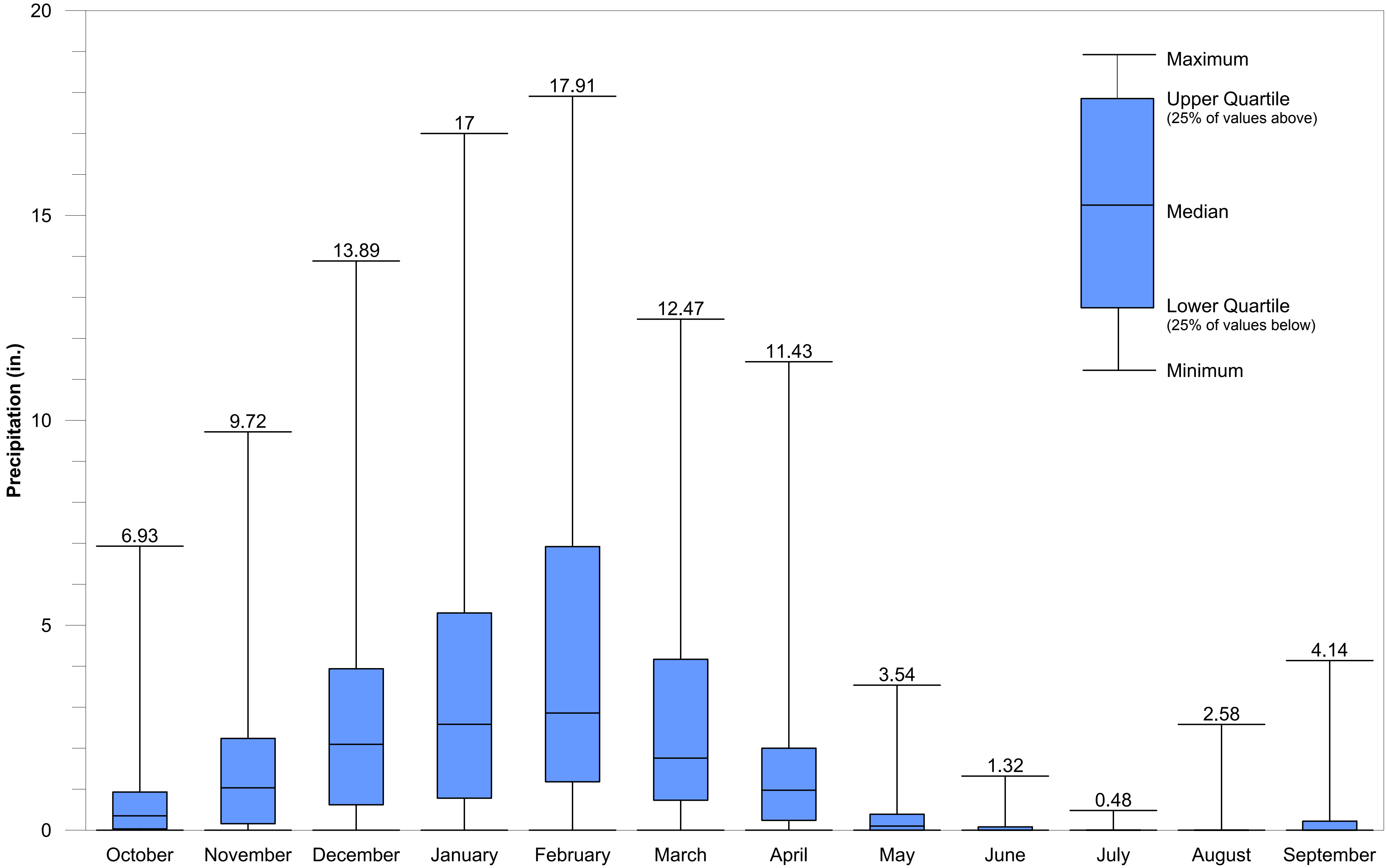


**Figure 2-3b**
**Box Whisker Plot of Average Monthly Precipitation at the Claremont Police Station Gage**
**Water Year 1928-2011**

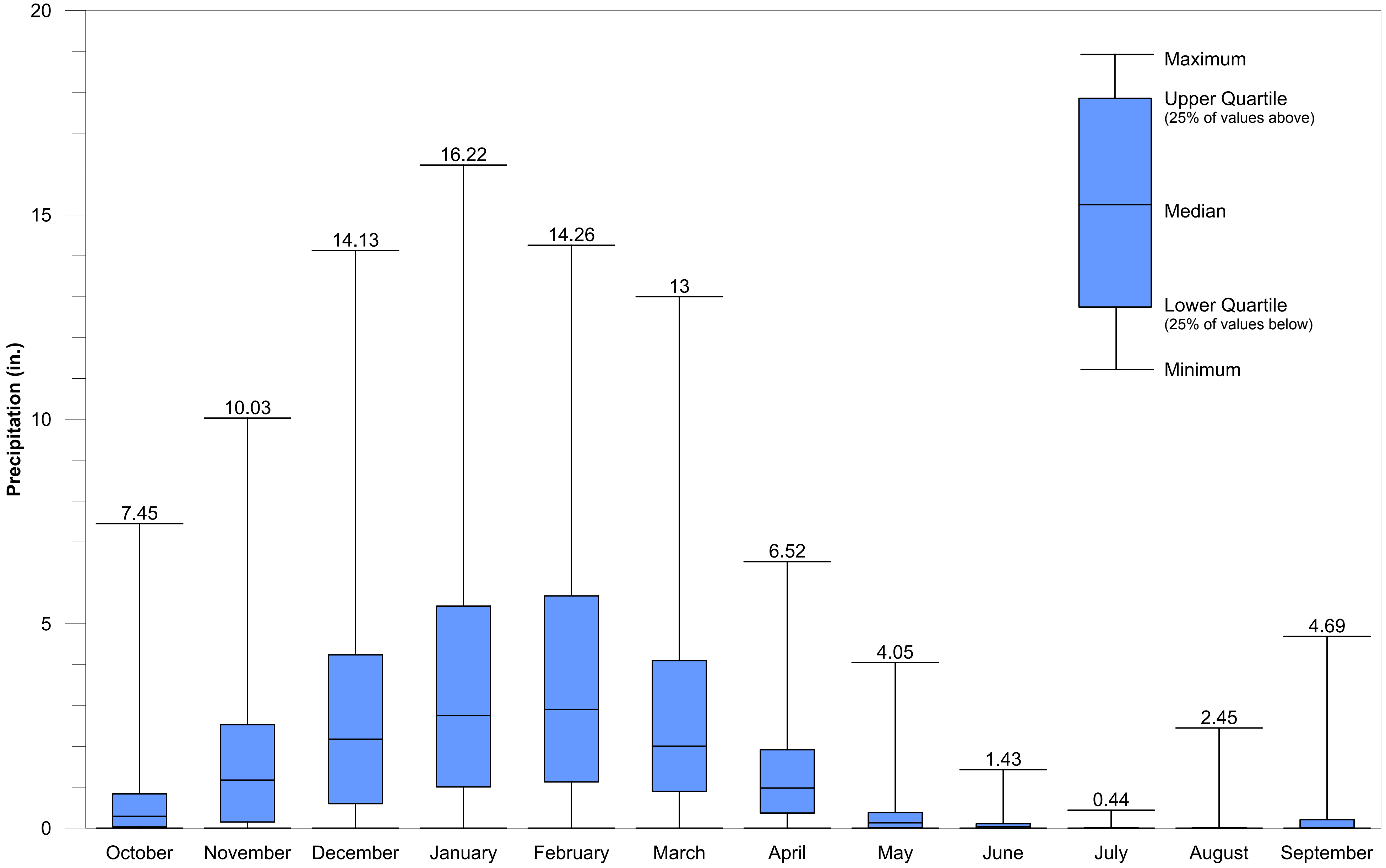


**Figure 2-3c**
**Box Whisker Plot of Average Monthly Precipitation at the Claremont-Slaughter Gage**
**Water Year 1939-2011**

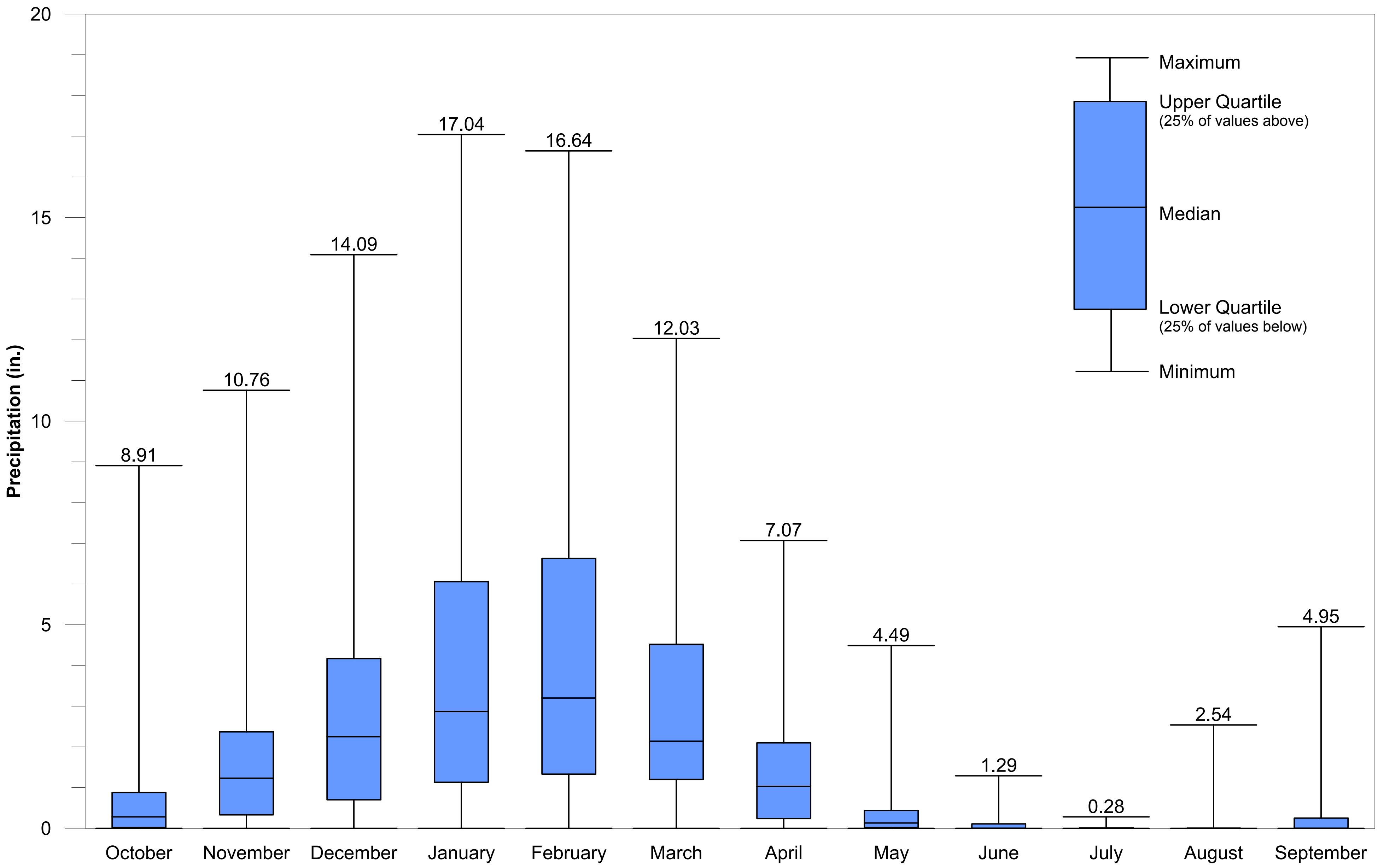
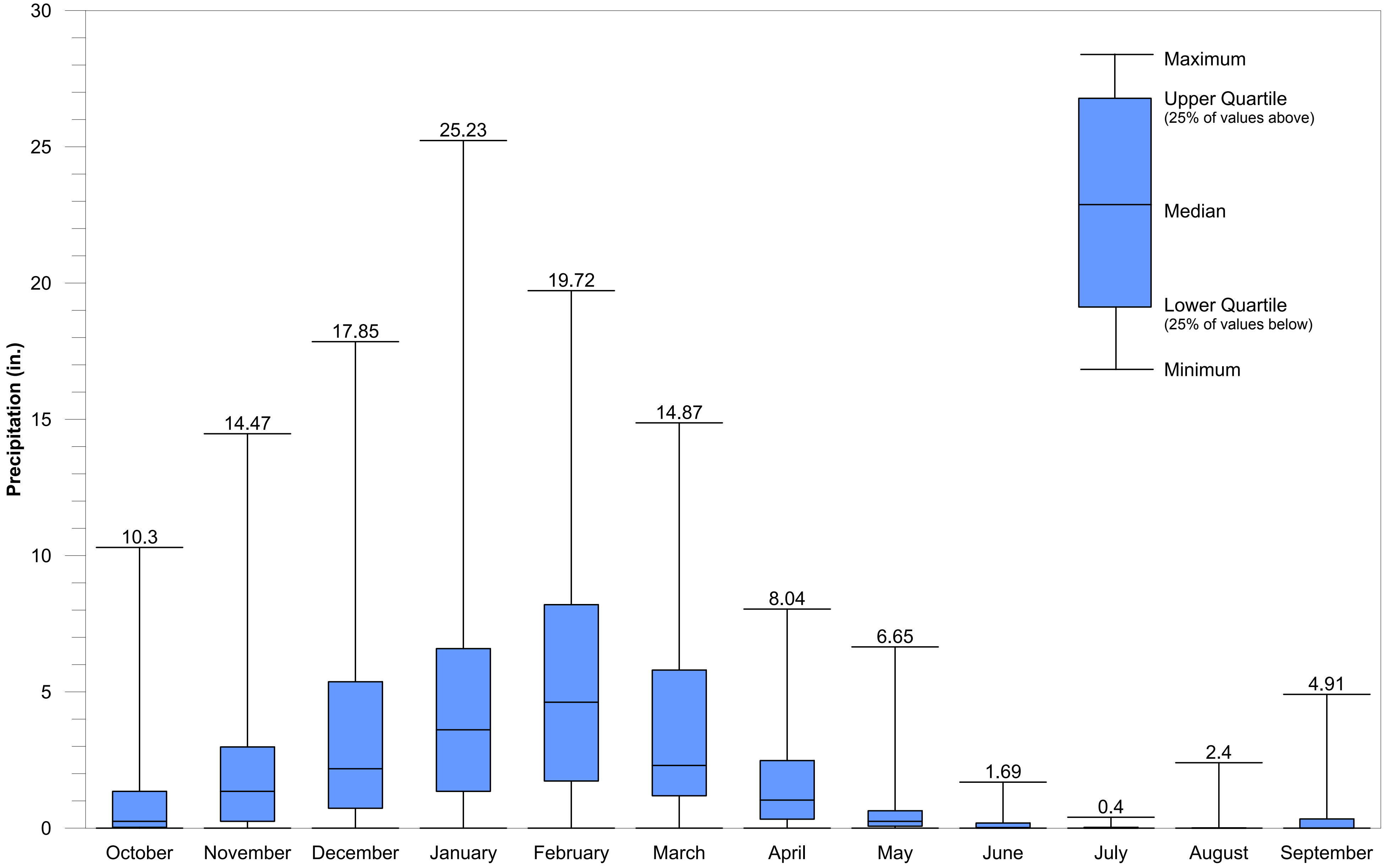
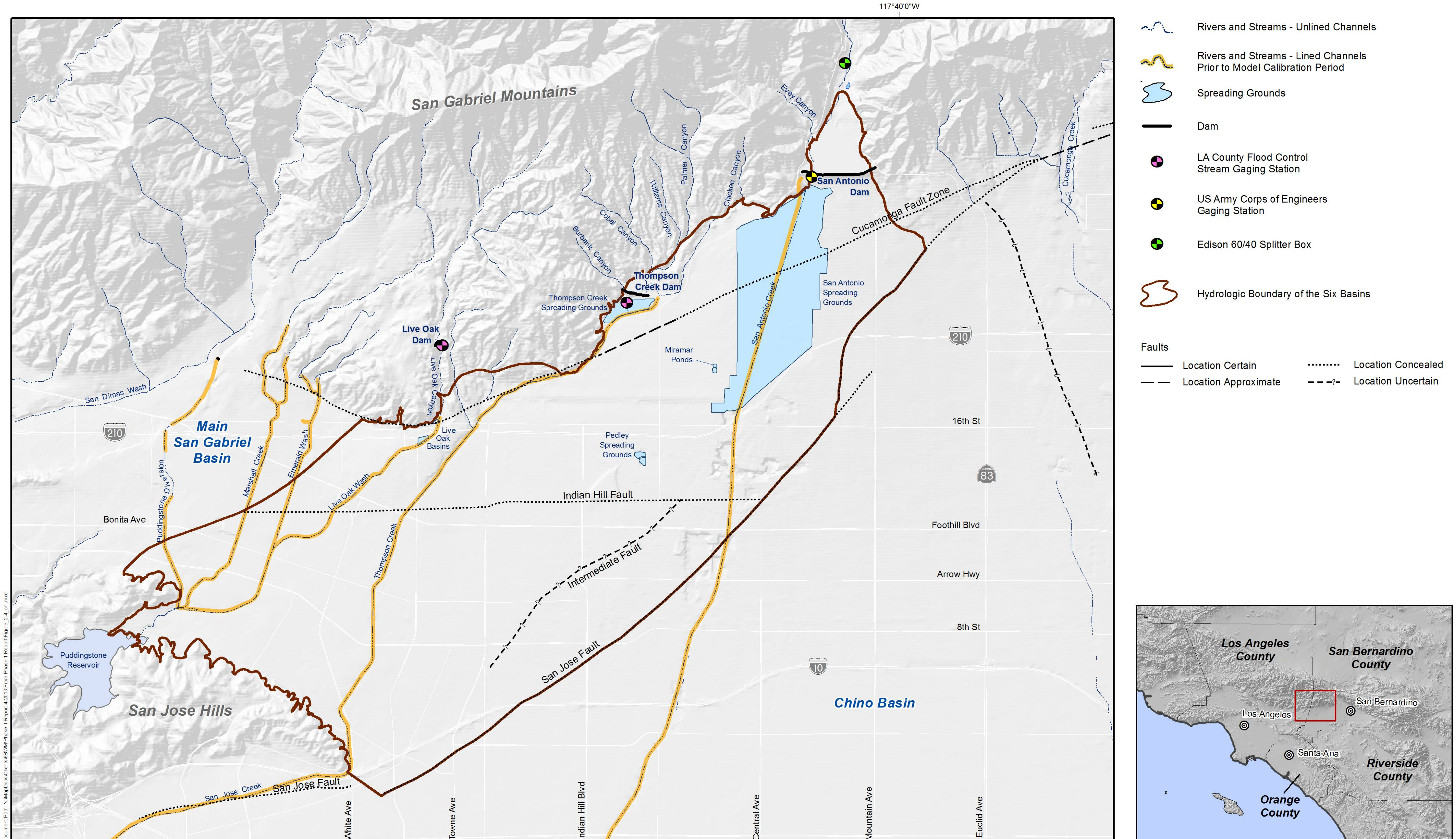


**Figure 2-3d**
**Box Whisker Plot of Average Monthly Precipitation at the San Antonio Dam Gage**
**Water Year 1956-2011**



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Author: LBB

Date: 20131101

0 2 Miles

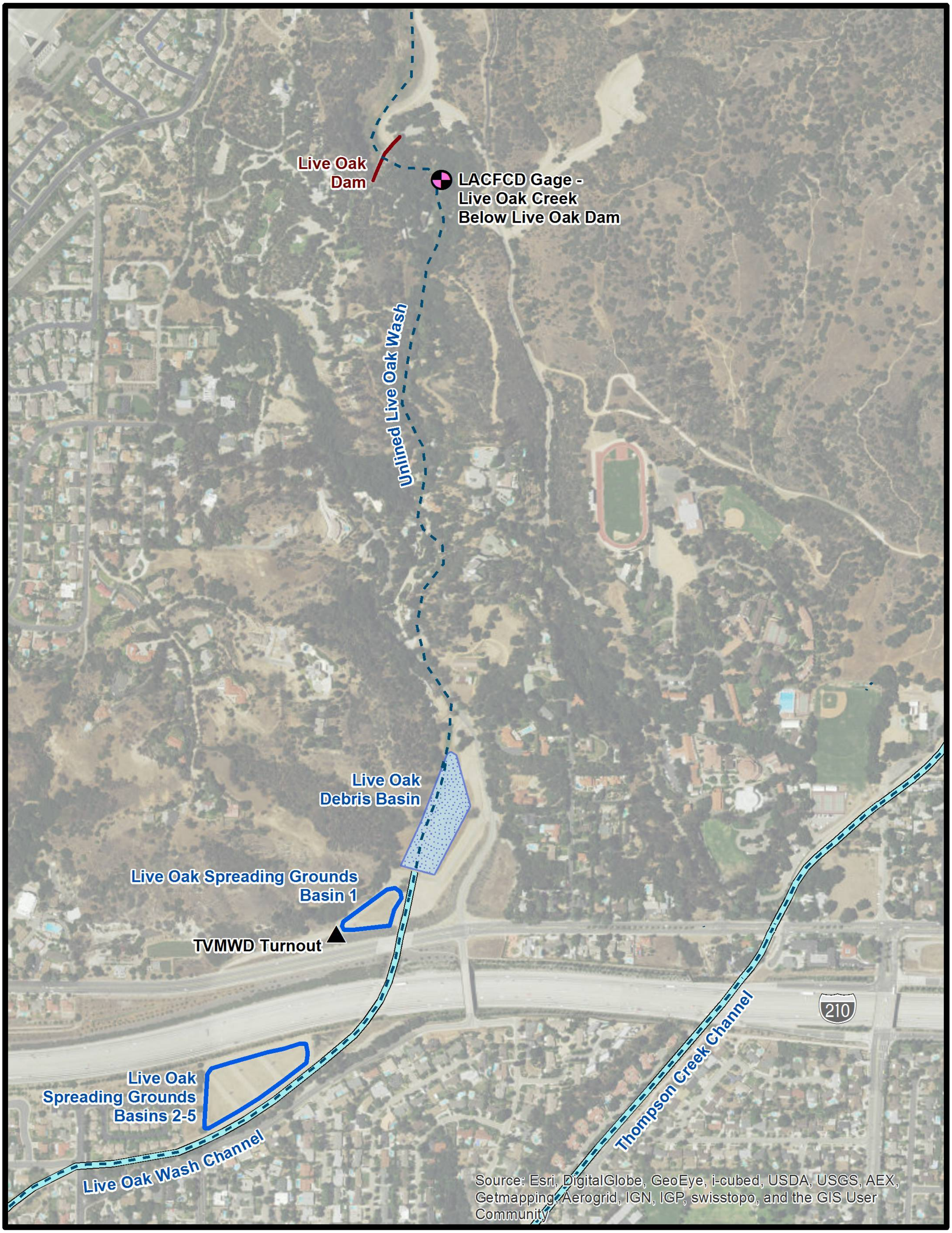
0 2 4 Kilometers

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

## Surface Water Features in the Six Basins Area

**Figure 2-4**

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0 100 200 400 600 Feet

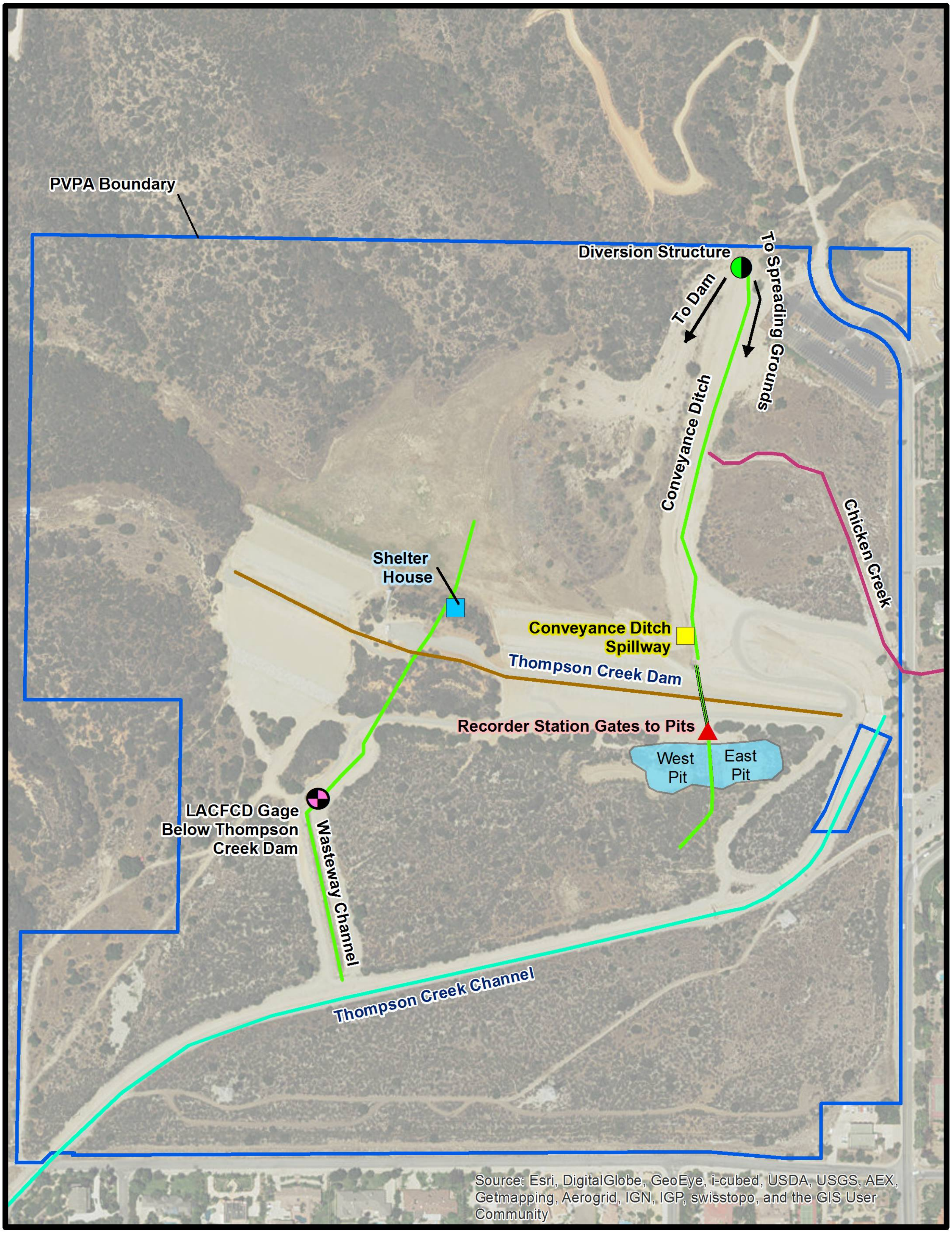
0 25 50 100 150 Meters

**Six Basins Watermaster**

*Strategic Plan for the Six Basins*

**Live Oak Spreading Grounds**

**Figure 2-5a**

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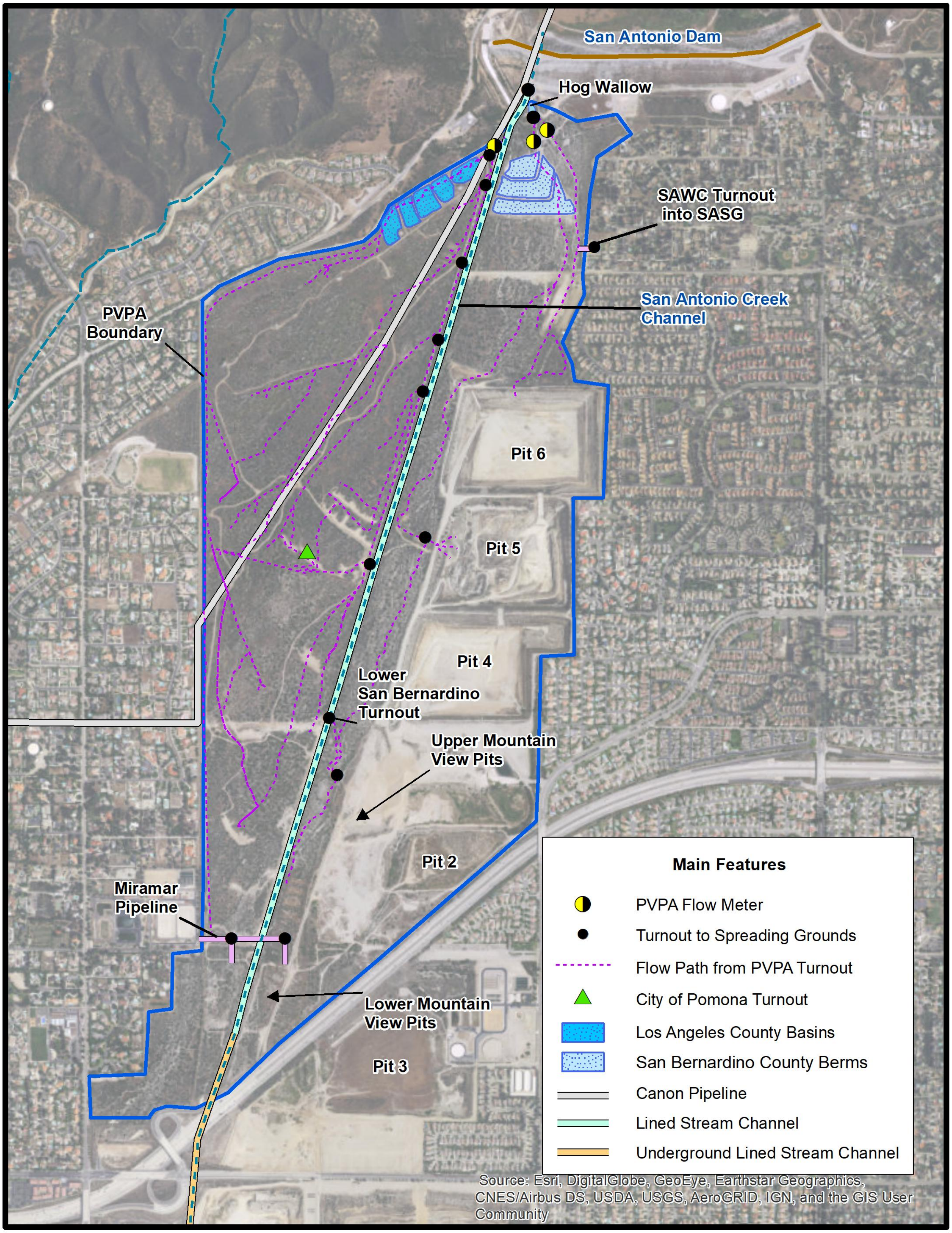
**Six Basins Watermaster**

*Strategic Plan for the Six Basins*

**Thompson Creek Spreading Grounds**

**Figure 2-5b**

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0 250 500 1,000 1,500 Feet

0 50 100 200 300 Meters

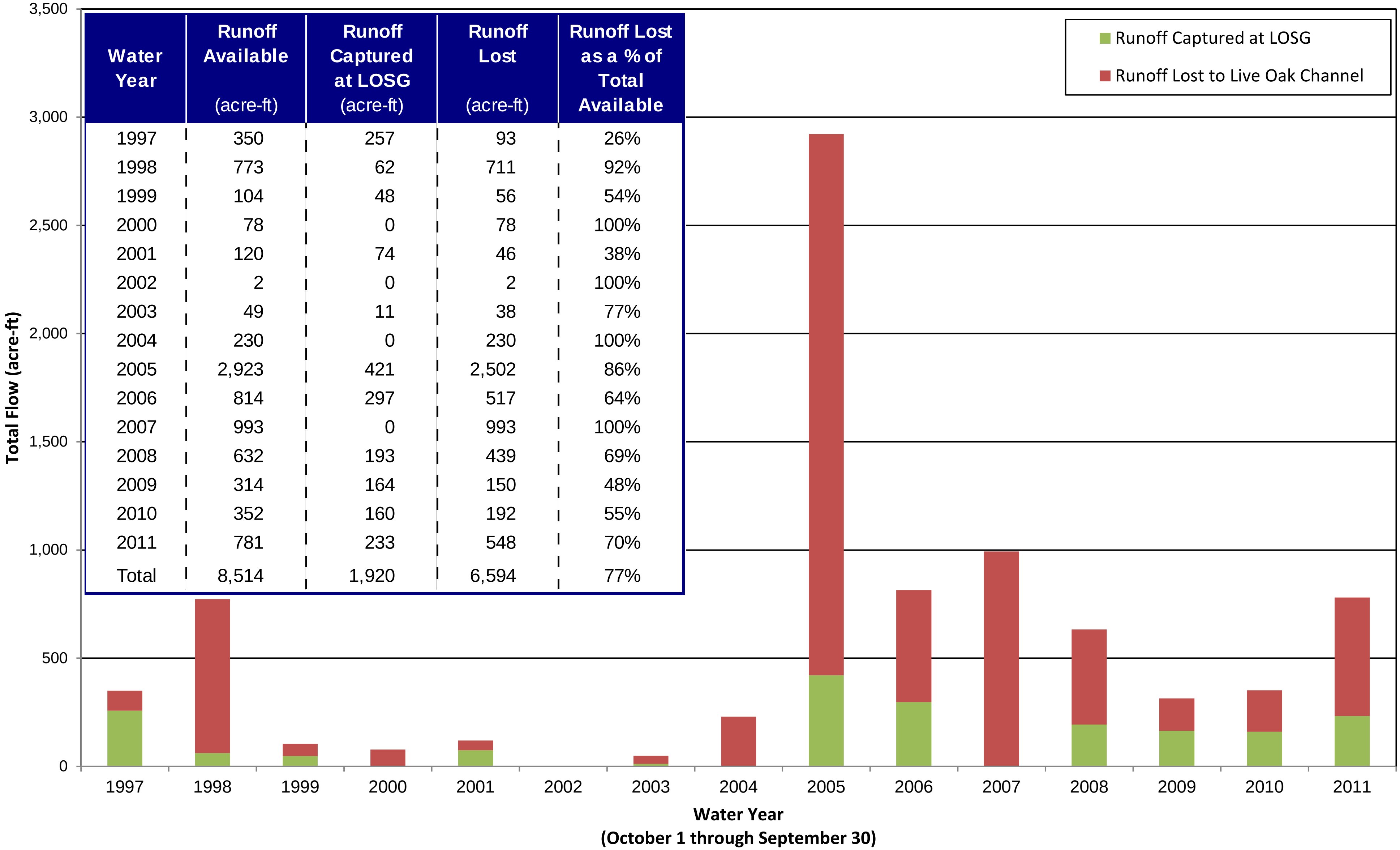
**Six Basins Watermaster**

*Strategic Plan for the Six Basins*

**San Antonio Spreading Grounds**

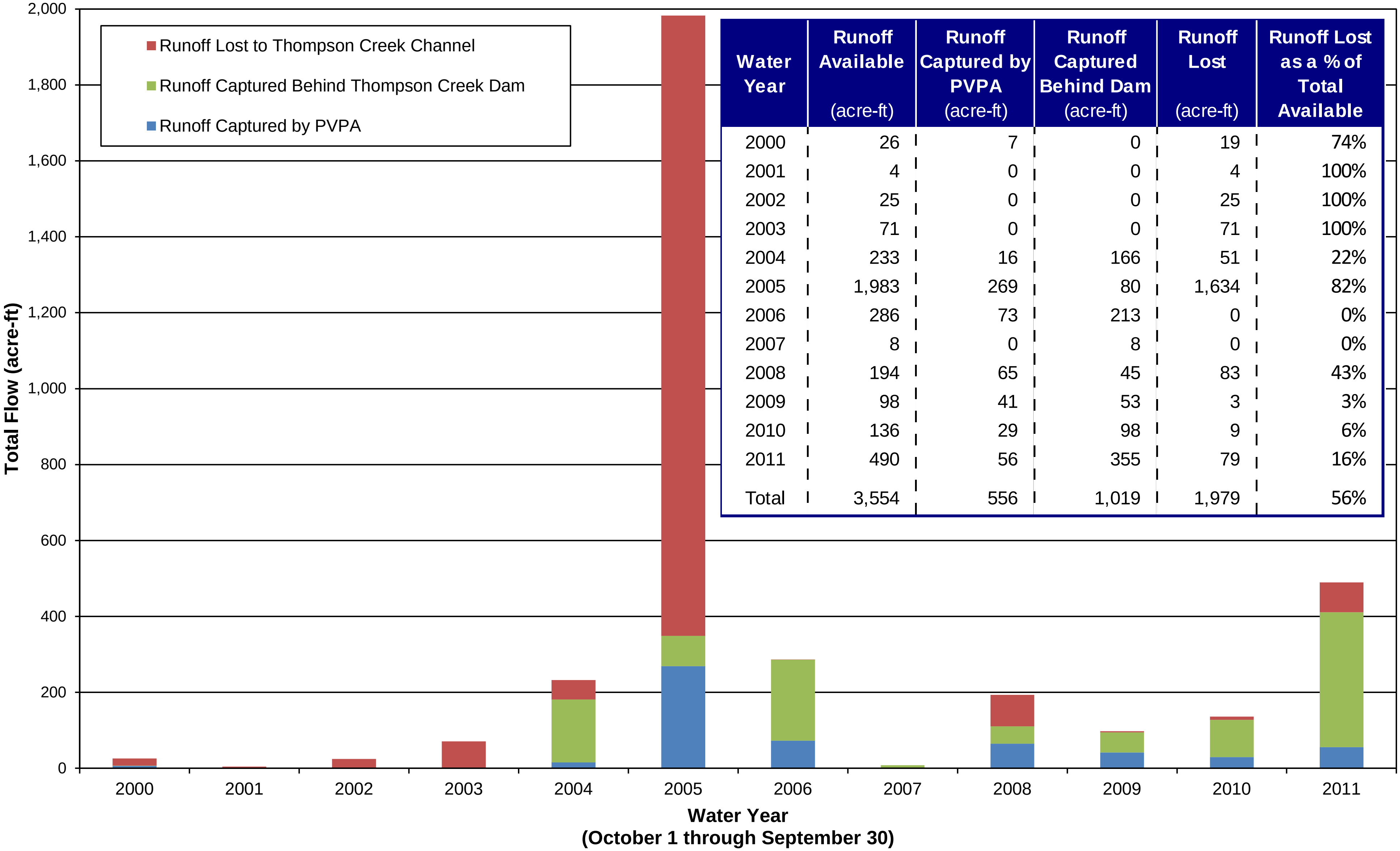
**Figure 2-5c**

## Figure 2-6a
## Surface-Water Runoff Captured and Lost from Live Oak Wash



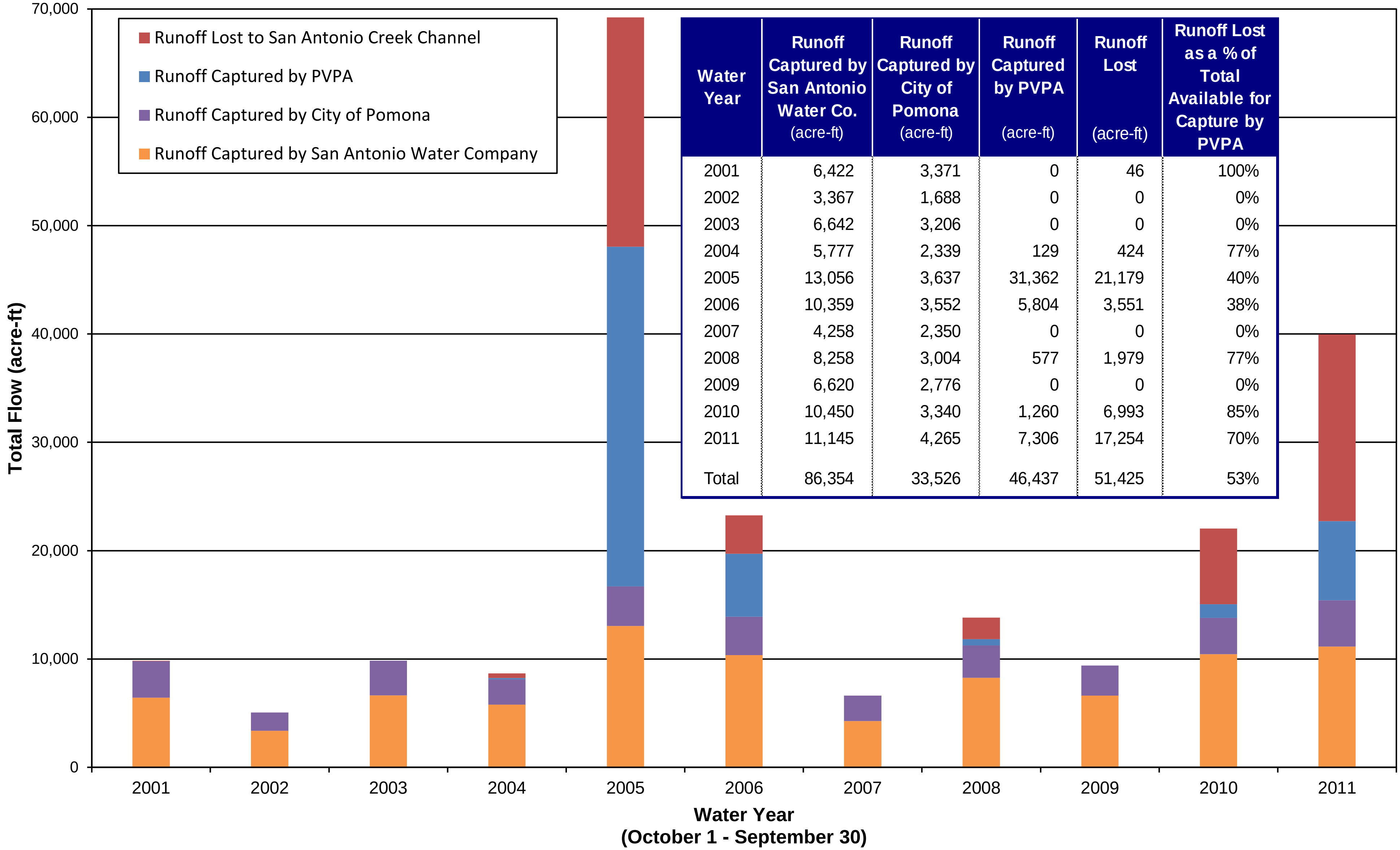

| Water Year | Runoff Available (acre-ft) | Runoff Captured at LOSG (acre-ft) | Runoff Lost (acre-ft) | Runoff Lost as a % of Total Available |
|---|---|---|---|---|
| 1997 | 350 | 257 | 93 | 26% |
| 1998 | 773 | 62 | 711 | 92% |
| 1999 | 104 | 48 | 56 | 54% |
| 2000 | 78 | 0 | 78 | 100% |
| 2001 | 120 | 74 | 46 | 38% |
| 2002 | 2 | 0 | 2 | 100% |
| 2003 | 49 | 11 | 38 | 77% |
| 2004 | 230 | 0 | 230 | 100% |
| 2005 | 2,923 | 421 | 2,502 | 86% |
| 2006 | 814 | 297 | 517 | 64% |
| 2007 | 993 | 0 | 993 | 100% |
| 2008 | 632 | 193 | 439 | 69% |
| 2009 | 314 | 164 | 150 | 48% |
| 2010 | 352 | 160 | 192 | 55% |
| 2011 | 781 | 233 | 548 | 70% |
| Total | 8,514 | 1,920 | 6,594 | 77% |

## Figure 2-6b
## Surface Water Runoff Captured and Lost from Thompson Creek



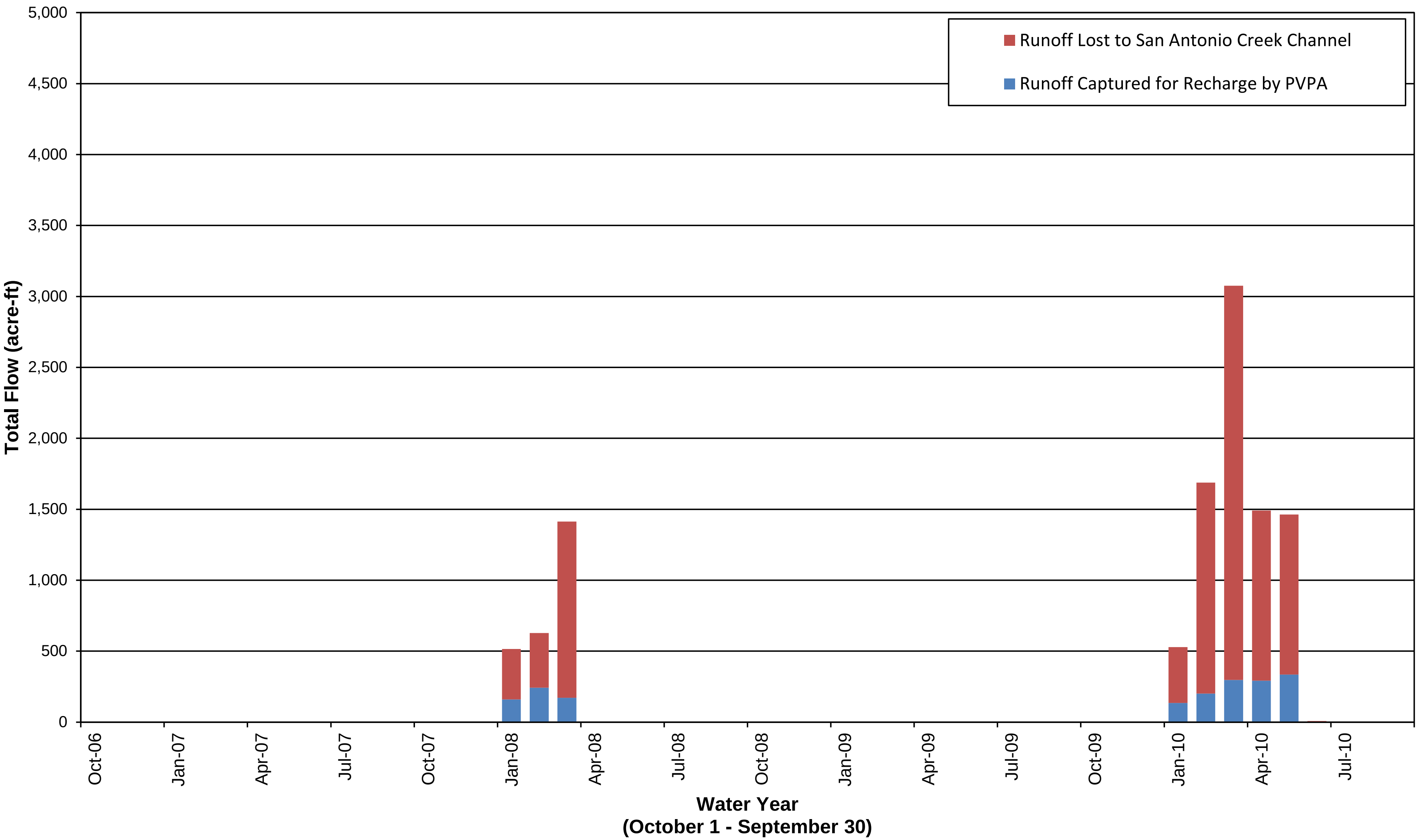

| Water Year | Runoff Available (acre-ft) | Runoff Captured by PVPA (acre-ft) | Runoff Captured Behind Dam (acre-ft) | Runoff Lost (acre-ft) | Runoff Lost as a % of Total Available |
|---|---|---|---|---|---|
| 2000 | 26 | 7 | 0 | 19 | 74% |
| 2001 | 4 | 0 | 0 | 4 | 100% |
| 2002 | 25 | 0 | 0 | 25 | 100% |
| 2003 | 71 | 0 | 0 | 71 | 100% |
| 2004 | 233 | 16 | 166 | 51 | 22% |
| 2005 | 1,983 | 269 | 80 | 1,634 | 82% |
| 2006 | 286 | 73 | 213 | 0 | 0% |
| 2007 | 8 | 0 | 8 | 0 | 0% |
| 2008 | 194 | 65 | 45 | 83 | 43% |
| 2009 | 98 | 41 | 53 | 3 | 3% |
| 2010 | 136 | 29 | 98 | 9 | 6% |
| 2011 | 490 | 56 | 355 | 79 | 16% |
| Total | 3,554 | 556 | 1,019 | 1,979 | 56% |

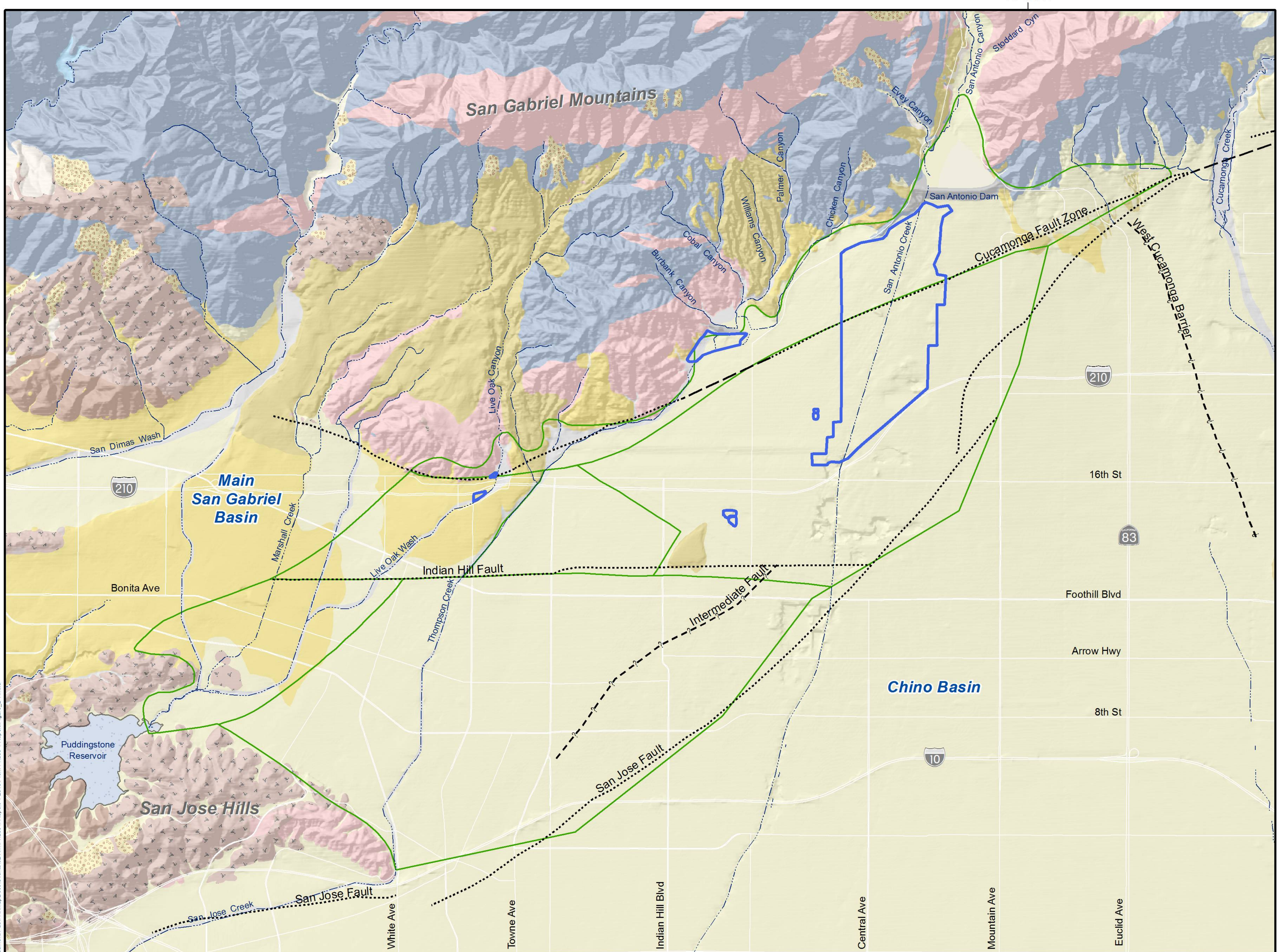
**Figure 2-6c**
**Surface Water Runoff Captured and Lost from San Antonio Creek**




| Water Year | Runoff Captured by San Antonio Water Co. (acre-ft) | Runoff Captured by City of Pomona (acre-ft) | Runoff Captured by PVPA (acre-ft) | Runoff Lost (acre-ft) | Runoff Lost as a % of Total Available for Capture by PVPA |
|---|---|---|---|---|---|
| 2001 | 6,422 | 3,371 | 0 | 46 | 100% |
| 2002 | 3,367 | 1,688 | 0 | 0 | 0% |
| 2003 | 6,642 | 3,206 | 0 | 0 | 0% |
| 2004 | 5,777 | 2,339 | 129 | 424 | 77% |
| 2005 | 13,056 | 3,637 | 31,362 | 21,179 | 40% |
| 2006 | 10,359 | 3,552 | 5,804 | 3,551 | 38% |
| 2007 | 4,258 | 2,350 | 0 | 0 | 0% |
| 2008 | 8,258 | 3,004 | 577 | 1,979 | 77% |
| 2009 | 6,620 | 2,776 | 0 | 0 | 0% |
| 2010 | 10,450 | 3,340 | 1,260 | 6,993 | 85% |
| 2011 | 11,145 | 4,265 | 7,306 | 17,254 | 70% |
| Total | 86,354 | 33,526 | 46,437 | 51,425 | 53% |

# Figure 2-6d
## Monthly Surface Water Runoff Discharged and Captured from San Antonio Dam
### Water Year 2007 - 2011






Surface Geology

Unconsolidated Sediments (Source: CGS Special Report 217)

- Qyf — Undifferentiated Quaternary (younger) alluvial deposits
- Qoa — Undifferentiated Quaternary (older) alluvial deposits

Consolidated Bedrock Formations (Source: CGS Special Report 217)

- Tss, Tsh, Tv — Puente Group: Tertiary sedimentary and volcanic rocks
- pKm, gr — Basement Complex: Cretaceous and Pre-Cretaceous igneous and metamorphic rocks

Spreading Grounds

Faults

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

Six Basins Adjudicated Boundaries

1 - Canyon
2 - Upper Claremont Heights
3 - Lower Claremont Heights
4 - Live Oak
5 - Ganesha
6 - Pomona


Document Path: N:\MapDocs\Clients\6BWM\Phase II Report 4-2013\From Phase 1 Report\Figure_2-7.mxd

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WILDERMUTH ENVIRONMENTAL, INC.

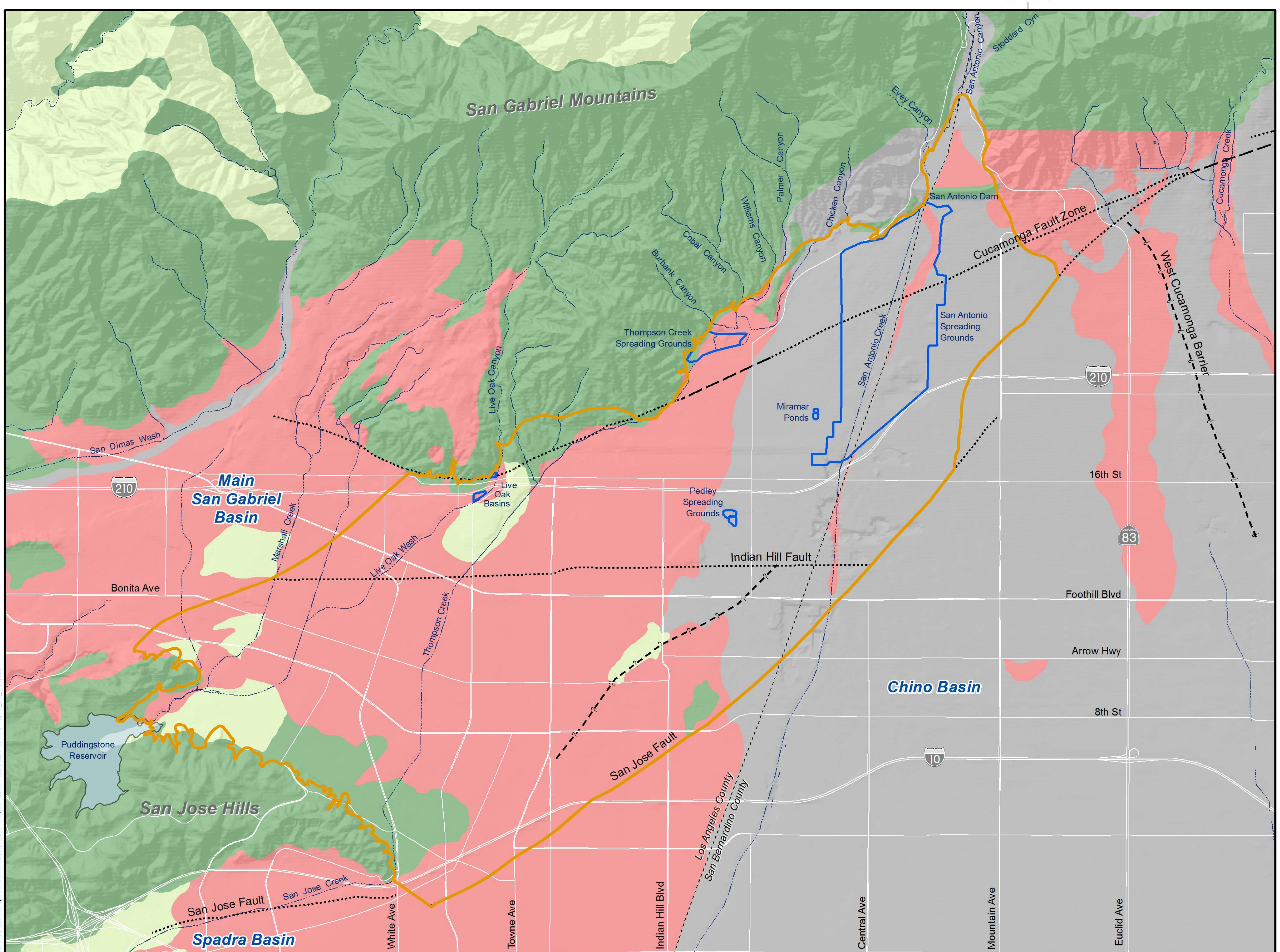
Author: LBB
Date: 20151207

0 2 Miles
0 2 4 Kilometers

**Six Basins Watermaster**
**Strategic Plan for the Six Basins**

# Geologic Map of the Six Basins Area

**Figure 2-7**




Hydrologic Soil Types

- A — Low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.
- B — Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.
- C — Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.
- D — High runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or nearthe surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

Source: Los Angeles County: United States Agriculture Dept Soils Bureau, 1917
SanBernardino County: National Cooperative Soil Survey

Hydrologic Six Basins Boundary

Spreading Grounds

Faults

Location Certain
Location Approximate
Location Concealed
Location Uncertain


Document Path: N:\MapDocs\Clients\6BWM\Phase II Report 4-2013\From Phase 1 Report\Figure_2-8_soils.mxd

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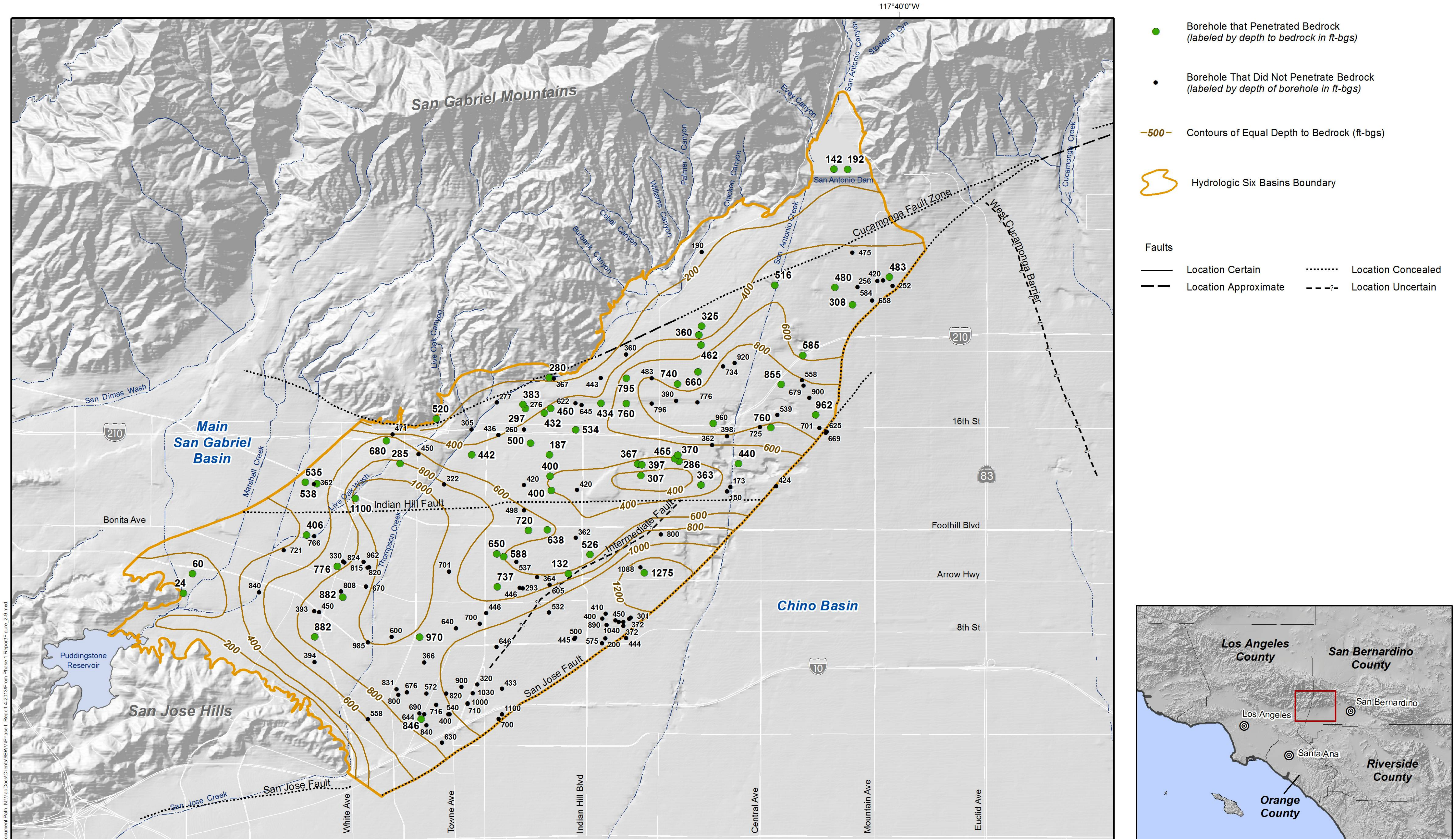
Date: 20120924

0 2 Miles
0 2 4 Kilometers

Six Basins Watermaster
Strategic Plan for the Six Basins

## Hydrologic Soil Types of the Soil Conservation Service

Figure 2-8




Prepared by:

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Updated By: csanchez

Date: 20151209

0 2 Miles

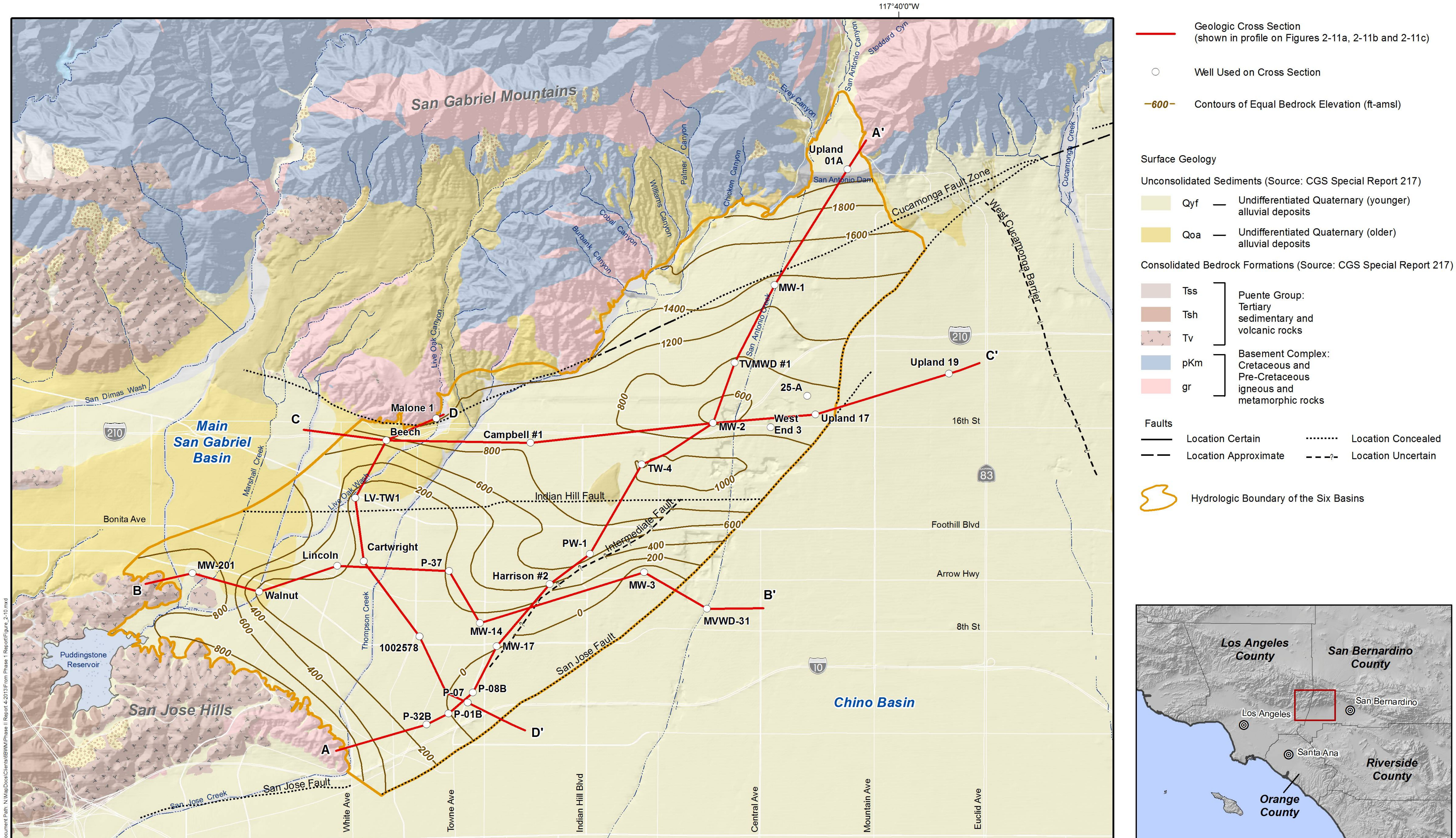
0 2 4 Kilometers

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

## Depth to the Bottom of the Aquifer

**Figure 2-9**




Prepared by:

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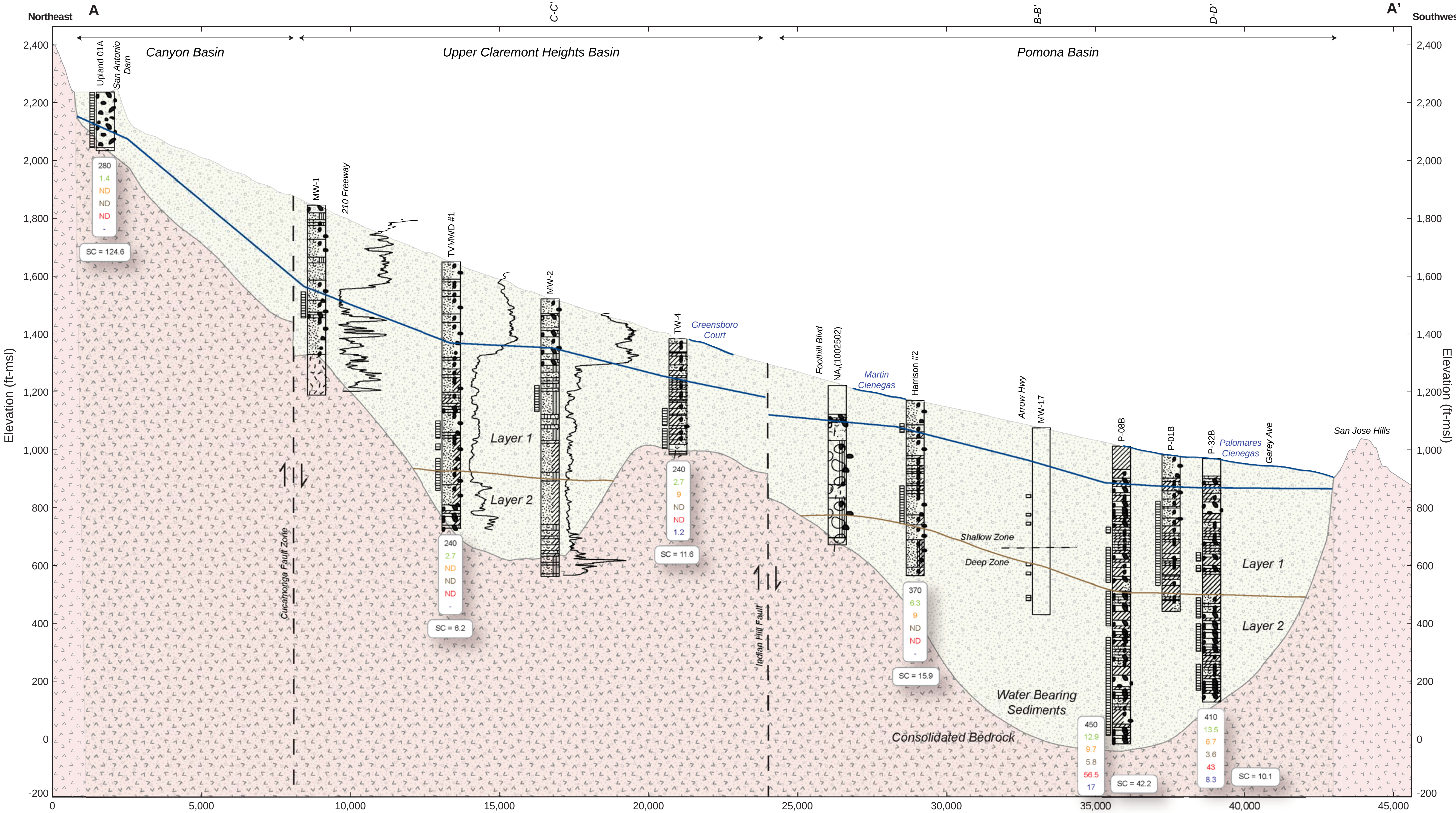
Wildermuth Environmental, Inc.

Author: LBB
Date: 20151207

Six Basins Watermaster
Strategic Plan for the Six Basins

# Elevation of the Bottom of the Aquifer and the Location of Geologic Cross-Sections

Figure 2-10




Report: STRAT+GEOPHYSICAL_11X17; File: 6BWM_V2.GPJ; 10/8/2012

Prepared by:

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Wildermuth Environmental, Inc.

Vertical Scale: 1" = 320'
Horizontal Scale: 1" = 3050'
Vertical Exaggeration: 9.5:1

Lithologic Graphics

- Gravel
- Granite
- Sand
- Decomposed Granite
- Silt
- Cobbles/Boulders
- Clay

Where the lithologic graphic column is split, the primary component is on the left side of the column;secondary component(s) are on the right.

- Well Screen Interval
- Water Level (Fall 2011)
- 16" Short Normal Geophysical Log

Maximum Concentration 2007 to 2011

TDS mg/L
$NO_3$-N mg/L
$ClO_4$ ug/L
TCE ug/L
1,1 DCE ug/L
Cr (VI) ug/L

ND = non detect
"-" = constituent not tested

Average Specific Capacity (gpm/ft)

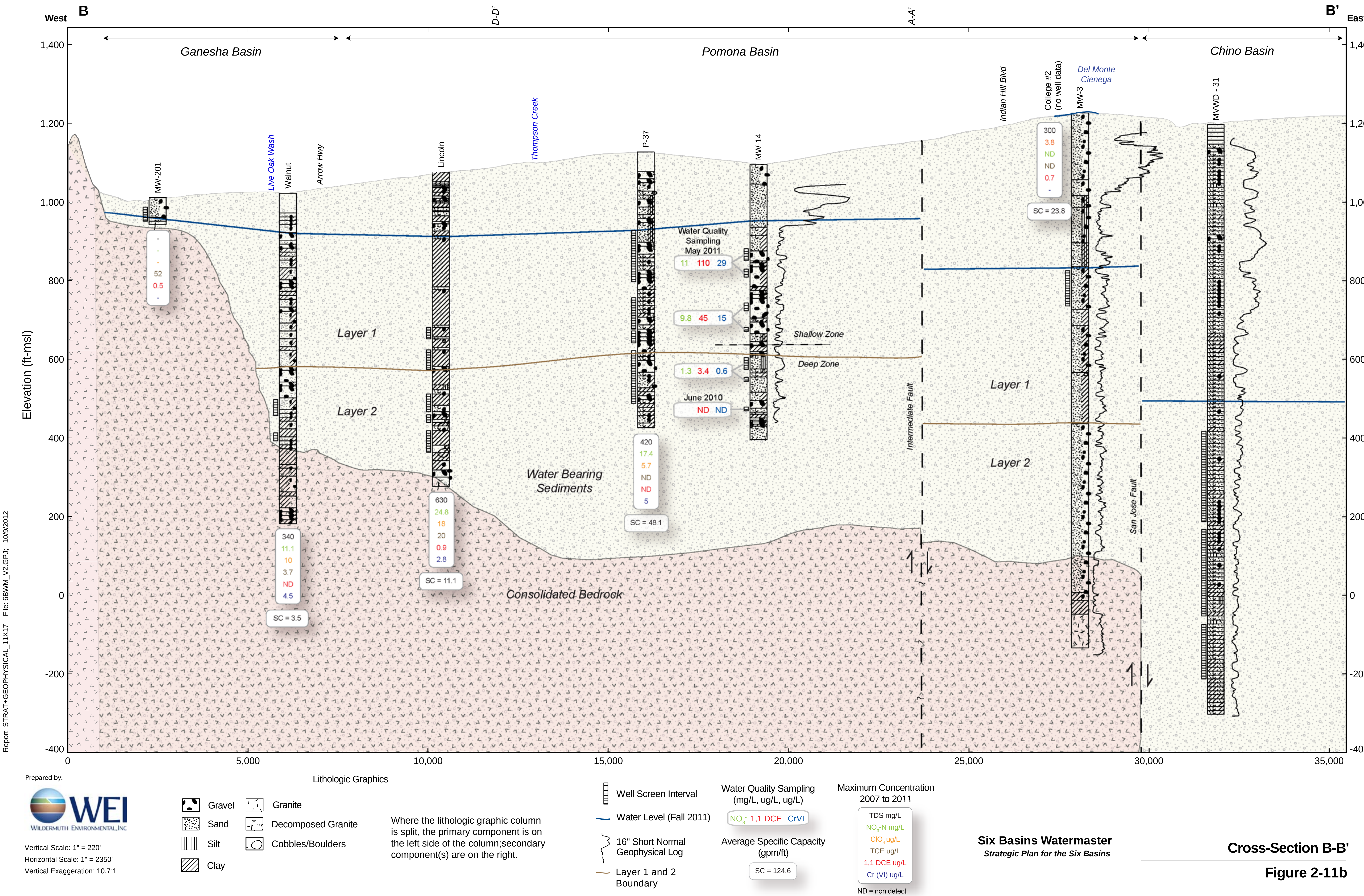
SC = 124.6

Layer 1 and 2 Boundary

**Six Basins Watermaster**
*Strategic Plan for the Six Basins*

## Cross-Section A-A'

## Figure 2-11a

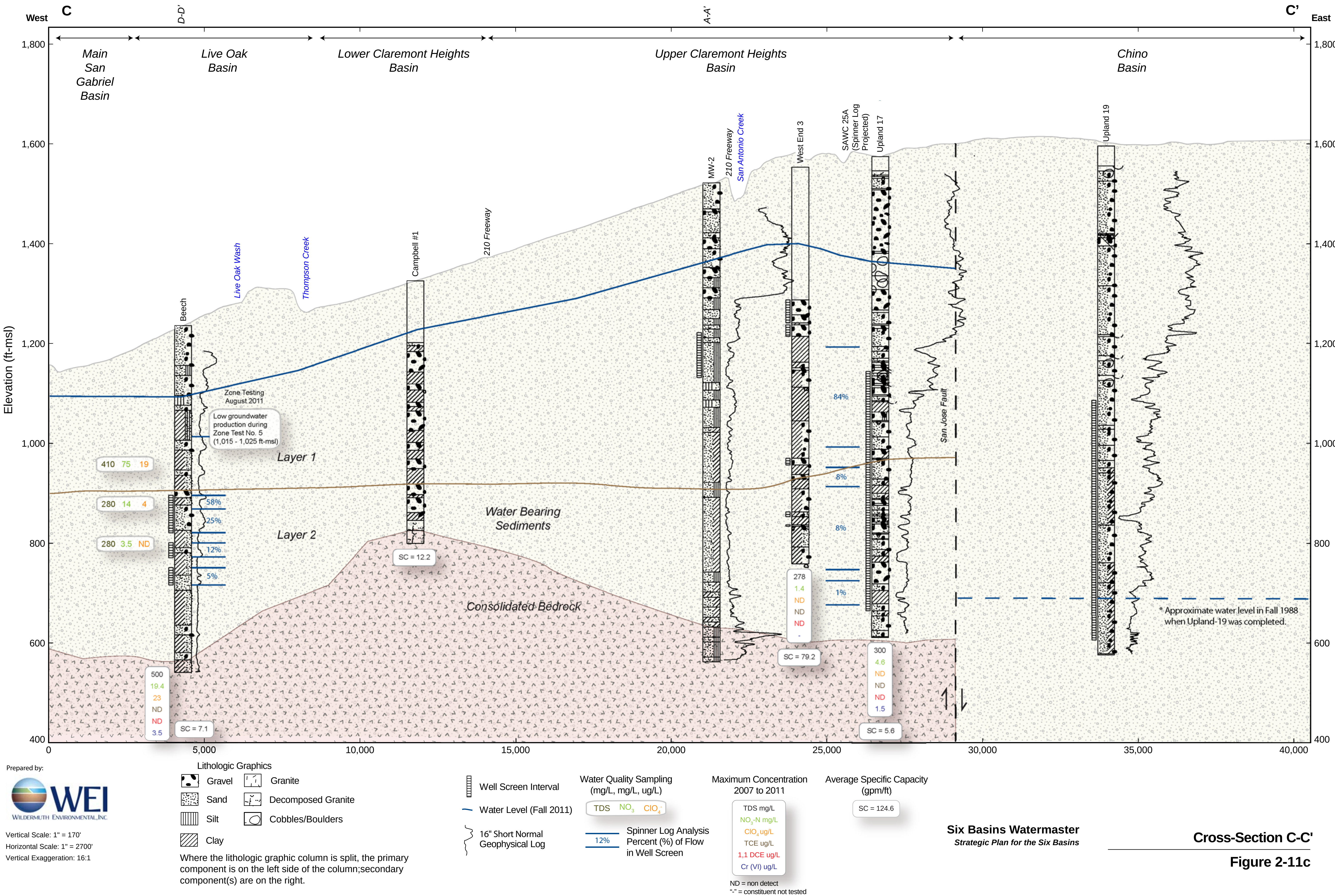



**Six Basins Watermaster**

*Strategic Plan for the Six Basins*

**Cross-Section B-B'**

**Figure 2-11b**




Report: STRAT+GEOPHYSICAL_11X17; File: 6BWM_V2.GPJ; 10/9/2012

Prepared by:

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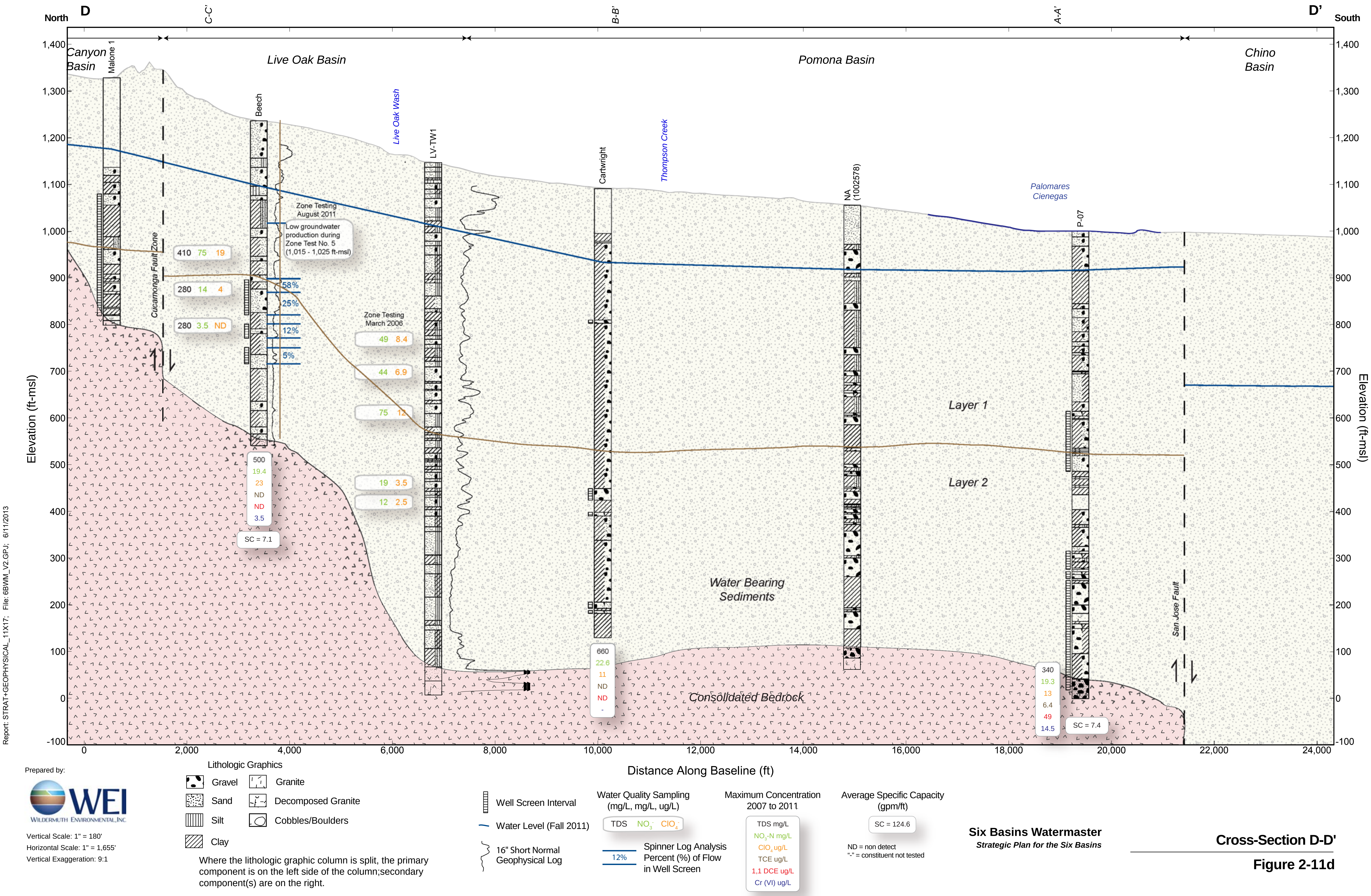
Vertical Scale: 1" = 170'
Horizontal Scale: 1" = 2700'
Vertical Exaggeration: 16:1

**Six Basins Watermaster**
*Strategic Plan for the Six Basins*

**Cross-Section C-C'**

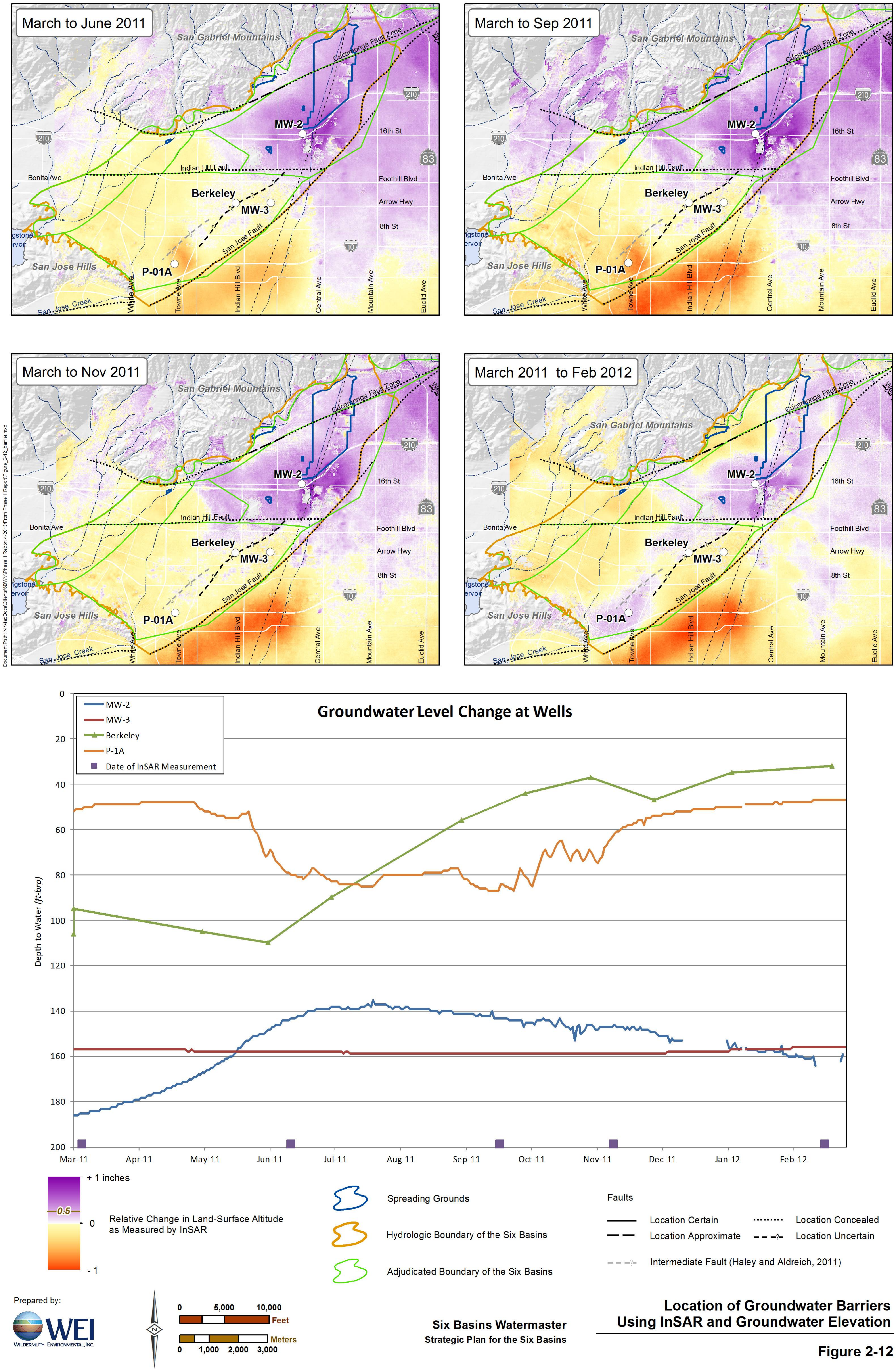
**Figure 2-11c**




**Six Basins Watermaster**
*Strategic Plan for the Six Basins*

**Cross-Section D-D'**

**Figure 2-11d**

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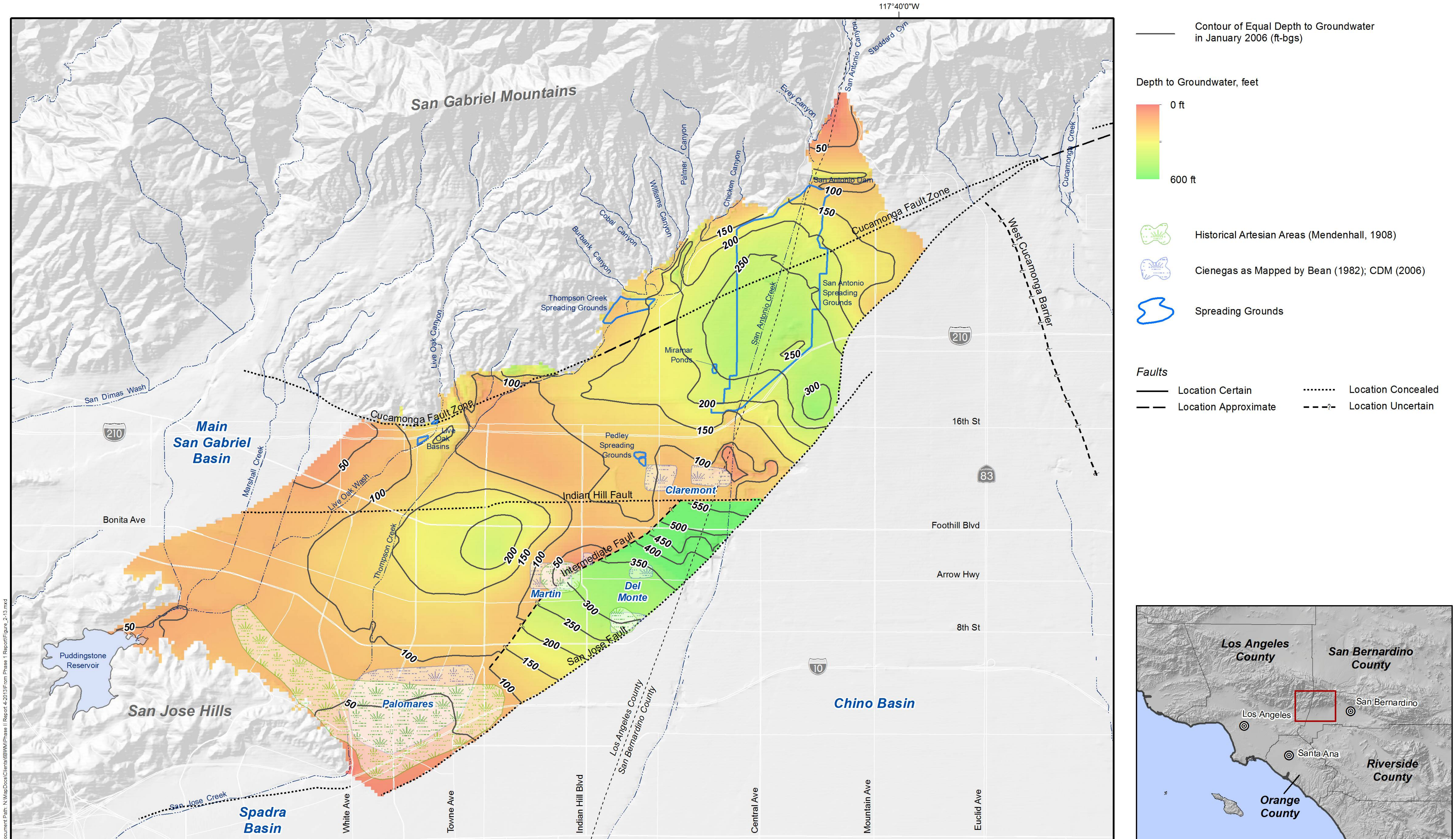
**Six Basins Watermaster**
**Strategic Plan for the Six Basins**

**Location of Groundwater Barriers Using InSAR and Groundwater Elevation**

**Figure 2-12**




Prepared by:

WEI Wildermuth Environmental, Inc.

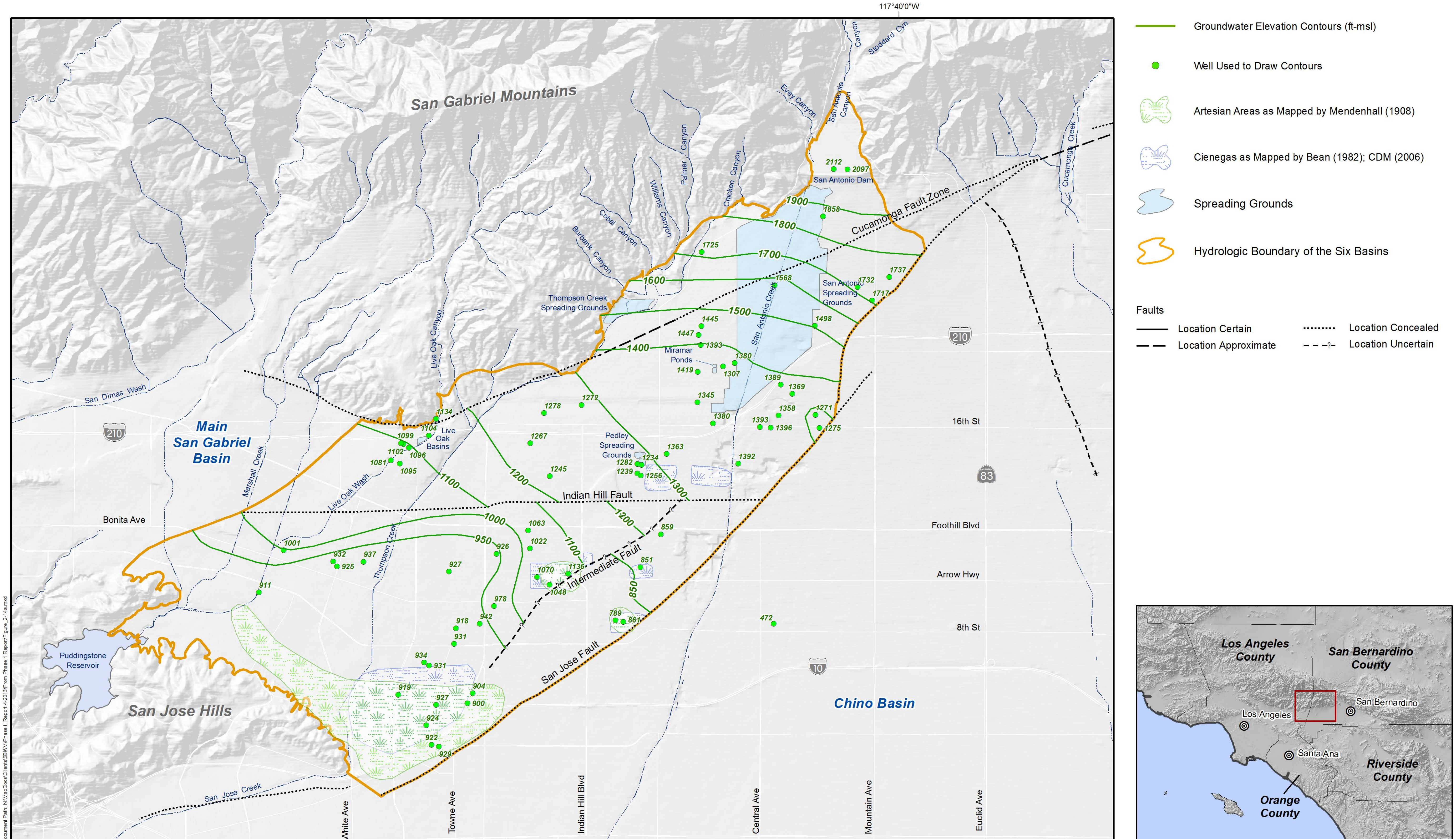
Author: LBB
Date: 20151207

0 2 Miles
0 2 4 Km

**Six Basins Watermaster**
**Strategic Plan for the Six Basins**

## Historical Areas of Rising Groundwater and Depth to Groundwater in January 2006

**Figure 2-13**




Prepared by:

WEI
Wildermuth Environmental, Inc.

Author: MJC
Date: 20131021
File: Figure_2-14a.mxd

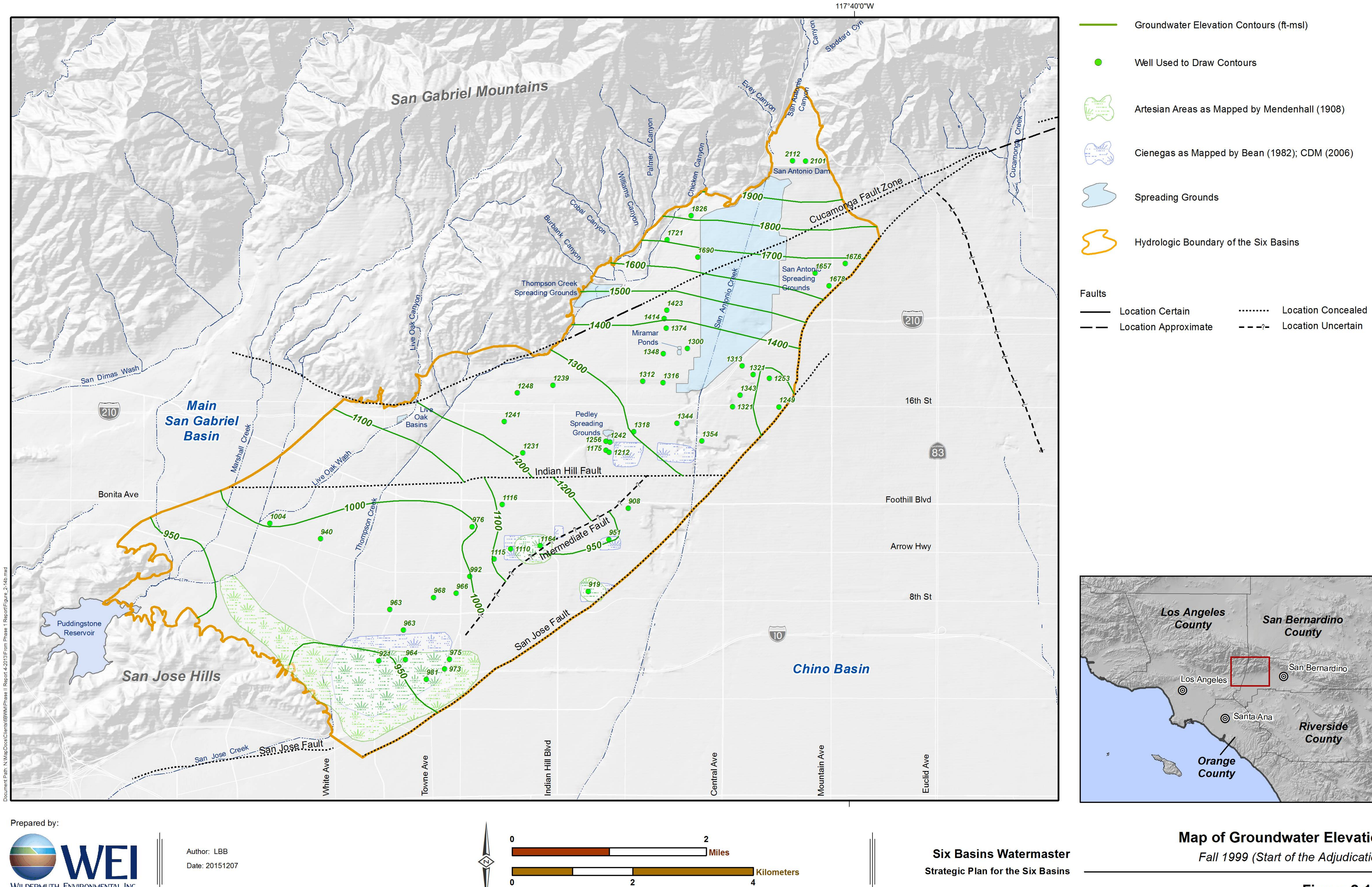
0 2 Miles
0 2 4 Kilometers

**Six Basins Watermaster**
**Strategic Plan for the Six Basins**

## Map of Groundwater Elevation

*Fall 2011*

**Figure 2-14a**



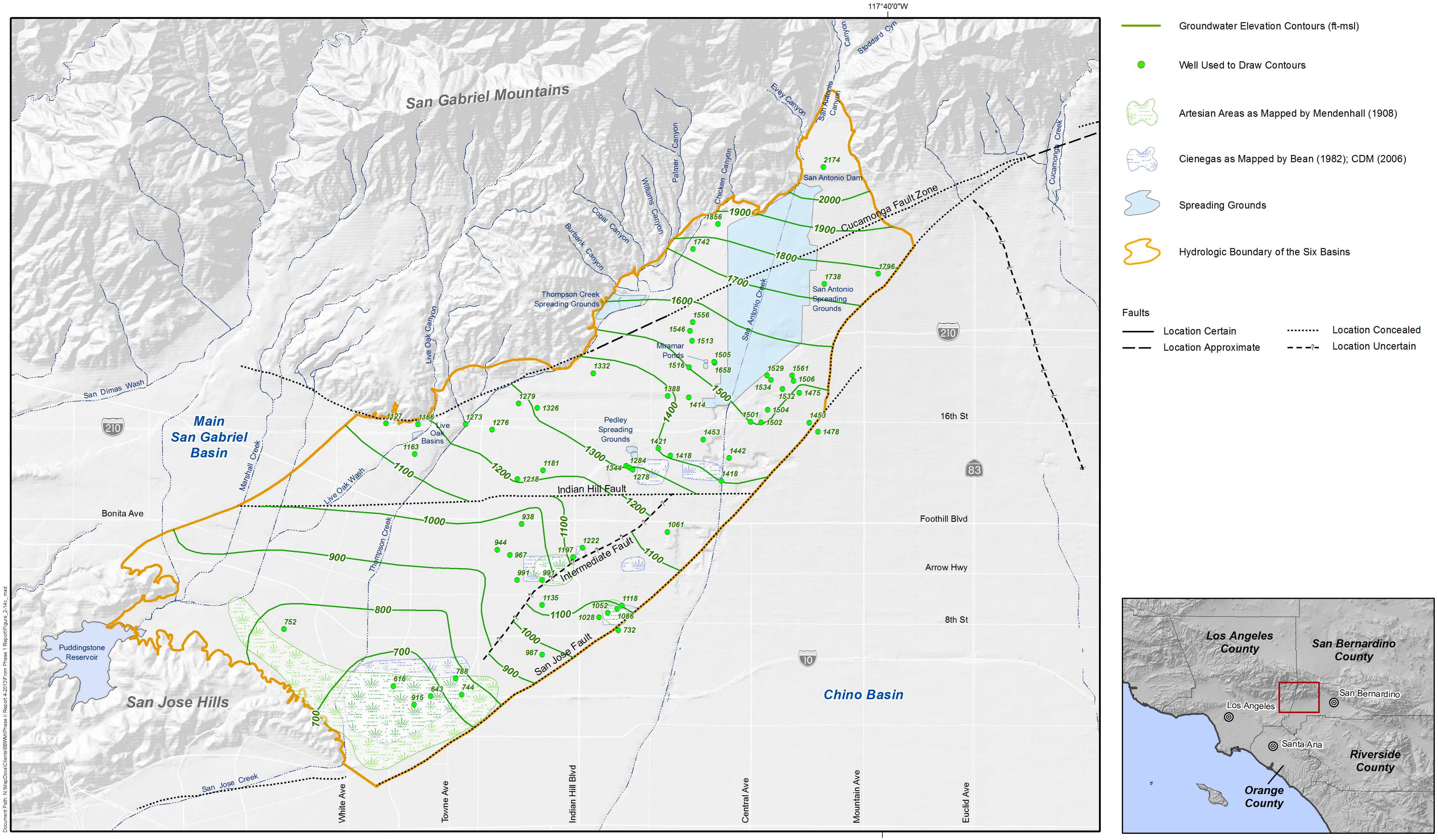

Six Basins Watermaster

Strategic Plan for the Six Basins

**Map of Groundwater Elevation**

*Fall 1999 (Start of the Adjudication)*

**Figure 2-14b**

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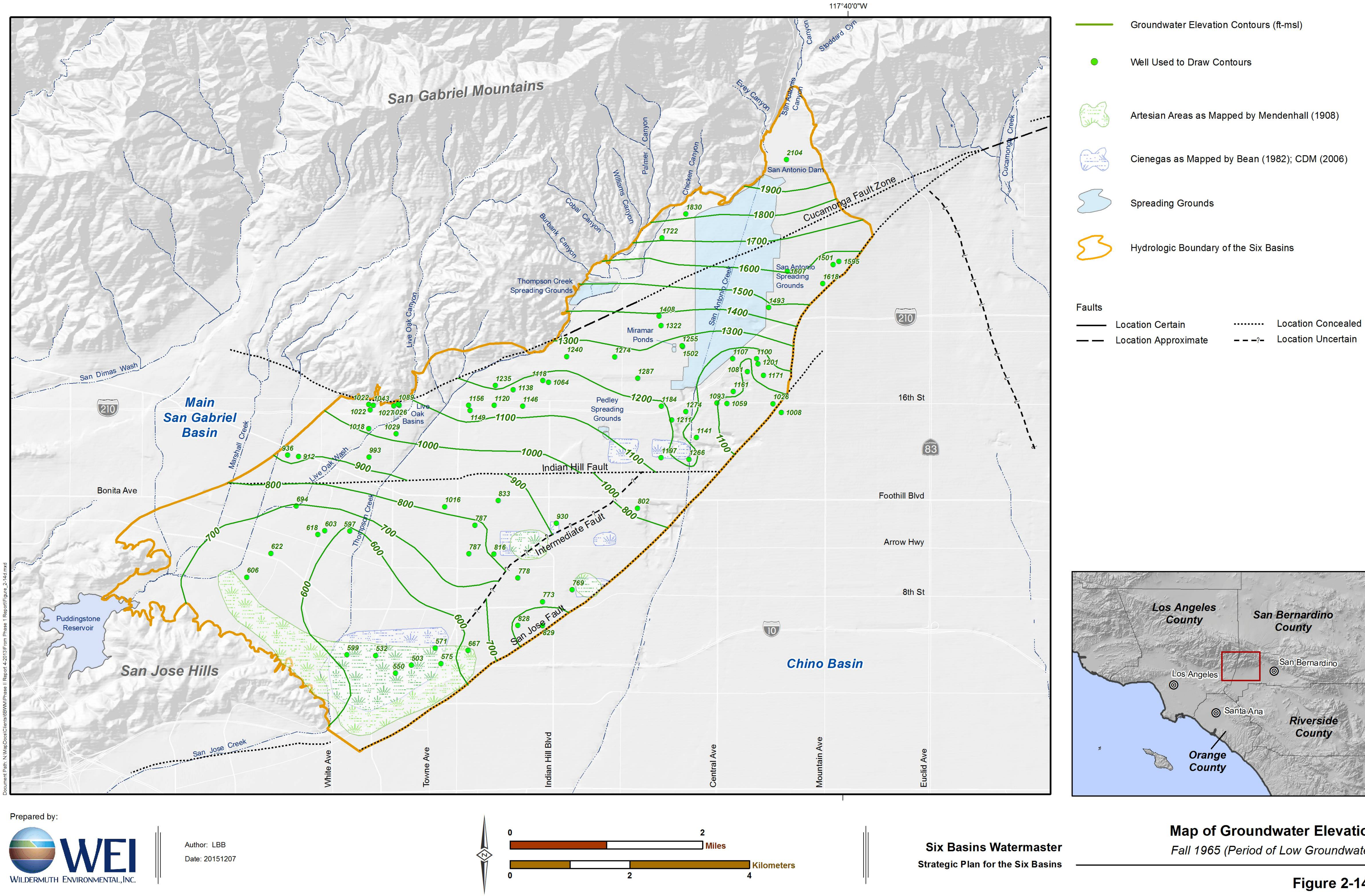
Author: LBB
Date: 20151207

0 2 Miles
0 2 4 Kilometers

Six Basins Watermaster
Strategic Plan for the Six Basins

**Map of Groundwater Elevation**
*Fall 1983 (Period of High Groundwater)*

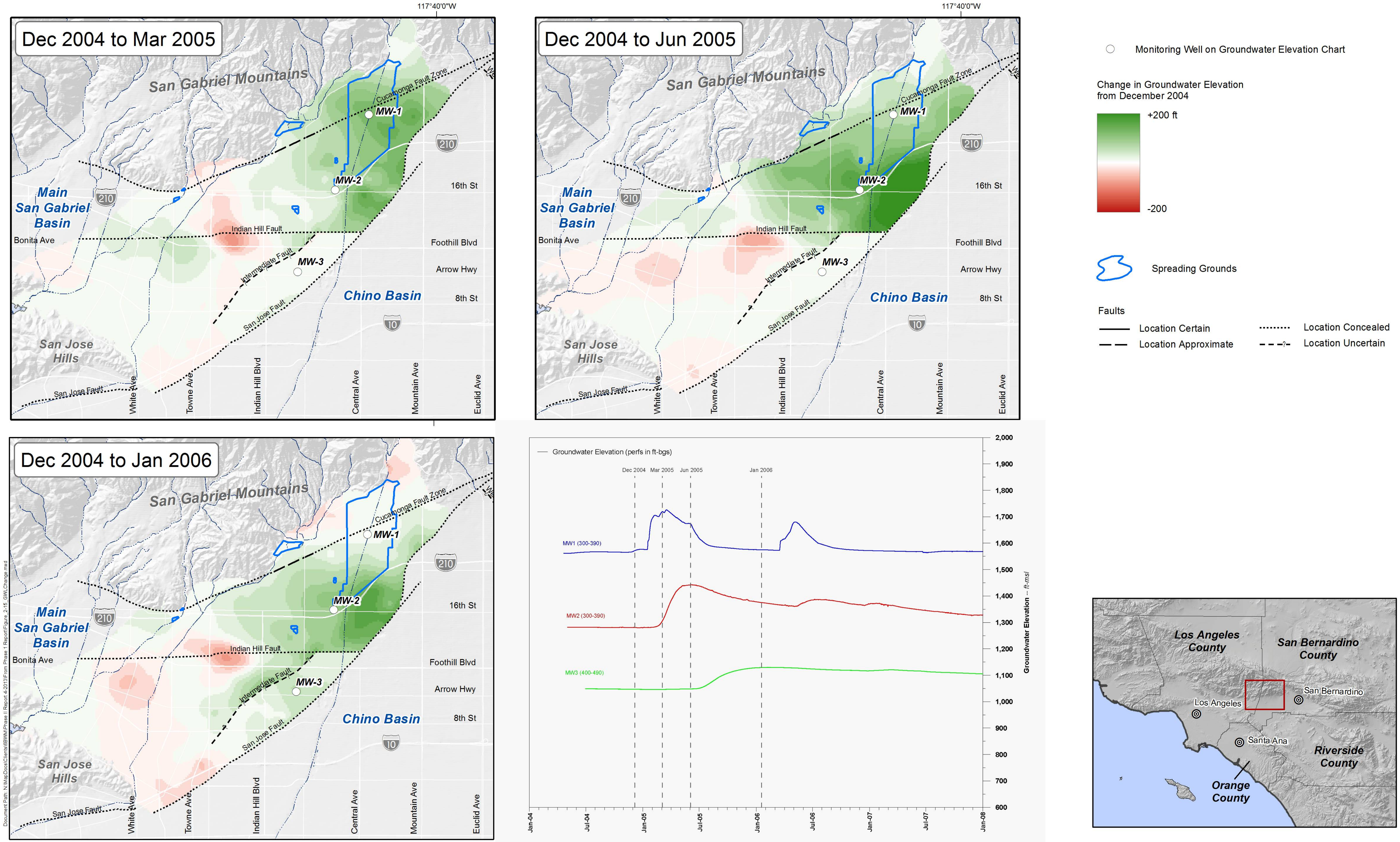
**Figure 2-14c**




**Map of Groundwater Elevation**

*Fall 1965 (Period of Low Groundwater)*

**Figure 2-14d**




Prepared by:

WILDERMUTH ENVIRONMENTAL, INC.

Author: csanchez

Date: 20151207

0 2 4 Miles

0 2 4 6 8 Km

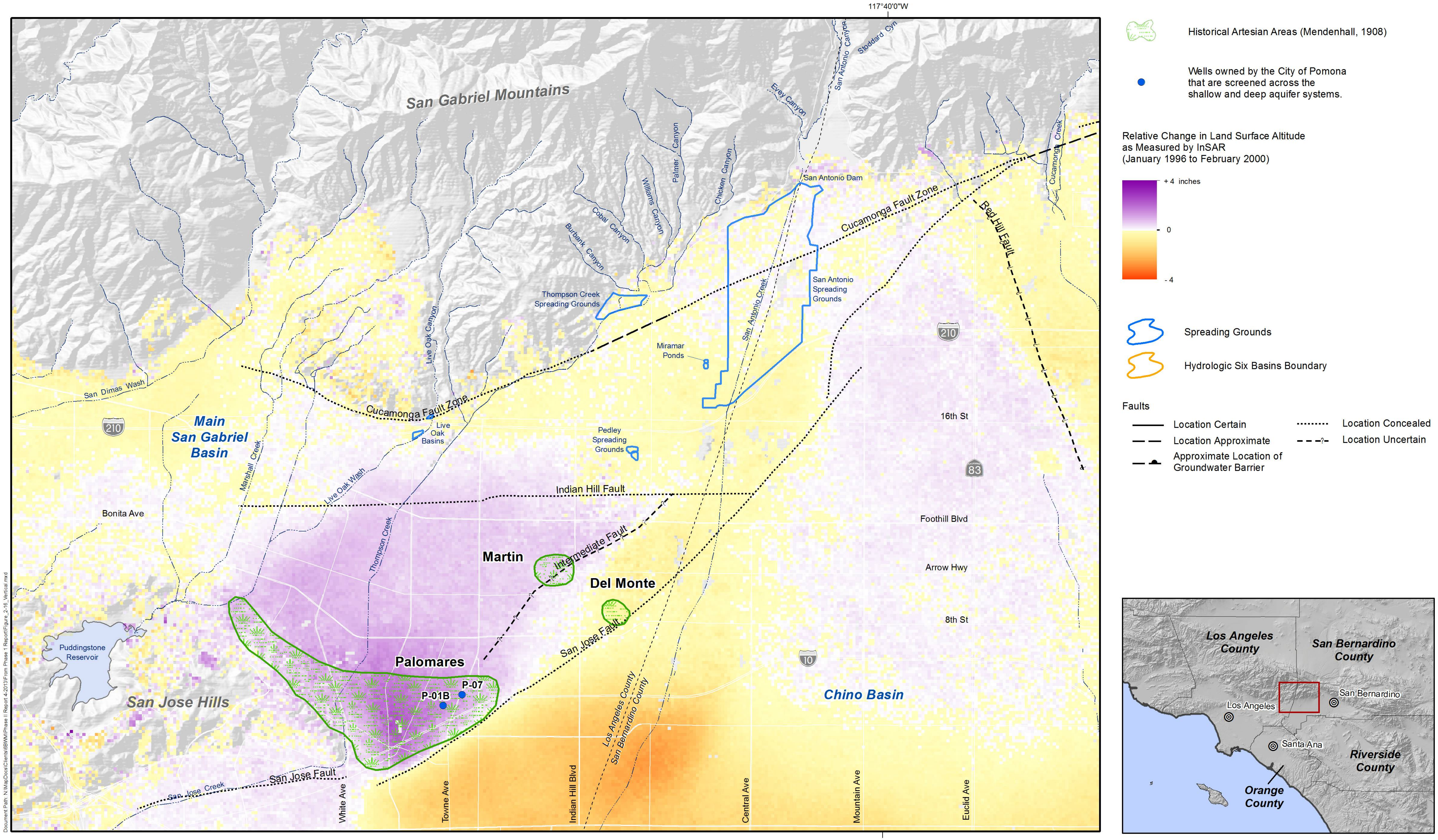
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Change in Groundwater Elevation**

*December 2004 to January 2006*

**Figure 2-15**

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Author: LBB

Date: 20151207

0 2 Miles

0 2 4 Km

Six Basins Watermaster

Strategic Plan for the Six Basins

**Map of Vertical Ground Motion Relative to Historical Artesian Areas**

**Figure 2-16**

## Figure 2-17
## Temporal and Vertical Variability of Groundwater Elevations within the Shallow and Deep Aquifer Systems
*Southern Pomona Basin*

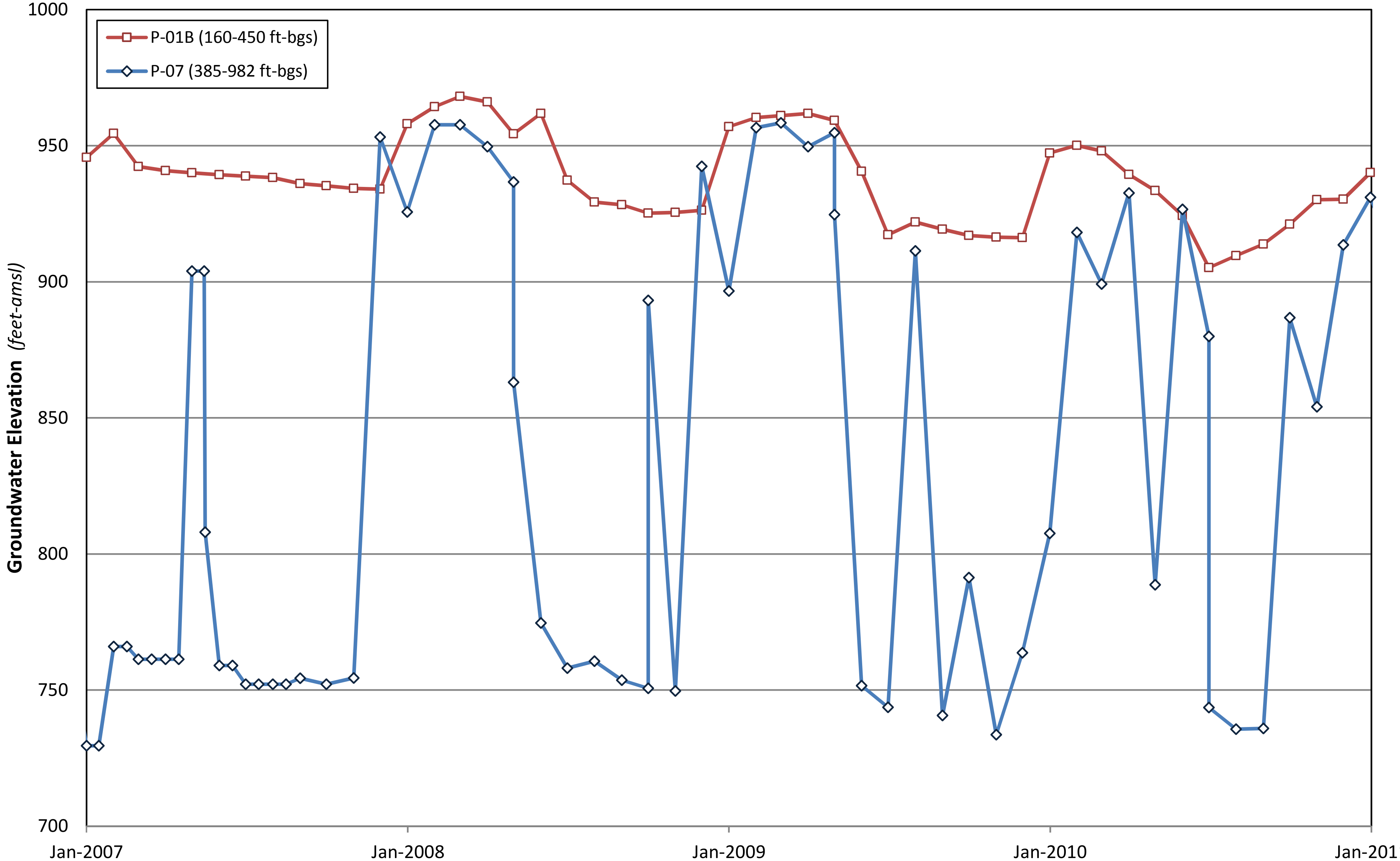


Figure 2-17_Palomares_Wells_WL.xls
12/8/2015

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## Figure 2-18
## Temporal and Vertical Variability of TDS and 1,1-DCE in the Shallow and Deep Aquifer Systems
*Southern Pomona Basin*

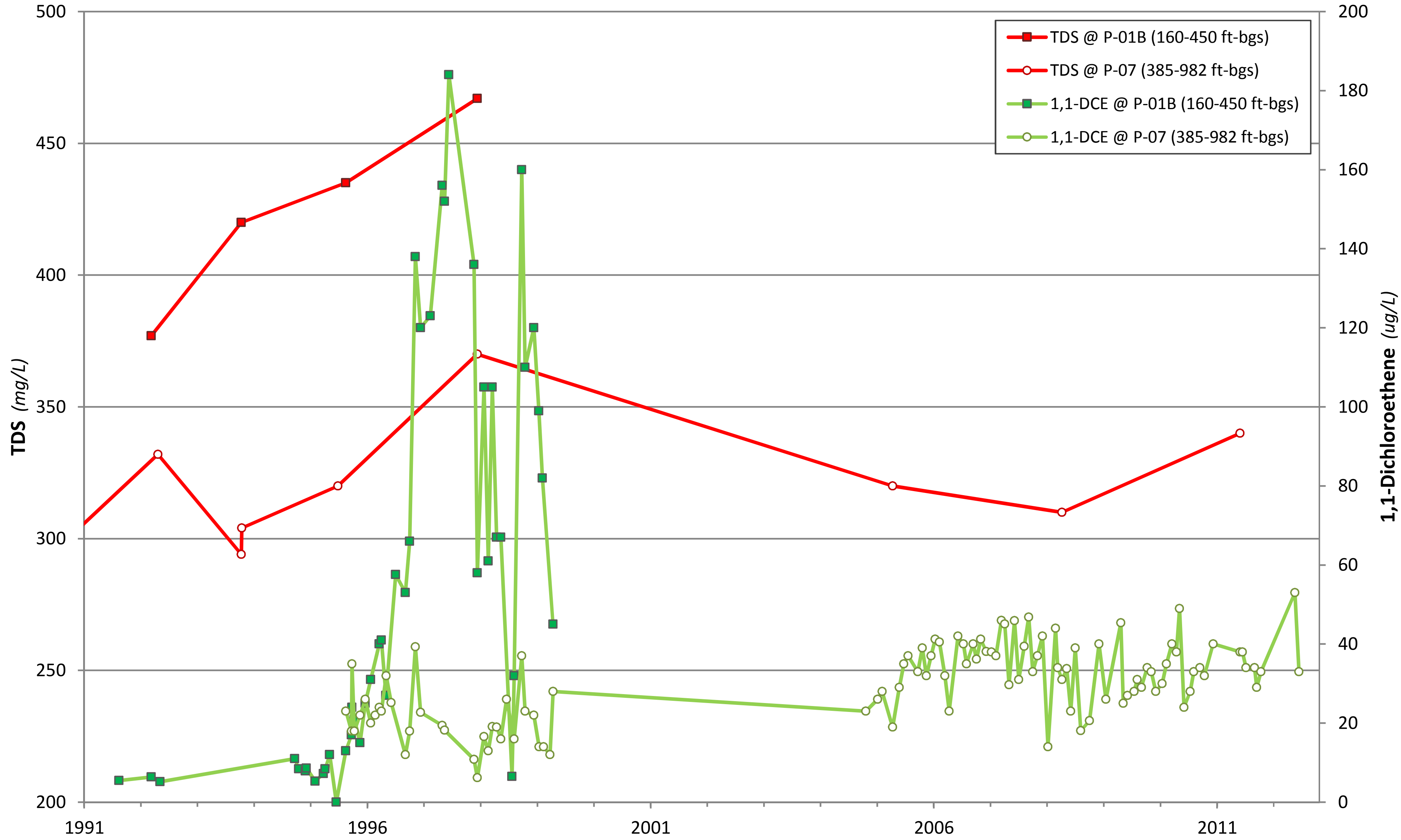


Figure 2-18_Palomares_Wells_WQ.xls
12/8/2015

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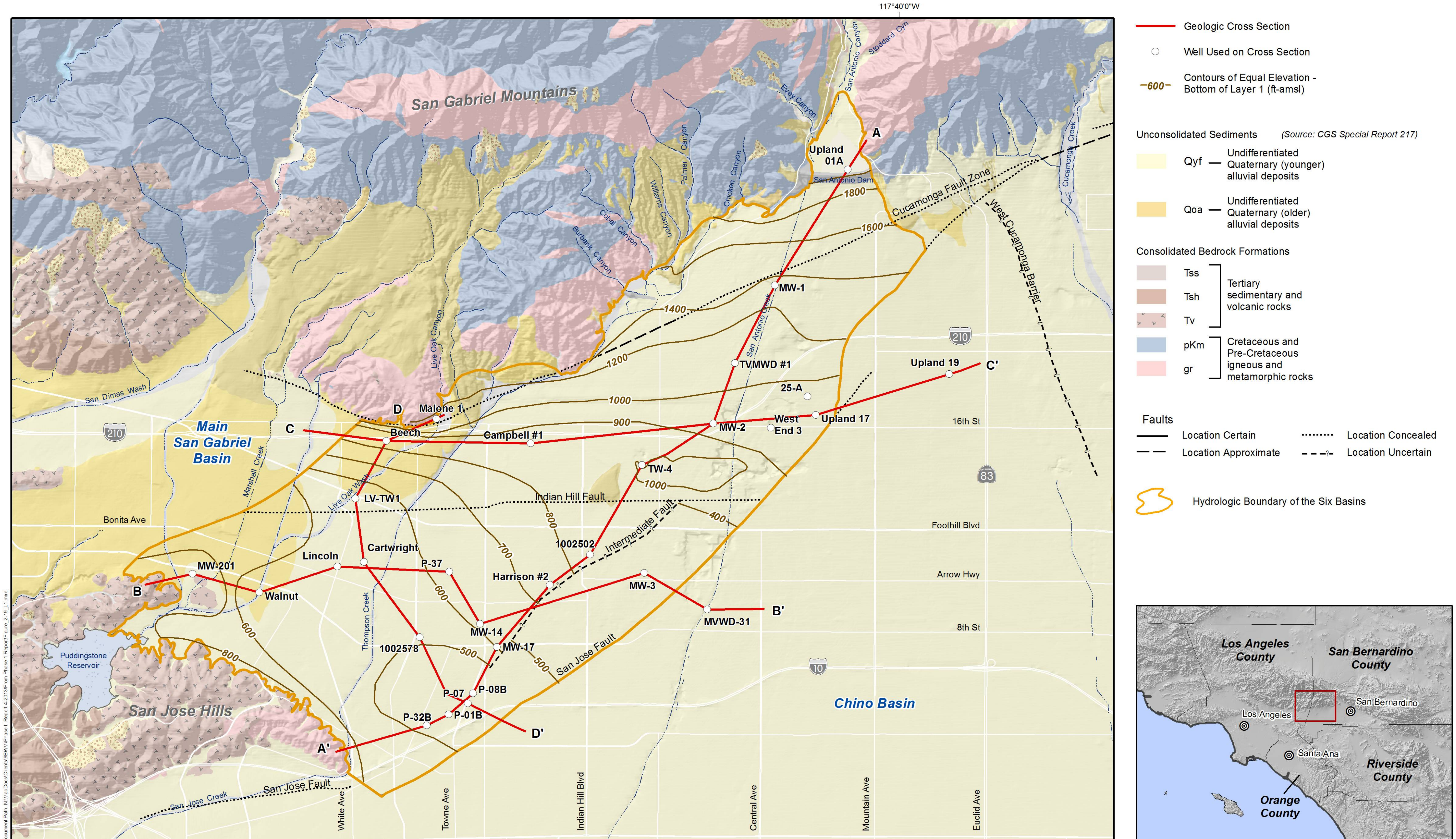


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WEI Wildermuth Environmental, Inc.

Author: LBB

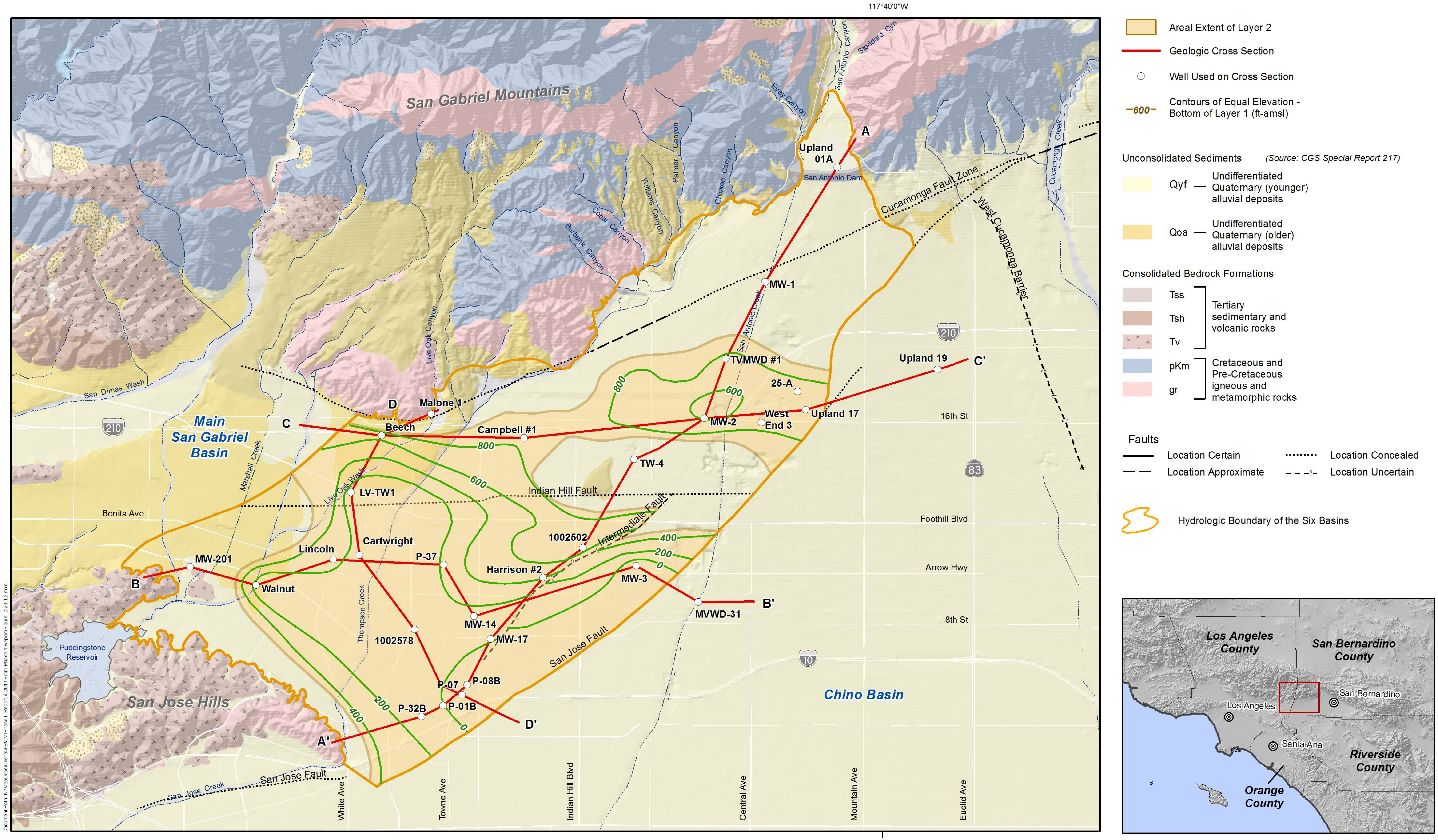
Date: 20151207

Six Basins Watermaster

Strategic Plan for the Six Basins

**Bottom of Layer 1 Equal Elevation Contour Map**

**Figure 2-19**




Prepared by:

WEI
Wildermuth Environmental, Inc.

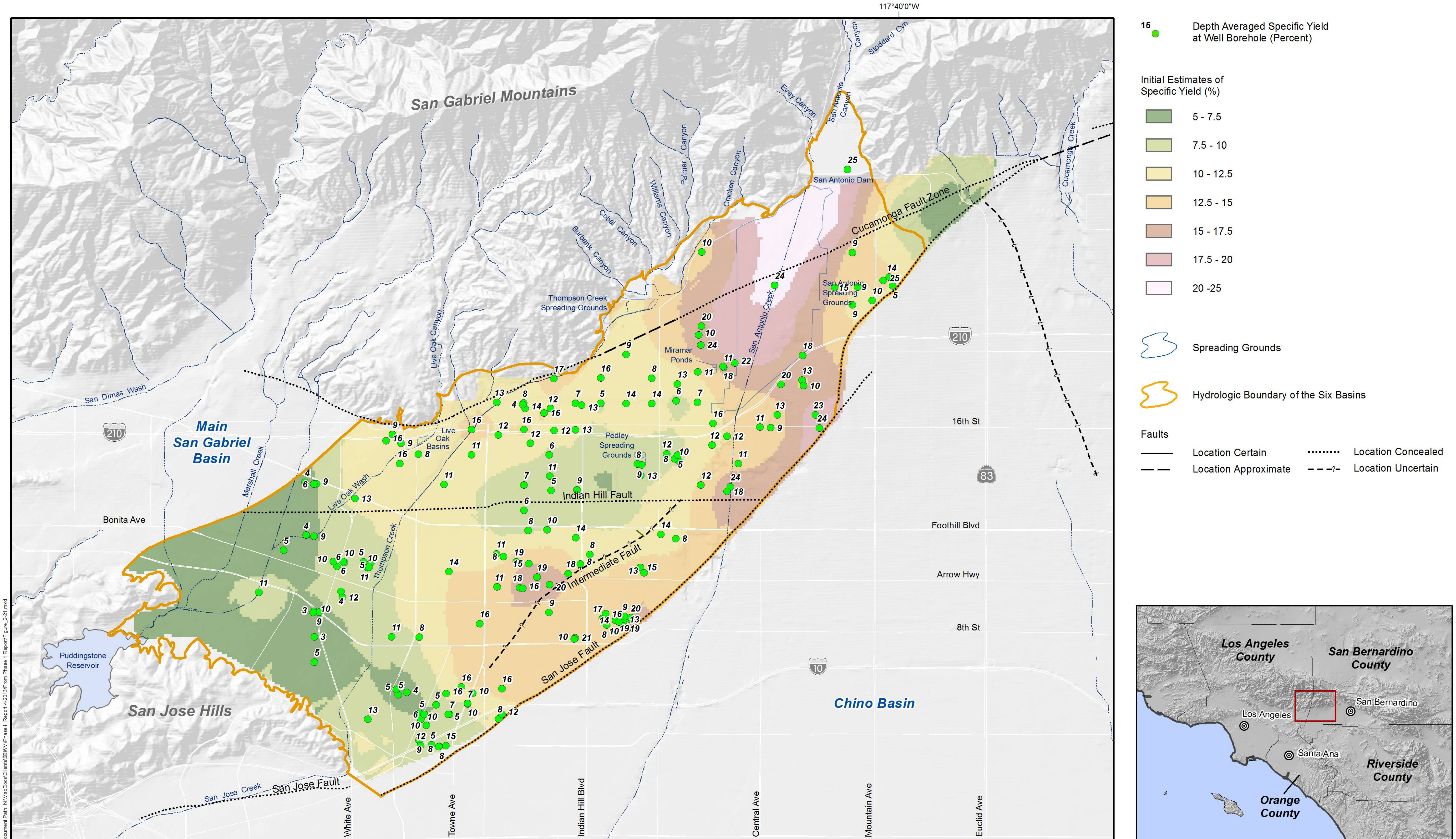
Author: LBB
Date: 20151207

0 1 2 Miles
0 2 4 Kilometers

Six Basins Watermaster
Strategic Plan for the Six Basins

**Bottom of Layer 2**
**Equal Elevation Contour Map**

**Figure 2-20**

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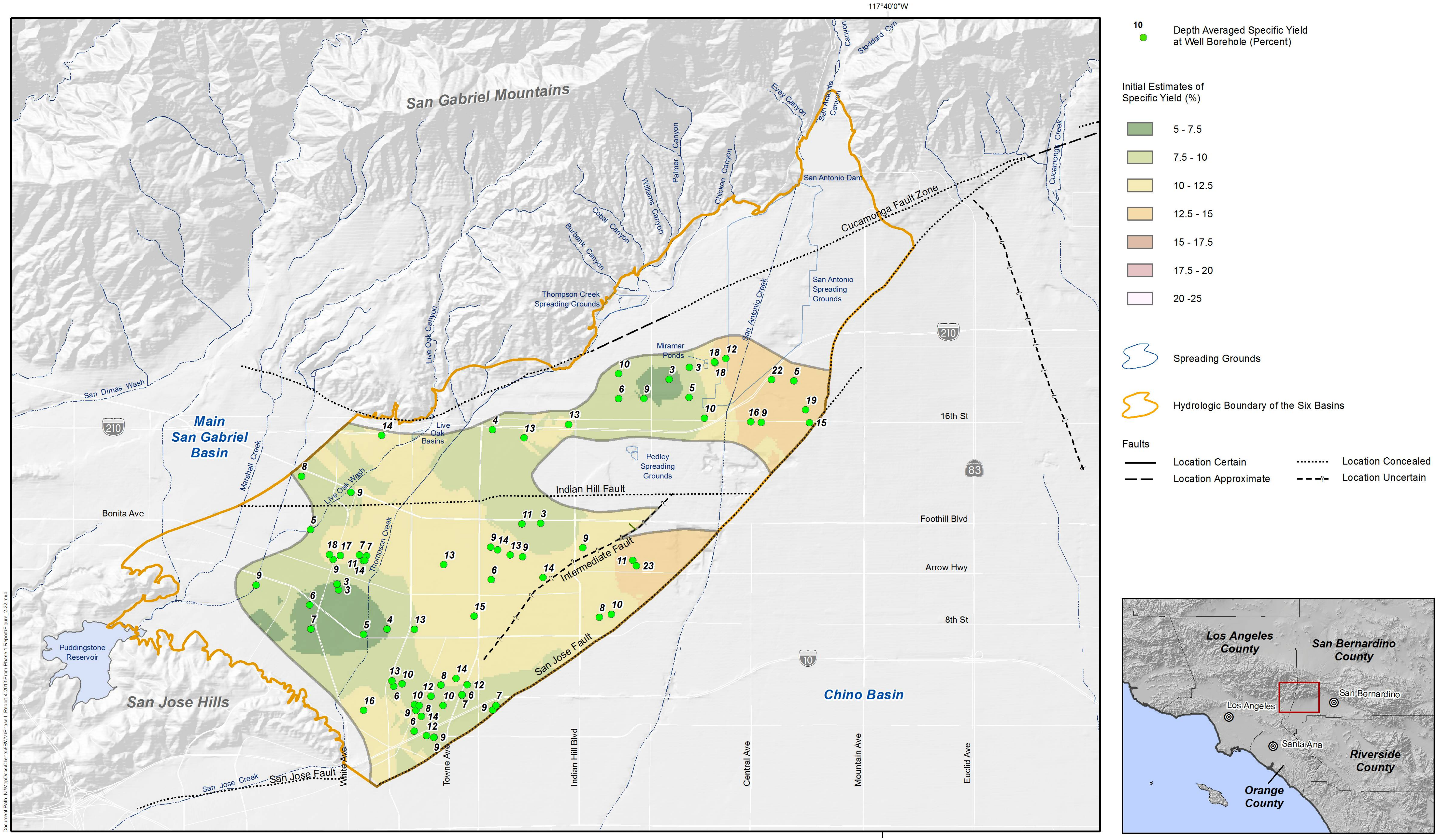
Date: 20151207

0 2 Miles
0 2 4 Kilometers

**Six Basins Watermaster**
**Strategic Plan for the Six Basins**

**Initial Estimates of Specific Yield**
*Layer 1*

**Figure 2-21**




Prepared by:

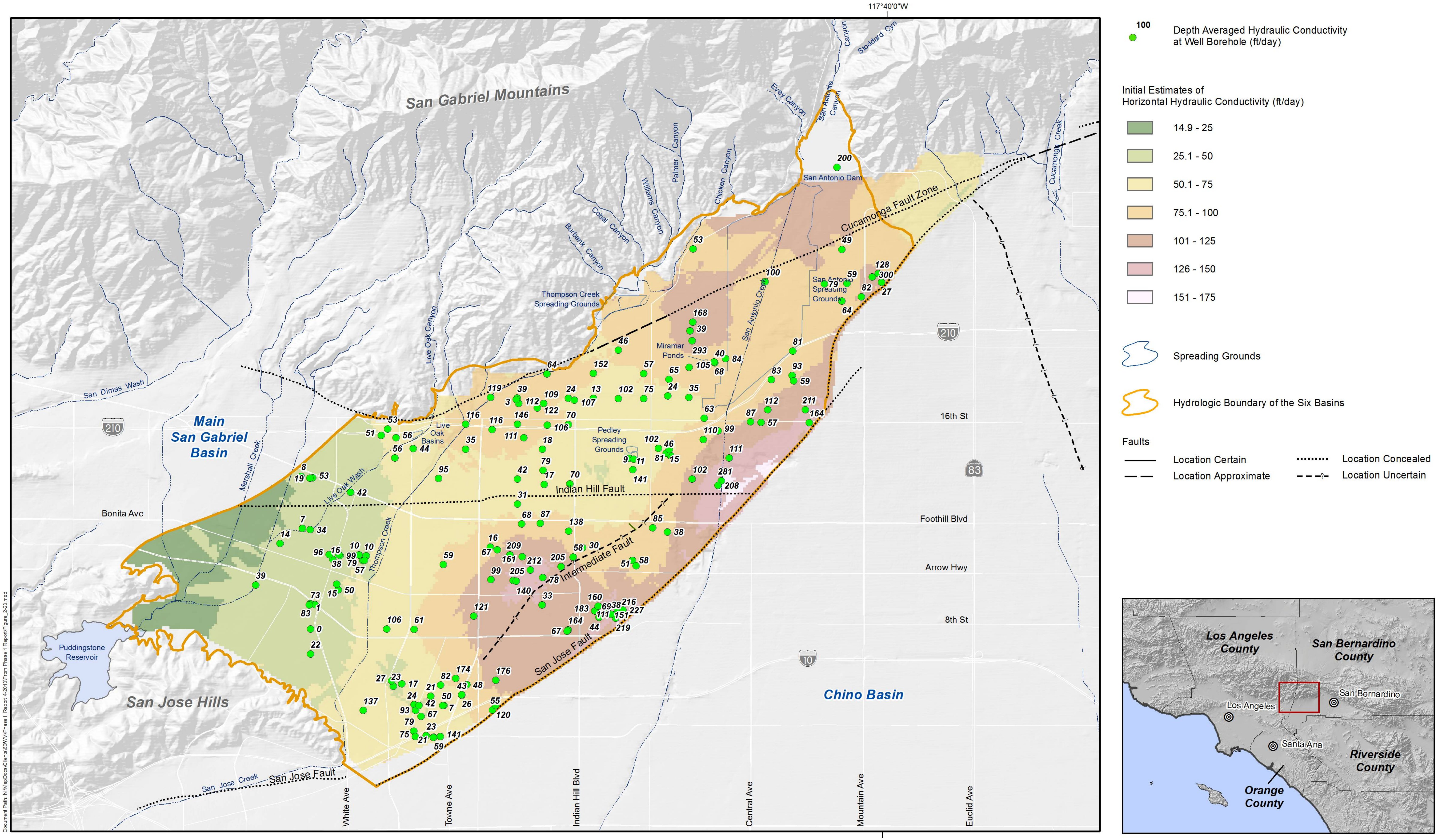
WILDERMUTH ENVIRONMENTAL, INC.

Author: LBB
Date: 20151207

**Six Basins Watermaster**
**Strategic Plan for the Six Basins**

**Initial Estimates of Specific Yield**
*Layer 2*

**Figure 2-22**




Prepared by:

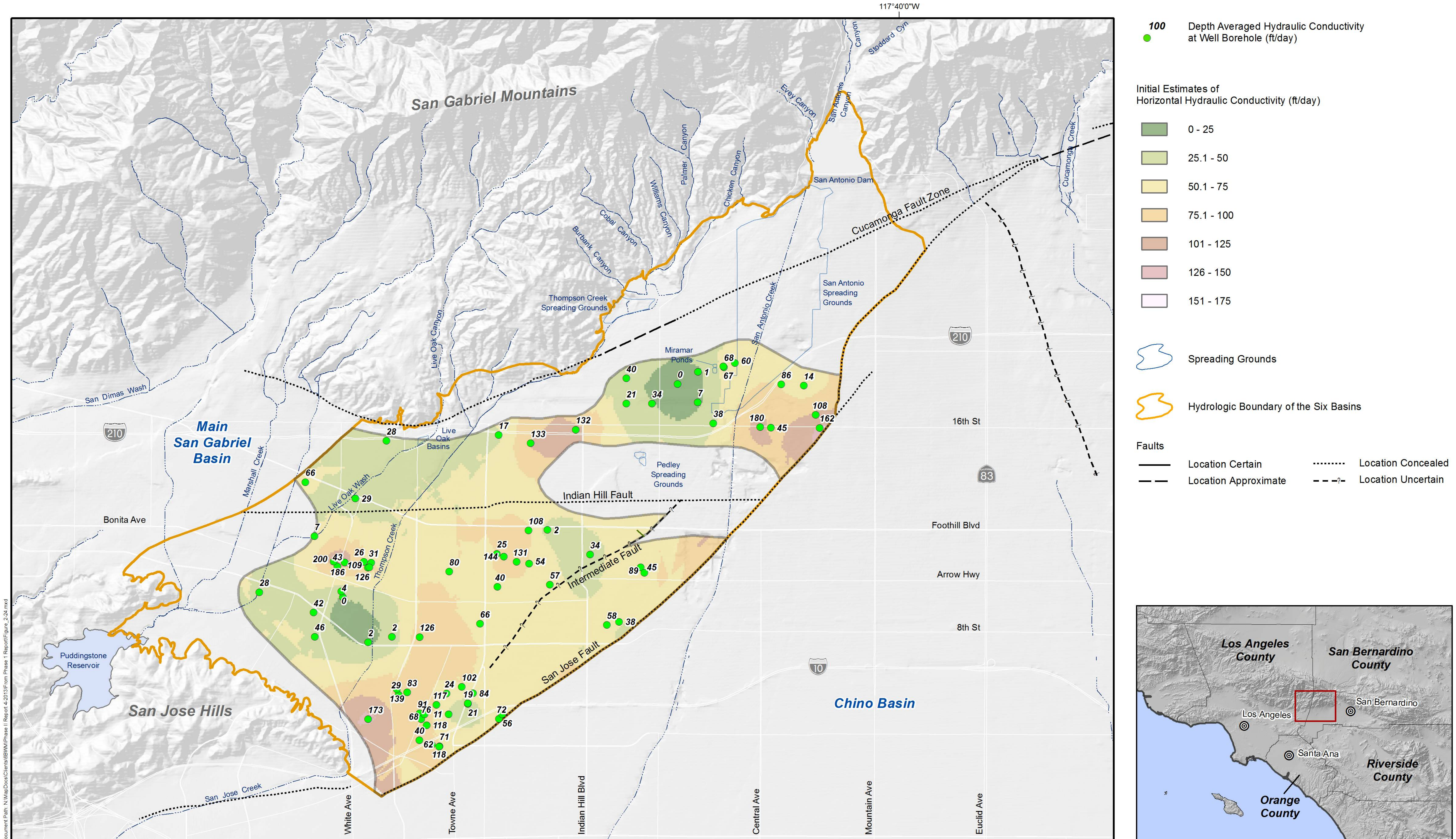
WEI
Wildermuth Environmental, Inc.

Author: LBB
Date: 20151207

**Six Basins Watermaster**
**Strategic Plan for the Six Basins**

**Initial Estimates of Horizontal Hydraulic Conductivity**
*Layer 1*

**Figure 2-23**




Prepared by:

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Wildermuth Environmental, Inc.

Author: LBB
Date: 20151207

0 2 Miles
0 2 4 Kilometers

**Six Basins Watermaster**
**Strategic Plan for the Six Basins**

## Initial Estimates of Horizontal Hydraulic Conductivity
*Layer 2*

**Figure 2-24**

## Figure 2-25
## Annual Groundwater Production in the Six Basins *(1978 - 2011)*

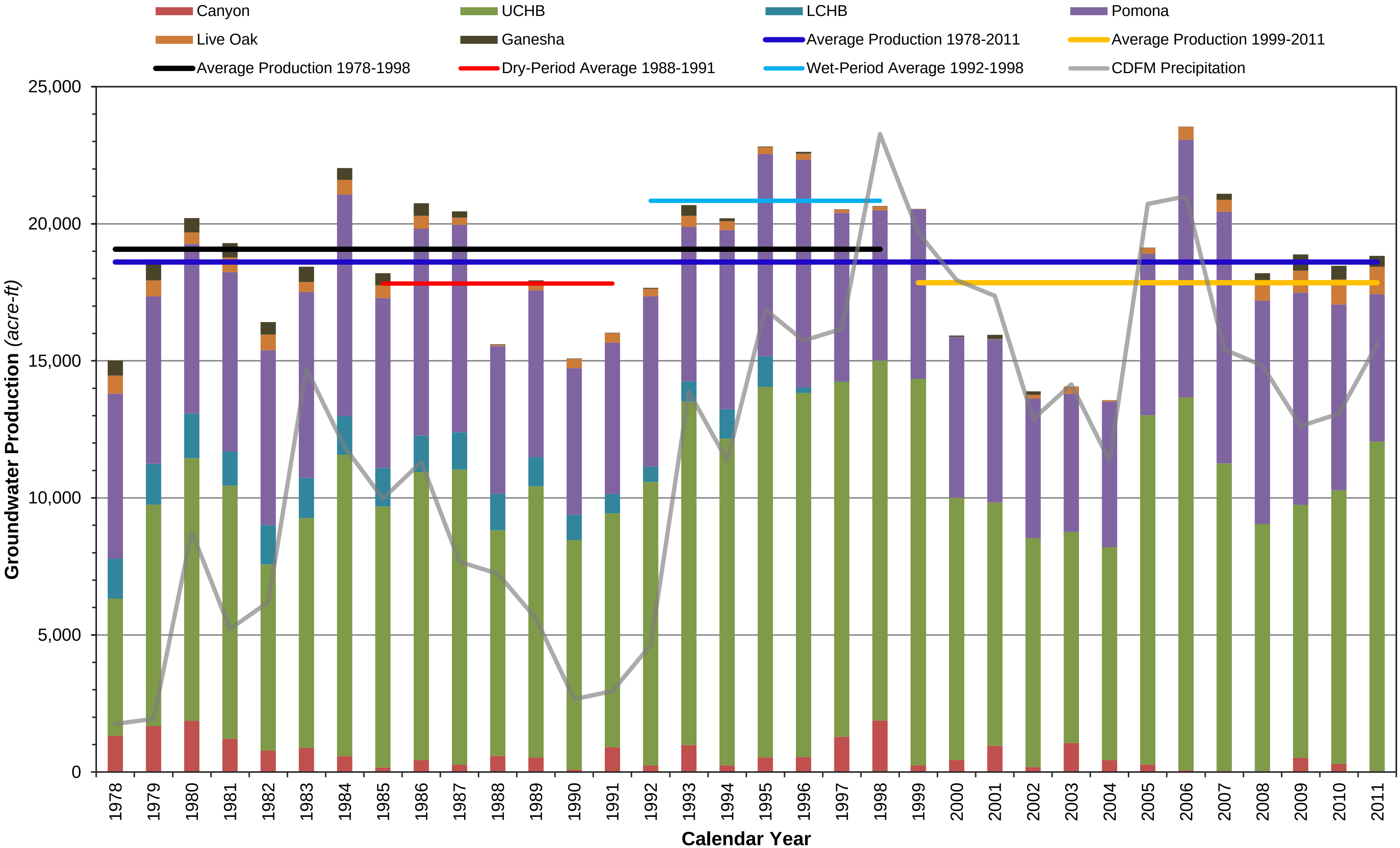


Figure 2-25.xlsx -- Figure 2-21
12/8/2015

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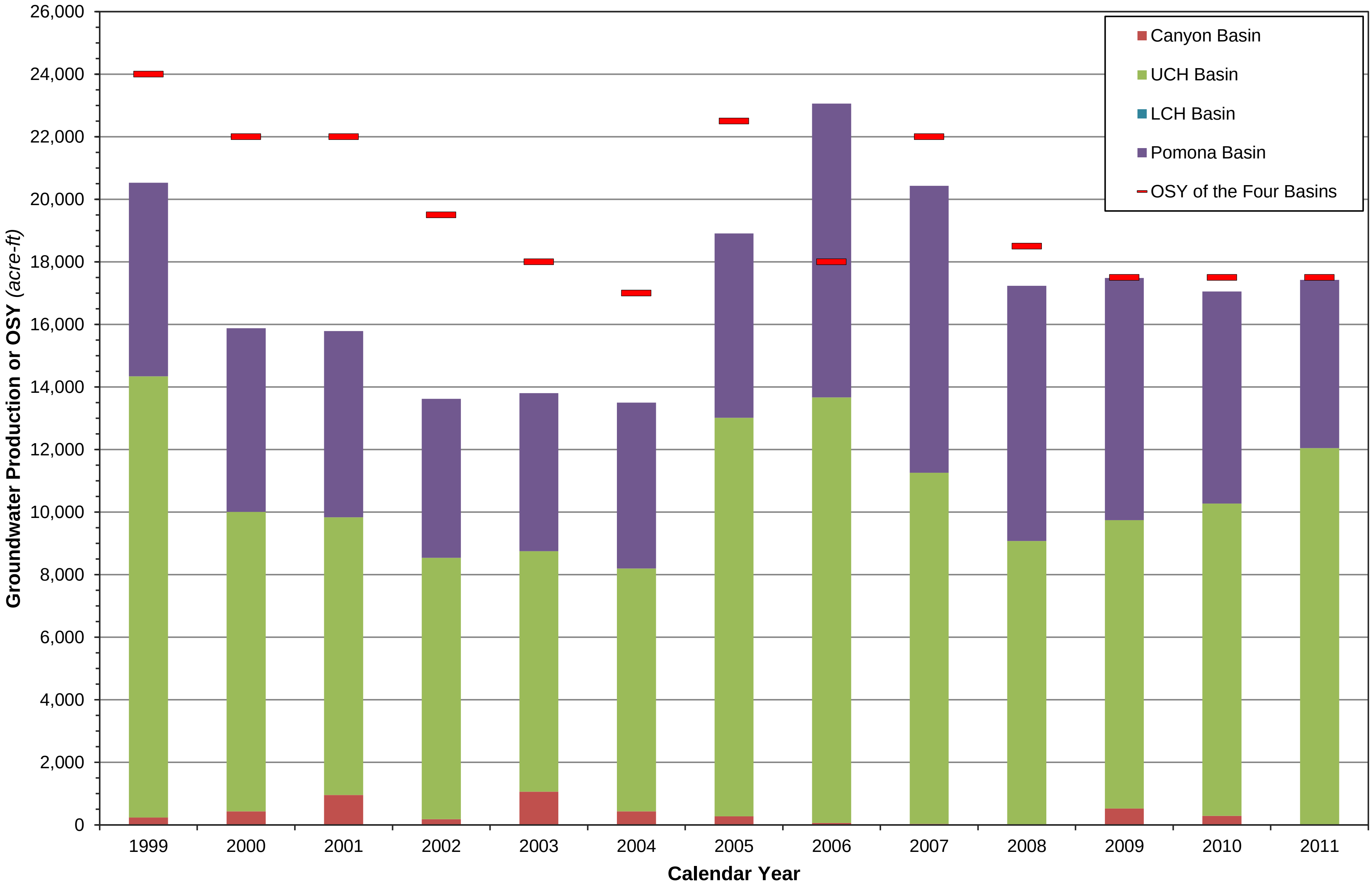
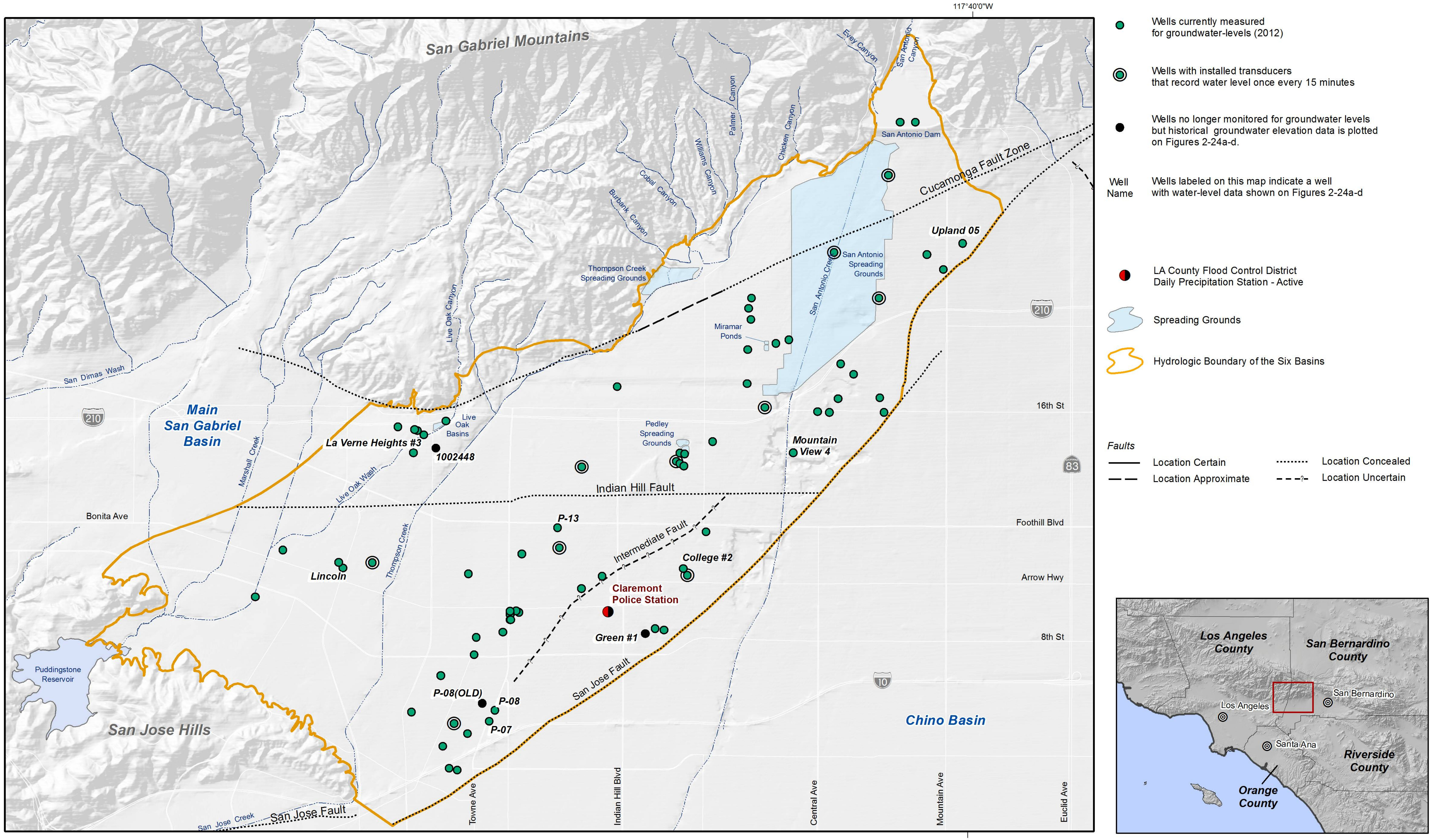
**Figure 2-26**
**Groundwater Production in the Four Basins vs. the Operating Safe Yield**
*1999-2011*



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Updated By: csanchez

Date: 20151209

0 2 Miles

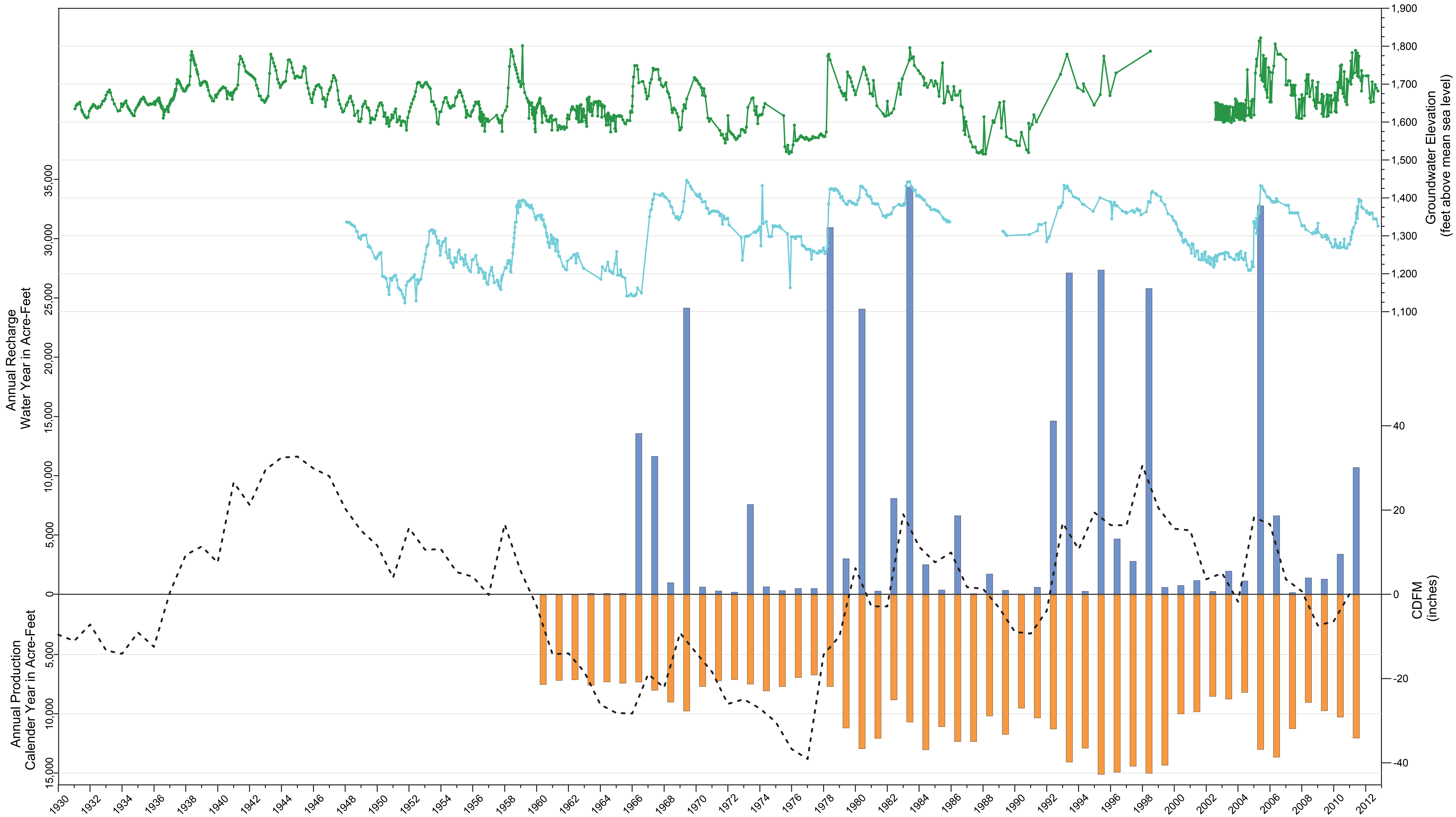
0 2 4 Km

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Groundwater-Level Monitoring in the Six Basins - 2012**

**Figure 2-27**





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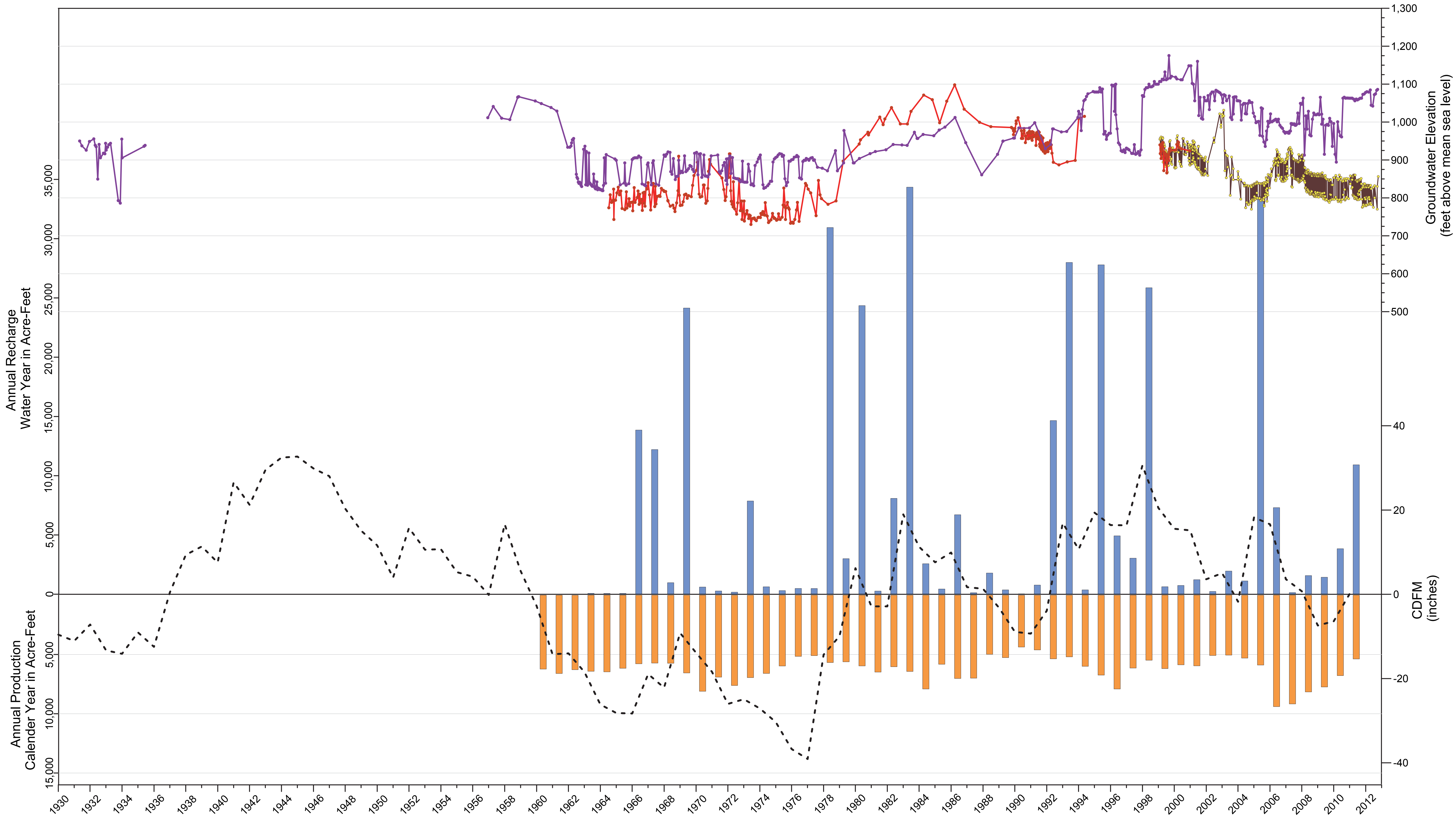
Author: VMW
Date: 12/09/2015
File: Figure2-24a_cyn_UC.grf

**Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate**

*Canyon, Upper Claremont, and Lower Claremont Basins*

**Six Basins Watermaster**
State of the Basin Report

**Figure 2-28a**

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949.420.3030
www.wildermuthenvironmental.com
Author: VMW
Date: 12/09/2015
File: Figure2-24b_UpperPomona.grf


Groundwater Levels at Wells (Perforated Interval Depth)

- P-13 (146-435 ft-bgs)
- Green #1 (260-845 ft-bgs)
- College #2 (330-800 ft-bgs)

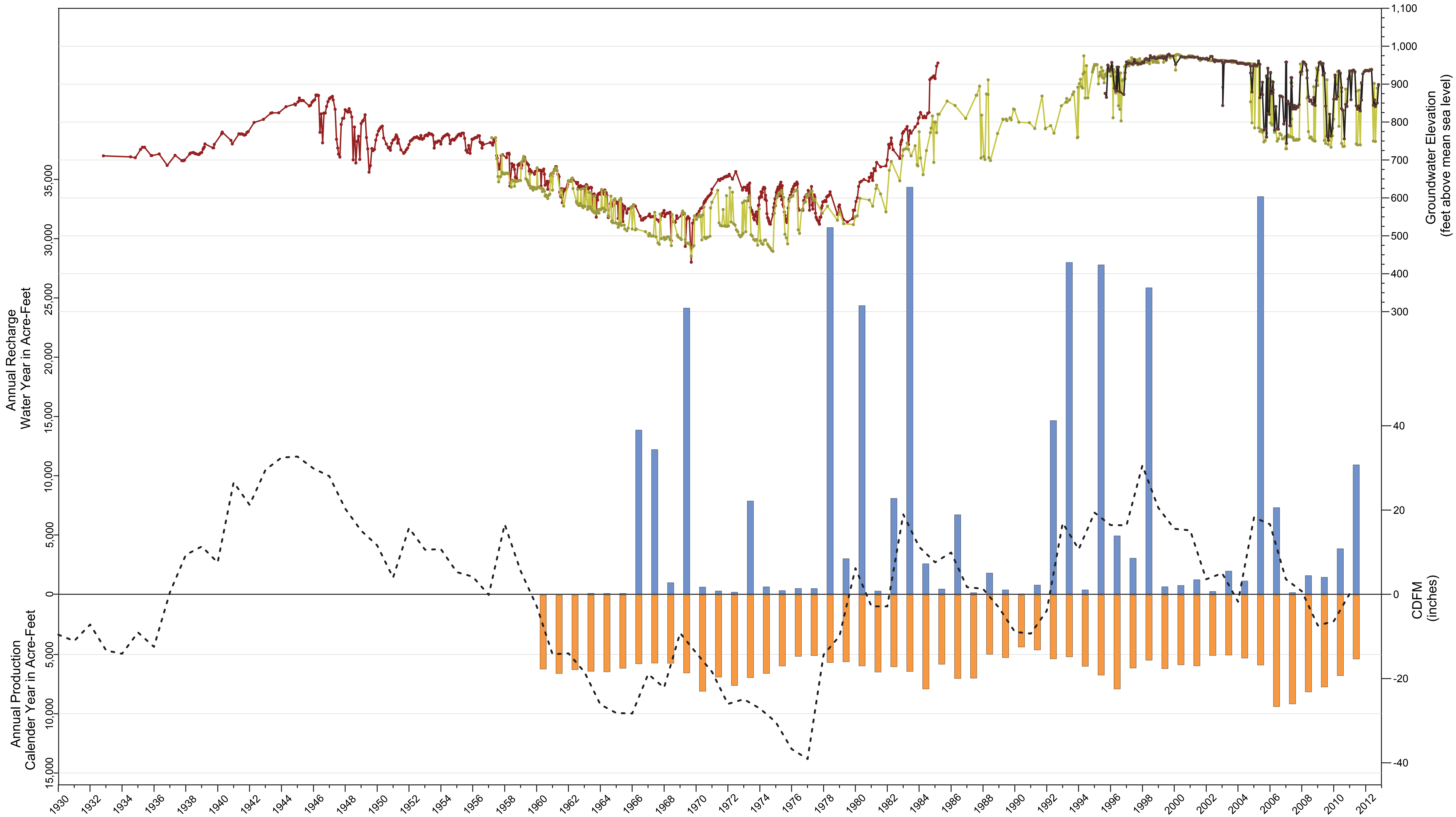
- Artificial Recharge of Native and Imported Water at the San Antonio, Thompson Creek, Live Oak, and Pomona Spreading Grounds
- Groundwater Production from Wells in the Pomona Basin
- Cumulative Departure from Mean Precipitation (Claremont Police Station Gage)

**Six Basins Watermaster**
State of the Basin Report

**Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate**

*Northern Pomona Basin*

**Figure 2-28b**





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Author: VMW

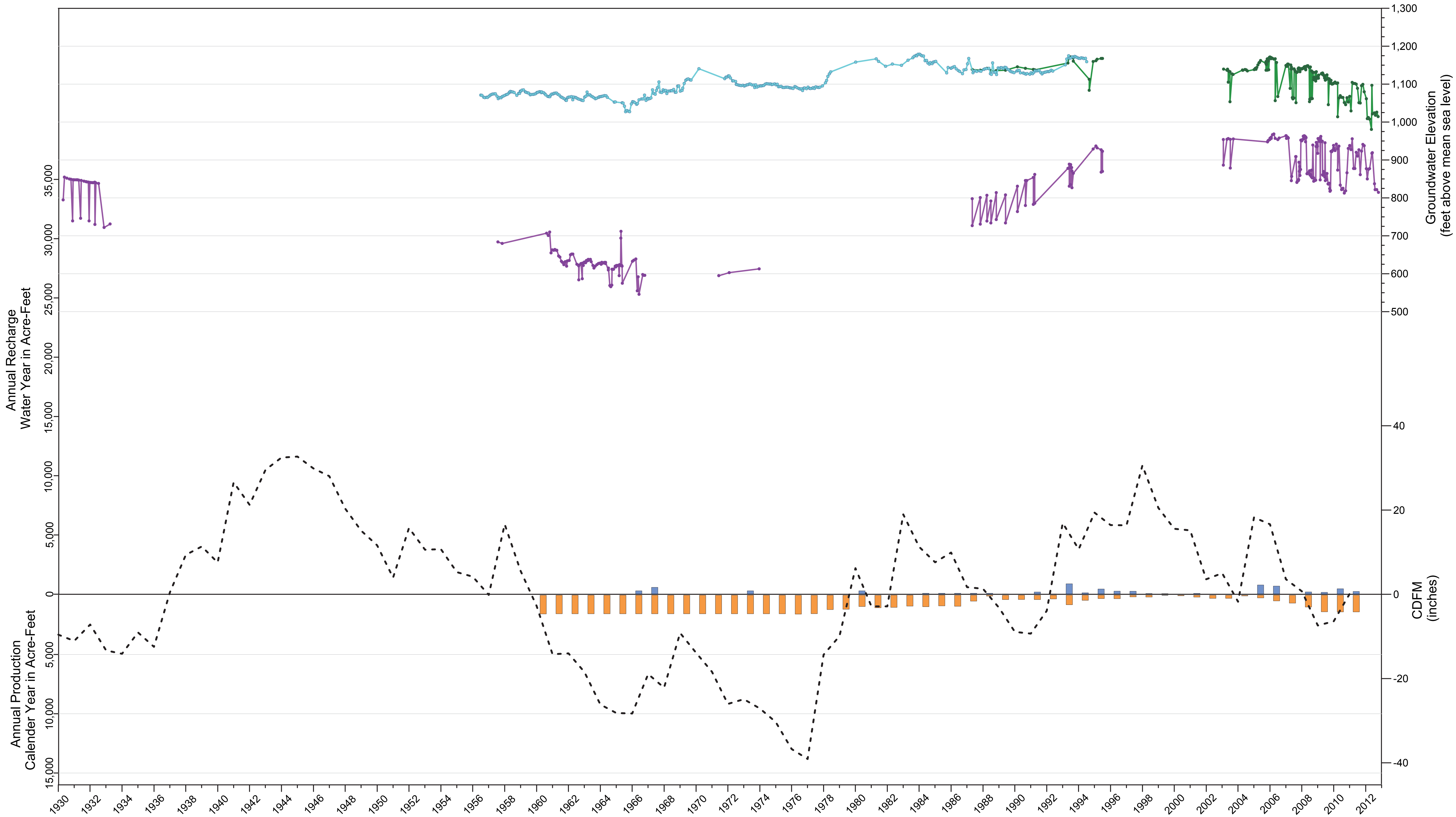
Date: 12/09/2015
File: Figure2-24c_SouthPomona.grf

**Six Basins Watermaster**
State of the Basin Report

**Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate**

*Southern Pomona Basin*

**Figure 2-28c**





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949.420.3030
www.wildermuthenvironmental.com
Author: VMW
Date: 12/09/2015
File: Figure2-24d_2Basins.grf


Groundwater Levels at Wells (Perforated Interval Depth)

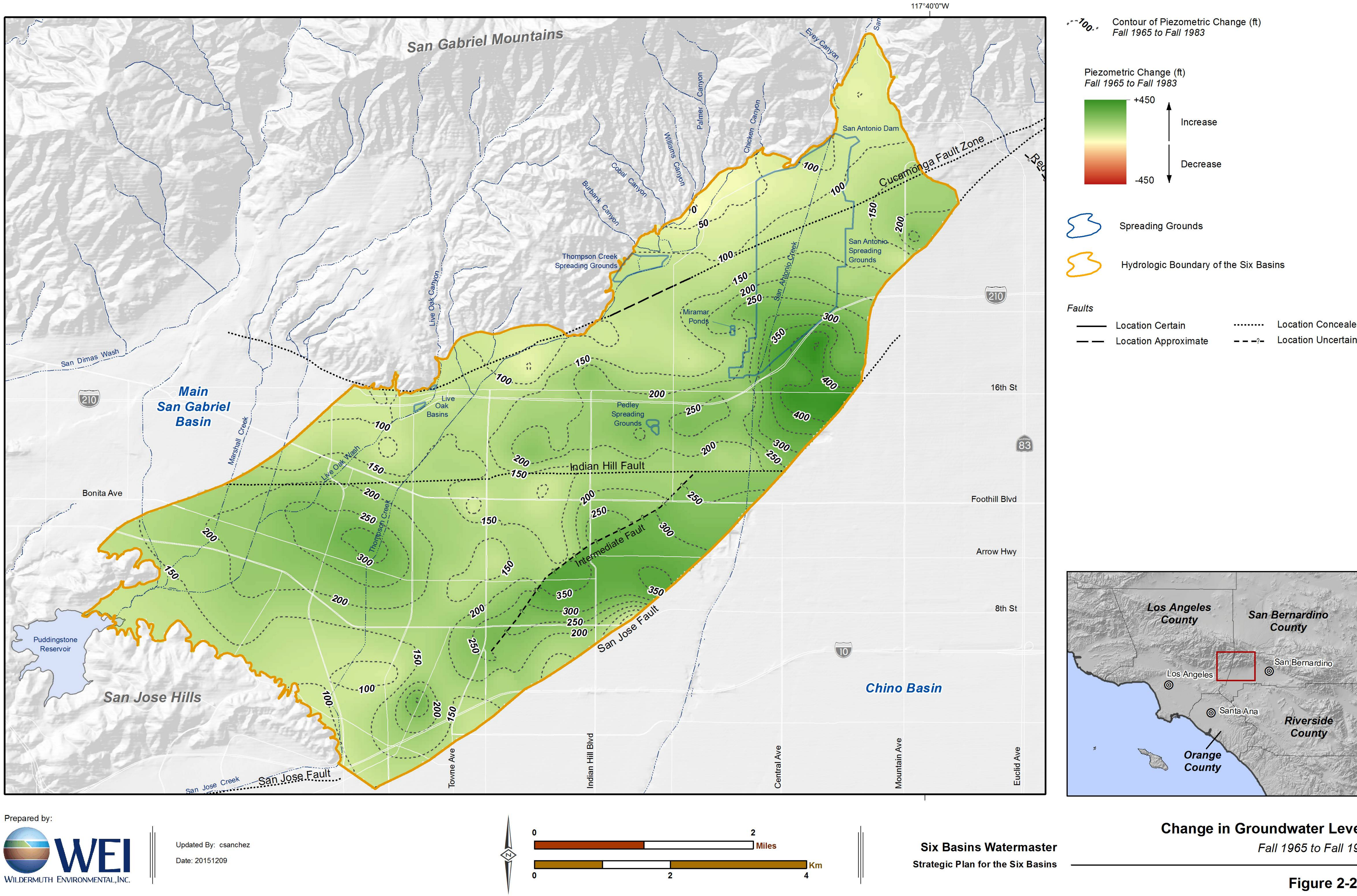
- 1002448 (no data)
- La Verne Heights #3 (no data)
- Lincoln (395-713 ft-bgs)

- Artificial Recharge of Native and Imported Water at the Live Oak Spreading Grounds
- Groundwater Production from Wells in the Live Oak and Ganesha Basins
- Cumulative Departure from Mean Precipitation (Claremont Police Station Gage)

**Six Basins Watermaster**
State of the Basin Report

**Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate**
*Two Basins*

**Figure 2-28d**




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: csanchez

Date: 20151209

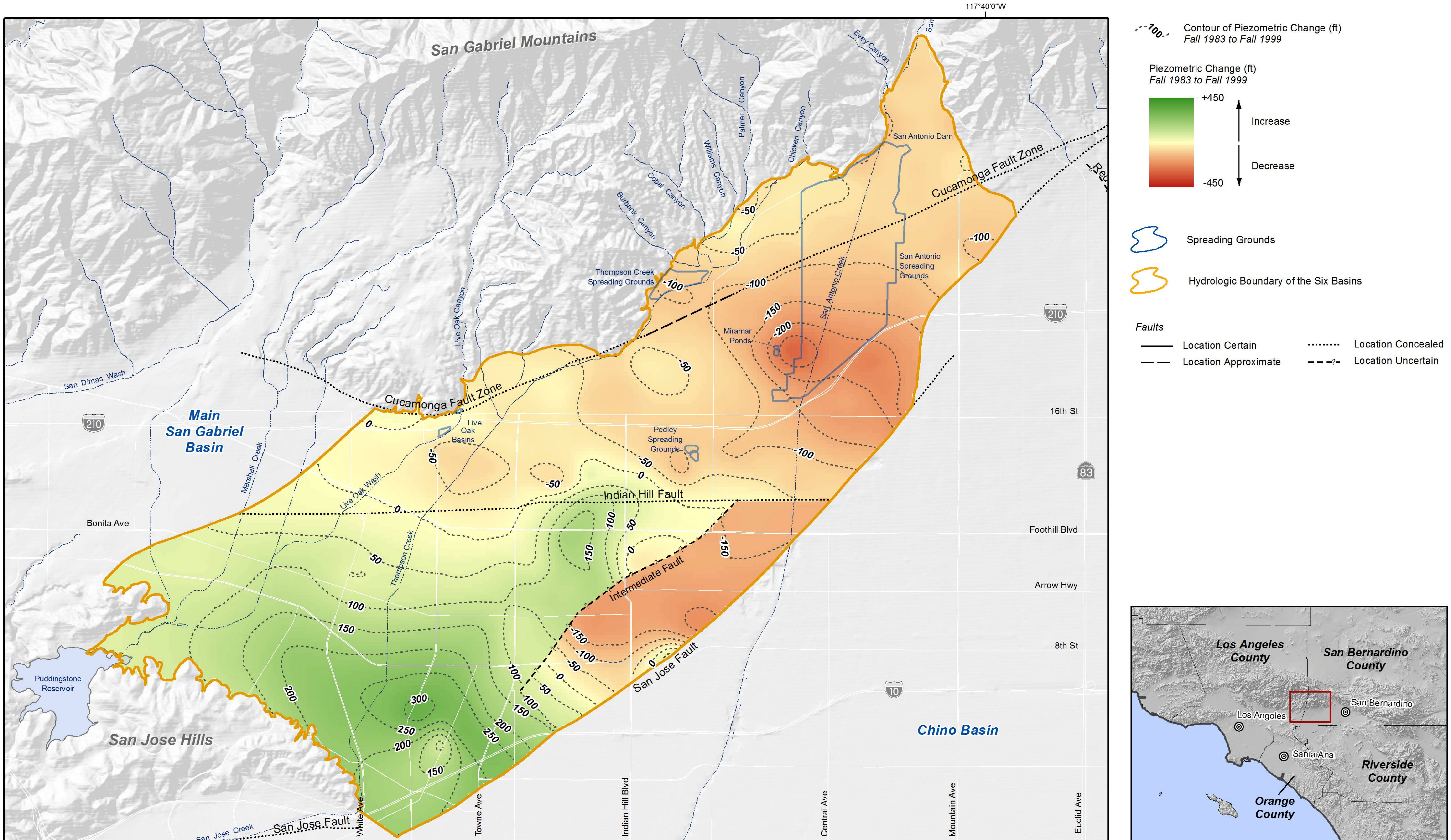
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Change in Groundwater Levels**

*Fall 1965 to Fall 1983*

**Figure 2-29a**




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: csanchez

Date: 20151209

0 2 Miles

0 2 4 Km

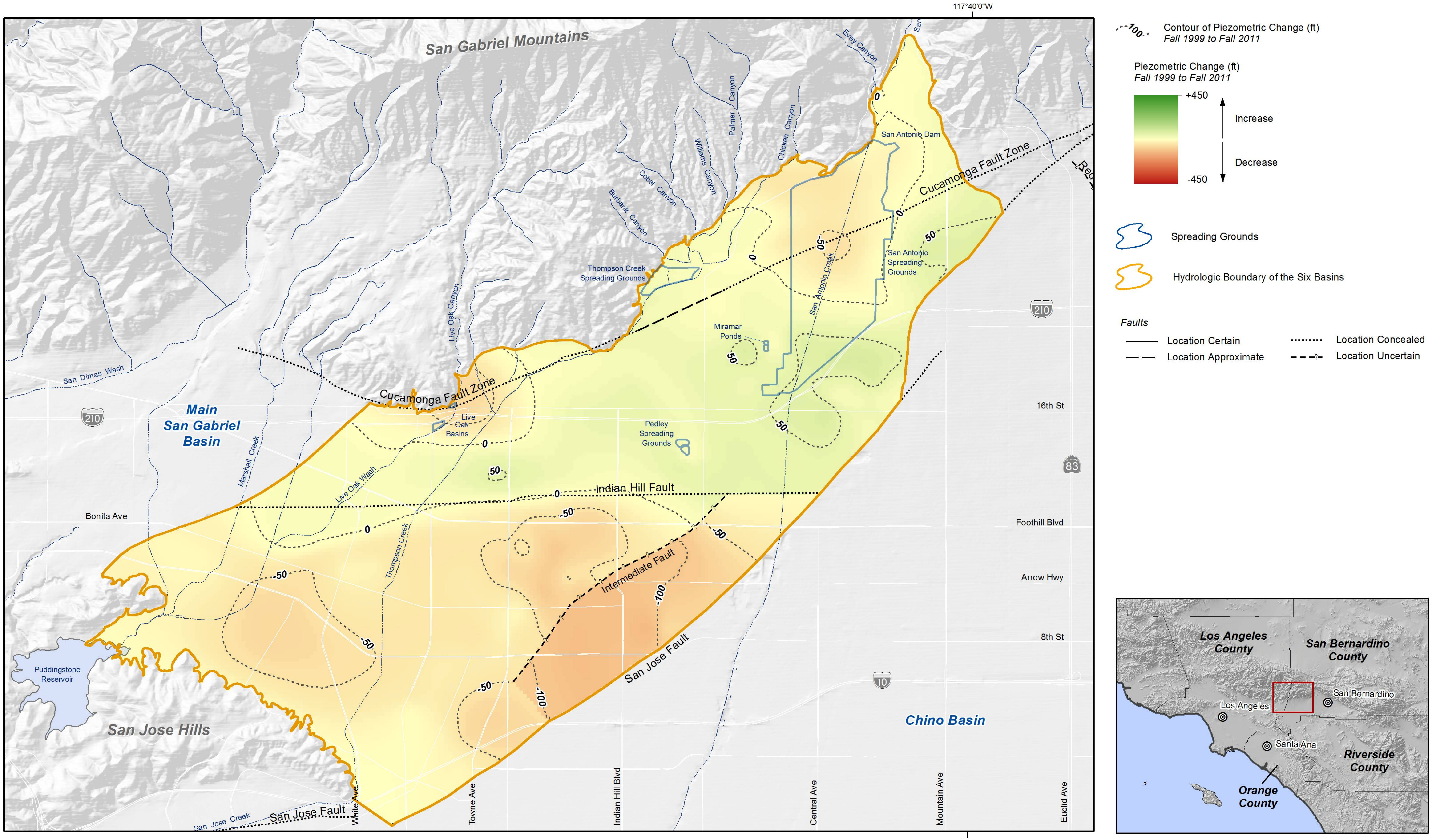
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

## Change in Groundwater Levels

*Fall 1983 to Fall 1999*

**Figure 2-29b**




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: csanchez

Date: 20151209

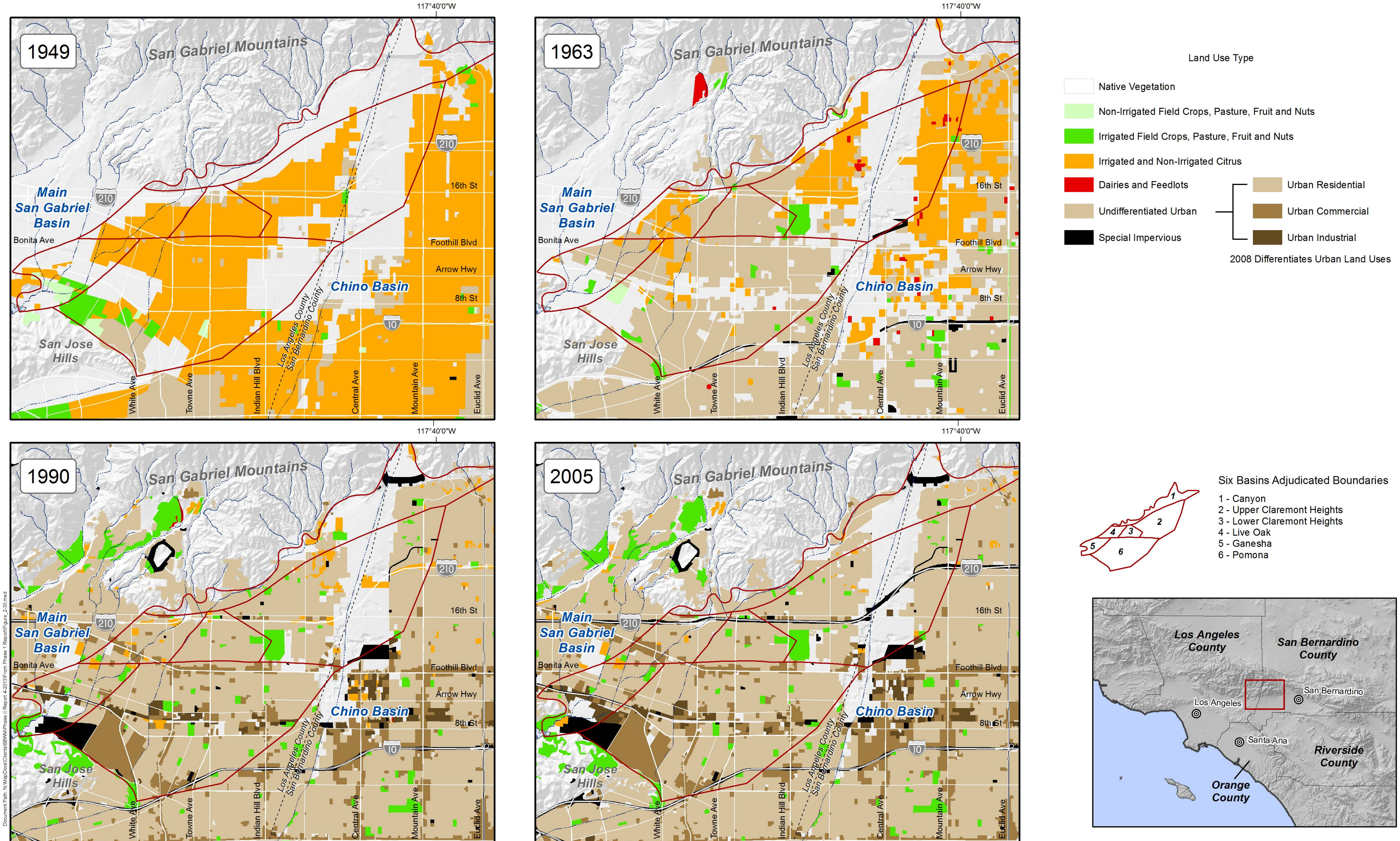
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Change in Groundwater Levels**

*Fall 1999 to Fall 2011*

**Figure 2-29c**




Prepared by:

WEI
Wildermuth Environmental, Inc.

Updated By: csanchez

Date: 20151209

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Land Use in the Six Basins**

*1949, 1963, 1990, and 2005*

**Figure 2-30**

**Figure 2-31**
**Land Use Change by Type (1949-2005)**

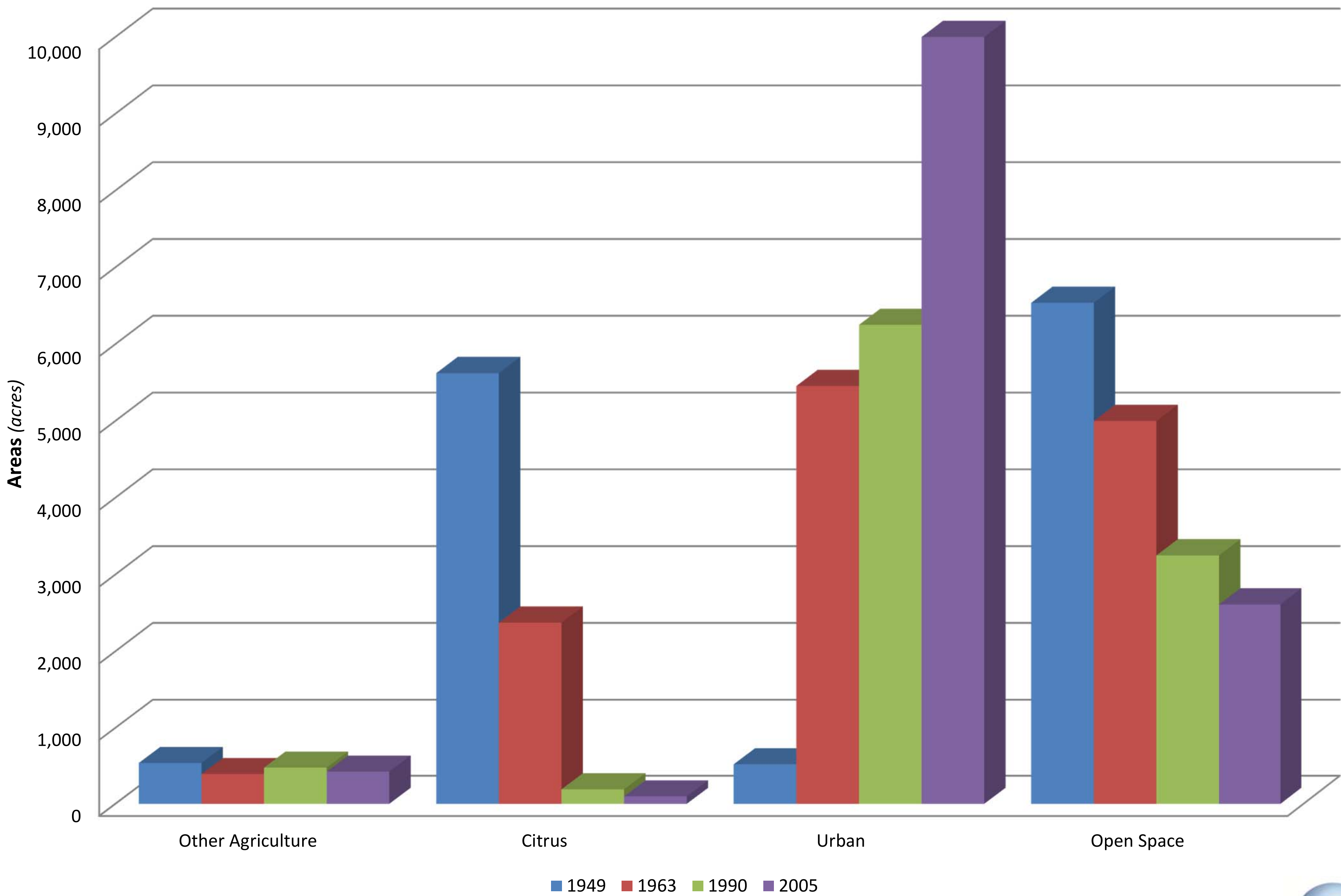
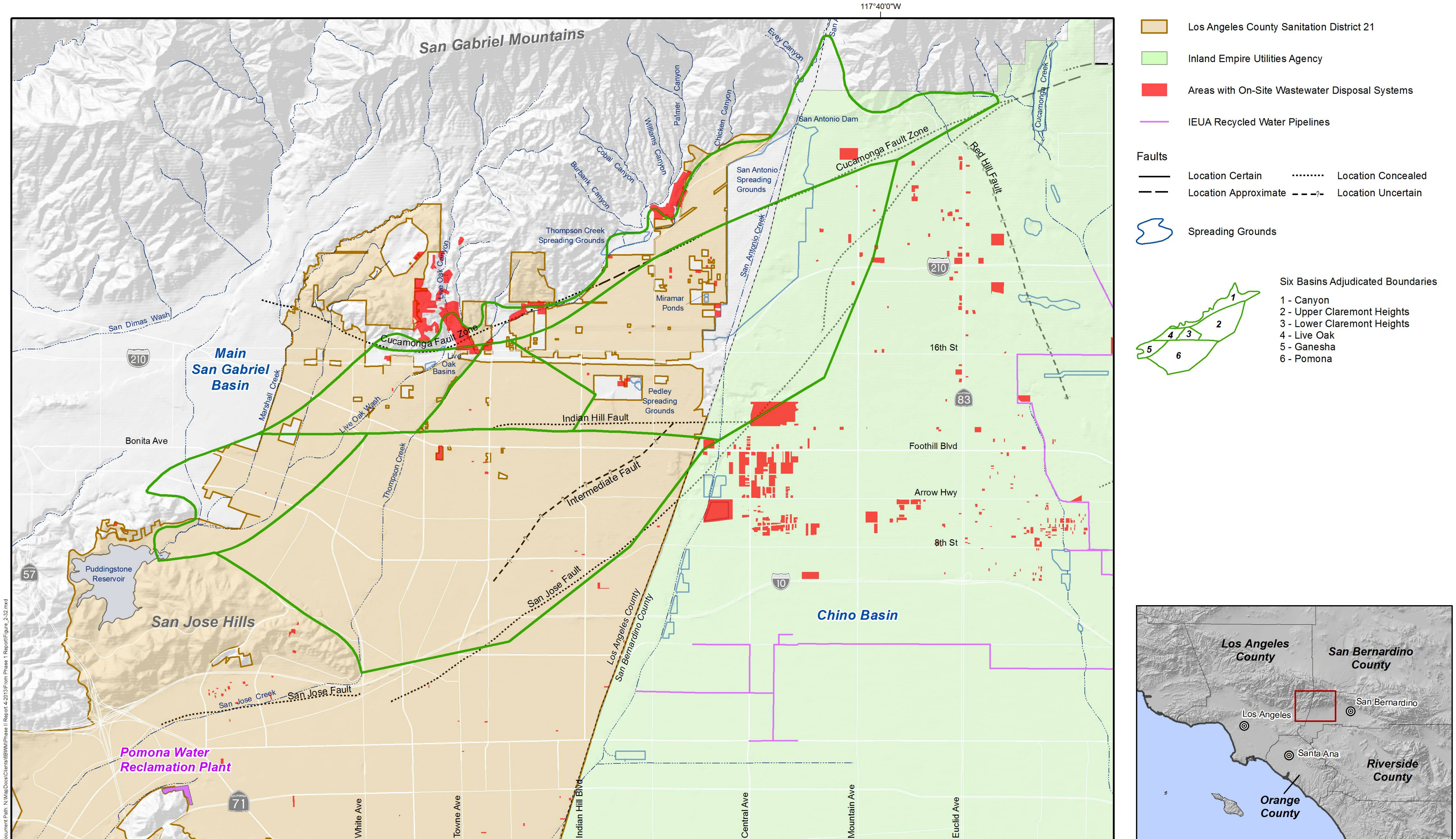



Figure_2-31_Major Land Use Changes.xlsx -- Figure_2-31




Prepared by:

WEI
Wildermuth Environmental, Inc.

Updated By: csanchez

Date: 20151209

0 2 Miles

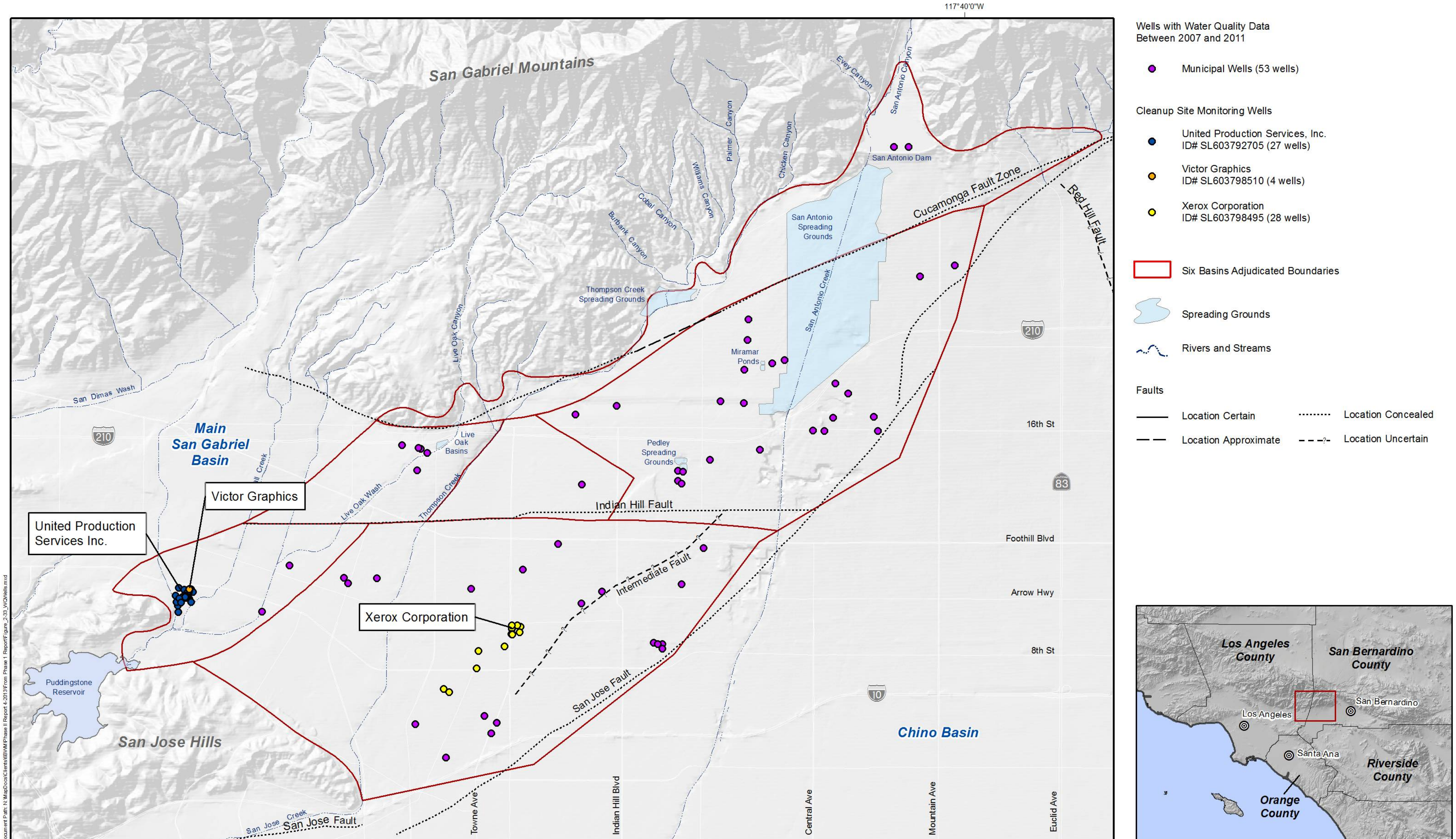
0 2 4 Km

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Current Wastewater Disposal and Recycled Water Facilities in the Six Basins Area**

**Figure 2-32**




Prepared by:

WEI Wildermuth Environmental, Inc.

Updated By: lboehm

Date: 20151209

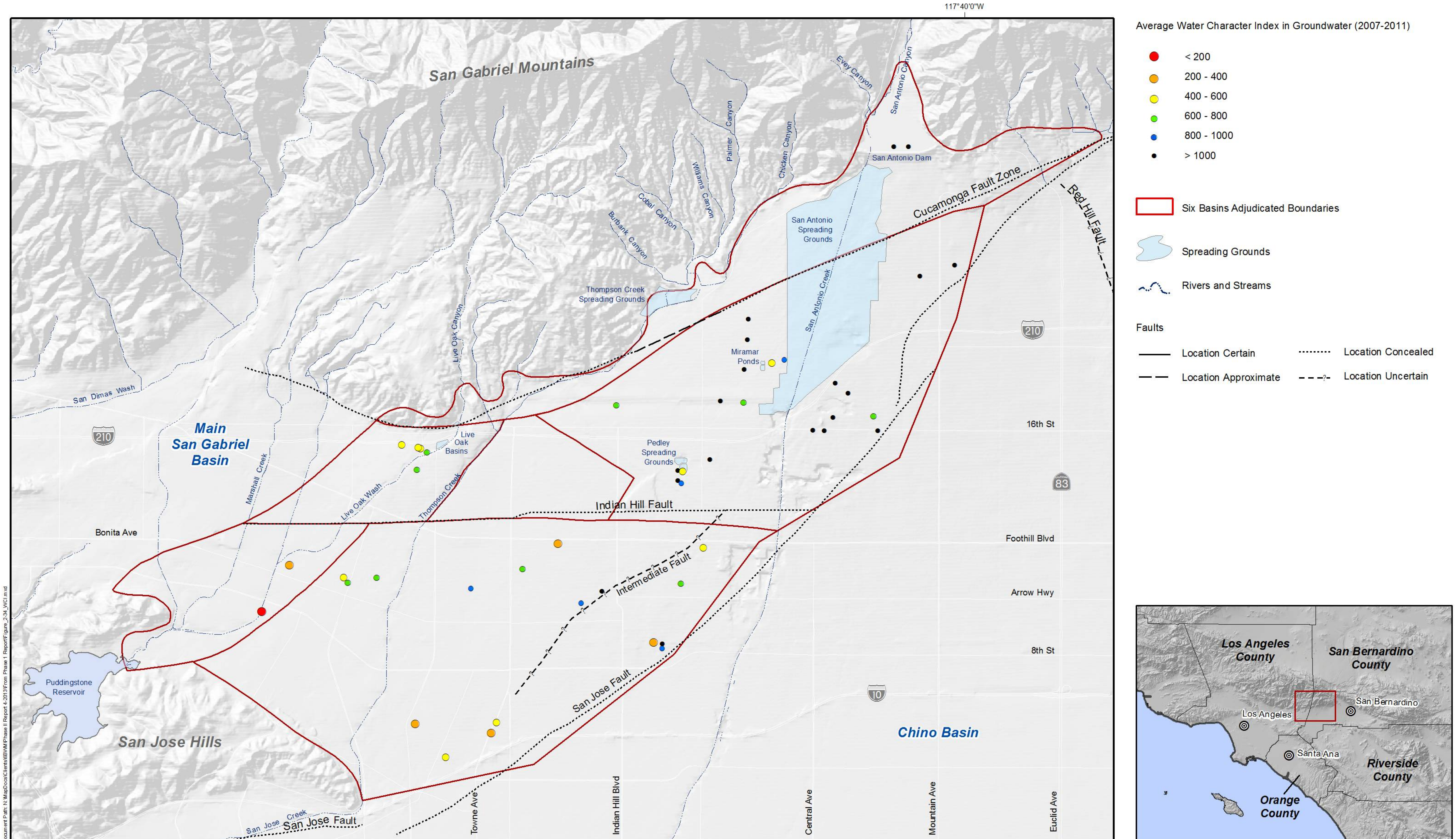
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Wells with Water Quality Data**

*Six Basins Area*

**Figure 2-33**




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: lboehm

Date: 20151209

0 2 Miles

0 2 4 KM

**Six Basins Watermaster**

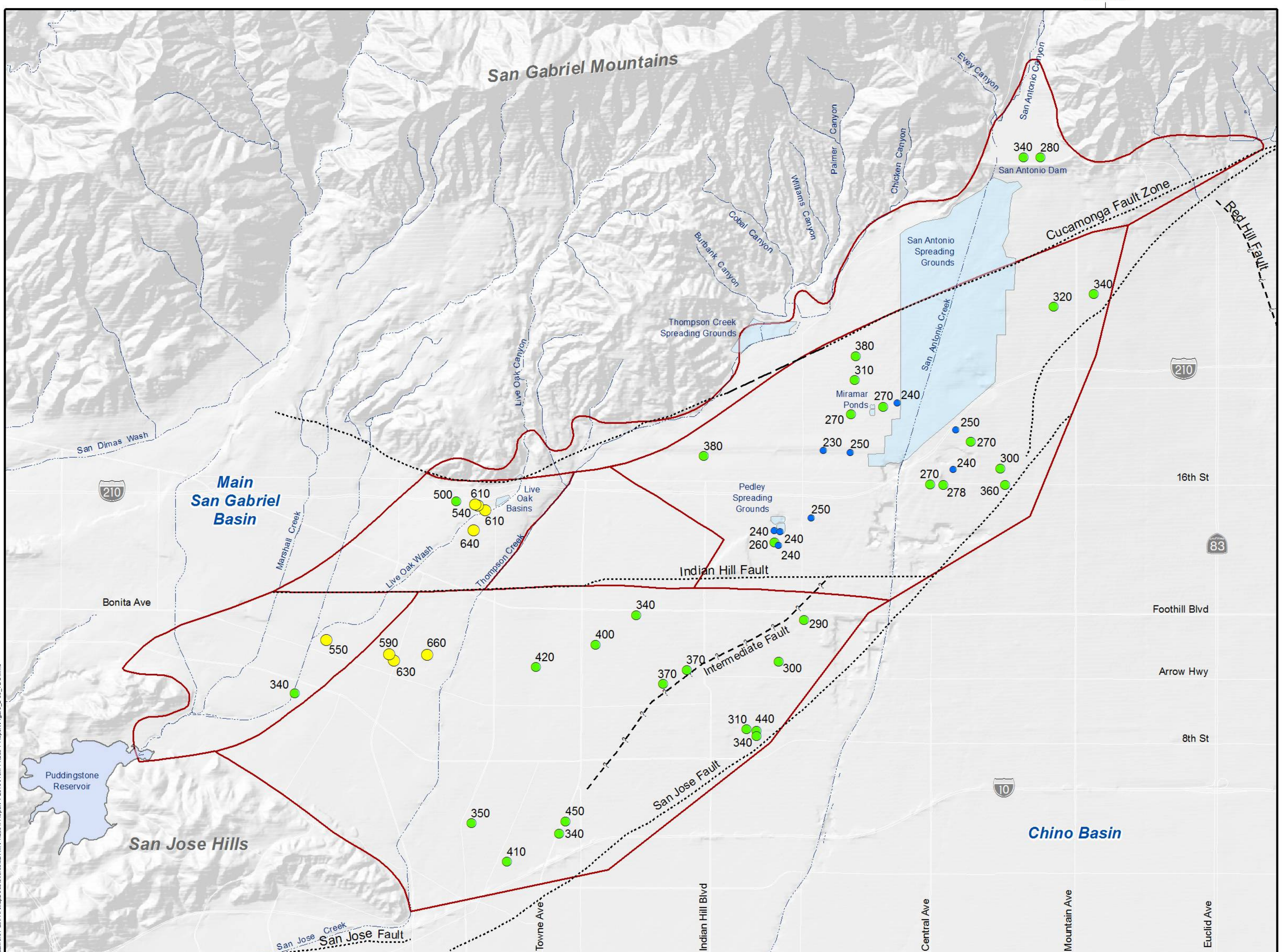
**Strategic Plan for the Six Basins**

## Water Character Index in Groundwater

*2007 - 2011*

**Figure 2-34**

117°40'0"W




Total Dissolved Solids Concentration at Wells
5-Year Maximum 2007 to 2011 (mg/L)

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

Secondary US EPA MCL = 500 mg/L

- Six Basins Adjudicated Boundaries
- Spreading Grounds
- Rivers and Streams

Faults

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


Prepared by:

WILDERMUTH ENVIRONMENTAL, INC.

Updated By: lboehm

Date: 20151209

0 2 Miles

0 2 4 KM

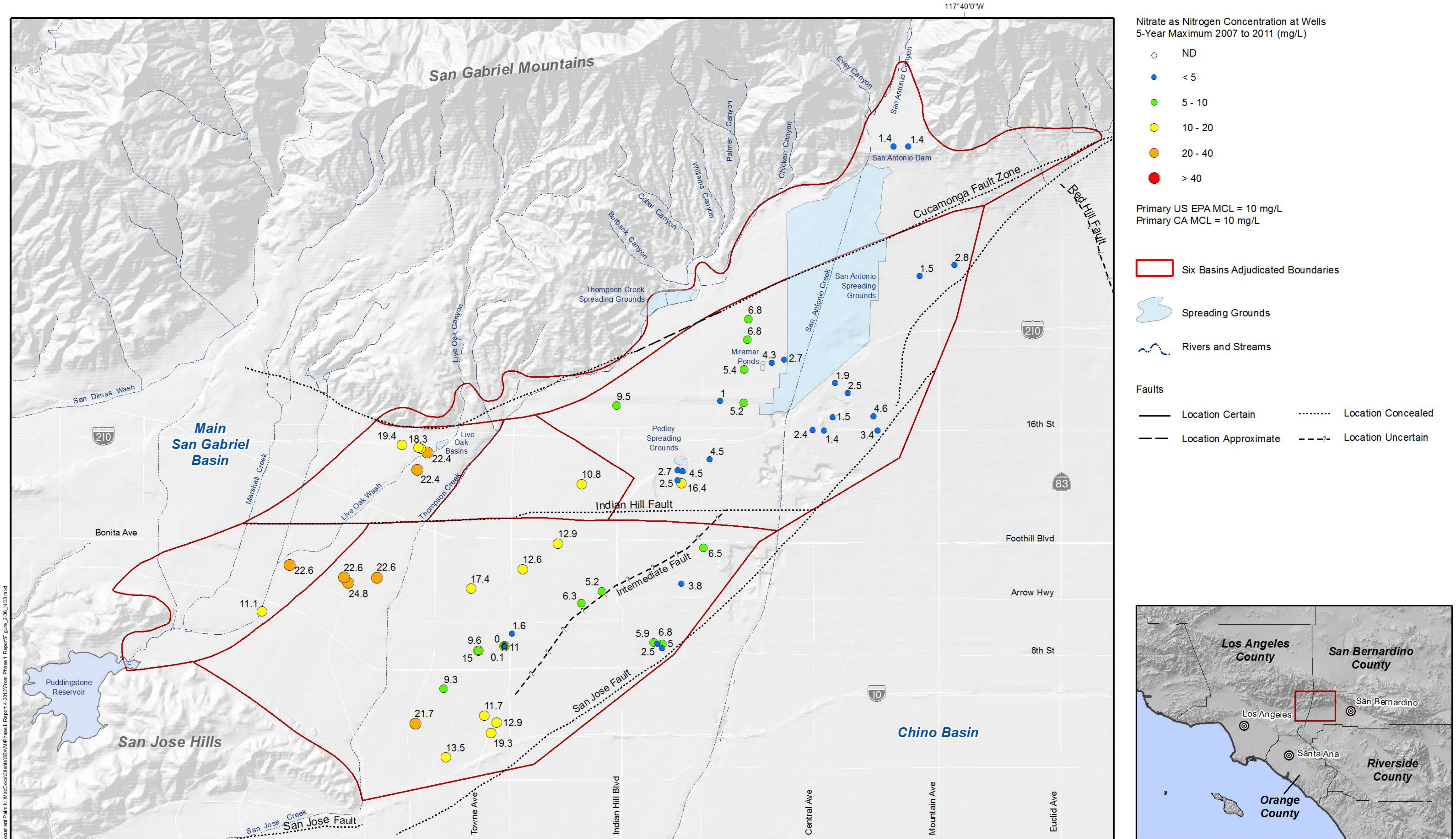
Six Basins Watermaster

Strategic Plan for the Six Basins

## Total Dissolved Solids in Groundwater

*Maximum Concentration (2007 to 2011)*

**Figure 2-35**




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: lboehm

Date: 20151209

0 2 Miles

0 2 4 KM

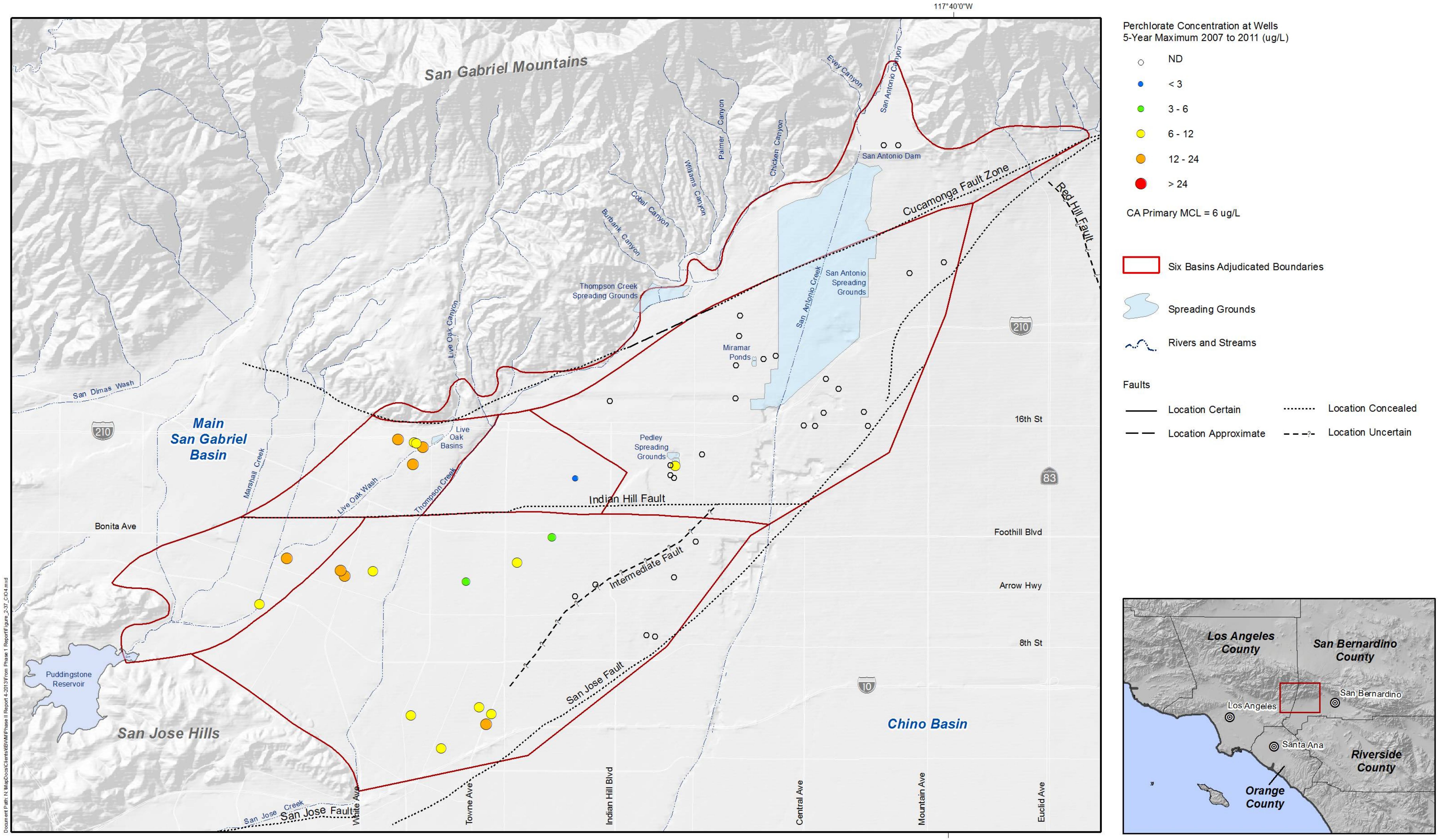
Six Basins Watermaster

Strategic Plan for the Six Basins

**Nitrate as Nitrogen in Groundwater**

*Maximum Concentration (2007 to 2011)*

**Figure 2-36**




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: lboehm

Date: 20151209

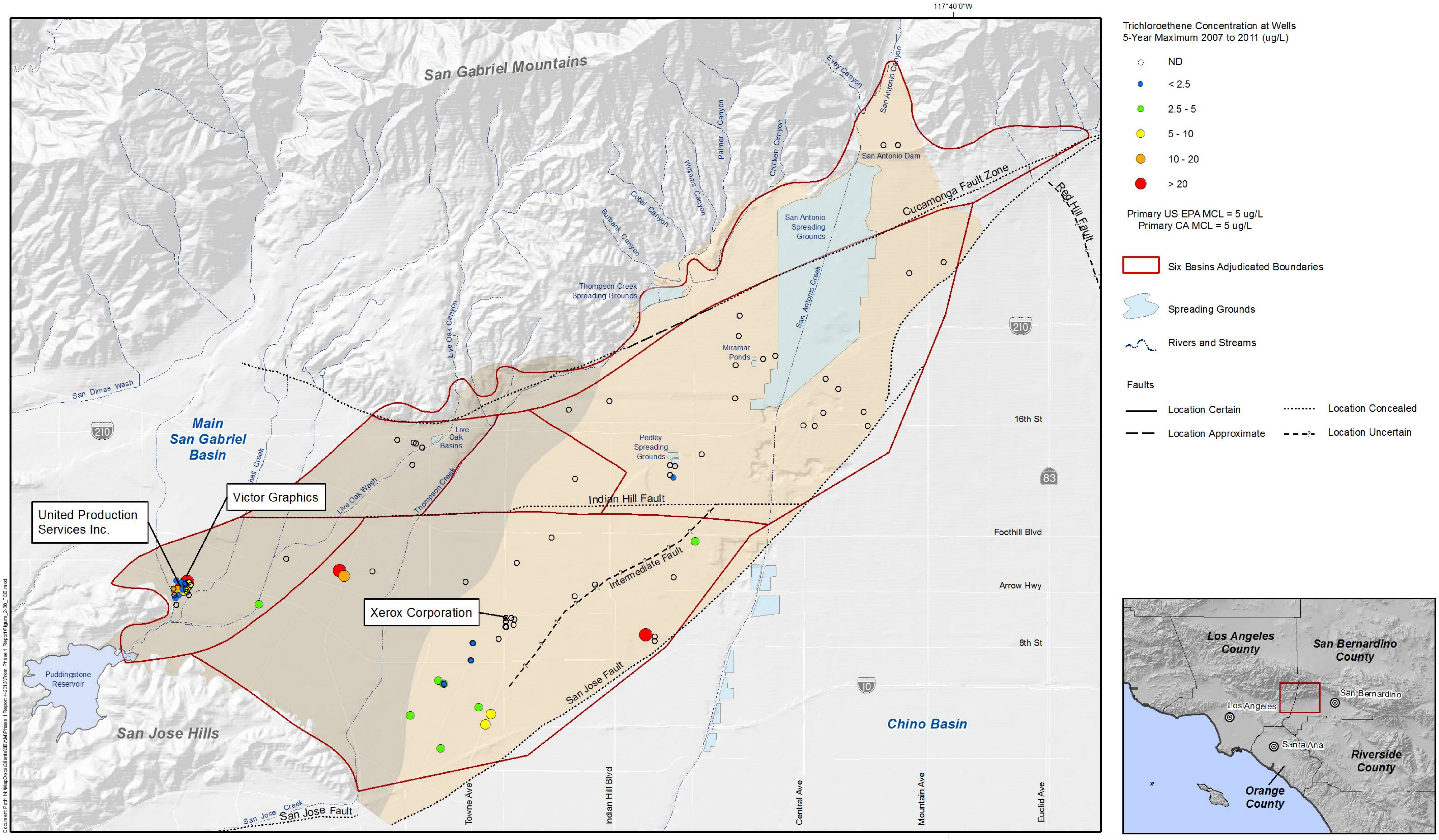
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Perchlorate in Groundwater**

*Maximum Concentration (2007 to 2011)*

**Figure 2-37**




Prepared by:

WEI
Wildermuth Environmental, Inc.

Updated By: lboehm

Date: 20151209

0 2 Miles

0 2 4 KM

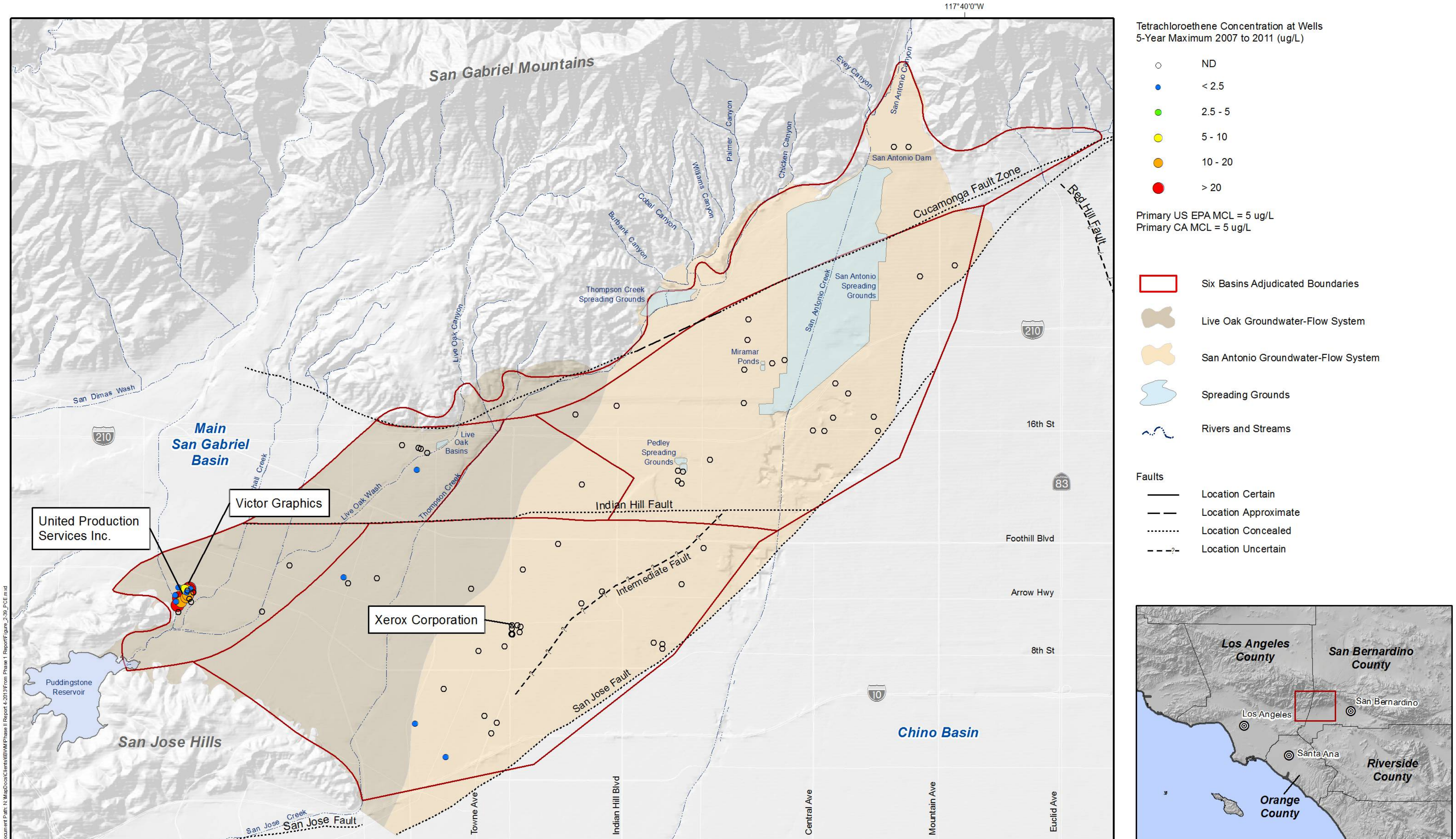
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Trichloroethene in Groundwater**

*Maximum Concentration (2007 to 2011)*

**Figure 2-38**




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: lboehm

Date: 20151209

0 2 Miles

0 2 4 KM

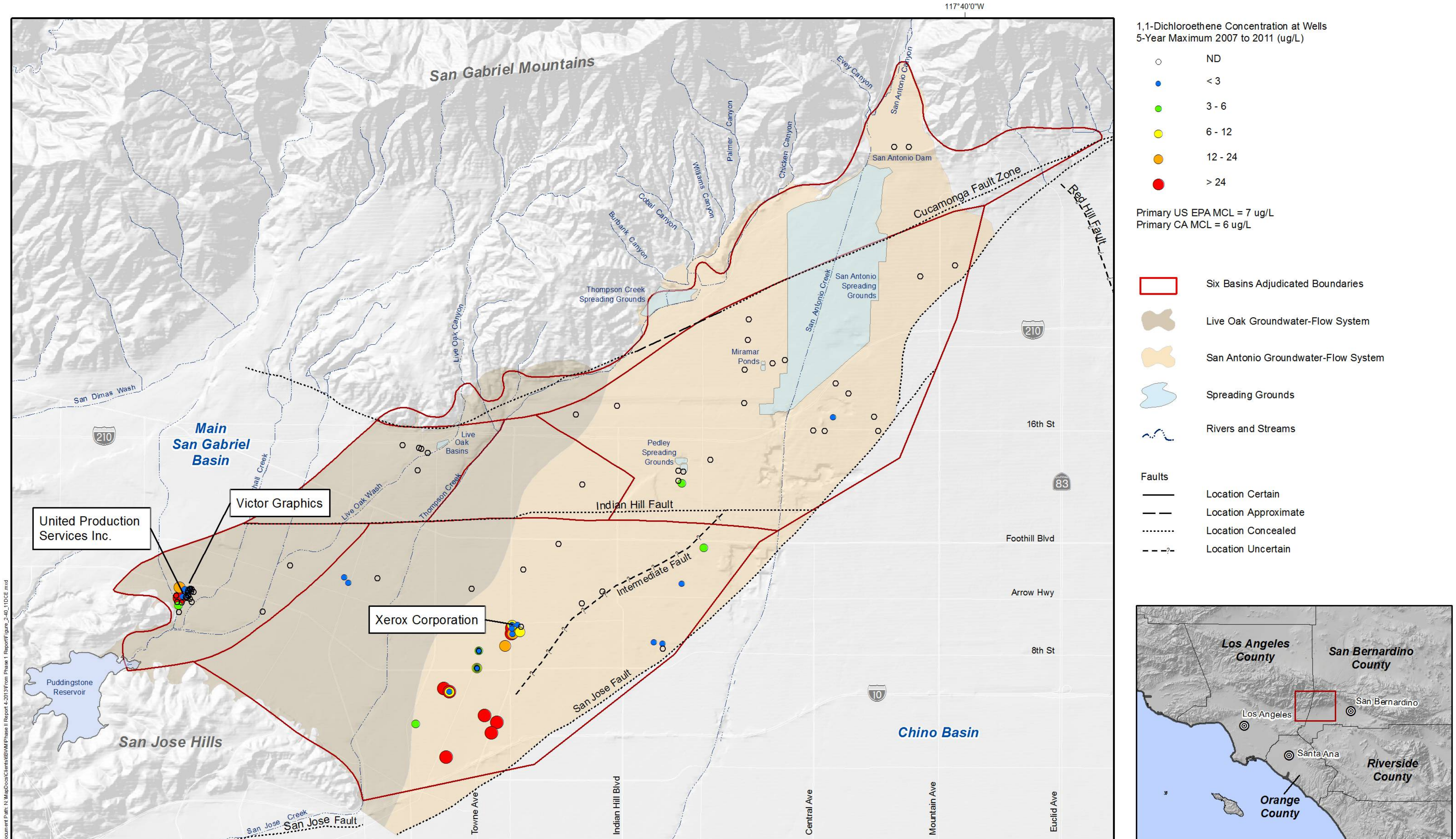
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Tetrachloroethene in Groundwater**

*Maximum Concentration (2007 to 2011)*

**Figure 2-39**




Prepared by:

WEI Wildermuth Environmental, Inc.

Updated By: lboehm

Date: 20151209

0 2 Miles

0 2 4 KM

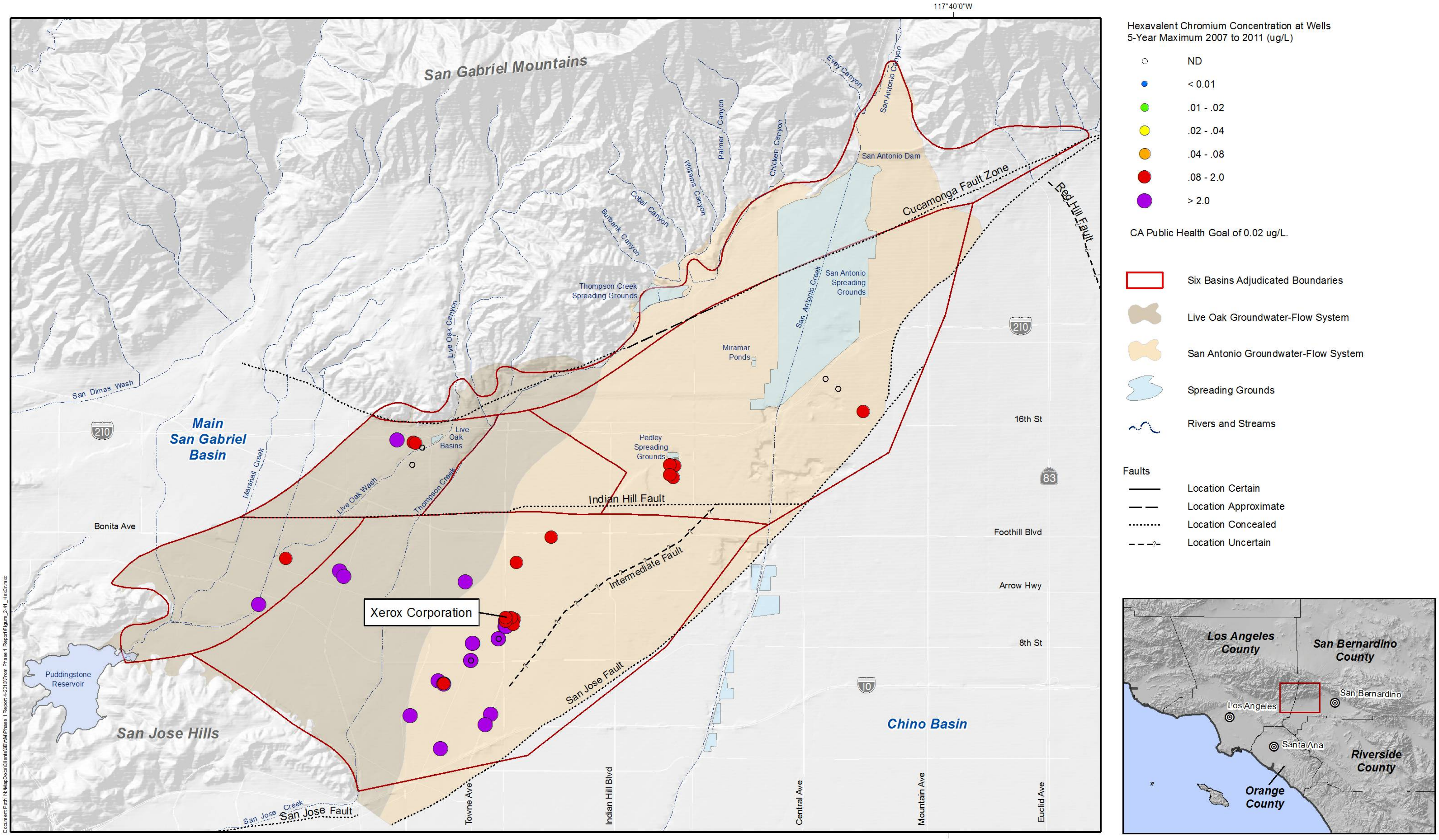
Six Basins Watermaster

Strategic Plan for the Six Basins

**1,1-Dichloroethene in Groundwater**

*Maximum Concentration (2007 to 2011)*

**Figure 2-40**




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: lboehm

Date: 20151209

0 2 Miles

0 2 4 KM

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

## Hexavalent Chromium in Groundwater

*Maximum Concentration (2007 to 2011)*

**Figure 2-41**


Prepared by:

WEI
Wildermuth Environmental, Inc.

Updated By: lboehm

Date: 20151209

0 100 200 Feet

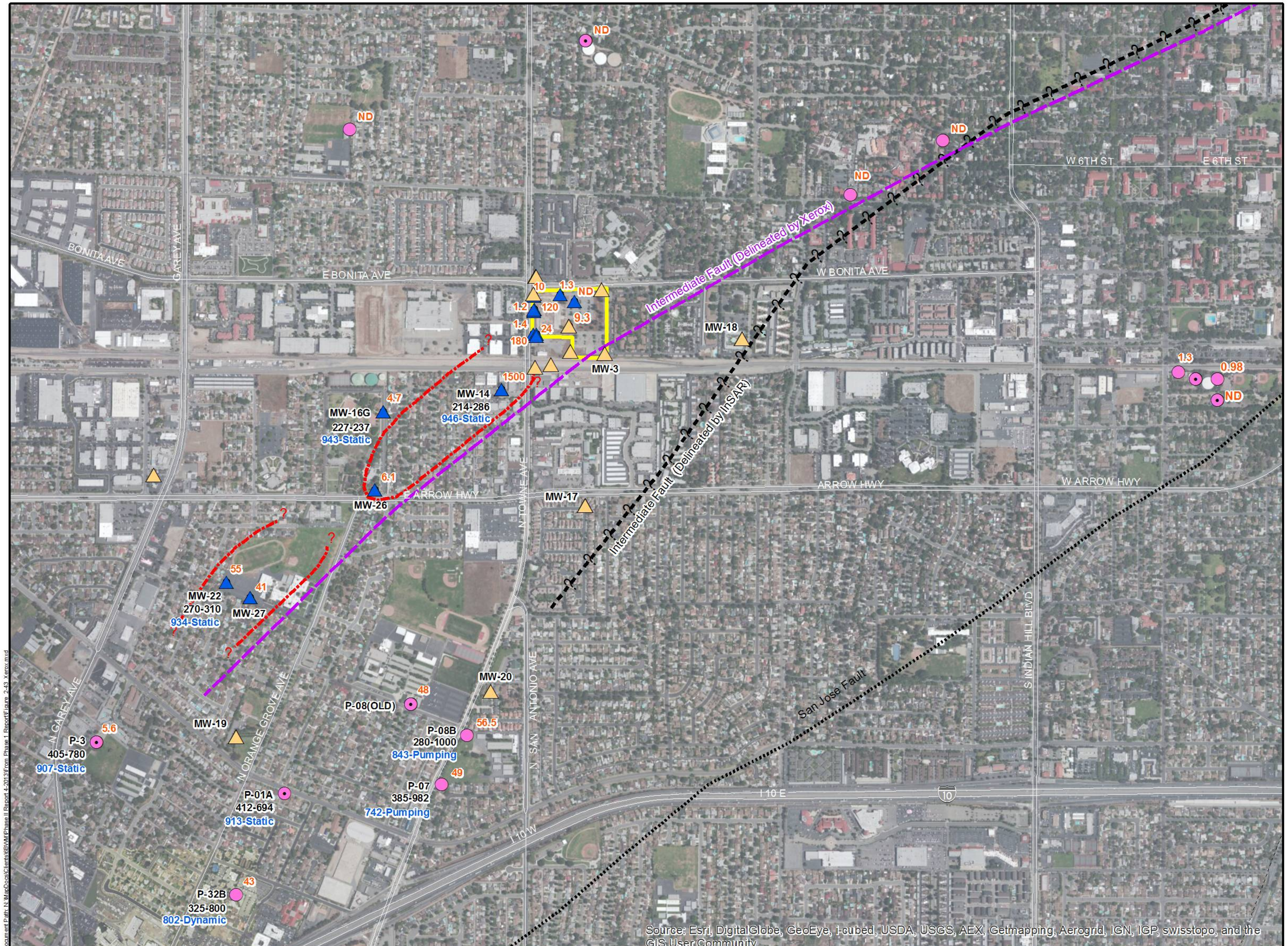
0 20 40 60 80 Meters

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

## Former United Production Services and Former Victor Graphics Sites

**Figure 2-42**




Former Xerox Corporation Property

Active Xerox Monitoring Wells

Abandoned Xerox Monitoring Wells

Active Production Wells

Inactive or Abandoned Production Wells

6.0 — Maximum 1,1-DCE Concentrations (ug/L) from 2007 to 2011

P-08B 280-1000 — Well Name and Minimum to Maximum Perforations (ft-bgs)

800-Static — Spring 2011 Groundwater Elevation (ft-amsl) and Well Activity

1,1 DCE Plume 6 ug/L Contour, May 2011. (Haley and Aldrich, 2011; Figure 10B)

Intermediate Fault as Delineated by Xerox Corporation (Haley and Aldrich, 2011; Figure 3 and Figure 10)

Intermediate Fault as Delineated by InSAR Data in Section 2.3 of this Report

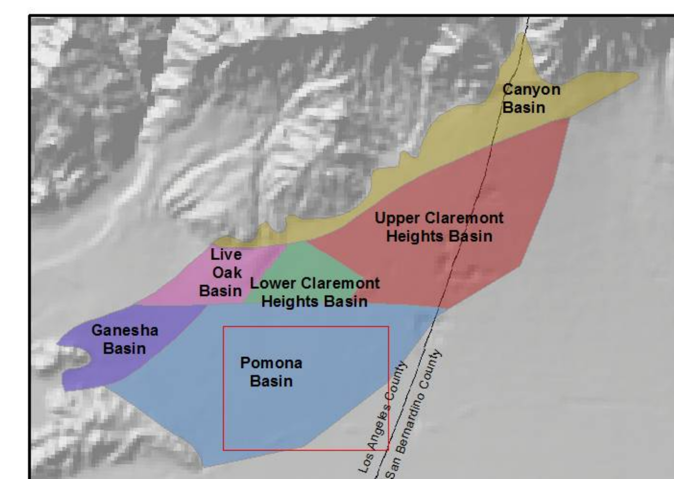
Faults

Location Certain

Location Approximate

Location Concealed

Location Uncertain




Prepared by:

WEI Wildermuth Environmental, Inc.

Updated By: lboehm

Date: 20151209

0 0.25 0.5 Miles

0 0.2 0.4 0.6 0.8 Kilometers

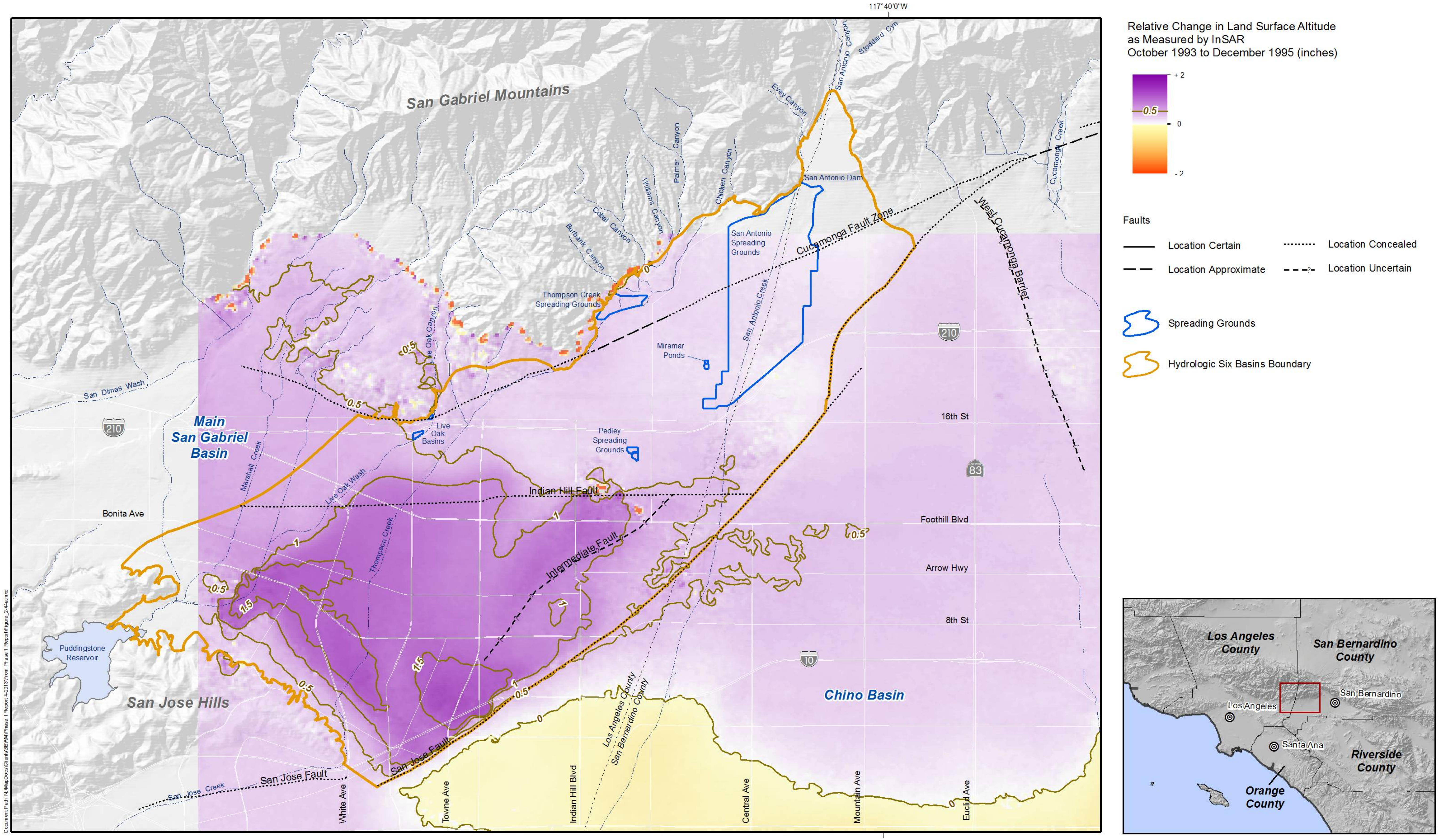
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

**Former Xerox Corporation Site**

*On-site and Off-site Features*

**Figure 2-43**




0 2 Miles
0 2 4 Km

Prepared by:

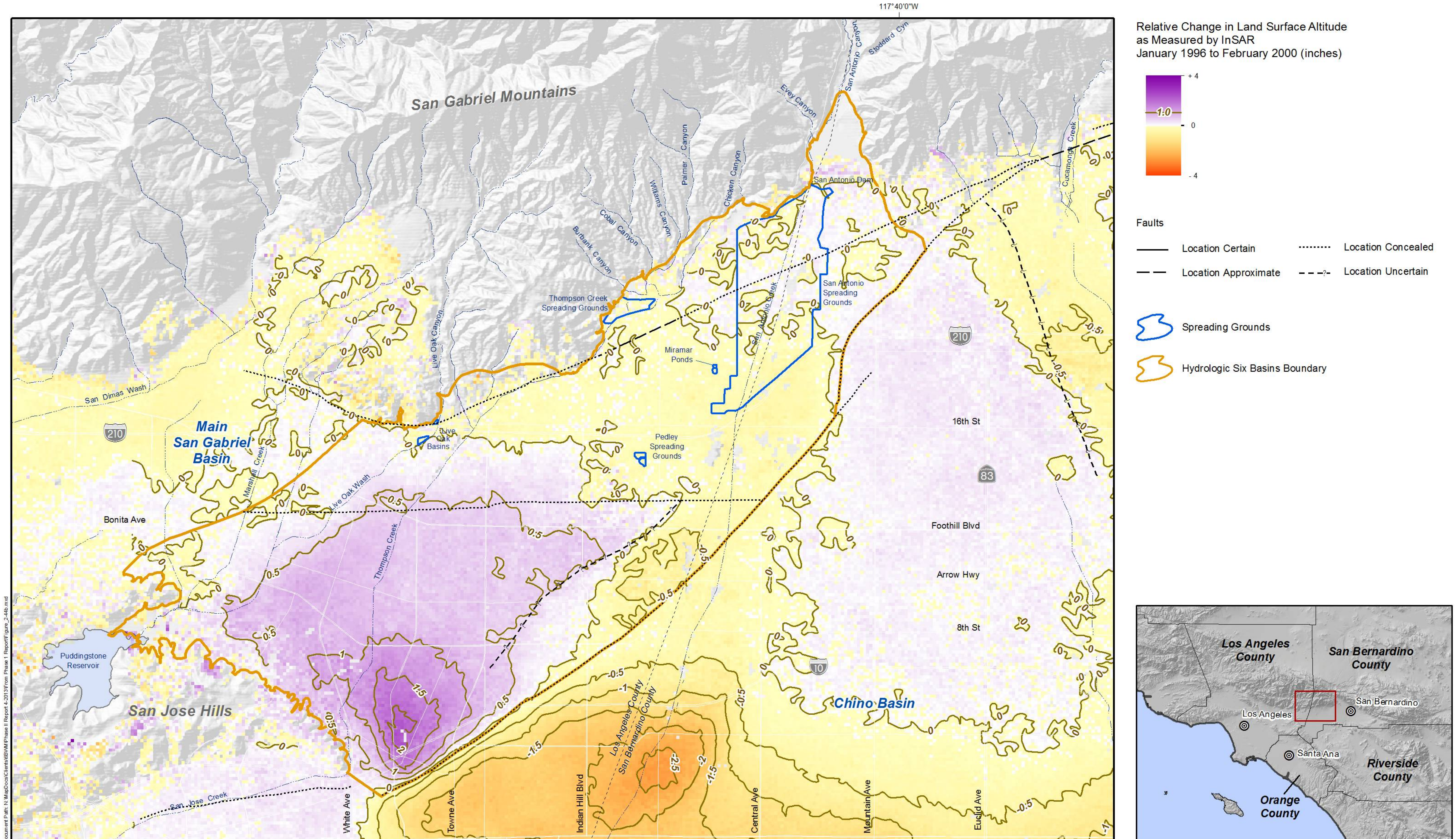
WEI
Wildermuth Environmental, Inc.

Updated By: lboehm
Date: 20151209

**Six Basins Watermaster**
Strategic Plan for the Six Basins

## Vertical Ground Motion (1993 to 1995) as Measured by InSAR

**Figure 2-44a**




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: lboehm

Date: 20151209

0 2 Miles

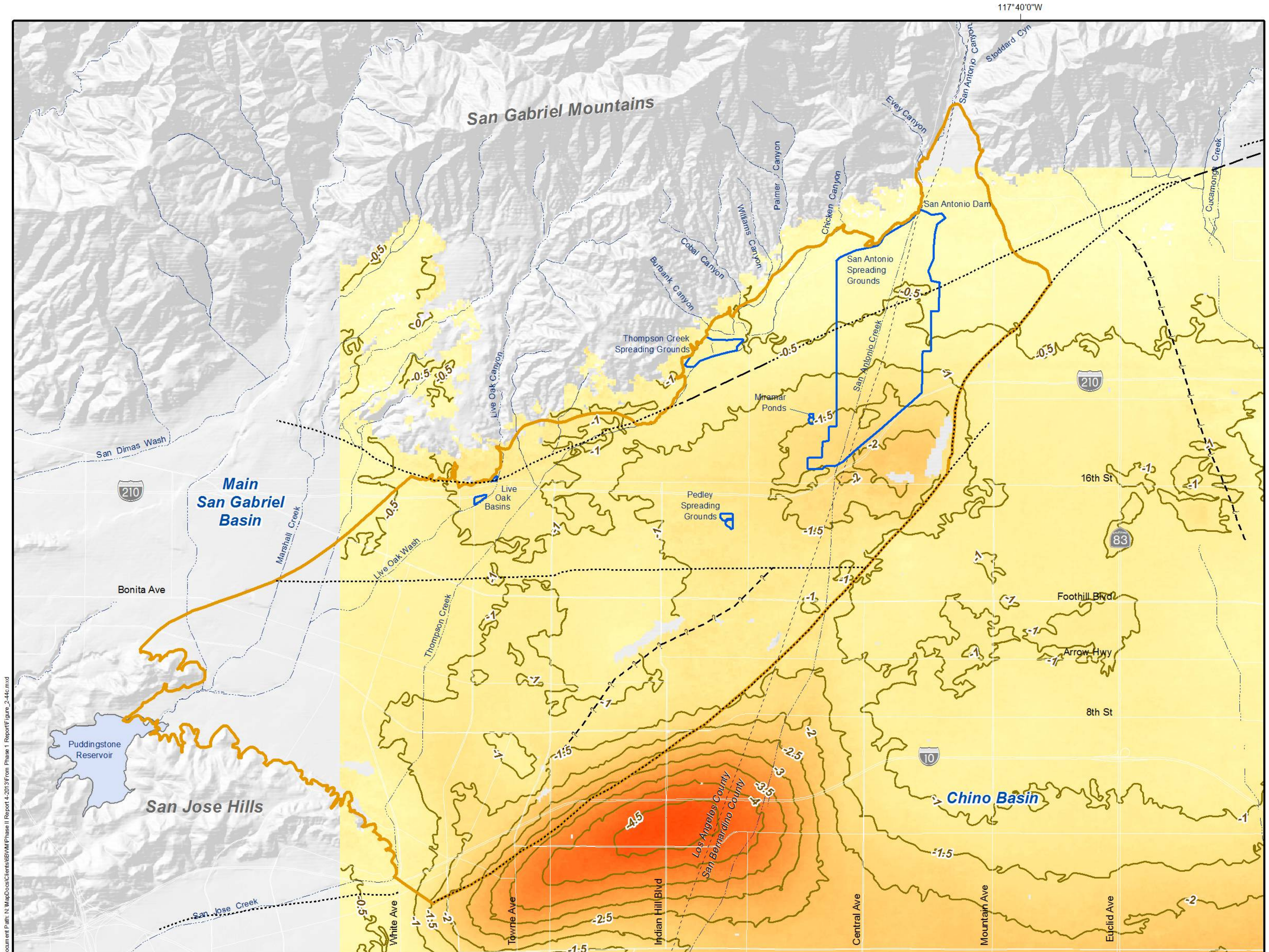
0 2 4 Km

Six Basins Watermaster

Strategic Plan for the Six Basins

**Vertical Ground Motion (1996 to 2000) as Measured by InSAR**

**Figure 2-44b**




Relative Change in Land Surface Altitude
as Measured by InSAR June 2005 to Septermber 2010 (inches)

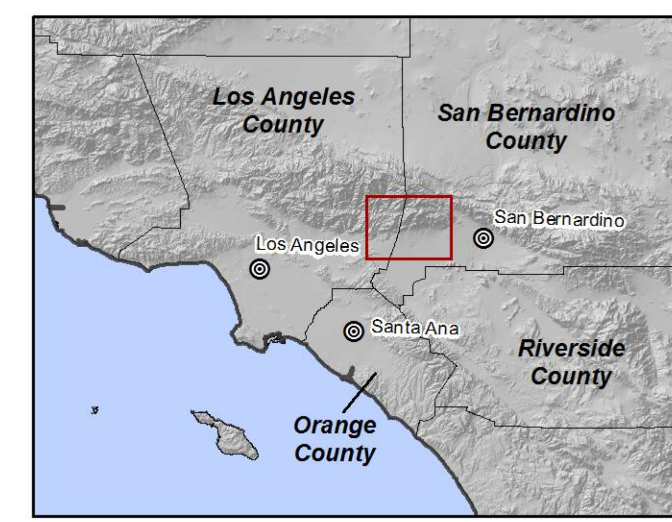
+ 5
1.0
0
- 5

Faults

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

Spreading Grounds

Hydrologic Six Basins Boundary




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: lboehm

Date: 20151209

0 2 Miles

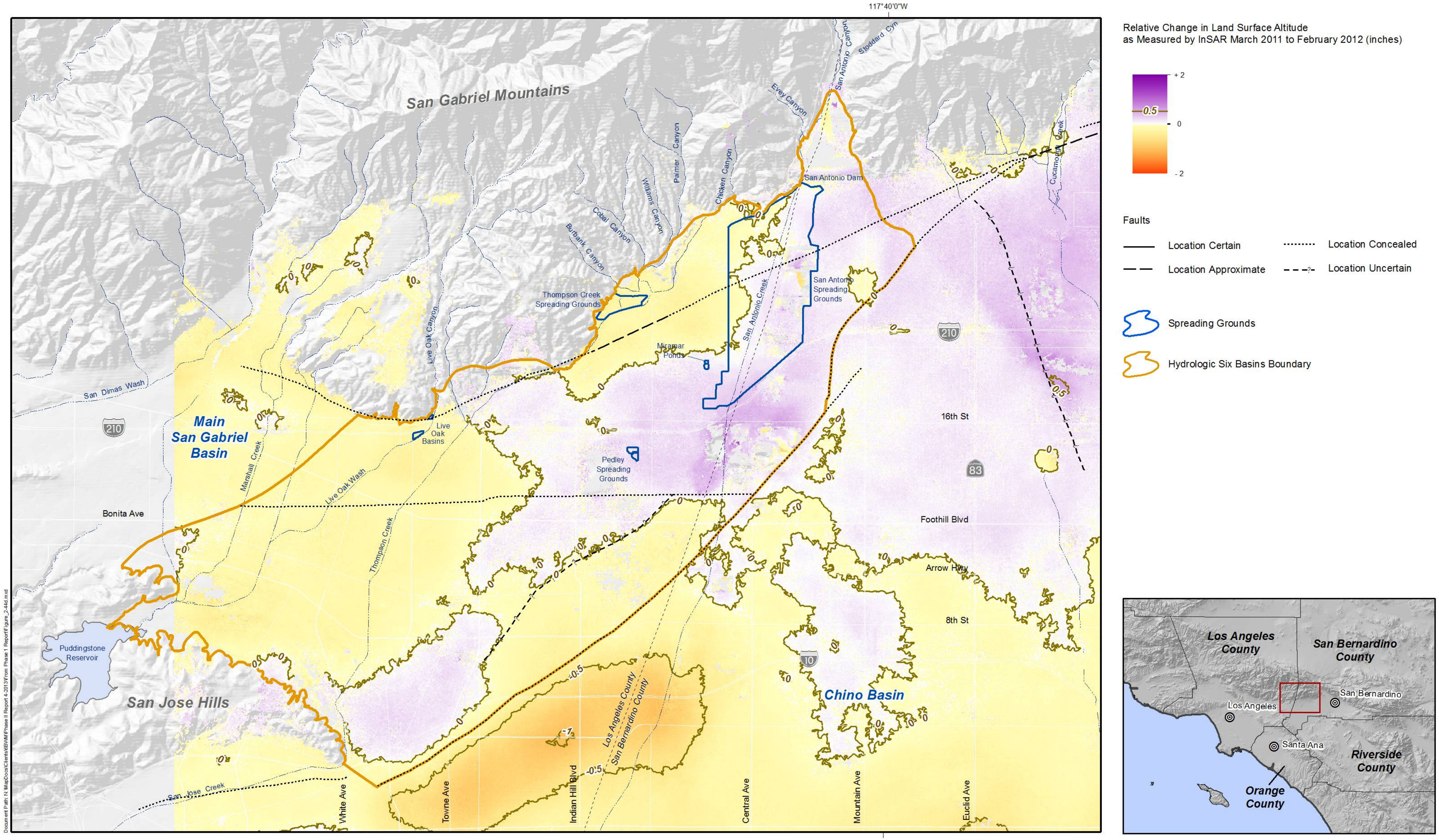
0 2 4 Km

Six Basins Watermaster

Strategic Plan for the Six Basins

## Vertical Ground Motion (2005 to 2010) as Measured by InSAR

Figure 2-44c




Prepared by:

WEI
WILDERMUTH ENVIRONMENTAL, INC.

Updated By: lboehm

Date: 20151209

0 2 Miles

0 2 4 Km

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

## Vertical Ground Motion (2011 to 2012) as Measured by InSAR

**Figure 2-44d**

# Section 3 - Development and Evaluation of the Baseline Alternative

This section describes the development and evaluation of the Baseline Alternative. The Baseline Alternative represents the independent water-supply plans of the Six Basins Parties in the absence of a Strategic Plan and was evaluated in two ways: (1) the 2015 Six Basins Groundwater-Flow Model was used to evaluate the impact of the Baseline on the groundwater basin and production sustainability and (2) the cost of the water-supply plans by individual Party and in aggregate. This evaluation serves as a "baseline" for comparison to the groundwater impacts and production sustainability and costs of the Strategic Plan Alternatives. The water supply plans characterized in this section (Sections 3.1 and 3.2) were published in January 2013 with updates in December 2015; the development and evaluation of the Baseline Alternative (Sections 3.3 through 3.6) was published in December 2015.

## 3.1 Sources of Water Supply

Water-supply sources available to the Six Basins Parties include: groundwater from the Six Basins, Chino Basin, Cucamonga Basin, and Spadra Basin; surface water from the San Antonio Creek watershed; imported water purchased from the TVMWD and IEUA; and recycled water. Each water-supply source is described below.

### 3.1.1 Six Basins Groundwater

Section 2 of this report describes the physical characteristics of the Six Basins and the groundwater management challenges that the Parties face related to surface water, hydrogeology, groundwater production, groundwater levels and storage, land use, water disposal, water quality, and land subsidence. The following describes how the Judgment governs groundwater production from the Six Basins.

The Judgment established the Safe Yield of the Six Basins as 19,300 acre-ft/yr (Section II.A of the Judgment). The safe yield is defined as: "the amount of groundwater, including Replenishment and return flows from imported water that can reasonably be produced from the combined Two Basins and Four Basins Areas on an annual basis without causing an undesirable result." Replenishment is Watermaster's program to augment the recharge of native surface water in the Six Basins and is carried out by the PVPA at the direction of Watermaster. Replenishment Water is native surface water spread by the PVPA at the SASG and TCSG (refer to Section 2.1 for details). The first 130 acre-ft/yr of native water spread by the City of Pomona and all native water spread by the LA County Flood Control District in the Two Basins is considered Replenishment Water.

Although prior hydrologic and physical conditions limited the Safe Yield to 19,300 acre-ft/yr, through the coordinated and equitable management of the Six Basins, the Physical Solution of the Judgment establishes that an Operating Safe Yield (OSY), an Operating Plan, and Base Annual Production Rights be established independently for the Four Basins. The City of La Verne is entitled to produce groundwater from the Two Basins in addition to its share of the OSY.

**Four Basins.** Each year, Watermaster is responsible for determining an OSY for the Four Basins, based on recent and expected replenishment, pumping, and groundwater levels. The OSY is allocated to each Party based on their percentage share of the Base Annual Production Right of 19,300 acre-ft/yr as shown in Table 3-1. In addition to each Party's share of the OSY, the following additional production rights are provided for in the Judgment:

- **Carryover Rights**. A Party that under-produces their share of the OSY in any given year may "carryover" the unproduced portion of the OSY to be produced in the following year. A Party's Carryover Right is limited to 25 percent of their share of the OSY. Each year, the first water produced by the Party is the Carryover Right from the previous year.
- **Storage and Recovery**. Parties holding a Base Annual Production Right in the Four Basins have the exclusive rights to utilize unused storage capacity in the Four Basins, subject to an approved Storage and Recovery Agreement with Watermaster. Storage and Recovery Agreements define the type of water that may be stored (other native water, imported water, or other water), list acceptable locations for spreading, define how the volume of recoverable water is calculated from the volume of water spread, and prescribe annual and total storage limitations. Currently, three Parties have Storage and Recovery Agreements with Watermaster: the City of Pomona, SAWCo, and the TVMWD.
- **Transfers**. Any Party's Base Annual Production Right, and its associated percentage of the OSY, as well as any Carryover Rights and water stored pursuant to a Storage and Recovery Agreement, may be transferred, in whole or in part, among the existing Parties or to any other person that becomes a Party on either a temporary or permanent basis.
- **Special Projects**. Any Party may propose, for Watermaster's approval, special projects for controlling groundwater levels or for the remediation of water quality problems in the Four Basins. Special project proposals must include an analysis of all project benefits as well as any potential adverse impacts to any other Party and include mitigation measures, as necessary. If the project is approved by Watermaster and the groundwater extractions resulting from the special project are deemed to benefit the overall management of the basin, Watermaster may exempt the water produced as part of the project, in whole or in part, from being debited against the producer's share of the OSY.
- **Temporary Surplus**. The Judgment recognizes that from time to time, it may be in the Parties' best interest for the control of high groundwater, water quality remediation, or other reasons for Watermaster to declare a Temporary Surplus of groundwater to be available for production over and above the then declared OSY. Temporary Surplus rights are not subject to the accrual of Carryover Rights.

Each year, a Party's total allowable production right is the sum of its share of the OSY, Carryover Rights from the previous year, total recoverable water in storage, transfers from other Parties, water from an approved special project, and Temporary Surplus water. To the extent that any Party's total production exceeds its total allowable production, that Party is obligated to recharge Replacement Water in an amount equal to the excess production. The Parties may obtain Replacement Water by directly purchasing imported water from the TVMWD or IEUA, arranging for the delivery of a native water supply other than that used for

Replenishment, or by paying a Replacement Water assessment to Watermaster so that it may acquire Replacement Water.

Watermaster is required to operate the Four Basins in a manner that protects against the threat of rising groundwater. In the event that Watermaster determines that Replenishment has to be terminated or curtailed in any year to protect against rising groundwater or that Replenishment Water is rejected due to insufficient storage capacity, some or all of a the following rights may be lost, listed in order of priority of loss: other water in storage, imported water in storage, native water in storage, Carryover Water, and Replenishment Water. The amount of water subject to loss is equal to the quantity of Replenishment Water that was curtailed or rejected. Losses of Carryover Water are allocated according to each Party's share of the Base Annual Production Right. Currently, Watermaster relies on a computer-simulation tool known as the Spreadsheet Model, which is based on the 2006 version of the groundwater-flow model of the Six Basins (CDM, 2006a), to evaluate the threat of rising groundwater and to determine if Replenishment should be curtailed. The Spreadsheet Model is also used, in part, to set the OSY at a level that does not result in a threat of rising groundwater in the event of wet or very-wet hydrologic conditions. The groundwater-flow model, and thus the Spreadsheet Model, is out-of-date and is no longer a reliable tool for assessing the threat of rising groundwater.

**Two Basins.** Production, Replenishment, and Storage and Recovery rights in the Two Basins are reserved solely for the City of La Verne and are not subject to any limitations, provided that the activities in the Two Basins area do not substantially injure the rights of any other Party.

### 3.1.2 Chino Basin Groundwater

The Chino Basin is one of the largest groundwater basins in Southern California, containing approximately 6 million acre-feet of water, and has an unused storage capacity in excess of 1 million acre-feet. The Chino Basin consists of approximately 220 square miles of the upper Santa Ana River watershed and lies within portions of San Bernardino, Riverside, and Los Angeles Counties. The Chino Basin is bounded by the Cucamonga Basin and the San Gabriel Mountains to the north, the Temescal Basin to the south, the Chino and Puente Hills to the southwest, the San Jose Hills and the Six Basins to the northwest, and the Rialto/Colton Basins to the east.

The Chino Basin is administered by the Chino Basin Watermaster (CBWM), which was established under a Judgment entered in the Superior Court of the State of California for the County of San Bernardino, entitled "Chino Basin Municipal Water District *v.* City of Chino *et al.*" (originally Case No. SCV 164327, the file was transferred August 1989 by order of the Court and assigned Case No. RCV 51010). The CBWM accounts for production and recharge, collects assessments, assesses over producers to buy replenishment water and recharges that water into the Chino Basin, accounts for storage and transactions among Parties, performs certain administrative functions, and supervises the implementation of the Optimum Basin Management Program (OBMP).

The Chino Basin Judgment resulted from studies and discussions that began in the early 1970s and continued for several years. The Judgment numerically defined the safe yield of the Chino Basin as 140,000 acre-ft/yr, and it was allocated among the three producer pools: (1) overlying agricultural pool (82,800 acre-ft/yr), (2) overlying non-agricultural pool (7,366 acre-ft/yr), and (3) appropriative pool (49,834 acre-ft/yr).

The overlying agricultural pool consists of all overlying producers that produce groundwater for uses other than industrial or commercial and the State of California. The overlying non-agricultural pool consists of overlying producers that produce groundwater for industrial and commercial uses. And, the appropriative pool consists of owners of appropriative rights. All Parties were assigned to a pool when the Judgment was entered. Five Parties to the Six Basins Judgment are appropriative pool Parties to the Chino Basin Judgment: the City of Pomona, the City of Upland, the Golden State Water Company, SAWCo, and the West End Consolidated Water Company.

A fundamental premise of the Chino Basin Judgment is that it allows all Chino Basin water users to pump sufficient water from the basin to meet their requirements. To the extent that a Party's groundwater pumping exceeds its share of the safe yield, assessments are levied by the CBWM, and the CBWM uses these assessments to purchase supplemental water to replace overproduction. The Judgment also provides that any subsequent change in the safe yield shall be debited or credited to the appropriative pool Parties, meaning that if the CBWM determines that the safe yield has changed, the change would be exclusively debited or credited to members of the appropriative pool and the rights allocated to the other pools and their respective Parties would remain unchanged.

In addition to each appropriator Party's share of the Safe Yield, the following additional production rights are allocated by the CBWM:

- A fraction of 5,000 acre-ft/yr of controlled overdraft through 2017
- Annual transfers of unproduced water from the overlying agricultural pool
- Transfers of rights from an overlying agricultural pool Party when the agricultural land used by that Party is converted to another land use, requiring service by an appropriator pool Party
- New yield from new stormwater recharge
- Recycled water recharged by the IEUA, credited according to each appropriator's percent contribution of total wastewater sent to the IEUA

Appropriator Parties can store unused production rights in the basin, and they may also sell unused water rights and/or water in storage to each other and to the CBWM. The CBWM assesses a two-percent loss rate to all water in storage, based on the amount of water in storage at the beginning of each accounting year.

The reliability of Chino Basin groundwater supplies is certain due to the Judgment requirement to replenish production in excess of the safe-yield.

### 3.1.3 Cucamonga Basin Groundwater

The Cucamonga Basin underlies the northern part of the upper Santa Ana Valley and is bounded by the San Gabriel Mountains and the Cucamonga Fault to the north, the Red Hill/East Etiwanda Fault System to southeast, and the West Cucamonga Barrier to the west. The Cucamonga Basin contains about 900,000 acre-ft of groundwater. The Red Hill/East Etiwanda Fault System is a barrier to groundwater flow, with groundwater levels reported to be 500 feet higher on the north side of the fault. Groundwater in Cucamonga Basin generally flows to the south (Wildermuth Environmental, 2012a).

Groundwater rights in the Cucamonga Basin were adjudicated as defined in the 1958 Judgment of the Superior Court (Decree No. 92645), herein referred to as the Cucamonga Basin Decree. The Cucamonga Basin Decree stipulates that 22,721 acre-ft/yr may be pumped from the basin and approximately 3,620 acre-ft/yr may be diverted from Cucamonga Creek. The Cucamonga Valley Water District (CVWD), SAWCo, and the City of Upland (through agreements with SAWCo and West End Consolidated Water Company) are the primary producers in the Cucamonga Basin. Pursuant to the Cucamonga Basin Decree, the CVWD has the right to produce 15,471 acre-ft/year from the Cucamonga Basin and the right to divert 3,620 acre-ft/yr from Cucamonga Creek, SAWCo has the right to produce 6,500 acre-ft/yr from the basin, and the West End Consolidated Water Company has the right to produce 750 acre-ft/yr, which is currently pumped by the City of Upland. The Decree also sets limits on how much produced groundwater may be exported and provides for limited water banking by SAWCo (Wildermuth Environmental, 2012b).

The Decree is solely an allocation of water rights and is silent as to the sustainable or safe yield of the Cucamonga Basin. The CVWD and SAWCo have investigated the yield of the Cucamonga Basin: estimates have varied between 13,500 acre-ft/yr and 16,000 acre-ft/yr (Wildermuth Environmental, 2012a). These estimates are below the decreed right of 22,721 acre-ft/yr. The CVWD and SAWCo are currently working on developing a groundwater management plan for the Cucamonga Basin to ensure the long-term reliability of groundwater and surface water resources.

### 3.1.4 Spadra Basin Groundwater

The Spadra Basin is an alluvial groundwater basin located to the south of the Six Basins between the San Jose Hills and Chino Basin and is almost entirely within the boundary of the City of Pomona's service area. The Spadra Basin is not adjudicated and the yield of the basin has been estimated to be approximately 1,500 acre-ft/yr (RMC, 2011a). Urban land uses overlie the basin, and the reach of San Jose Creek that traverses the Spadra Basin is lined with concrete. This results in minimal recharge to the groundwater basin. Groundwater typically contains high concentrations of TDS, nitrate, and VOCs (RMC, 2011b). Groundwater production from the Spadra Basin is limited due to its low yield and poor groundwater quality.

### 3.1.5 San Antonio Creek Surface Water

A description of the resources, water rights, and beneficial uses of surface water runoff from the San Antonio Creek watershed is provided above in Section 2.1.

### 3.1.6 Imported Water

Imported water is available to the Six Basins Parties from the TVMWD and IEUA: both are member agencies of the MWDSC. The MWDSC is a consortium of 26 cities and water districts that provide drinking water to about 19 million people in parts of Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties—a service area of about 5,200 square miles. The MWDSC currently delivers about 2 million acre-ft/yr of imported water to its service area from the State Water Project (SWP) and the Colorado River.

The IEUA was established in 1950 as a wholesale agency to provide supplemental imported water from the MWDSC to the Chino Valley area located in San Bernardino County. The City of Upland is the only Six Basins Party that purchases imported water from the IEUA. Water supplied to the City of Upland by the IEUA is 100 percent SWP water, treated at the Water Facilities Authority's Agua de Lejos Water Treatment Plant located in the City of Upland (City of Upland, 2011).

The TVMWD was established in 1950 as a wholesale water agency that supplies imported water to the cities and communities in the Pomona, Walnut, and San Gabriel Valleys of Los Angeles County, including the Cities of Charter Oak, Claremont, Covina, Covina Knolls, Diamond Bar, Glendora, Industry, La Verne, Pomona, Rowland Heights, San Dimas, Walnut, and West Covina. The TVMWD serves imported water to its member agencies from the MWDSC's F.E. Weymouth Water Treatment Plant (Weymouth WTP) or from its Miramar Water Treatment Plant (Miramar WTP) (TVMWD, 2011).

The Weymouth WTP is located in the heart of the TVMWD's service area and can deliver up to 520 million gallons of water per day to customers in Los Angeles and Orange Counties. Most of the water treated at Weymouth originates from the Colorado River, with a small amount originating from the SWP. The City of Pomona is the only Six Basins Party that receives water from the Weymouth WTP.

The TVMWD operates the Miramar WTP, which is located at its headquarters in the City of Claremont. The Miramar WTP receives 100 percent untreated SWP water from the MWDSC's Foothill Feeder and treats it for potable use. Water deliveries from the Miramar WTP are supplemented with Six Basins groundwater produced by the TVMWD. Currently, groundwater makes up about 4 percent of the total deliveries from the TVMWD's Miramar system. The City of La Verne and Golden State Water Company (for their Claremont and San Dimas systems) have a 50/50 share of the available water from the Miramar WTP, but they currently do not utilize the total water available. Excess water can be delivered to the City of Pomona, Walnut Valley Water District, and Rowland Water District on an interruptible basis.

The ability of the TVMWD and IEUA to meet their member agencies' water demands is dependent on the MWDSC's ability to deliver water. Although the MWDSC continues to face ongoing water-supply challenges for both the SWP and Colorado River systems, through the implementation and support of programs to increase the reliability of local water supplies in Southern California (e.g. conjunctive use, conservation, water shortage planning, transfer and storage programs, tiered water rates, etc.), the MWDSC projects that they will be able to meet their overall system demands through 2035 (MWDSC, 2010; TVMWD, 2011; Civiltec Engineering, 2011a; City of Upland, 2011; Kennedy/Jenks, 2011; RMC, 2011a).

From 2002 through 2007, the MWDSC's average rates increased by about six percent per year. From 2007-2012, the MWDSC's average water rates increased by about ten percent per year. And from 2012 through 2014, the MWDSC's average water rates increased by about three percent per year. The MWDSC's full-service untreated Tier 1 rate for 2015 is $582 per acre-ft. The MWDSC is projecting a rate increase of two percent by 2016.

A brief summary of the imported water supply challenges on the SWP and Colorado River is provided below.

**State Water Project.** The SWP is owned by the State of California and operated by the Department of Water Resources (DWR). The SWP transports Feather River water, stored in and released from Lake Oroville, and unregulated flows diverted directly from the Delta south via the California Aqueduct to the MWDSC service area (MWDSC, 2010). In the Antelope Valley, the California Aqueduct divides into the East and West Branches. The East Branch carries water to Silverwood Lake and Lake Perris (DWR, 2010). From Silverwood Lake, SWP water is conveyed to the San Bernardino area at the Devil Canyon Afterbay. The MWDSC supplies SWP water to the TVMWD area from its Foothill Feeder Pipeline, which starts at the Devil Canyon Afterbay and traverses westward toward Los Angeles. In a 100-percent allocation year, based on their contract, the DWR will provide the MWDSC with 1,911,500 acre-ft of SWP water (Table A amount) (California DWR, 2010).

In December 2014, the DWR published the Final State Water Project Delivery Reliability Report (California DWR, 2014). This report updates the DWR's estimate of current (2013) and future (2033) SWP water delivery reliability. The report is produced every two years as part of a settlement agreement that was signed in 2003. The 2013 report shows that current and future SWP deliveries will be impacted by two significant factors: 1) a significant restriction on the SWP and Central Valley Project (CVP) Delta pumping, as required by the biological opinions issued by the U.S. Fish and Wildlife Service (December 2008) and the National Marine Fisheries Service (June 2009); and 2) climate change, which is altering hydrologic conditions in the State.

The report assumes no Delta improvements are made. It predicts that the average annual SWP deliveries will decrease by about 5.6 percent from current to future conditions. In addition to concerns over climate and environmental issues that impact average delivery reliability, the Delta contains a fragile levee system that is used to convey water from the Sacramento River to the Harvey O. Banks pumping station. This levee system is threatened by earthquakes and floods. Should a major levee failure occur, SWP water exports from the Delta could be interrupted for several years (WEI, 2012b). The report emphasizes the "need for local agencies to develop resilient and robust water sources and infrastructure to maximize the efficient use of a variable water supply."

**Colorado River.** The Colorado River was the MWDSC's original source of imported water when the agency was established in 1928. The MWDSC constructed the Colorado River Aqueduct (CRA) to transport water from Lake Havasu, located at the border of Arizona and California, to Southern California. The CRA is 242 miles long and terminates at Lake Mathews in Riverside County. The capacity of the CRA is 1.25 million acre-ft/yr. The MWDSC has a legal entitlement to receive water from the Colorado River under a permanent service contract with the U.S. Secretary of the Interior (MWDSC, 2010).

The Colorado River is managed and operated under numerous federal laws, compacts, decrees, contracts, court decisions, and regulatory guidelines that are collectively referred to by the U.S. Bureau of Reclamation (USBR) as The Law of the River. The Colorado River Compact of 1922 apportioned 15 million acre-ft/yr of water between the seven states: 7.5 million acre-ft/yr was apportioned to the upper basin states of Colorado, New Mexico, Utah, and Wyoming, and 7.5 million acre-ft/yr was apportioned to the lower basin states of Arizona, California and Nevada. The Boulder Canyon Project Act of 1928 divided the lower basin's 7.5 million acre-ft/yr between the three states, of which 4.4 million acre-ft/yr was allocated to California (USBR, 2008). The California Seven Party Agreement of 1931 set the basis for priorities among California contractors to utilize the State's 4.4 million acre-ft/yr allocation. Of this, the MWDSC has a fourth priority right to 550 thousand acre-ft/yr, a fifth priority right to an additional 662 thousand acre-ft/yr, and a right of up to 180 thousand acre-ft/yr when surplus flows are available. In total, the Seven Party Agreement allocated nearly 5.4 million acre-ft/yr to California contractors (MWDSC, 2010). For many years, California contractors utilized more than their 4.4 million acre-ft/yr limit, but as population and water demands began to grow in Arizona and Nevada, California was eventually required to cut back use to the agreed upon 4.4

million acre-ft/yr apportionment (USBR, 2008). Many years of court battles, some of which are still not resolved, ensued within California as contractors struggled to secure their respective rights that were not all clearly defined in the 1931 Seven Party Agreement. The MWDSC now has a firm supply of 550,000 acre-ft/yr of Colorado River water. To increase their allocation, the MWDSC has developed a multitude of conservation, storage, and transfer programs with various parties inside and outside of California (MWDSC, 2010).

The MWDSC's Colorado River supplies also face other threats to reliability, including a long-term drought that has greatly reduced storage on the river system; costly pest control programs and a loss of operational flexibility due to the spread of invasive quagga mussels throughout the CRA distribution system; the management of high salinity levels, which require that river water be blended with lower-salinity SWP water to meet regulatory limitations for TDS concentrations in many of the MWDSC's service areas; other water quality concerns related to uranium, perchlorate, and hexavalent chromium; and climate change (MWDSC, 2010).

### 3.1.7 Recycled Water

Domestic and commercial wastewater originating in the Six Basins is treated by the LACSD at the San Jose Creek Water Reclamation Plant (WRP) for the City of La Verne; by the LACSD at the Pomona WRP for the Cities of Claremont, Pomona, and parts of La Verne; or by the IEUA at Regional Plant #1 for the City of Upland (refer to Figure 2-33). Recycled water from the San Jose WRP and the IEUA are not considered viable water resources for the Six Basins. Conveying recycled water from the San Jose Creek WRP back to the Six Basins for reuse is not presently considered feasible given its distance from the basin (Civiltec, 2011a). In 2015, the IEUA plans to either reuse or recharge nearly 100 percent of its available recycled water within its service area in the Chino Basin[19] (City of Upland, 2010).

Recycled water from the Pomona WRP is an available source of recycled water for the Six Basins. The Pomona WRP has a treatment capacity of up to 15 million gallons per day (mgd). Currently, flows vary from 4 mgd to 15 mgd and average about 9 mgd. The LACSD has agreements to deliver up to one-third of its recycled water available from the Pomona WRP to the Walnut Valley Water District and the remaining two-thirds to the City of Pomona. Based on average plant production, the amount of recycled water available to the City of Pomona through this agreement is about 6,720 acre-ft/yr. Recycled water that is not utilized by the Walnut Valley Water District and/or the City of Pomona is made available to other LACSD customers.

## 3.2 Water Demands and Water-Supply Plans

Table 3-2 summarizes the 2011 and projected (2015-2035) total water demands and supply plans of the Parties to the Six Basins Judgment. This information was collected from the Parties in 2012 and compiled as part of Phase 1 of the Strategic Plan for the Six Basins (WEI, 2013). In this analysis, each Party's 2010 Urban Water Management Plan (UWMP) was reviewed and used as the starting point, and adjustments were made based on feedback from the Parties. In many cases, the sum of the water supplies stated in the UWMPs was in excess of a Party's total

[19] IEUA must discharge a minimum of 17,000 acre-ft/yr of treated wastewater to the Santa Ana River per the requirements of the 1969 Santa Ana River Judgment.

demand. In Table 3-2, only the actual volume of each water supply needed to meet the demands was considered in the water-supply plan of a Party so that the total supply equals the total demand. Additionally, each Party used different assumptions about future OSY to project their total production from the Six Basins. For the purpose of demonstrating what the Parties believed was their minimum requirement from the Six Basins, the assumptions were not standardized. Table 3-3 describes each Party's projected Six Basins supply by sub-basin. If the Parties did not supply sub-basin specific demand projections for Six Basins groundwater, the future supply by sub-basin was estimated based on the Party's average percentage use of each sub-basin between 1999 and 2011.

The water demands and supply plans of the individual Parties, as described in Phase 1 of the Strategic Plan for the Six Basins (WEI, 2013), are described below.

### 3.2.1 City of La Verne

Figure 3-1 is a stacked bar-chart showing the City of La Verne's historical (1999-2011) and projected (2015-2035) total water demands and water supplies by source. The two water-supply sources available to the City of La Verne include groundwater from the Six Basins and imported water purchased from the TVMWD. The City of La Verne's total water demand declined from about 9,400 acre-ft in 2007 to about 6,900 acre-ft in 2011. The decreasing trend in demand was likely due to the economic downturn and water conservation measures associated with multiple dry years. Demand is projected to increase to 8,835 acre-ft by 2035, a 22 percent increase. Due to the implementation of water conservation measures required by the State of California, 2035 water demands are projected to be less than the demand in 2007, even though population is projected to increase.

The City of La Verne's water-supply plan can be described as maximizing allowable production from the Six Basins and purchasing the balance from the TVMWD. The City of La Verne's future projected supply from the Six Basins is 3,035 acre-ft/yr: 1,520 acre-ft/yr from the Pomona Basin assuming an OSY of 20,000 acre-ft/yr, 921 acre-ft/yr from the Live Oak Basin, and 594 acre-ft/yr from the Ganesha Basin. Projected pumping from the Two Basins represents the historical maximum annual production from these basins (at the time the UWMP was prepared) because no studies have been performed to determine the long-term sustainable yield of the Two Basins.

In this projection, City of La Verne's future increases in demand are met with increased imported water and increased production from the Live Oak and Ganesha Basins. The City of La Verne desires to increase production from the Six Basins and minimize reliance on imported water. The total production capacity of the City's wells in the Pomona Basin is about 3,000 acre-ft/yr, but pumping is limited by water quality contamination: only about 1,600 acre-ft/yr of this capacity can be utilized based on the current capacity for treatment and blending (Civiltec, 2011a). The City of La Verne is interested in pursuing increased production in the Pomona Basin using the Special Projects provision of the Judgment.

### 3.2.2 City of Pomona

Figure 3-2 is a stacked bar-chart showing the City of Pomona's historical (1999-2011) and projected (2015-2035) total water demands and water supplies by source. The sources of water supply available to the City of Pomona include: groundwater from the Six Basins, Chino

Basin, and Spadra Basin; native surface water from San Antonio Creek Watershed; imported water purchased from the TVMWD; and recycled water from the Pomona WRP.

The City of Pomona's total water demand declined from about 38,000 acre-ft/yr in 1999 to about 22,000 acre-ft/yr in 2011. The decrease in demand between 1999 and 2007 was due to a decrease in demand by the industrial sector. The City of Pomona historically served recycled water to several industrial operations (e.g. paper production plants) that no longer operate in the area. Between 1999 and 2007, recycled water demand decreased from 7,621 acre-ft/yr to 2,350 acre-ft/yr. Further reductions in total demand from 2007 to 2011 are likely due to the economic downturn and water conservation measures associated with multiple dry years. Demand is projected to increase from 2011 to about 28,000 acre-ft/yr by 2035, a 27 percent increase. Due to the implementation of water conservation measures required by the State of California, water demands in 2035 are projected to be less than demands in 2007 (the peak demand for non-industrial customers in the City of Pomona) even though population is projected to increase.

The City of Pomona's water-supply plan can be described as maximizing the use of local potable supplies (Six Basins, Chino Basin, and surface water from San Antonio Canyon) and non-potable supplies (Spadra Basin and recycled water) and purchasing the balance from the TVMWD. Local water sources, when maximized, make up about 90 percent of the City of Pomona's supplies. At times, more native surface water is available from San Antonio Canyon than can be treated for use at the City's Pedley Filtration Plant (PFP), so the surplus water is spread in the Six Basins at the SASG or the PSG.

As part of its 2011 Integrated Water Supply Plan, the City evaluated various water-supply plan options to maximize local water resources and minimize the cost to produce that water. The preferred alternative excluded plans to increase production from the Six Basins because of the high cost of the necessary groundwater treatment (RMC, 2011b).

The City of Pomona's projected supply from the Six Basins is about 4,000 acre-ft/yr, assuming an OSY of 19,300 acre-ft/yr. Water is produced from the Upper Claremont Heights Basin and the Pomona Basin. Based on the average distribution of production from 1999 through 2011, about 30 percent of the demand (1,200 acre-ft/yr) will be produced from the Upper Claremont Heights Basin and 70 percent (2,800 acre-ft/yr) from the Pomona Basin. The City has some flexibility for increasing production from the Six Basins beyond the OSY given that they can recharge and store water as part of their Storage and Recovery agreement with the Watermaster, but this is not reflected in the supply plan. The terms of the Storage and Recovery agreement, which has been in place since 1999, allow the City of Pomona to store all native water recharged in the SASG or PSG in excess of 130 acre-ft/yr.

Based on the City of Pomona's projected use of recycled water, which ranges from about 1,800 to 3,200 acre-ft/yr, a surplus of recycled water is available from the Pomona WRP. Assuming plant production remains around 9 mgd, as previously described, a surplus of 3,325 to 4,545 acre-ft/yr of recycled water is available, or more if plant production increases. The City's Integrated Water Supply Plan identified limited opportunities to put more recycled water to direct use and concluded that indirect potable reuse (IPR) was not an option due to a lack of sufficient blending water, as required by state regulations (RMC, 2011b).

### 3.2.3 Golden State Water Company

Figure 3-3 is a stacked bar-chart showing the Golden State Water Company's historical (1999 to 2011) and projected (2015 to 2035) total water demands and water supplies by source for its Claremont System. The three water supply sources available to the Golden State Water Company include groundwater from the Six Basins and Chino Basin and imported water purchased from the TVMWD. More recently, an intertie with the City of Upland was constructed in the event of water shortage emergencies. The Golden State Water Company began using this intertie in 2011 and will continue to supplement demands in the short-term while low groundwater levels in the Upper Claremont Heights Basin are limiting production. The Golden State Water Company's water supply plan does not project long-term use of this intertie as a regular water supply.

The Golden State Water Company's total water demand decreased from about 13,900 acre-ft/yr in 2007 to about 10,800 acre-ft/yr in 2011. This decreasing trend was likely due to the economic downturn and water conservation measures associated with multiple dry years. Total water demand is projected to be about 12,000 acre-ft/yr by 2035, an 11 percent increase.

The Golden State Water Company's water-supply plan can be described as maximizing allowable production from the Six Basins and Chino Basin and purchasing the balance from the TVMWD. Six Basins groundwater produced by the Golden State Water Company is from the Upper Claremont Heights Basin and the Pomona Basin. Production from the Upper Claremont Heights Basin is constrained by low water levels during dry periods. Prolonged dry periods (i.e. 2001 to 2004 and 2007 to 2010) have prevented the Golden State Water Company from maximizing their share of the OSY during these periods. The Golden State Water Company desires to produce at least 7,800 acre-ft/yr from the Six Basins, assuming an OSY of 17,500 acre-ft/yr.[20]

### 3.2.4 San Antonio Water Company

SAWCo is a private water company with both retail and wholesale customers. Of its total shareholdings, retail shares make up about 15 percent and wholesale shares about 85 percent. The service area population of SAWCo (shown in Table 3-2) represents the retail customer population. Unlike other agencies in the Six Basins, the water supply plan of SAWCo was not developed to meet the water use demands of its shareholders but rather the entitlements of shareholders to the "entire water of the company." Although finite in number, shares in SAWCo are a commodity that may be divided or sold; for this reason, even though the "entire water of the company" is known, the distribution of entitlements among the shareholders has an unpredictable nature due to the liquidity of the shares (Civiltec 2011c). The "entire water of the company" is based on the hydrologic conditions in the area and has ranged from 10,000 to 16,574 acre-ft/yr.

Figure 3-4 is a stacked bar-chart showing SAWCo's historical (1999 to 2011) and projected (2015 to 2035) total water demands and water supplies by source. The water supply sources available to SAWCo include groundwater from the Six Basins, Chino Basin, and Cucamonga Basin, and surface water from San Antonio Canyon. The projected use of each supply source shown is static over the planning period and is based on established groundwater rights in the Six Basins (1,112 acre-ft/yr—based on an OSY of 17,500), Chino Basin (1,507 acre-ft/yr), and

[20] Golden State Water Company's total share of the OSY is the sum of its share and the shares of the City of Claremont and Pomona College (39.363 percent).

Cucamonga Basin (6,500 acre-ft/yr), and the historical average availability from San Antonio Canyon (7,455 acre-ft/yr).

SAWCo's water supply plan can be described as maximizing production from the Six Basins and Cucamonga Basin. Next, demands are met with native surface water from San Antonio Canyon. In average and wet years, surface water is more plentiful, and excess water can be used for recharge in the Six Basins and the Cucamonga Basin. Lastly, demands are met with production from the Chino Basin. Production from the Chino Basin is minimized if possible because (i) it is a more expensive supply compared to the SAWCo's other local sources and (ii) SAWCo can monetize the unused Chino Basin rights by leasing or transferring them to other agencies in the Chino Basin.

All water produced from the Six Basins by SAWCo is from the Upper Claremont Heights Basin. SAWCo has some flexibility for increasing production from the Six Basins beyond the OSY given that they can recharge and store water as part of their Storage and Recovery agreement with Watermaster. The terms of the Storage and Recovery Agreement, which was approved in 2007, allow SAWCo to spread and store 1,000 acre-ft/yr at the SASG up to a maximum storage account balance of 2,000 acre-ft. These terms encourage regular recovery of water from storage.

### 3.2.5 City of Upland

Figure 3-5 is a stacked bar-chart showing the City of Upland's historical (1999 to 2011) and projected (2015 to 2035) total water demands and water supplies by source. The sources of water supply available to the City of Upland include: groundwater from the Six Basins, Chino Basin, and Cucamonga Basin; water purchased from SAWCo; and imported and recycled water purchased from the IEUA. Water purchased from SAWCo can be a combination of any of the water supply sources available to SAWCo, some of which are already mixed in the distribution system prior to delivery to Upland. The relative contribution of each source varies from year-to-year, so purchases from SAWCo cannot be broken down by source for future projections.

The City of Upland's total water demand declined from about 24,000 acre-ft/yr in 2007 to about 19,500 acre-ft/yr in 2010. The decreasing trend in demand was likely due to the economic downturn and water conservation measures associated with multiple dry years. Demand is expected to be relatively constant through the planning period at about 22,000 acre-ft/yr.

The City of Upland's water supply plan can be described as maximizing production from the Six Basins, Cucamonga Basin, and shares of SAWCo. Remaining demand is met with purchases of SWP water from the IEUA and lastly from Chino Basin groundwater. Production from the Chino Basin is minimized if possible because (i) it is a more expensive supply compared to the City's other local sources of water supply and (ii) the City can monetize unused Chino Basin rights by leasing or transferring them to other agencies in the Chino Basin. In drier years, when surface water sources from SAWCo and Six Basins groundwater are less abundant, the City of Upland relies more heavily on groundwater from the Chino Basin and imported water from the IEUA. By 2015, about 900 acre-ft/yr of recycled water for direct non-potable use will be added to the City of Upland's supply portfolio.

As shown in Figure 3-5, the City of Upland's production from the Six Basins has sometimes been in excess of its share of the OSY. Transfers of rights from SAWCo (OSY or water from storage) have allowed the City of Upland to avoid a Replacement Water obligation for overproduction. The City of Upland's production in the Six Basins has been from the Upper Claremont Heights Basin and the Canyon Basin. At current production rates in the Six Basins, the City is approaching the capacity of its existing facilities. The City of Upland desires to increase its use of groundwater from the Six Basins as it is the least expensive water supply source available. One new well is planned for construction in the near future.

### 3.2.6 Three Valleys Municipal Water District

Figure 3-6 is a stacked bar chart showing TVMWD's historical (1999 to 2011) and projected (2015 to 2035) total water demands and water supplies by source. The total demands and supply plan of the TVMWD as shown in Figure 3-6 represents the total imported water demand of its entire service area, which includes retail water agencies that are not Parties to the Six Basins Judgment.

The total water supplied by TVMWD to its member agencies declined from a peak of about 87,700 acre-ft/yr in 2003 to about 48,000 acre-ft/yr in 2011. The decrease in deliveries through 2011 was largely due to court-mandated restrictions on State Water Project deliveries and drought conditions on both the SWP and the CRA. The water demand of TVMWD member agencies is projected to increase to about 62,000 acre-ft/yr by 2035.

Although TVMWD has been a Party to the Six Basins Judgment since 1999, it only recently acquired a Base Annual Production Right: in 2010, the TVMWD purchased 0.13 percent of the City of La Verne's Base Annual Production Right. This equates to about a 25 acre-ft/yr share of the Six Basins OSY. The TVMWD constructed its first groundwater well in 2009. This well is located on the Miramar WTP property and has a capacity of about 800 acre-ft/yr. The TVMWD utilizes the well to the maximum extent possible each year to supplement imported water treated at Miramar. Over-production of its water right is replaced through purchases of the unused water rights of other Parties or by recovering groundwater from its Storage and Recovery Account. The terms of the Storage and Recovery agreement allow the TVMWD to spread and store 1,000 acre-ft/yr of imported water at the SASG or the Miramar spreading grounds (located adjacent to the Miramar WTP) up to a maximum storage account balance of 3,500 acre-ft.

The Storage and Recovery agreement is used primarily as part of a Conjunctive Use Program (CUP) with the MWDSC. At the request of the MWDSC, the TVMWD must spread 700 acre-ft/yr up to a maximum storage account balance of 3,000 acre-ft. In dry years, or other water shortage events, the MWDSC can request that the TVMWD pump water up to 1,000 acre-ft/yr from the storage account in lieu of delivering a like amount of imported water. To comply with the terms of CUP, the TVMWD has constructed a new well, which started producing water in 2014 and adds an additional 800 acre-ft/yr of groundwater production capacity. The TVMWD plans on constructing two more wells.

The TVMWD desires to further increase conjunctive use of the Six Basins as a means of providing its member agencies with a reliable, local water supply. Accordingly, the TVMWD secured grant funding through the LACFCD to expand the imported water pipeline north into the SASG to increase the spreading capacity for conjunctive use. Increasing spreading will require a modification to the TVMWD's existing Storage and Recovery Agreement and the construction of additional wells to recover the water.

### 3.2.7 Aggregate Water-Supply Plan for the Six Basins Parties

In summary, the total water demands of the Six Basins Parties are projected to increase from about 104,000 acre-ft in 2011 to about 128,000 acre-ft in 2035. Excluding the imported water demands of the TVMWD's member agencies outside of the Six Basins, the total water demands of the Six Basins Parties are projected to increase from about 67,000 acre-ft/yr in 2011 to about 77,000 acre-ft/yr by 2035.

Table 3-2 shows that the Parties plan to meet the projected increase in demands primarily with groundwater from the Six Basins and Chino Basin and with recycled water. Figure 3-7 shows the historical (1999-2011) and planned (2015-2035) groundwater production from the Six Basins by Party. The figure illustrates that by 2020, the Parties plan to produce about 6,000 acre-ft/yr more from the Six Basins than was produced in 2011.

Section 2 of this report describes that the availability of groundwater from the Six Basins and native surface water from San Antonio Creek is directly related to the amount of precipitation. For example, during dry years/periods, the surface-water runoff in San Antonio Creek is less, and groundwater levels in the Four Basins are lower, compared to wet years/periods. In response, SAWCo and the City of Pomona divert less surface water from San Antonio Creek, Watermaster sets a lower OSY for the Four Basins, and the Parties generally increase the use of imported water or Chino Basin groundwater. During wet years/periods, the opposite occurs. Tables 3-4a, 3-4b, and 3-4c describe this behavior for each Party for 2015, 2025, and 2035 demands, respectively.[21] In these tables, dry, normal, and wet years are represented by the following OSYs for the Four Basins: 16,000 acre-ft, 19,000 acre-ft, and 22,000 acre-ft, respectively. Note that San Antonio Creek diversions are directly related to OSY, which is based on the historical relationship between OSY and San Antonio Creek diversions. These tables form the basis for the development of the Baseline Alternative described below.

## 3.3 Development of the Baseline Alternative

Since the amount of precipitation has an important effect on the water supplies available to the Parties and hence the water-supply plans of the Parties, the Baseline Alternative needed to be simulated over a long-term representative hydrology. The Baseline Alternative was described in enough detail to perform the numerical groundwater-flow modeling of the Six Basins. and to develop cost estimates by Party associated with the water-supply plans of the Baseline Alternative. The Baseline Alternative was developed through the following process:

- Describe the planning period and its assumed hydrology.
- Describe the OSY associated with the planning period hydrology.
- Describe each Party's water-supply plans based on the OSY over the planning period, including groundwater production, artificial recharge, and utilization of other water supply sources.

[21] During the preparation of these tables, the Parties refined some of their projected water-supply plans, compared to the supply plans as described in Table 6-2.

### 3.3.1 The Planning Period and its Assumed Hydrology

The planning period for the evaluation of the Baseline Alternative (and for all Strategic Plan Alternatives) is fiscal years 2013-2066. This period extends beyond the ultimate development plans of the local planning agencies and is long enough to demonstrate the long-term impacts of the Baseline and Strategic Plan Alternatives on the groundwater basin and production sustainability at wells. Impacts on the groundwater basin include changes in the water budget and OSY, groundwater levels, rising groundwater and liquefaction potential.

The assumed hydrology of the planning period was based on the historical record of precipitation for the period of 1960-2013, the characteristics of which are shown in Figure 3-8. Using this historical precipitation record for the planning period is appropriate because it contains wet periods and dry periods of various length and intensity, and the annual average precipitation (17.82 inches) is virtually equal to the long-term annual average for 1924-2012 (17.76 inches).[22] The assumed hydrology of the planning period begins with an extended dry period from 2013-2030 (corresponding to the historical period 1961 through 1977), which is a conservative assumption for the evaluation of groundwater impacts and production sustainability of wells in the Baseline and Strategic Plan Alternatives.

The same techniques and tools used to estimate the recharge components to the Six Basins for model calibration were used to estimate the recharge components for the Baseline Alternative.

Table 3-5a shows the water budget for the Baseline Alternative and contains the recharge and discharge components, change in storage, and annual developed yield estimates.

The methods and results for estimating recharge are summarized below:

- *Subsurface boundary inflow from the San Gabriel Mountains.* Hydrological Simulation Program—Fortran (HSPF) is a watershed-simulation model that was developed and is maintained by the USGS and EPA (Bicknell, B.R., et al, 1997; http://water.usgs.gov/software/HSPF/). An HSPF model of the eastern San Gabriel Mountains was constructed and calibrated over the period 1950-2012 to estimate the water budget of the mountain block (see Appendix A). The HSPF Model was used to generate the initial estimates of subsurface recharge from the San Gabriel Mountains to the Six Basins. These estimates were modified during the calibration of the groundwater-flow model. The final values of subsurface boundary inflow from the San Gabriel Mountains were used in the Baseline Alternative and are shown in Table 3-5a. This recharge component ranges from about 2,300 to 22,900 acre-ft/yr and averages about 8,700 acre-ft/yr, or 27 percent of total recharge.

- *Subsurface boundary inflow from the San Jose Hills.* The Rainfall, Runoff, Router, Root-zone Model (R4 Model) was used to estimate this recharge component for model calibration. Because this recharge component was estimated to be relatively small with little variability (108 to 279 acre-ft/yr during the calibration period), it was assumed to be the average value from the calibration period of 230 acre-ft/yr, or one percent of total recharge.

- *Deep infiltration of precipitation and applied water*. The R4 Model was used to estimate this recharge component for the Baseline Alternative, using the ultimate land use

[22] La Verne Fire Station precipitation gauge (LACDPW Station No. 196).

conditions across the Six Basins. This recharge component ranges from about 5,000 to 20,500 acre-ft/yr and averages about 10,300 acre-ft/yr, or 32 percent of total recharge.

- *Stormwater infiltration at spreading grounds.* The spreading of native surface water at LOSG, TCSG, and SASG was estimated by routing the surface-water runoff from the San Gabriel Mountains (estimated by HSPF model) through the spreading grounds using the R4 Model. The volume of native water available for spreading at the SASG was based on historical dam outflows for the hydrologic planning period, as measured by the US ACOE. The water was routed through the spreading grounds using a spreadsheet model based on the best available understanding of how the grounds are operated by the PVPA. Annual recharge of native water at all three spreading grounds ranges from about 200 to 36,300 acre-ft/yr and averages about 7,400 acre-ft/yr, or 23 percent of total recharge.

- *Streambed infiltration in unlined stream channels.* This recharge component was estimated by routing the surface-water runoff from the San Gabriel Mountains (estimated by HSPF model) through the unlined stream channels using the R4 Model. Because there are few unlined stream reaches in the Six Basins, this recharge component is relatively small, ranging from about 40 to 800 acre-ft/yr, and averages about 300 acre-ft/yr, or one percent of total recharge.

- *Returns from septic tanks.* This recharge component was assumed to be 400 acre-ft/yr (end of calibration value) for the Baseline Alternative, and assumes no change in the number of septic systems over the planning period. Returns from septic tanks contribute about one percent of the total recharge.

- *Artificial recharge of native water.* As stated above, the City of Pomona and SAWCo plan to artificially recharge native surface water from San Antonio Canyon in the Six Basins (490 and 300 acre-ft/yr, respectively) to augment their production rights from the Six Basins. Both Parties can do this because of their existing storage and recovery agreements. In the Baseline Alternative, this artificial recharge occurs at the SASG and PSG in the Upper Claremont Heights Basin. Artificial recharge of native water contribute about two percent of the total recharge.

- *Artificial recharge of imported water.* All other artificial recharge assumed to occur in the Baseline Alternative is imported water to satisfy a Replacement Water obligation caused by a Party that over-produces its share of the annual OSY. These Parties include: the TVMWD and GSWC. In the Baseline Alternative, this artificial recharge occurs at the SASG and the Miramar Ponds in the Upper Claremont Heights Basin. Total annual artificial recharge of imported water is shown in Table 3-5a, ranges from about 2,000 to 5,600 acre-ft/yr, and averages about 4,000 acre-ft/yr or 12 percent of the total recharge.

- *Total recharge.* Total annual recharge ranges from about 13,200 to 74,300 acre-ft/yr and averages about 32,100 acre-ft/yr.

### 3.3.2 Operating Safe Yield

The annual OSY was estimated over the planning period in order to estimate groundwater production for the Baseline Alternative. The OSY is the annual amount of groundwater that Watermaster determines can be pumped from the Four Basins free of any Replacement Water obligation. Watermaster sets the OSY based on recent and expected replenishment, pumping, and groundwater levels in the Four Basins—factors that are heavily influenced by precipitation and runoff in the watershed tributary to the Six Basins.

To estimate OSY based on the assumed hydrology of the Baseline Alternative, the following iterative process was executed:

- Run the Baseline Alternative with the Six Basins model, using the components of recharge listed in Table 3-5a, a constant OSY of 19,300 acre-ft/yr, and the water-supply plans of the Parties under an OSY of 19,300 acre-ft/yr.
- Compute the annual developed yield (DY) of the Four Basins over the planning period from the model-generated water budget.
- Use the following equation to estimate annual OSY:

$$OSY_{t_i} = \overline{DY}_{t_o-t_f} + k(\overline{DY}_{t_{i-3}-t_{i-1}} - \overline{DY}_{t_o-t_f})$$

where:

$OSY_{t_i}$ is the OSY of year *i*

$\overline{DY}_{t_o-t_f}$ is the long-term average DY during the baseline period

$k$ is a constant (0.25) to limit OSY to a practical range (~15,000 to 25,000 acre-ft/yr)

$\overline{DY}_{t_{i-3}-t_{i-1}}$ is the average DY from the three years prior to year *i*

Figure 3-9 shows the estimated OSY of the Four Basins over the planning period using the method described above. Note that the estimated OSY increases during wet years/periods, decreases during dry years/periods, and ranges between about 15,000 to 25,000 acre-ft/yr, which is consistent with Watermaster's historical behavior in setting the annual OSY. For these reasons, the estimated OSY for the Four Basins, as shown in Figure 3-9, was used to project the Parties' annual groundwater production and water-supply plans for the Baseline Alternative.

### 3.3.3 Groundwater Production

As the Parties' water-supply plans demonstrate, and as summarized in Tables 3-4a, 3-4b, and 3-4c, groundwater from the Six Basins is the preferred source of water supply. In the Baseline Alternative, each Party pumps its share of the annual OSY shown in Figure 3-9 with the following exceptions:

- The Golden State Water Company desires that groundwater from the Six Basins supply at least 8,340 acre-ft/yr, which is about 60% of its total demand. Therefore, Golden State Water Company plans to over-produce its share of the OSY when the OSY is less than 21,200 acre-ft/yr.
- The City of Pomona and SAWCo plan to recharge native surface water from San Antonio Canyon in the Six Basins (620 and 300 acre-ft/yr, respectively) to augment their production rights from the Six Basins. Both Parties can do this because of their existing storage and recovery accounts. Both Parties plan to pump the recharged water in the same year. For the City of Pomona, the first 130 acre-ft is considered part of the Safe

Yield and does not accrue in its storage account. In the Baseline Alternative, the City pumps 490 acre-ft/yr more than its share of the annual OSY, and SAWCo pumps 300 acre-ft/yr more than its share.

- The TVMWD plans to pump groundwater up to its well capacities, which reach 3,200 acre-ft/yr by 2018 and remain constant thereafter.
- The City of La Verne plans to pump its share of the OSY from the Pomona Basin in the Baseline Alternative but also has independent discretion to pump groundwater from the Two Basins. The City plans to pump 1,830 acre-ft/yr from the Two Basins during the Baseline Alternative.

Total annual groundwater production from the Six Basins for the Baseline Alternative is shown in Table 3-5a. Production ranges from 22,000 to 30,300 acre-ft/yr and averages about 25,700 acre-ft/yr.

### 3.3.4 Utilization of Other Water Supplies

Sources of water supply available to the Parties other than groundwater from the Six Basins include: groundwater from the Chino Basin, Cucamonga Basin, and Spadra Basin; surface water runoff from San Antonio Canyon; imported water; and recycled water. It is important to quantify the use of these other water supplies in the Baseline Alternative such that cost estimates of the Parties' water-supply plans can be derived and compared to the costs associated with the water-supply plans under the Strategic Plan alternatives.

These other water supplies are described in Section 3.1. The uses of these supplies by Party, and under variable hydrologic conditions, are described in Section 3.2 and in Tables 3-4a, 3-4b, and 3-4c.

## 3.4 Evaluation of the Baseline Alternative

The 2015 Six Basins Groundwater-Flow Model was used to simulate the water-supply plans of the Baseline Alternative and estimate the response of the groundwater basin, including the water budget, groundwater elevations, and groundwater-flow directions. These estimates were analyzed to assess the sustainability of production at wells and the threat of rising groundwater.

### 3.4.1 Water Budget of the Baseline Alternative

The simulated, annual water budget of the Baseline Alternative is described in the following tables:

- Table 3-5a is the water budget for the total Six Basins,
- Table 3-5b is the water budget for the Four Basins,
- Table 3-5c is the water budget for the Four Basins north of the Indian Hill Fault,
- Table 3-5d is the water budget for the Pomona Basin,
- Table 3-5e is the water budget for the Two Basins, and

- Table 3-6 is a statistical summary of the water-budget tables listed above.

The following are the significant observations from the analysis of the water budget of the Baseline Alternative.

Table 3-5a is the annual water budget for the Six Basins, as simulated by the model for the Baseline Alternative. On average, total recharge of about 32,100 acre-ft/yr is less than total discharge of about 34,100 acre-ft/yr. Total subsurface outflow to the Chino Basin remained relatively constant over the planning period and averaged about 8,000 acre-ft/yr. The long-term average developed yield of the Six Basins was about 18,900 acre-ft/yr—about 400 acre-ft/yr less than the Safe Yield in the Judgment for the Six Basins of 19,300 acre-ft/yr.

Table 3-5b is the annual water budget for the Four Basins, as simulated by the model for the Baseline Alternative. On average, total recharge of about 31,400 acre-ft/yr is less than total discharge of about 33,200 acre-ft/yr. Total subsurface outflow to the Chino Basin remained relatively constant over the planning period and averaged about 8,000 acre-ft/yr. There is no projected outflow of rising groundwater from the Four Basins. The long-term average developed yield of the Four Basins is projected to be about 17,300 acre-ft/yr.

Table 3-5c is the annual water budget for the portion of the Four Basins north of the Indian Hill Fault (Canyon, Upper Claremont Heights, and Lower Claremont Heights Basins), as simulated by the model for the Baseline Alternative. On average, the total recharge of about 25,800 acre-ft/yr is less than the total discharge of about 26,600 acre-ft/yr. Most of the subsurface outflow from this area occurs across the Indian Hill Fault into the Pomona Basin, which averages about 9,500 acre-ft/yr. A smaller volume of subsurface outflow occurs across the San Jose Fault into the Chino Basin, which averages about 2,700 acre-ft/yr, and from the Lower Claremont Heights Basin to the Two Basins, which averages about 1,300 acre-ft/yr. Subsurface outflow is greatest in the years following very wet periods; for example, total subsurface outflow was about 18,000 acre-ft in 2037 (corresponding to hydrologic year 1984, which followed the wet period of 1978-83) compared to long-term average subsurface outflow of about 13,500 acre-ft/yr. There is no projected outflow of rising groundwater from this area. The long-term average developed yield from this area is projected to be about 7,500 acre-ft/yr.

Table 3-5d is the annual water budget for the Pomona Basin, as simulated by the model for the Baseline Alternative. On average, the total recharge of about 15,000 acre-ft/yr is less than the total discharge of about 16,100 acre-ft/yr. Subsurface outflow to the Chino Basin averages about 5,300 acre-ft/yr over the planning period. There is no projected outflow of rising groundwater from the Pomona Basin. The long-term average developed yield from the Pomona Basin is projected to be about 9,800 acre-ft/yr.

Table 3-5e is the annual water budget for the Two Basins, as simulated by the model for the Baseline Alternative. On average, the total recharge of about 3,700 acre-ft/yr is less than the total discharge of about 3,900 acre-ft/yr. Subsurface outflow to the Pomona Basin averages about 1,700 acre-ft/yr over the planning period. The long-term average developed yield from the Two Basins is projected to be about 1,700 acre-ft/yr.

### 3.4.2 Groundwater-Level Response

#### 3.4.2.1 Projected Groundwater Elevations and Groundwater-Flow Directions

Figure 3-10a is a groundwater-elevation contour map for July 2012, which represents the initial condition for groundwater elevations at the start of the planning period.[23] The initial condition is the time during the planning period of maximum groundwater elevation in the Pomona Basin and the Two Basins. The arrows on the map depict the general groundwater-flow directions across the Six Basins, which are perpendicular to the contours from higher elevation to lower elevation. In general, groundwater flow mimics the surface-water drainage patterns: from areas of recharge in in the north towards the south. Along this general flow path, groundwater encounters bedrock ridges and barriers to groundwater flow that deflect and retard the flow. As groundwater mounds behind bedrock ridges and/or fault barriers, it flows within the shallower sediments over and across these obstructions into down-gradient basins.

Model-predicted groundwater elevations were also mapped for the following conditions during the planning period for the Baseline Alternative:

- **Figure 3-10b—July 2036**. The groundwater elevations shown in this figure represent the time during the planning period of maximum groundwater elevation in the portion of the Four Basins north of the Indian Hill Fault, following an intense wet period from 2031-2036 (corresponding to the historical period 1978 through 1983). Groundwater elevations across most of the Pomona Basin are lower compared to the initial condition. The figure shows that groundwater-flow directions do not change significantly compared to the initial conditions; although, the hydraulic gradients across most of the Six Basins steepen due to the increased recharge of native water.

- **Figure 3-10c—July 2066**. The groundwater elevations shown in this figure represent the end of the planning period, which is the time of minimum groundwater elevation in the Pomona Basin. The figure shows that groundwater-flow directions do not change significantly compared to the initial condition (Figure 3-10a) or to periods of higher groundwater elevations (Figure 3-10b).

In general, groundwater elevations change across the Six Basins over planning period, but the shape and orientation of the contours do not change significantly, demonstrating that groundwater-flow patterns within Six Basins are consistent over time in the Baseline Alternative.

#### 3.4.2.2 Change in Groundwater Elevations and Storage

Figure 3-11a shows the projected change in groundwater elevations for the Baseline Alternative from the initial condition (July 2012) to the time of maximum groundwater elevation in the portion of the Four Basins north of the Indian Hill Fault (July 2036) following the end of an intense wet period from 2031-2036 (corresponding to the historical wet period 1978 through 1983). Table 3-7 lists the total storage and storage changes associated with the change in groundwater elevations shown in Figure 3-11a. The main observations from this figure and table are that:

[23] The groundwater elevations in this figure are the same model-predicted groundwater elevations from the end of the calibration period.

- Groundwater elevations increased most significantly in the vicinity of the SASG, where high volumes of stormwater runoff recharged during and after the wet period. Storage increased by about 66,000 acre-ft or 29 percent of the initial storage of about 226,000 acre-ft.

- Groundwater elevations gradually declined across most of the Pomona Basin during this period. Storage decreased in the Pomona Basin from 2012-2036 by about 35,000 acre-ft or 9 percent of the initial storage of about 384,000 acre-ft. This is because, on average, discharge exceeds recharge in the Pomona Basin during this period by about 1,500 acre-ft/yr.

Figure 3-11b shows the projected change in groundwater elevations for the Baseline Alternative from the initial condition (July 2012) to the end of the planning period (July 2066). Table 3-7 lists the total storage and storage changes associated with the change in groundwater elevations shown in Figure 6-11b. The main observations from this figure and table are that:

- Groundwater elevations increased by about 0-10 feet in the vicinity of the SASG by the end of the planning period. This is because, on average, about 4,800 acre-ft/yr of artificial recharge of native and imported water occurs in the Baseline Alternative.[24] The artificial recharge occurs at the SASG and PSG, so groundwater elevations are supported in this area by the artificial recharge.

- Groundwater elevations decreased by up to 20 feet across most other portions of the Four Basins north of the Indian Hill Fault by the end of the planning period. For the Four Basins north of the Indian Hill Fault, storage decreased from 2012-2066 by about 43,000 acre-ft or 19 percent of the initial storage of about 226,000 acre-ft. This is because, on average, discharge exceeds recharge in Four Basins north of the Indian Hill Fault by about 800 acre-ft/yr in the Baseline Alternative.

- In the Pomona Basin, groundwater elevations from 2012-2066 decreased, which resulted in a storage decrease of about 58,000 acre-ft or 15 percent of the initial storage of about 384,000 acre-ft. This is because, on average, discharge exceeds recharge in the Pomona Basin by about 1,100 acre-ft/yr in the Baseline Alternative. This imbalance of recharge and discharge is caused, in part, because the City of Pomona and GSWC plan to over-pump their OSY rights, and such over-pumping will occur, in part, in the Pomona Basin. The replacement of the over-pumping occurs as artificial recharge at the SASG and PSG in the Upper Claremont Heights Basin.

- Even though groundwater elevations in the Pomona Basin are projected to decline in the Baseline Alternative, the groundwater elevations in the Pomona Basin in the 1960s were significantly lower than groundwater elevations projected for the end of the planning period (2066) by about 100-300 feet. This is an important finding of the Baseline Alternative, because it suggests it suggests that Baseline Alternative is feasible from a physical standpoint, and that Strategic Plan Alternatives that result in additional lowering of groundwater levels in the Pomona Basin are potentially feasible.

[24] The artificial recharge of native water is performed by the City of Pomona and SAWCo to augment their pumping rights beyond the limits of their OSY rights. The artificial recharge of imported water is required to replace the over-pumping of OSY rights, mainly by the TVMWD and GSWC.

#### 3.4.2.3 Production Sustainability at Wells

Appendix A contains time-series charts of projected groundwater levels at all production wells in the Six Basins for the Baseline Alternative (Figures D-1 to D-47). Analysis of model calibration indicated that in some areas in the model domain the model consistently estimated higher or lower groundwater elevations compared to observed groundwater elevations, which means the model-projected groundwater elevations have a consistent elevation bias over time. Each production well in the Six Basins was analyzed for elevation bias by comparing measured versus simulated groundwater elevations over the last 20 years of the calibration period (1993-2012) and a bias-adjustment was determined for each well. Table D-1 lists the bias-adjustment for each production well in the Six Basins. The bias-adjustments were applied to the time-series of projected groundwater elevations for each well in the charts of Appendix A.

Each of these time-series charts includes a "sustainability metric," as provided by the well owner. The sustainability metric, as used herein, refers specifically to the lowest water-level elevation that enables the well to produce groundwater at a desired production rate, given the well construction and pumping equipment. Groundwater production at a well is presumed to be sustainable if the water level at that well is above the sustainability metric. If the water-level declines below the sustainability metric, it is presumed that the well owner will either be required to lower the pumping equipment to continue pumping at the levels defined by the OSY or fail to produce groundwater at the planned rate. In the evaluation of sustainability herein, it was assumed that the well owner would lower its pumps to sustain production.

The results of the Baseline Alternative indicate that production sustainability is not a major challenge for any Party. The time-series charts in Appendix A indicate that the following wells are projected to have water levels decline to or below their respective sustainability metric at some time during the planning period of the Baseline Alternative:

- GSWC Berkley No. 2
- GSWC Del Monte No. 1
- GSWC Pomello No. 1
- GSWC Pomello No. 4
- GSWC Mills No. 1
- TVMWD No. 1
- City of Pomona P-37
- City of Pomona TW-1

#### 3.4.2.4 The Threat of Rising Groundwater and Liquefaction

Rising groundwater can occur when groundwater levels approach the ground surface. Liquefaction potential occurs when groundwater levels rise to within 50 feet of the ground surface. Figure 6-11a is a map that shows groundwater-elevation change from the initial condition (2012) to the time during the planning period of maximum storage in the Six Basins (2036). The maps shows the generalized areas in the Six Basins of projected potential for rising groundwater and/or liquefaction at some time during the planning period for the Baseline Alternative. These threats of rising groundwater and liquefaction are spatially confined to the northern portion of the Upper Claremont Heights Basin—near the location of the artificial recharge of stormwater in the SASG. The threats of rising groundwater and liquefaction are temporally constrained to wet periods when relatively large volumes of stormwater recharge occur—about 4 percent of the time during the planning period.

### 3.4.3 Groundwater in Storage versus Subsurface Outflow

Figure 3-12a is a time-series chart that shows the relationship between groundwater storage versus subsurface outflow for the combined Canyon, Lower Claremont Heights, and Upper Claremont Heights Basins over the planning period for the Baseline Alternative. Subsurface outflow from this area occurs to the Pomona Basin, the Chino Basin, and the Two Basins. As noted previously, most of the subsurface outflow from this area occurs across the Indian Hill Fault into the Pomona Basin (about 70 percent of total subsurface outflow). Figure 3-12a shows that subsurface outflow from this area is directly related to storage. During 2013-2036, storage increased from about 225,500 acre-ft to about 292,000 acre-ft, and subsurface outflow increased by about 7,700 acre-ft/yr. During 2036-2066, storage decreased from about 292,000 acre-ft to about 182,500 acre-ft, and subsurface outflow decreased by about 5,700 acre-ft/yr.

Figure 3-12b is a time-series chart that shows the relationship between groundwater in storage in the Pomona Basin versus subsurface outflow to the Chino Basin over the planning period for the Baseline Alternative. Figure 3-12b shows that subsurface outflow from the Pomona Basin is directly related to storage. Storage is projected to decrease over the planning period from about 384,000 acre-ft to about 326,000 acre-ft, and subsurface outflow decreased by about 900 acre-ft/yr.

## 3.5 Water-Supply Costs of the Baseline Alternative

A cost model was developed and used to evaluate the cost of the water-supply plans by individual Party and in aggregate for the Baseline Alternative. The evaluation will serve as a “baseline” for comparison to the costs of the Strategic Plan alternatives, which will assist the Parties in ranking and selecting specific projects or alternatives for implementation.

The cost model for the Baseline Alternative is included as Appendix B and is comprised of a series of four linked spreadsheet tables for each Party:

A. A breakdown of the Party’s water-supply plan (see Section 3.2) into annual estimates for the period 2013-2040 under the variable OSY assumed for the Baseline Alternative (see Section 3.3). The groundwater sources are further broken down in these spreadsheets if different costs are associated with wells in the same basin or subbasin. For instance, some wells in the Pomona Basin require treatment (and its associated cost) to make potable water, and some do not.

B. A breakdown of the Party’s annual water rights and storage accounting for the Four Basins for the period 2013-2040 under the variable OSY assumed for the Baseline Alternative. This effort is necessary to track storage and recovery accounts (if the Party maintains a storage and recovery agreement with Watermaster) and to compute Replacement Water obligations.

C. A breakdown of the annual unit costs for each of the Party’s water supplies for the period of 2013-2040. WEI worked closely with each Party to generate the unit costs for 2013. Each Party provided data and information in different formats and levels of detail. The unit costs were grouped into the following categories:

i. *Commodity* costs are the cost of acquiring the water supply. For example, the commodity costs for Six Basins and Chino Basin groundwater are the Watermaster assessments.

ii. *Production* costs are the energy costs associated with producing the water supply.

iii. *Operations and Maintenance (O&M)* costs are the variable costs for field staff, contract services, tools and equipment, training and supplies, repairs and general maintenance, and the regulatory compliance associated with producing the water supply. This excludes maintenance on reservoirs or pipelines and the variable O&M costs associated with treatment.

iv. *Treatment* costs include the costs for chemicals and other variable O&M associated with the treatment necessary to produce potable water.

v. *Boosting* costs are the energy costs associated with boosting water to system pressure. Boosting costs were in some cases described separately from production costs for specific water supplies that require boosting.

D. A breakdown of the total annual costs and total annual unit costs for each water supply and the annual melded unit cost for the period 2013-2040.

## 3.5.1 Assumptions for Estimating Cost

### 3.5.1.1 Inflation Rate

All unit costs, except for imported water, were assumed to increase at 2.5 percent per year.

### 3.5.1.2 Imported Water Cost

The unit cost of Tier 1 treated, imported water from the TVMWD was obtained from the TVMWD for the period of 2013-2040. The TVMWD assumes this unit cost will increase by about four to five percent per year.

The unit cost of Tier 1 untreated imported water from the IEUA was obtained from the IEUA for 2013. This unit cost was assumed to increase by five percent per year through 2040 in the Baseline Alternative.

### 3.5.1.3 Water Transfers

Water transfers are any exchange or sale of water from one Party to another. The cost of acquiring water through a water transfer was assumed to be the same for all Parties: 80 percent of the cost of acquiring Tier 1 treated, imported water.

## 3.5.2 Cost Estimates of the Baseline Alternative

Figure 3-13 displays the melded unit cost of each Party's water-supply plan. The unit cost of the water-supply plans increase over time for each Party, and the rate of increase for each Party is dependent on its mix of water sources.

The aggregate melded unit cost of water for the Six Basins Parties increases from $595/acre-ft in 2013 to $1,606/acre-ft in 2040. The aggregated melded unit cost of water for the Six Basins Parties, excluding the TVMWD, increases from $416/acre-ft in 2013 to $1,016/acre-ft in 2040.

### 3.5.3 Sensitivity Analysis

As discussed in Section 3.1, the annual increase in the unit cost of imported water has varied from about five to 10 percent. The cost model described above assumes an annual increase of five percent for the unit cost of imported water. A sensitivity analysis was performed on the melded unit cost of water supply for all Six Basins Parties by adjusting the assumption for the annual increase in the cost of imported water. In this analysis, the annual increase in the cost of imported water was assumed to be 10 percent and 2.5 percent (as opposed five percent), and the melded unit cost of water supply for all Six Basins Parties was re-computed.

Figure 3-14 shows the results of the sensitivity analysis, which suggests the cost model is sensitive to the assumed rate of annual increase in the cost of imported water. By 2040 the melded unit costs of water supply were $818/acre-ft, $1,016/acre-ft, and $1,861/acre-ft, assuming annual rate increases in the cost of imported water of 2.5, 5, and 10 percent, respectively.

## 3.6 Conclusions and Recommendations

The following are the main conclusions derived from the evaluation of the Baseline Alternative and recommendations for the development and evaluation of Strategic Plan alternatives for the Six Basins:

- The water-supply plans of the Baseline Alternative are different compared to the water-supply plans of the post-Judgment period (1999-2013). Many of the Parties plan to increase groundwater production from the Six Basins—in some cases, exceeding their share of the OSY, which requires replacement through the artificial recharge of native and imported waters. The artificial recharge occurs north of the Indian Hill Fault, mainly in the vicinity of the SASG. Some of the increased production is planned to occur south of the Indian Hill Fault in the Pomona and Ganesha Basins. The production and recharge activities associated with the water-supply plans in the Baseline Alternative are projected to maintain higher groundwater elevations relative to the groundwater elevations of the historical post-Judgment period in the vicinity of the SASG during most of the planning period, and cause groundwater-level declines in the areas south of the Indian Hill Fault. These predicted groundwater-level changes will provide some advantages to the Parties:
    - The increase in groundwater levels in the vicinity of the SASG will support production capacity at wells in this area—especially during dry periods when, historically, lower groundwater levels have caused reduced pumping capacities at wells.
    - The decline in groundwater levels south of the Indian Hill Fault (especially in the Pomona Basin) will lessen the threats of rising groundwater and liquefaction potential.
    - The decline in groundwater levels in the Pomona Basin will increase subsurface inflow from the Upper Claremont Heights, Lower Claremont Heights, and Two Basins and reduce subsurface outflow to the Chino Basin, which will have the effect of better balancing recharge and discharge in the Pomona Basin and stabilizing groundwater levels at a new lower equilibrium.

- A concern for some Parties is that recharge occurring at the SASG leads to increased subsurface outflow from the Upper Claremont Heights Basin to the Chino Basin. The model simulation of the Baseline Alternative indicates that most of the subsurface outflow from the Upper Claremont Heights Basin occurs across the Indian Hill Fault to recharge the Pomona Basin. This suggests that Strategic Plan alternatives that include projects to enhance artificial recharge at the SASG are viable and should be evaluated. Before full-scale implementation of such projects, we recommend the collection of additional field information to confirm these conclusions regarding the fate of recharge at the SASG and the relative magnitude of subsurface discharge from the Upper Claremont Heights Basin.
- The greatest regulatable storage reservoir in the Six Basins is in the Pomona Basin. Future long-term storage programs should be conducted in the Pomona Basin, and not in the Upper Claremont Heights Basin. This is because:
    - The Pomona Basin is the largest subbasin within the Six Basins. For example, groundwater in storage in the Pomona Basin was about 384,000 acre-ft in 2012, while total storage in the combined Upper Claremont Heights, Lower Claremont Heights, and Canyon basins was about 225,500 acre-ft.
    - Subsurface outflow from the Pomona Basin is much smaller and less volatile than subsurface outflow from the combined Upper Claremont Heights and Lower Claremont Heights basins. For example, subsurface outflow from the Pomona Basin averages about 5,300 acre-ft/yr and ranges from 4,700 to 5,900 acre-ft/yr. Subsurface outflow from the combined Upper Claremont Heights and Lower Claremont Heights basins averages about 13,500 acre-ft/yr and ranges from about 9,000 to 18,000 acre-ft/yr.
    - Subsurface outflow from the combined Upper Claremont Heights and Lower Claremont Heights basins is highest in years following wet periods when large volumes of recharge occur at the SASG. This indicates the recharge at the SASG exits the Upper Claremont Heights and Lower Claremont Heights basins relatively rapidly compared to Pomona Basin.
- The model results of the Baseline Alternative indicate that groundwater levels will decline in the Pomona Basin, which will lessen the threats of rising groundwater and liquefaction potential, and will increase the yield of the Pomona Basin by reducing subsurface outflow by about 900 acre-ft/yr. In the 1960s, groundwater levels in some parts of the Pomona Basin were 100-300 feet lower than predicted for the end of the planning period. This suggests that Strategic Plan alternatives that include projects to increase production from the Pomona Basin in excess of the production plans in the Baseline Alternative may be viable (subject to water quality and subsidence challenges), could further decrease subsurface outflow to the Chino Basin, and should be evaluated.

**Table 3-1**
**Base Annual Production Rights of the Six Basins Parties**

| **Six Basins Watermaster Party** | *% Share* | Base Annual Production Right (acre-ft) |
|---|---|---|
| City of Claremont | 2.772% | 535.0 |
| City of La Verne | 7.601% | 1,467.0 |
| City of Pomona | 20.798% | 4,013.9 |
| City of Upland | 9.544% | 1,842.0 |
| Golden State Water Company | 34.741% | 6,705.0 |
| Pomona College | 1.850% | 357.0 |
| San Antonio Water Company | 7.166% | 1,383.0 |
| Three Valleys Municipal Water District | 0.130% | 25.0 |
| West End Consolidated Water Company | 15.399% | 2,972.0 |
| **Totals** | **100%** | **19,300.0** |

**Table 3-2**
**2011 and Projected (2015 to 2035) Water Demands and Supply Plans of the Six Basins Parties**

| Agency | Year | Service Area Population[1] | Water Demand[2] (acre-ft) | Water Supply Sources Available to the Six Basins Parties (acre-ft) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Groundwater | | | | San Antonio Creek[4] | Purchase From SAWC[5] | Imported Water Purchase from: | | | Purchase From Upland[9] | Recycled Water | Total Supply |
| | | | | Six Basins | Other | | | | | TVMWD[6] | IEUA[7] | MWDSC[8] | | | |
| | | | | | Chino Basin | Cucamonga Basin | Spadra Basin[3] | | | | | | | | |
| *(a)* | *(b)* | *( c)* | *(d)* | *(e)* | *(f)* | *(g)* | *(h)* | *(i)* | *(j)* | *(k)* | *(l)* | *(m)* | *(n)* | *(o)* | *(p)* |
| City of La Verne | 2011 | 28,932 | 6,873 | 2,155 | | | | | | 4,718 | | | | | 6,873 |
| | 2015 | 32,230 | 8,127 | 4,027 | | | | | | 4,100 | | | | | 8,127 |
| | 2020 | 32,722 | 7,527 | 4,077 | | | | | | 3,450 | | | | | 7,527 |
| | 2025 | 33,214 | 7,816 | 4,077 | | | | | | 3,739 | | | | | 7,816 |
| | 2030 | 33,706 | 8,094 | 4,077 | | | | | | 4,017 | | | | | 8,094 |
| | 2035 | 34,198 | 8,385 | 4,077 | | | | | | 4,308 | | | | | 8,385 |
| City of Pomona[3] | 2011 | 170,229 | 22,122 | 3,844 | 10,783 | | 278 | 3,383 | | 2,790 | | | | 1,044 | 22,122 |
| | 2015 | 179,799 | 23,798 | 4,014 | 13,103 | | 400 | 2,500 | | 1,986 | | | | 1,795 | 23,798 |
| | 2020 | 189,552 | 25,383 | 4,014 | 14,300 | | 400 | 2,500 | | 1,724 | | | | 2,445 | 25,383 |
| | 2025 | 198,998 | 26,288 | 4,014 | 14,300 | | 400 | 2,500 | | 2,379 | | | | 2,695 | 26,288 |
| | 2030 | 208,144 | 26,847 | 4,014 | 14,300 | | 400 | 2,500 | | 2,438 | | | | 3,195 | 26,847 |
| | 2035 | 216,899 | 28,095 | 4,014 | 15,000 | | 400 | 2,500 | | 2,986 | | | | 3,195 | 28,095 |
| Golden State Water Company (GSWC)[9] | 2011 | 35,248 | 10,835 | 6,340 | 549 | | | | | 3,130 | | | 816 | | 10,835 |
| | 2015 | 35,994 | 12,459 | 7,836 | 411 | | | | | 4,212 | | | | | 12,459 |
| | 2020 | 36,793 | 11,334 | 7,836 | 411 | | | | | 3,087 | | | | | 11,334 |
| | 2025 | 37,566 | 11,572 | 7,836 | 411 | | | | | 3,325 | | | | | 11,572 |
| | 2030 | 38,306 | 11,800 | 7,836 | 411 | | | | | 3,553 | | | | | 11,800 |
| | 2035 | 39,015 | 12,018 | 7,836 | 411 | | | | | 3,771 | | | | | 12,018 |
| San Antonio Water Company (SAWC)[10] | 2011 | 3,371 | 16,811 | 1,174 | 221 | 6,062 | | 8,800 | | | | | | | 19,439 |
| | 2015 | 3,429 | 16,645 | 1,112 | 1,507 | 6,500 | | 5,019 | | | | | | | 16,645 |
| | 2020 | 3,486 | 16,645 | 1,112 | 1,507 | 6,500 | | 5,019 | | | | | | | 16,645 |
| | 2025 | 3,544 | 16,645 | 1,112 | 1,507 | 6,500 | | 5,019 | | | | | | | 16,645 |
| | 2030 | 3,602 | 16,645 | 1,112 | 1,507 | 6,500 | | 5,019 | | | | | | | 16,645 |
| | 2035 | 3,659 | 16,645 | 1,112 | 1,507 | 6,500 | | 5,019 | | | | | | | 16,645 |
| City of Upland[5,9] | 2011 | 73,732 | 21,894 | 4,547 | 500 | 618 | | | 11,021 | | 5,209 | | | | 21,894 |
| | 2015 | 76,110 | 23,092 | 4,547 | 1,000 | 750 | | | 10,000 | | 5,895 | | | 900 | 23,092 |
| | 2020 | 78,500 | 21,244 | 4,547 | 1,000 | 750 | | | 10,000 | | 4,047 | | | 900 | 21,244 |
| | 2025 | 79,680 | 21,551 | 4,547 | 1,000 | 750 | | | 10,000 | | 4,354 | | | 900 | 21,551 |
| | 2030 | 80,870 | 21,858 | 4,547 | 1,000 | 750 | | | 10,000 | | 4,661 | | | 900 | 21,858 |
| | 2035 | 82,050 | 22,166 | 4,547 | 1,000 | 750 | | | 10,000 | | 4,969 | | | 900 | 22,166 |
| Three Valleys Municipal Water District[6] (TVMWD) | 2011 | 573,799 | 48,164 | 779 | | | | | | | | 47,385 | | | 48,164 |
| | 2015 | 600,336 | 54,884 | 1,800 | | | | | | | | 53,084 | | | 54,884 |
| | 2020 | 629,479 | 51,488 | 3,200 | | | | | | | | 48,288 | | | 51,488 |
| | 2025 | 658,138 | 53,981 | 3,200 | | | | | | | | 50,781 | | | 53,981 |
| | 2030 | 685,795 | 59,761 | 3,200 | | | | | | | | 56,561 | | | 59,761 |
| | 2035 | 712,264 | 61,884 | 3,200 | | | | | | | | 58,684 | | | 61,884 |
| Total[1,2,11] | 2011 | 650,902 | 104,225 | 18,839 | 12,053 | 6,680 | 278 | 12,183 | 11,021 | 10,637 | 5,209 | 47,385 | 816 | 1,044 | 106,852 |
| | 2015 | 679,875 | 118,707 | 23,336 | 16,021 | 7,250 | 400 | 7,519 | 10,000 | 10,298 | 5,895 | 53,084 | 0 | 2,695 | 118,707 |
| | 2020 | 711,465 | 115,360 | 24,786 | 17,218 | 7,250 | 400 | 7,519 | 10,000 | 8,261 | 4,047 | 48,288 | 0 | 3,345 | 115,360 |
| | 2025 | 741,362 | 118,410 | 24,786 | 17,218 | 7,250 | 400 | 7,519 | 10,000 | 9,443 | 4,354 | 50,781 | 0 | 3,595 | 118,410 |
| | 2030 | 770,267 | 124,997 | 24,786 | 17,218 | 7,250 | 400 | 7,519 | 10,000 | 10,008 | 4,661 | 56,561 | 0 | 4,095 | 124,997 |
| | 2035 | 797,973 | 128,128 | 24,786 | 17,918 | 7,250 | 400 | 7,519 | 10,000 | 11,065 | 4,969 | 58,684 | 0 | 4,095 | 128,128 |
| Total Excluding TVMWD Service Area outside of Six Basins[12] | 2011 | 311,512 | 66,698 | 18,839 | 12,053 | 6,680 | 278 | 12,183 | 11,021 | 10,637 | 5,209 | 9,858 | 816 | 1,044 | 69,326 |
| | 2015 | 325,120 | 74,121 | 23,336 | 16,021 | 7,250 | 400 | 7,519 | 10,000 | 10,298 | 5,895 | 8,498 | 0 | 2,695 | 74,121 |
| | 2020 | 339,030 | 72,133 | 24,786 | 17,218 | 7,250 | 400 | 7,519 | 10,000 | 8,261 | 4,047 | 5,061 | 0 | 3,345 | 72,133 |
| | 2025 | 351,666 | 73,872 | 24,786 | 17,218 | 7,250 | 400 | 7,519 | 10,000 | 9,443 | 4,354 | 6,243 | 0 | 3,595 | 73,872 |
| | 2030 | 363,932 | 75,244 | 24,786 | 17,218 | 7,250 | 400 | 7,519 | 10,000 | 10,008 | 4,661 | 6,808 | 0 | 4,095 | 75,244 |
| | 2035 | 375,821 | 77,309 | 24,786 | 17,918 | 7,250 | 400 | 7,519 | 10,000 | 11,065 | 4,969 | 7,865 | 0 | 4,095 | 77,309 |

**Footnotes:**

1 -- The total service area population is not the summation of each agency shown in the table. The service area population of the TVWMD includes that of the City of La Verne, the City of Pomona, and the GSWC. Thus, the total service area population is equal to TVMWD + SAWC + City of Upland.

2 -- Water demands represent the total water demand of each agency's service area, except for TVMWD. In the case of TVMWD, the total demand only represents its service area's demand for imported water purchases from TVMWD. SAWC's water demand includes the demand of its primary shareholder, the City of Upland. And, City of Upland's water demand includes sales to the GSWC. Thus, the total demand at the bottom of Table 3-2 is not the summation of each agency. The total demand is equal to the summation of all agency demands less the imported water demand of the City of La Verne, the City of Pomona, and the GSWC shown in column (k), less the demand for purchases from the SAWC shown in column (j), and less the demand for purchases from the City of Upland shown in column (n).

3 -- Water produced by the City of Pomona from the Spadra Basin is used to meet non-potable water demands.

4 -- San Antonio Creek is the native surface water generated in the San Antonio Creek Watershed upstream of the San Antonio Dam. In the case of the SAWC, some of the water from the San Antonio Canyon that will be delivered to the Tunnel Ponds for percolation into the San Antonio Tunnel. Water extracted from the Tunnel is shown in the SAWC UWMP as groundwater resource, however, because this source must first be diverted from San Antonio Creek to reach the Tunnels, it is included here as San Antonio Creek.

5 -- The City of Upland is the primary shareholder of the SAWC. Water purchased from the SAWC can be a combination of any of the water supply sources available to the SAWC, some of which are already mixed in the distribution system prior to delivery to Upland. The relative contribution of each source varies from year-to-year. Thus, purchases from the SAWC cannot be broken down by source and is shown here as Upland's total demand for SAWC water.

6 -- The TVMWD is the regional imported water wholesale agency serving Six Basins parties in the Los Angeles County (City of La Verne, City of Pomona, and Golden State Water Company). TVMWD purchases imported water from the MWDSC and supplies water to its service area from either the MWDSC's Weymouth WTP or its own Miramar WTP. Water deliveries from the TVMWD's Miramar distribution system can include groundwater pumped from the Six Basins.

7 -- The IEUA is the regional imported water wholesale agency serving Six Basins parties in the San Bernardino County (City of Upland). IEUA purchases water from the MWDSC. Water purchased by the City of Upland from the IEUA is treated and delivered by the Water Facilities Authority (WFA).

8 -- The MWDSC is the imported water wholesale agency that sells water to smaller wholesale agencies and cities throughout much of southern California. The MWDSC also imports water from the SWP and the Colorado River.

9-- In 2011, an intertie between the GSWC and the City of Upland was constructed in the event of water shortage emergencies. The GSWC began using this intertie in 2011 and will continue to supplement demands in the short-term while low groundwater levels in the Upper Claremont Heights Basin are limiting production. The 2011 actual supply plans of the two agencies reflect the use of this intertie, but the projected water supply plans of the GSWC and the City of Upland do not project long-term use of this intertie as a regular water supply.

10 -- The SAWC is a private water company with both retail and wholesale customers. Of its total shareholdings, retail shares make up about 20 percent and wholesale shares about 80 percent. The service area population shown represents the retail customer population.

11 -- The total supply equals the summation of Six Basins groundwater, other groundwater, San Antonio and Evey Canyon, imported water from IEUA, and imported Water from MWDSC. Purchases from SAWC are not included in the summation because this supply is already counted as part of the sums for Six Basins, Chino Basin, Cucamonga Basin, and San Antonio Canyon. Similarly purchases from Upland are not included. And, supply purchased from TVMWD is not included in the summation because this supply is already counted as part of the sum for imported water purchased from MWDSC.

12 -- The total supply excluding TVMWD service area outside of the Six Basins equals the summation of Six Basins groundwater, other groundwater, San Antonio and Evey Canyon, imported water from IEUA, and imported Water from MWDSC. Purchases from SAWC, Upland, and TVMWD are not included in the summation. See note 11.

**Table 3-3**
**2011 and Projected (2015 to 2035) Demands for Six Basins Groundwater by Sub-Basin**

| Agency | Year | Six Basins Groundwater Production Projections (acre-ft)[1] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Four Basins | | | | | Two Basins | | | Total Six Basins Production |
| | | Canyon | Upper Claremont Heights | Lower Claremont Heights | Pomona | Total Four Basins | Live Oak | Ganesha | Total Two Basins | |
| **La Verne, City of** | 2011 | 0 | 0 | 0 | 752 | **752** | 1,002 | 401 | **1,403** | **2,155** |
| | 2015 | 0 | 0 | 0 | 1,383 | **1,383** | 1,300 | 1,344 | **2,644** | **4,027** |
| | 2020 | 0 | 0 | 0 | 1,383 | **1,383** | 1,350 | 1,344 | **2,694** | **4,077** |
| | 2025 | 0 | 0 | 0 | 1,383 | **1,383** | 1,350 | 1,344 | **2,694** | **4,077** |
| | 2030 | 0 | 0 | 0 | 1,383 | **1,383** | 1,350 | 1,344 | **2,694** | **4,077** |
| | 2035 | 0 | 0 | 0 | 1,383 | **1,383** | 1,350 | 1,344 | **2,694** | **4,077** |
| **Pomona, City of** | 2011 | 0 | 1,514 | 0 | 2,330 | **3,844** | 0 | 0 | **0** | **3,844** |
| | 2015 | 0 | 1,200 | 0 | 2,814 | **4,014** | 0 | 0 | **0** | **4,014** |
| | 2020 | 0 | 1,200 | 0 | 2,814 | **4,014** | 0 | 0 | **0** | **4,014** |
| | 2025 | 0 | 1,200 | 0 | 2,814 | **4,014** | 0 | 0 | **0** | **4,014** |
| | 2030 | 0 | 1,200 | 0 | 2,814 | **4,014** | 0 | 0 | **0** | **4,014** |
| | 2035 | 0 | 1,200 | 0 | 2,814 | **4,014** | 0 | 0 | **0** | **4,014** |
| **Golden State Water Company** | 2011 | 0 | 4,046 | 0 | 2,295 | **6,340** | 0 | 0 | **0** | **6,340** |
| | 2015 | 0 | 3,918 | 0 | 3,918 | **7,836** | 0 | 0 | **0** | **7,836** |
| | 2020 | 0 | 3,918 | 0 | 3,918 | **7,836** | 0 | 0 | **0** | **7,836** |
| | 2025 | 0 | 3,918 | 0 | 3,918 | **7,836** | 0 | 0 | **0** | **7,836** |
| | 2030 | 0 | 3,918 | 0 | 3,918 | **7,836** | 0 | 0 | **0** | **7,836** |
| | 2035 | 0 | 3,918 | 0 | 3,918 | **7,836** | 0 | 0 | **0** | **7,836** |
| **San Antonio Water Company** | 2011 | 0 | 1,174 | 0 | 0 | **1,174** | 0 | 0 | **0** | **1,174** |
| | 2015 | 0 | 1,112 | 0 | 0 | **1,112** | 0 | 0 | **0** | **1,112** |
| | 2020 | 0 | 1,112 | 0 | 0 | **1,112** | 0 | 0 | **0** | **1,112** |
| | 2025 | 0 | 1,112 | 0 | 0 | **1,112** | 0 | 0 | **0** | **1,112** |
| | 2030 | 0 | 1,112 | 0 | 0 | **1,112** | 0 | 0 | **0** | **1,112** |
| | 2035 | 0 | 1,112 | 0 | 0 | **1,112** | 0 | 0 | **0** | **1,112** |
| **Upland, City of** | 2011 | 0 | 4,547 | 0 | 0 | **4,547** | 0 | 0 | **0** | **4,547** |
| | 2015 | 50 | 4,497 | 0 | 0 | **4,547** | 0 | 0 | **0** | **4,547** |
| | 2020 | 50 | 4,497 | 0 | 0 | **4,547** | 0 | 0 | **0** | **4,547** |
| | 2025 | 50 | 4,497 | 0 | 0 | **4,547** | 0 | 0 | **0** | **4,547** |
| | 2030 | 50 | 4,497 | 0 | 0 | **4,547** | 0 | 0 | **0** | **4,547** |
| | 2035 | 50 | 4,497 | 0 | 0 | **4,547** | 0 | 0 | **0** | **4,547** |
| **TVMWD** | 2011 | 0 | 779 | 0 | 0 | **779** | 0 | 0 | **0** | **779** |
| | 2015 | 0 | 1,800 | 0 | 0 | **1,800** | 0 | 0 | **0** | **1,800** |
| | 2020 | 0 | 3,200 | 0 | 0 | **3,200** | 0 | 0 | **0** | **3,200** |
| | 2025 | 0 | 3,200 | 0 | 0 | **3,200** | 0 | 0 | **0** | **3,200** |
| | 2030 | 0 | 3,200 | 0 | 0 | **3,200** | 0 | 0 | **0** | **3,200** |
| | 2035 | 0 | 3,200 | 0 | 0 | **3,200** | 0 | 0 | **0** | **3,200** |
| **Total** | 2011 | 0 | 12,059 | 0 | 5,377 | **17,436** | 1,002 | 401 | 1,403 | **18,839** |
| | 2015 | 50 | 12,527 | 0 | 8,115 | **20,692** | 1,300 | 1,344 | 2,644 | **23,336** |
| | 2020 | 50 | 13,927 | 0 | 8,115 | **22,092** | 1,350 | 1,344 | 2,694 | **24,786** |
| | 2025 | 50 | 13,927 | 0 | 8,115 | **22,092** | 1,350 | 1,344 | 2,694 | **24,786** |
| | 2030 | 50 | 13,927 | 0 | 8,115 | **22,092** | 1,350 | 1,344 | 2,694 | **24,786** |
| | 2035 | 50 | 13,927 | 0 | 8,115 | **22,092** | 1,350 | 1,344 | 2,694 | **24,786** |

**Footnotes:**
1 -- Each party used different assumptions about future OSY to project their total production from the Six Basins. For the purpose of demonstrating what the agencies believe is their minimum requirement from the Six Basins, the assumptions were not standardized. If the parties did not supply sub-basin specific demand projections for Six Basins groundwater, the future supply was estimated based on the party's average percentage use of each sub-basin between 1999 and 2011.

## Table 3-4a
## Water Supply Plan for the Six Basins Agencies as a Function of OSY based on 2015 Demands

*(acre-feet)*

| Agency | 2015 Water Demand[1] | Share of OSY at 16,000 19,000 22,000 | Water Supply Sources Available to the Six Basins Parties | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Groundwater | | | | | | San Antonio Creek | Purchase From SAWC[2] | Imported Water | | | | Recycled Water | Total Supply[3] |
| | | | Six Basins | | Other | | | | | | | | | | | |
| | | | Four Basins | Two Basins | Chino Basin | Cuc-amonga Basin | San Antonio Tunnel | Spadra Basin | | | TVMWD Treated Water | TVMWD Raw Water[3] | IEUA | MWDSC | | |
| City of La Verne | 8,127 | 1,216 | 1,216 | 1,830 | | | | | | | 5,081 | | | | | 8,127 |
| | | 1,444 | 1,444 | 1,830 | | | | | | | 4,853 | | | | | 8,127 |
| | | 1,672 | 1,672 | 1,830 | | | | | | | 4,625 | | | | | 8,127 |
| City of Pomona | 23,798 | 3,328 | 3,948 | | 13,103 | | | 400 | 1,890 | | 2,662 | | | | 1,795 | 23,798 |
| | | 3,952 | 4,572 | | 13,103 | | | 400 | 3,026 | | 902 | | | | 1,795 | 23,798 |
| | | 4,576 | 5,196 | | 12,859 | | | 400 | 3,554 | | 994 | | | | 1,795 | 24,798 |
| Golden State Water Company (GSWC) | 12,459 | 6,298 | 8,340 | | 411 | | | | | | 3,708 | 2,042 | | | | 14,501 |
| | | 7,479 | 8,340 | | 411 | | | | | | 3,708 | 861 | | | | 13,320 |
| | | 8,660 | 8,660 | | 411 | | | | | | 3,388 | 0 | | | | 12,459 |
| San Antonio Water Company (SAWC) | 16,574 | 1,147 | 1,447 | | 1,507 | 6,500 | 936 | | 1,900 | | | | | | | 12,290 |
| | | 1,362 | 1,662 | | 1,507 | 6,500 | 1,498 | | 3,041 | | | | | | | 14,208 |
| | | 1,577 | 1,877 | | 1,507 | 6,500 | 1,759 | | 3,572 | | | | | | | 15,215 |
| City of Upland[3] | 23,092 | 3,991 | 3,991 | | 1,000 | 750 | | | | 10,000 | | | 6,451 | | 900 | 23,092 |
| | | 4,739 | 4,739 | | 1,000 | 750 | | | | 10,000 | | | 5,703 | | 900 | 23,092 |
| | | 5,487 | 5,487 | | 1,000 | 750 | | | | 10,000 | | | 4,955 | | 900 | 23,092 |
| Three Valleys Municipal Water District (TVMWD) | 54,884 | 21 | 1,600 | | | | | | | | | 1,600 | | 53,284 | | 56,484 |
| | | 25 | 1,600 | | | | | | | | | 1,600 | | 53,284 | | 56,484 |
| | | 29 | 1,600 | | | | | | | | | 1,600 | | 53,284 | | 56,484 |

**Footnotes:**

1 -- Water demands represent the total water demand of each agency's service area, except for TVMWD. In the case of TVMWD, the total demand only represents its service area's demand for imported water purchases from TVMWD. The demands shown for the TVWMD include the imported water demands of the City of La Verne, the City of Pomona, and the GSWC, as well of the demands of other agencies outside of the Six Basins. Also, the demands of the SAWC include the demands of its primary shareholder, the City of Upland.

2 -- The City of Upland is the primary shareholder of the SAWC. Water purchased from the SAWC can be a combination of any of the water supply sources available to the SAWC, some of which are already mixed in the distribution system prior to delivery to Upland. The relative contribution of each source varies from year-to-year. Thus, purchases from the SAWC cannot be broken down by source and is shown here as Upland's total demand for

3 -- In the instances where Total Supply is greater than the Water Demand the agency is an overproducer and uses TVMWD Raw Water as the supply for Replacement Water.

## Table 3-4b
## Water Supply Plan for the Six Basins Agencies as a Function of OSY based on 2025 Demands

*(acre-feet)*

| Agency | 2025 Water Demand[1] | Share of OSY at 16,000 19,000 22,000 | Water Supply Sources Available to the Six Basins Parties | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Groundwater | | | | | | San Antonio Creek | Purchase From SAWC[2] | Imported Water | | | | Recycled Water | Total Supply[3] |
| | | | Six Basins | | Other | | | | | | | | | | | |
| | | | Four Basins | Two Basins | Chino Basin | Cuc-amonga Basin | San Antonio Tunnel | Spadra Basin | | | TVMWD Treated Water | TVMWD Raw Water[3] | IEUA | MWDSC | | |
| City of La Verne | 7,816 | 1,216 | 1,216 | 1,830 | | | | | | | 4,770 | | | | | 7,816 |
| | | 1,444 | 1,444 | 1,830 | | | | | | | 4,542 | | | | | 7,816 |
| | | 1,672 | 1,672 | 1,830 | | | | | | | 4,314 | | | | | 7,816 |
| City of Pomona | 26,288 | 3,328 | 3,948 | | 14,300 | | | 400 | 1,890 | | 3,056 | | | | 2,695 | 26,289 |
| | | 3,952 | 4,572 | | 14,300 | | | 400 | 3,026 | | 1,295 | | | | 2,695 | 26,288 |
| | | 4,576 | 5,196 | | 13,450 | | | 400 | 3,554 | | 994 | | | | 2,695 | 26,289 |
| Golden State Water Company (GSWC) | 11,572 | 6,298 | 8,340 | | 411 | | | | | | 2,821 | 2,042 | | | | 13,614 |
| | | 7,479 | 8,340 | | 411 | | | | | | 2,821 | 861 | | | | 12,433 |
| | | 8,660 | 8,660 | | 411 | | | | | | 2,501 | 0 | | | | 11,572 |
| San Antonio Water Company (SAWC) | 16,574 | 1,147 | 1,447 | | 1,507 | 6,500 | 936 | | 1,900 | | | | | | | 12,290 |
| | | 1,362 | 1,662 | | 1,507 | 6,500 | 1,498 | | 3,041 | | | | | | | 14,208 |
| | | 1,577 | 1,877 | | 1,507 | 6,500 | 1,759 | | 3,572 | | | | | | | 15,215 |
| City of Upland[3] | 21,551 | 3,991 | 3,991 | | 1,000 | 750 | | | | 10,000 | | | 4,910 | | 900 | 21,551 |
| | | 4,739 | 4,739 | | 1,000 | 750 | | | | 10,000 | | | 4,162 | | 900 | 21,551 |
| | | 5,487 | 5,487 | | 1,000 | 750 | | | | 10,000 | | | 3,414 | | 900 | 21,551 |
| Three Valleys Municipal Water District (TVMWD) | 53,981 | 21 | 3,200 | | | | | | | | | 3,200 | | 50,781 | | 57,181 |
| | | 25 | 3,200 | | | | | | | | | 3,200 | | 50,781 | | 57,181 |
| | | 29 | 3,200 | | | | | | | | | 3,200 | | 50,781 | | 57,181 |

**Footnotes:**

1 -- Water demands represent the total water demand of each agency's service area, except for TVMWD. In the case of TVMWD, the total demand only represents its service area's demand for imported water purchases from TVMWD. The demands shown for the TVWMD include the imported water demands of the City of La Verne, the City of Pomona, and the GSWC, as well of the demands of other agencies outside of the Six Basins. Also, the demands of the SAWC include the demands of its primary shareholder, the City of Upland.

2 -- The City of Upland is the primary shareholder of the SAWC. Water purchased from the SAWC can be a combination of any of the water supply sources available to the SAWC, some of which are already mixed in the distribution system prior to delivery to Upland. The relative contribution of each source varies from year-to-year. Thus, purchases from the SAWC cannot be broken down by source and is shown here as Upland's total demand for

3 -- In the instances where Total Supply is greater than the Water Demand the agency is an overproducer and uses TVMWD Raw Water as the supply for Replacement Water.

## Table 3-4c
## Water Supply Plan for the Six Basins Agencies as a Function of OSY based on 2035 Demands

*(acre-feet)*

| Agency | 2025 Water Demand[1] | Share of OSY at 16,000 19,000 22,000 | Water Supply Sources Available to the Six Basins Parties | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Groundwater | | | | | | San Antonio Creek | Purchase From SAWC[2] | Imported Water | | | | Recycled Water | Total Supply[3] |
| | | | Six Basins | | Other | | | | | | | | | | | |
| | | | Four Basins | Two Basins | Chino Basin | Cuc-amonga Basin | San Antonio Tunnel | Spadra Basin | | | TVMWD Treated Water | TVMWD Raw Water[3] | IEUA | MWDSC | | |
| City of La Verne | 8,385 | 1,216 | 1,216 | 1,830 | | | | | | | 5,339 | | | | | 8,385 |
| | | 1,444 | 1,444 | 1,830 | | | | | | | 5,111 | | | | | 8,385 |
| | | 1,672 | 1,672 | 1,830 | | | | | | | 4,883 | | | | | 8,385 |
| City of Pomona | 28,095 | 3,328 | 3,948 | | 15,000 | | | 400 | 1,890 | | 3,662 | | | | 3,195 | 28,095 |
| | | 3,952 | 4,572 | | 15,000 | | | 400 | 3,026 | | 1,902 | | | | 3,195 | 28,095 |
| | | 4,576 | 5,196 | | 15,000 | | | 400 | 3,554 | | 750 | | | | 3,195 | 28,095 |
| Golden State Water Company (GSWC) | 12,018 | 6,298 | 8,340 | | 411 | | | | | | 3,267 | 2,042 | | | | 14,060 |
| | | 7,479 | 8,340 | | 411 | | | | | | 3,267 | 861 | | | | 12,879 |
| | | 8,660 | 8,660 | | 411 | | | | | | 2,947 | 0 | | | | 12,018 |
| San Antonio Water Company (SAWC) | 16,574 | 1,147 | 1,447 | | 1,507 | 6,500 | 936 | | 1,900 | | | | | | | 12,290 |
| | | 1,362 | 1,662 | | 1,507 | 6,500 | 1,498 | | 3,041 | | | | | | | 14,208 |
| | | 1,577 | 1,877 | | 1,507 | 6,500 | 1,759 | | 3,572 | | | | | | | 15,215 |
| City of Upland[3] | 22,166 | 3,991 | 3,991 | | 1,000 | 750 | | | | 10,000 | | | 5,525 | | 900 | 22,166 |
| | | 4,739 | 4,739 | | 1,000 | 750 | | | | 10,000 | | | 4,777 | | 900 | 22,166 |
| | | 5,487 | 5,487 | | 1,000 | 750 | | | | 10,000 | | | 4,029 | | 900 | 22,166 |
| Three Valleys Municipal Water District (TVMWD) | 61,884 | 21 | 3,200 | | | | | | | | | 3,200 | | 58,684 | | 65,084 |
| | | 25 | 3,200 | | | | | | | | | 3,200 | | 58,684 | | 65,084 |
| | | 29 | 3,200 | | | | | | | | | 3,200 | | 58,684 | | 65,084 |

**Footnotes:**

1 -- Water demands represent the total water demand of each agency's service area, except for TVMWD. In the case of TVMWD, the total demand only represents its service area's demand for imported water purchases from TVMWD. The demands shown for the TVWMD include the imported water demands of the City of La Verne, the City of Pomona, and the GSWC, as well of the demands of other agencies outside of the Six Basins. Also, the demands of the SAWC include the demands of its primary shareholder, the City of Upland.

2 -- The City of Upland is the primary shareholder of the SAWC. Water purchased from the SAWC can be a combination of any of the water supply sources available to the SAWC, some of which are already mixed in the distribution system prior to delivery to Upland. The relative contribution of each source varies from year-to-year. Thus, purchases from the SAWC cannot be broken down by source and is shown here as Upland's total demand for

3 -- In the instances where Total Supply is greater than the Water Demand the agency is an overproducer and uses TVMWD Raw Water as the supply for Replacement Water.

## Table 3-5a
## Projected Water Budget for the Six Basins -- *Baseline Alternative*

*(acre-feet)*

| Fiscal Year | Historical Hydrologic Year Used in Simulation | Recharge: Subsurface Boundary Inflow from the San Gabriel Mountains | Recharge: Subsurface Boundary Inflow from the San Jose Hills | Recharge: Deep Infiltration of Precipitation and Applied Water | Recharge: Storm-Water Infiltration at Spreading Grounds | Recharge: Streambed Infiltration in Unlined Channels | Recharge: Returns from Septic Systems | Recharge: Artificial Recharge of Native Water | Recharge: Artificial Recharge of Imported Water | Recharge: Total Recharge | Discharge: Groundwater Production | Discharge: Rising Groundwater Outflow in Cienega Areas | Discharge: Subsurface Outflow to Chino Basin | Discharge: Total Discharge | Change in Storage: Annual | Change in Storage: Cumulative | Annual Developed Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2013 | 1960 | 9,652 | 229 | 6,082 | 230 | 110 | 400 | 790 | 2,244 | 19,736 | 22,842 | 0 | 8,093 | 30,935 | -11,200 | -11,200 | 8,608 |
| 2014 | 1961 | 6,975 | 229 | 5,206 | 178 | 70 | 400 | 790 | 2,004 | 15,853 | 21,971 | 0 | 7,809 | 29,780 | -13,927 | -25,127 | 5,250 |
| 2015 | 1962 | 12,244 | 229 | 10,365 | 11,040 | 358 | 400 | 790 | 3,624 | 39,049 | 22,553 | 0 | 7,614 | 30,167 | 8,882 | -16,244 | 27,021 |
| 2016 | 1963 | 7,993 | 229 | 7,192 | 258 | 99 | 400 | 790 | 3,504 | 20,466 | 23,982 | 0 | 7,546 | 31,528 | -11,062 | -27,306 | 8,625 |
| 2017 | 1964 | 7,607 | 229 | 8,802 | 273 | 149 | 400 | 790 | 3,648 | 21,898 | 24,382 | 0 | 7,386 | 31,767 | -9,870 | -37,176 | 10,074 |
| 2018 | 1965 | 8,028 | 229 | 9,208 | 420 | 180 | 400 | 790 | 3,648 | 22,903 | 25,024 | 0 | 7,148 | 32,171 | -9,268 | -46,444 | 11,317 |
| 2019 | 1966 | 15,773 | 229 | 10,821 | 12,946 | 318 | 400 | 790 | 4,284 | 45,562 | 24,637 | 0 | 7,026 | 31,663 | 13,899 | -32,546 | 33,462 |
| 2020 | 1967 | 16,963 | 229 | 13,982 | 8,612 | 433 | 400 | 790 | 4,800 | 46,210 | 25,908 | 0 | 7,051 | 32,958 | 13,251 | -19,294 | 33,569 |
| 2021 | 1968 | 14,871 | 229 | 9,606 | 313 | 127 | 400 | 790 | 3,972 | 30,308 | 27,223 | 0 | 7,130 | 34,353 | -4,045 | -23,339 | 18,416 |
| 2022 | 1969 | 22,925 | 229 | 14,877 | 22,036 | 577 | 400 | 790 | 3,192 | 65,026 | 27,922 | 0 | 7,186 | 35,107 | 29,919 | 6,580 | 53,858 |
| 2023 | 1970 | 15,067 | 229 | 9,772 | 2,167 | 148 | 400 | 790 | 3,192 | 31,765 | 29,620 | 0 | 7,444 | 37,064 | -5,299 | 1,281 | 20,339 |
| 2024 | 1971 | 12,690 | 229 | 9,205 | 475 | 163 | 400 | 790 | 3,192 | 27,143 | 28,521 | 0 | 7,531 | 36,052 | -8,909 | -7,629 | 15,630 |
| 2025 | 1972 | 9,638 | 229 | 8,904 | 305 | 94 | 400 | 790 | 3,192 | 23,552 | 28,221 | 0 | 7,483 | 35,705 | -12,153 | -19,782 | 12,086 |
| 2026 | 1973 | 12,778 | 229 | 12,289 | 6,426 | 372 | 400 | 790 | 3,192 | 36,476 | 25,605 | 0 | 7,414 | 33,019 | 3,457 | -16,325 | 25,080 |
| 2027 | 1974 | 13,048 | 229 | 10,209 | 722 | 209 | 400 | 790 | 4,176 | 29,784 | 25,726 | 0 | 7,464 | 33,190 | -3,406 | -19,731 | 17,354 |
| 2028 | 1975 | 10,877 | 229 | 10,110 | 312 | 180 | 400 | 790 | 4,092 | 26,990 | 25,787 | 0 | 7,502 | 33,289 | -6,298 | -26,029 | 14,606 |
| 2029 | 1976 | 9,712 | 229 | 9,102 | 3,686 | 108 | 400 | 790 | 4,056 | 28,082 | 25,908 | 0 | 7,472 | 33,380 | -5,297 | -31,327 | 15,764 |
| 2030 | 1977 | 3,478 | 229 | 11,262 | 1,630 | 188 | 400 | 790 | 3,972 | 21,949 | 25,484 | 0 | 7,400 | 32,884 | -10,935 | -42,262 | 9,787 |
| 2031 | 1978 | 13,760 | 229 | 20,540 | 33,566 | 767 | 400 | 790 | 4,248 | 74,301 | 24,940 | 76 | 7,485 | 32,501 | 41,799 | -462 | 61,701 |
| 2032 | 1979 | 7,052 | 229 | 12,568 | 4,885 | 339 | 400 | 790 | 4,608 | 30,870 | 27,323 | 407 | 7,918 | 35,648 | -4,777 | -5,239 | 17,147 |
| 2033 | 1980 | 11,501 | 229 | 17,335 | 23,759 | 564 | 400 | 790 | 3,192 | 57,771 | 27,323 | 708 | 8,148 | 36,178 | 21,593 | 16,353 | 44,933 |
| 2034 | 1981 | 5,635 | 229 | 8,144 | 387 | 105 | 400 | 790 | 3,192 | 18,881 | 30,319 | 776 | 8,347 | 39,441 | -20,560 | -4,206 | 5,777 |
| 2035 | 1982 | 7,993 | 229 | 10,648 | 8,517 | 312 | 400 | 790 | 3,192 | 32,081 | 26,271 | 614 | 8,284 | 35,169 | -3,088 | -7,294 | 19,201 |
| 2036 | 1983 | 12,591 | 229 | 17,371 | 36,338 | 765 | 400 | 790 | 3,744 | 72,229 | 26,392 | 810 | 8,443 | 35,645 | 36,584 | 29,290 | 58,442 |
| 2037 | 1984 | 8,747 | 229 | 9,268 | 12,920 | 159 | 400 | 790 | 3,660 | 36,173 | 27,057 | 978 | 9,086 | 37,121 | -948 | 28,342 | 21,660 |
| 2038 | 1985 | 7,676 | 229 | 8,677 | 1,270 | 184 | 400 | 790 | 3,228 | 22,454 | 28,321 | 909 | 9,152 | 38,382 | -15,928 | 12,414 | 8,375 |
| 2039 | 1986 | 7,280 | 229 | 11,956 | 8,944 | 306 | 400 | 790 | 3,192 | 33,096 | 27,422 | 868 | 8,962 | 37,253 | -4,157 | 8,257 | 19,284 |
| 2040 | 1987 | 2,812 | 229 | 8,208 | 268 | 114 | 400 | 790 | 3,192 | 16,012 | 25,303 | 864 | 8,871 | 35,037 | -19,025 | -10,768 | 2,296 |
| 2041 | 1988 | 5,758 | 229 | 10,900 | 2,025 | 213 | 400 | 790 | 4,368 | 24,683 | 24,213 | 767 | 8,734 | 33,714 | -9,032 | -19,800 | 10,024 |
| 2042 | 1989 | 3,297 | 229 | 8,836 | 428 | 180 | 400 | 790 | 5,076 | 19,235 | 24,274 | 714 | 8,596 | 33,584 | -14,349 | -34,149 | 4,059 |
| 2043 | 1990 | 2,320 | 229 | 7,192 | 281 | 132 | 400 | 790 | 5,040 | 16,385 | 23,487 | 604 | 8,421 | 32,512 | -16,127 | -50,276 | 1,530 |
| 2044 | 1991 | 5,425 | 229 | 10,249 | 6,549 | 281 | 400 | 790 | 5,544 | 29,467 | 23,427 | 502 | 8,191 | 32,120 | -2,654 | -52,930 | 14,439 |
| 2045 | 1992 | 6,883 | 229 | 12,146 | 18,776 | 415 | 400 | 790 | 5,592 | 45,231 | 23,669 | 515 | 8,049 | 32,233 | 12,997 | -39,932 | 30,284 |
| 2046 | 1993 | 14,152 | 229 | 18,250 | 29,274 | 752 | 400 | 790 | 5,436 | 69,282 | 25,061 | 933 | 8,266 | 34,259 | 35,023 | -4,909 | 53,858 |
| 2047 | 1994 | 6,153 | 229 | 7,622 | 281 | 159 | 400 | 790 | 4,524 | 20,158 | 28,122 | 925 | 8,550 | 37,596 | -17,438 | -22,347 | 5,369 |
| 2048 | 1995 | 10,152 | 229 | 13,433 | 31,386 | 586 | 400 | 790 | 3,192 | 60,167 | 27,522 | 872 | 8,598 | 36,992 | 23,176 | 829 | 46,716 |
| 2049 | 1996 | 7,452 | 229 | 9,466 | 3,960 | 255 | 400 | 790 | 3,192 | 25,744 | 28,920 | 874 | 8,731 | 38,526 | -12,782 | -11,953 | 12,157 |
| 2050 | 1997 | 8,995 | 229 | 11,676 | 2,368 | 392 | 400 | 790 | 3,192 | 28,041 | 26,089 | 796 | 8,688 | 35,574 | -7,532 | -19,486 | 14,575 |
| 2051 | 1998 | 12,778 | 229 | 15,284 | 17,376 | 715 | 400 | 790 | 3,852 | 51,423 | 26,513 | 884 | 8,629 | 36,026 | 15,397 | -4,089 | 37,268 |
| 2052 | 1999 | 4,916 | 229 | 5,836 | 3,595 | 112 | 400 | 790 | 3,576 | 19,453 | 26,089 | 919 | 8,780 | 35,788 | -16,335 | -20,424 | 5,388 |
| 2053 | 2000 | 7,234 | 229 | 9,092 | 426 | 221 | 400 | 790 | 3,852 | 22,244 | 25,726 | 677 | 8,703 | 35,106 | -12,862 | -33,286 | 8,222 |
| 2054 | 2001 | 5,677 | 229 | 8,446 | 564 | 270 | 400 | 790 | 4,092 | 20,468 | 25,363 | 596 | 8,512 | 34,471 | -14,003 | -47,289 | 6,478 |
| 2055 | 2002 | 2,851 | 229 | 5,564 | 173 | 56 | 400 | 790 | 4,332 | 14,394 | 23,790 | 478 | 8,335 | 32,604 | -18,209 | -65,498 | 459 |
| 2056 | 2003 | 5,239 | 229 | 10,155 | 539 | 226 | 400 | 790 | 5,352 | 22,930 | 23,548 | 327 | 8,105 | 31,980 | -9,051 | -74,549 | 8,355 |
| 2057 | 2004 | 4,117 | 229 | 8,019 | 786 | 132 | 400 | 790 | 5,508 | 19,981 | 23,487 | 256 | 7,916 | 31,660 | -11,679 | -86,228 | 5,511 |
| 2058 | 2005 | 13,874 | 229 | 17,141 | 35,758 | 581 | 400 | 790 | 5,544 | 74,317 | 23,487 | 440 | 7,898 | 31,825 | 42,492 | -43,736 | 59,645 |
| 2059 | 2006 | 7,277 | 229 | 9,098 | 8,171 | 214 | 400 | 790 | 5,544 | 31,723 | 26,513 | 505 | 8,141 | 35,159 | -3,436 | -47,172 | 16,743 |
| 2060 | 2007 | 2,998 | 229 | 5,008 | 151 | 38 | 400 | 790 | 3,576 | 13,191 | 26,997 | 336 | 8,121 | 35,454 | -22,262 | -69,434 | 369 |
| 2061 | 2008 | 6,511 | 229 | 9,443 | 2,347 | 270 | 400 | 790 | 3,264 | 23,253 | 26,755 | 0 | 7,832 | 34,587 | -11,333 | -80,767 | 11,368 |
| 2062 | 2009 | 4,922 | 229 | 8,144 | 353 | 169 | 400 | 790 | 3,420 | 18,427 | 24,334 | 0 | 7,608 | 31,942 | -13,515 | -94,283 | 6,609 |
| 2063 | 2010 | 7,263 | 229 | 10,377 | 6,794 | 316 | 400 | 790 | 4,992 | 31,161 | 23,850 | 0 | 7,456 | 31,307 | -146 | -94,429 | 17,922 |
| 2064 | 2011 | 7,755 | 229 | 10,812 | 23,203 | 344 | 400 | 790 | 5,316 | 48,850 | 24,698 | 0 | 7,421 | 32,118 | 16,732 | -77,697 | 35,324 |
| 2065 | 2012 | 2,271 | 229 | 7,147 | 239 | 118 | 400 | 790 | 4,764 | 15,958 | 25,908 | 0 | 7,471 | 33,379 | -17,420 | -95,117 | 2,934 |
| 2066 | 2013 | 7,395 | 229 | 5,764 | 169 | 71 | 400 | 790 | 3,972 | 18,790 | 25,726 | 0 | 7,329 | 33,055 | -14,265 | -109,382 | 6,699 |
| Average | | 8,686 | 229 | 10,311 | 7,386 | 272 | 400 | 790 | 3,992 | 32,066 | 25,732 | 369 | 7,990 | 34,092 | -2,026 | | 18,925 |
| Median | | 7,641 | 229 | 9,536 | 2,096 | 211 | 400 | 790 | 3,852 | 27,067 | 25,726 | 331 | 7,984 | 33,649 | -8,221 | | 14,507 |
| Minimum | | 2,271 | 229 | 5,008 | 151 | 38 | 400 | 790 | 2,004 | 13,191 | 21,971 | 0 | 7,026 | 29,780 | -22,262 | | 369 |
| Maximum | | 22,925 | 229 | 20,540 | 36,338 | 767 | 400 | 790 | 5,592 | 74,317 | 30,319 | 978 | 9,152 | 39,441 | 42,492 | | 61,701 |
| Total | | 469,030 | 12,366 | 556,813 | 398,853 | 14,710 | 21,600 | 42,660 | 215,544 | 1,731,576 | 1,389,553 | 19,929 | 431,476 | 1,840,958 | -109,382 | | 1,021,967 |
| Total (%) | | 27% | 1% | 32% | 23% | 1% | 1% | 2% | 12% | 100% | 75% | 1% | 23% | 100% | na | | na |

# Table 3-5b

## Projected Water Budget for the Four Basins -- *Baseline Alternative*

*(acre-feet)*

| Fiscal Year | Historical Hydrologic Year Used in Simulation | Recharge | | | | | | | | | | Discharge | | | | | Change in Storage | | Annual Developed Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Subsurface Boundary Inflow from the San Gabriel Mountains | Subsurface Boundary Inflow from the San Jose Hills | Subsurface Inflow from the Two Basins | Deep Infiltration of Precipitation and Applied Water | Storm-Water Infiltration at Spreading Grounds | Streambed Infiltration in Unlined Channels | Returns from Septic Systems | Artificial Recharge of Native Water | Artificial Recharge of Imported Water | Total Inflow | Groundwater Production | Rising Groundwater Outflow to Storm Drains | Subsurface Outflow to the Two Basins | Subsurface Outflow to Chino Basin | Total Outflow | Annual | Cumulative | |
| 2013 | 1960 | 9,595 | 172 | 1,340 | 5,141 | 166 | 110 | 384 | 790 | 2,244 | 19,942 | 21,012 | 0 | 1,193 | 8,093 | 30,299 | -10,357 | -10,357 | 7,621 |
| 2014 | 1961 | 6,940 | 172 | 1,291 | 4,406 | 149 | 70 | 384 | 790 | 2,004 | 16,206 | 20,141 | 0 | 1,137 | 7,809 | 29,087 | -12,881 | -23,238 | 4,466 |
| 2015 | 1962 | 11,991 | 172 | 1,302 | 8,799 | 10,428 | 358 | 384 | 790 | 3,624 | 37,848 | 20,723 | 0 | 710 | 7,614 | 29,047 | 8,801 | -14,437 | 25,110 |
| 2016 | 1963 | 7,924 | 172 | 1,382 | 6,078 | 180 | 99 | 384 | 790 | 3,504 | 20,513 | 22,152 | 0 | 898 | 7,546 | 30,596 | -10,083 | -24,520 | 7,774 |
| 2017 | 1964 | 7,539 | 172 | 1,388 | 7,439 | 184 | 149 | 384 | 790 | 3,648 | 21,692 | 22,552 | 0 | 947 | 7,386 | 30,884 | -9,192 | -33,712 | 8,922 |
| 2018 | 1965 | 7,941 | 172 | 1,405 | 7,784 | 219 | 180 | 384 | 790 | 3,648 | 22,523 | 23,194 | 0 | 913 | 7,148 | 31,254 | -8,731 | -42,443 | 10,025 |
| 2019 | 1966 | 15,461 | 172 | 1,423 | 9,148 | 12,365 | 318 | 384 | 790 | 4,284 | 44,344 | 22,807 | 0 | 582 | 7,026 | 30,415 | 13,929 | -28,514 | 31,662 |
| 2020 | 1967 | 16,434 | 172 | 1,512 | 12,015 | 7,866 | 433 | 384 | 790 | 4,800 | 44,406 | 24,078 | 0 | 442 | 7,051 | 31,570 | 12,836 | -15,679 | 31,323 |
| 2021 | 1968 | 14,761 | 172 | 1,604 | 8,052 | 194 | 127 | 384 | 790 | 3,972 | 30,057 | 25,393 | 0 | 869 | 7,130 | 33,392 | -3,335 | -19,014 | 17,296 |
| 2022 | 1969 | 21,504 | 172 | 1,688 | 12,668 | 20,832 | 577 | 384 | 790 | 3,192 | 61,807 | 26,092 | 0 | 71 | 7,186 | 33,348 | 28,459 | 9,445 | 50,569 |
| 2023 | 1970 | 14,965 | 172 | 1,804 | 8,221 | 2,012 | 148 | 384 | 790 | 3,192 | 31,688 | 27,790 | 0 | 800 | 7,444 | 36,034 | -4,345 | 5,100 | 19,462 |
| 2024 | 1971 | 12,601 | 172 | 1,782 | 7,753 | 335 | 163 | 384 | 790 | 3,192 | 27,171 | 26,691 | 0 | 1,119 | 7,531 | 35,341 | -8,170 | -3,070 | 14,539 |
| 2025 | 1972 | 9,593 | 172 | 1,763 | 7,427 | 244 | 94 | 384 | 790 | 3,192 | 23,659 | 26,391 | 0 | 1,308 | 7,483 | 35,183 | -11,524 | -14,594 | 10,886 |
| 2026 | 1973 | 12,514 | 172 | 1,707 | 10,413 | 5,918 | 372 | 384 | 790 | 3,192 | 35,462 | 23,775 | 0 | 1,115 | 7,414 | 32,305 | 3,157 | -11,437 | 22,950 |
| 2027 | 1974 | 12,927 | 172 | 1,743 | 8,662 | 453 | 209 | 384 | 790 | 4,176 | 29,517 | 23,896 | 0 | 1,198 | 7,464 | 32,559 | -3,042 | -14,479 | 15,888 |
| 2028 | 1975 | 10,802 | 172 | 1,742 | 8,545 | 191 | 180 | 384 | 790 | 4,092 | 26,898 | 23,957 | 0 | 1,354 | 7,502 | 32,813 | -5,915 | -20,394 | 13,160 |
| 2029 | 1976 | 9,652 | 172 | 1,735 | 7,576 | 3,617 | 108 | 384 | 790 | 4,056 | 28,090 | 24,078 | 0 | 1,405 | 7,472 | 32,955 | -4,865 | -25,259 | 14,367 |
| 2030 | 1977 | 3,403 | 172 | 1,711 | 9,508 | 1,495 | 188 | 384 | 790 | 3,972 | 21,622 | 23,654 | 0 | 1,355 | 7,400 | 32,408 | -10,786 | -36,045 | 8,106 |
| 2031 | 1978 | 12,575 | 172 | 1,739 | 17,506 | 32,107 | 767 | 384 | 790 | 4,248 | 70,288 | 23,110 | 0 | 413 | 7,485 | 31,009 | 39,280 | 3,235 | 57,351 |
| 2032 | 1979 | 6,821 | 172 | 1,902 | 10,601 | 4,328 | 339 | 384 | 790 | 4,608 | 29,944 | 25,493 | 0 | 1,145 | 7,918 | 34,556 | -4,612 | -1,377 | 15,483 |
| 2033 | 1980 | 10,191 | 172 | 1,940 | 14,715 | 22,654 | 564 | 384 | 790 | 3,192 | 54,603 | 25,493 | 0 | 865 | 8,148 | 34,505 | 20,098 | 18,721 | 41,608 |
| 2034 | 1981 | 5,536 | 172 | 2,016 | 6,718 | 307 | 105 | 384 | 790 | 3,192 | 19,220 | 28,489 | 0 | 1,761 | 8,347 | 38,596 | -19,376 | -655 | 5,131 |
| 2035 | 1982 | 7,799 | 172 | 1,876 | 8,911 | 8,093 | 312 | 384 | 790 | 3,192 | 31,530 | 24,441 | 0 | 1,757 | 8,284 | 34,483 | -2,953 | -3,608 | 17,506 |
| 2036 | 1983 | 11,755 | 172 | 1,867 | 14,771 | 34,972 | 765 | 384 | 790 | 3,744 | 69,219 | 24,562 | 0 | 1,112 | 8,443 | 34,117 | 35,102 | 31,494 | 55,130 |
| 2037 | 1984 | 8,608 | 172 | 1,921 | 7,718 | 12,729 | 159 | 384 | 790 | 3,660 | 36,143 | 25,227 | 0 | 2,037 | 9,086 | 36,350 | -208 | 31,287 | 20,570 |
| 2038 | 1985 | 7,587 | 172 | 1,908 | 7,250 | 1,130 | 184 | 384 | 790 | 3,228 | 22,633 | 26,491 | 0 | 2,375 | 9,152 | 38,018 | -15,386 | 15,901 | 7,087 |
| 2039 | 1986 | 7,169 | 172 | 1,849 | 9,984 | 8,662 | 306 | 384 | 790 | 3,192 | 32,507 | 25,592 | 0 | 2,251 | 8,962 | 36,806 | -4,298 | 11,603 | 17,312 |
| 2040 | 1987 | 2,734 | 172 | 1,781 | 6,843 | 186 | 114 | 384 | 790 | 3,192 | 16,195 | 23,473 | 0 | 2,253 | 8,871 | 34,596 | -18,401 | -6,798 | 1,090 |
| 2041 | 1988 | 5,657 | 172 | 1,696 | 9,145 | 1,820 | 213 | 384 | 790 | 4,368 | 24,245 | 22,383 | 0 | 2,122 | 8,734 | 33,239 | -8,995 | -15,793 | 8,231 |
| 2042 | 1989 | 3,213 | 172 | 1,660 | 7,357 | 269 | 180 | 384 | 790 | 5,076 | 19,100 | 22,444 | 0 | 2,037 | 8,596 | 33,076 | -13,976 | -29,769 | 2,602 |
| 2043 | 1990 | 2,260 | 172 | 1,595 | 5,992 | 189 | 132 | 384 | 790 | 5,040 | 16,554 | 21,657 | 0 | 1,967 | 8,421 | 32,045 | -15,491 | -45,260 | 337 |
| 2044 | 1991 | 5,211 | 172 | 1,546 | 8,687 | 6,114 | 281 | 384 | 790 | 5,544 | 28,730 | 21,597 | 0 | 1,628 | 8,191 | 31,416 | -2,686 | -47,947 | 12,576 |
| 2045 | 1992 | 6,469 | 172 | 1,550 | 10,323 | 18,046 | 415 | 384 | 790 | 5,592 | 43,740 | 21,839 | 0 | 1,259 | 8,049 | 31,147 | 12,593 | -35,354 | 28,050 |
| 2046 | 1993 | 12,487 | 172 | 1,658 | 15,461 | 27,644 | 752 | 384 | 790 | 5,436 | 64,784 | 23,231 | 0 | 385 | 8,266 | 31,881 | 32,903 | -2,451 | 49,908 |
| 2047 | 1994 | 6,050 | 172 | 1,805 | 6,397 | 187 | 159 | 384 | 790 | 4,524 | 20,468 | 26,292 | 0 | 1,696 | 8,550 | 36,538 | -16,070 | -18,520 | 4,908 |
| 2048 | 1995 | 9,471 | 172 | 1,780 | 11,326 | 30,335 | 586 | 384 | 790 | 3,192 | 58,035 | 25,692 | 0 | 1,305 | 8,598 | 35,595 | 22,440 | 3,920 | 44,150 |
| 2049 | 1996 | 7,198 | 172 | 1,828 | 7,990 | 3,553 | 255 | 384 | 790 | 3,192 | 25,361 | 27,090 | 0 | 1,709 | 8,731 | 37,531 | -12,170 | -8,250 | 10,939 |
| 2050 | 1997 | 8,772 | 172 | 1,753 | 9,846 | 1,877 | 392 | 384 | 790 | 3,192 | 27,178 | 24,259 | 0 | 1,756 | 8,688 | 34,703 | -7,526 | -15,776 | 12,752 |
| 2051 | 1998 | 12,171 | 172 | 1,777 | 12,972 | 16,311 | 715 | 384 | 790 | 3,852 | 49,145 | 24,683 | 0 | 1,390 | 8,629 | 34,703 | 14,442 | -1,333 | 34,483 |
| 2052 | 1999 | 4,812 | 172 | 1,791 | 4,882 | 3,502 | 112 | 384 | 790 | 3,576 | 20,021 | 24,259 | 0 | 1,916 | 8,780 | 34,955 | -14,934 | -16,267 | 4,959 |
| 2053 | 2000 | 7,156 | 172 | 1,708 | 7,581 | 240 | 221 | 384 | 790 | 3,852 | 22,104 | 23,896 | 0 | 2,014 | 8,703 | 34,613 | -12,509 | -28,776 | 6,746 |
| 2054 | 2001 | 5,569 | 172 | 1,672 | 7,097 | 274 | 270 | 384 | 790 | 4,092 | 20,319 | 23,533 | 0 | 1,853 | 8,512 | 33,898 | -13,578 | -42,354 | 5,073 |
| 2055 | 2002 | 2,812 | 172 | 1,598 | 4,585 | 147 | 56 | 384 | 790 | 4,332 | 14,877 | 21,960 | 0 | 1,903 | 8,335 | 32,199 | -17,322 | -59,676 | -484 |
| 2056 | 2003 | 5,106 | 172 | 1,541 | 8,577 | 254 | 226 | 384 | 790 | 5,352 | 22,402 | 21,718 | 0 | 1,655 | 8,105 | 31,479 | -9,077 | -68,752 | 6,499 |
| 2057 | 2004 | 4,042 | 172 | 1,526 | 6,713 | 662 | 132 | 384 | 790 | 5,508 | 19,929 | 21,657 | 0 | 1,568 | 7,916 | 31,142 | -11,212 | -79,965 | 4,147 |
| 2058 | 2005 | 12,688 | 172 | 1,546 | 14,540 | 34,621 | 581 | 384 | 790 | 5,544 | 70,865 | 21,657 | 0 | 692 | 7,898 | 30,247 | 40,618 | -39,347 | 55,941 |
| 2059 | 2006 | 7,166 | 172 | 1,695 | 7,637 | 7,961 | 214 | 384 | 790 | 5,544 | 31,563 | 24,683 | 0 | 1,438 | 8,141 | 34,262 | -2,699 | -42,046 | 15,650 |
| 2060 | 2007 | 2,962 | 172 | 1,700 | 4,102 | 137 | 38 | 384 | 790 | 3,576 | 13,861 | 25,167 | 0 | 1,688 | 8,121 | 34,976 | -21,115 | -63,161 | -314 |
| 2061 | 2008 | 6,389 | 172 | 1,656 | 7,949 | 2,010 | 270 | 384 | 790 | 3,264 | 22,883 | 24,925 | 0 | 1,425 | 7,832 | 34,181 | -11,298 | -74,459 | 9,573 |
| 2062 | 2009 | 4,843 | 172 | 1,584 | 6,842 | 212 | 169 | 384 | 790 | 3,420 | 18,417 | 22,504 | 0 | 1,352 | 7,608 | 31,465 | -13,048 | -87,507 | 5,247 |
| 2063 | 2010 | 7,103 | 172 | 1,557 | 8,764 | 6,328 | 316 | 384 | 790 | 4,992 | 30,405 | 22,020 | 0 | 1,113 | 7,456 | 30,590 | -185 | -87,691 | 16,054 |
| 2064 | 2011 | 7,455 | 172 | 1,593 | 9,152 | 22,576 | 344 | 384 | 790 | 5,316 | 47,782 | 22,868 | 0 | 920 | 7,421 | 31,208 | 16,575 | -71,117 | 33,336 |
| 2065 | 2012 | 2,201 | 172 | 1,637 | 5,938 | 170 | 118 | 384 | 790 | 4,764 | 16,173 | 24,078 | 0 | 1,244 | 7,471 | 32,792 | -16,619 | -87,736 | 1,904 |
| 2066 | 2013 | 7,359 | 172 | 1,613 | 4,760 | 146 | 71 | 384 | 790 | 3,972 | 19,267 | 23,896 | 0 | 1,271 | 7,329 | 32,496 | -13,229 | -100,965 | 5,905 |
| Average | | 8,406 | 172 | 1,670 | 8,690 | 6,993 | 272 | 384 | 790 | 3,992 | 31,369 | 23,902 | 0 | 1,346 | 7,990 | 33,239 | -1,870 | | 17,251 |
| Median | | 7,497 | 172 | 1,695 | 8,021 | 1,848 | 211 | 384 | 790 | 3,852 | 27,035 | 23,896 | 0 | 1,330 | 7,984 | 33,015 | -7,848 | | 12,664 |
| Minimum | | 2,201 | 172 | 1,291 | 4,102 | 137 | 38 | 384 | 790 | 2,004 | 13,861 | 20,141 | 0 | 71 | 7,026 | 29,047 | -21,115 | | -484 |
| Maximum | | 21,504 | 172 | 2,016 | 17,506 | 34,972 | 767 | 384 | 790 | 5,592 | 70,865 | 28,489 | 0 | 2,375 | 9,152 | 38,596 | 40,618 | | 57,351 |
| Total | | 453,942 | 9,288 | 90,190 | 469,268 | 377,599 | 14,710 | 20,736 | 42,660 | 215,544 | 1,693,937 | 1,290,733 | 0 | 72,693 | 431,476 | 1,794,902 | -100,965 | | 931,563 |
| Total (%) | | 27% | 1% | 5% | 28% | 22% | 1% | 1% | 3% | 13% | 100% | 72% | 0% | 4% | 24% | 100% | na | | na |

# Table 3-5c

## Projected Water Budget for the Upper Claremont Heights, Lower Claremont Heights, and Canyon Basins -- *Baseline Alternative*

*(acre-feet)*

| Fiscal Year | Historical Hydrologic Year Used in Simulation | Recharge | | | | | | | | Discharge | | | | | | Change in Storage | | Annual Developed Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Subsurface Boundary Inflow from the San Gabriel Mountains | Deep Infiltration of Precipitation and Applied Water | Storm-Water Infiltration at Spreading Grounds | Streambed Infiltration in Unlined Channels | Returns from Septic Systems | Artificial Recharge of Native Water | Artificial Recharge of Imported Water | Total Recharge | Groundwater Production | Rising Groundwater Outflow to Storm Drains | Subsurface Outlow to the Two Basins | Subsurface Outflow to the Pomona Basin | Subsurface Outflow to Chino Basin | Total Discharge | Annual | Cumulative | |
| 2013 | 1960 | 9,595 | 2,932 | 166 | 110 | 378 | 790 | 2,244 | 16,214 | 11,152 | 0 | 1,193 | 6,882 | 2,243 | 21,470 | -5,257 | -5,257 | 2,861 |
| 2014 | 1961 | 6,940 | 2,558 | 149 | 70 | 378 | 790 | 2,004 | 12,889 | 10,754 | 0 | 1,137 | 6,898 | 2,157 | 20,946 | -8,056 | -13,313 | -96 |
| 2015 | 1962 | 11,991 | 5,363 | 10,428 | 358 | 378 | 790 | 3,624 | 32,932 | 11,418 | 0 | 710 | 6,985 | 2,131 | 21,245 | 11,687 | -1,626 | 18,692 |
| 2016 | 1963 | 7,924 | 3,444 | 180 | 99 | 378 | 790 | 3,504 | 16,319 | 12,464 | 0 | 898 | 7,083 | 2,167 | 22,613 | -6,294 | -7,919 | 1,877 |
| 2017 | 1964 | 7,539 | 4,249 | 184 | 149 | 378 | 790 | 3,648 | 16,936 | 12,864 | 0 | 947 | 6,858 | 2,123 | 22,792 | -5,856 | -13,775 | 2,571 |
| 2018 | 1965 | 7,941 | 4,423 | 219 | 180 | 378 | 790 | 3,648 | 17,579 | 12,402 | 0 | 913 | 6,799 | 2,064 | 22,178 | -4,599 | -18,374 | 3,365 |
| 2019 | 1966 | 15,461 | 5,343 | 12,365 | 318 | 378 | 790 | 4,284 | 38,939 | 12,308 | 0 | 582 | 7,032 | 2,093 | 22,015 | 16,923 | -1,450 | 24,157 |
| 2020 | 1967 | 16,434 | 7,439 | 7,866 | 433 | 378 | 790 | 4,800 | 38,139 | 13,106 | 0 | 442 | 7,366 | 2,219 | 23,132 | 15,006 | 13,556 | 22,522 |
| 2021 | 1968 | 14,761 | 4,417 | 194 | 127 | 378 | 790 | 3,972 | 24,640 | 13,957 | 0 | 869 | 7,651 | 2,358 | 24,836 | -196 | 13,360 | 8,999 |
| 2022 | 1969 | 21,504 | 7,727 | 20,832 | 577 | 378 | 790 | 3,192 | 55,000 | 14,468 | 0 | 71 | 7,890 | 2,476 | 24,905 | 30,095 | 43,455 | 40,581 |
| 2023 | 1970 | 14,965 | 4,483 | 2,012 | 148 | 378 | 790 | 3,192 | 25,968 | 15,717 | 0 | 800 | 8,590 | 2,750 | 27,857 | -1,889 | 41,566 | 9,847 |
| 2024 | 1971 | 12,601 | 4,373 | 335 | 163 | 378 | 790 | 3,192 | 21,832 | 14,905 | 0 | 1,119 | 8,958 | 2,834 | 27,816 | -5,984 | 35,582 | 4,939 |
| 2025 | 1972 | 9,593 | 3,955 | 244 | 94 | 378 | 790 | 3,192 | 18,245 | 14,687 | 0 | 1,308 | 9,043 | 2,800 | 27,838 | -9,593 | 25,989 | 1,111 |
| 2026 | 1973 | 12,514 | 6,247 | 5,918 | 372 | 378 | 790 | 3,192 | 29,411 | 12,916 | 0 | 1,115 | 9,130 | 2,735 | 25,896 | 3,515 | 29,504 | 12,449 |
| 2027 | 1974 | 12,927 | 4,935 | 453 | 209 | 378 | 790 | 4,176 | 23,868 | 12,992 | 0 | 1,198 | 9,380 | 2,760 | 26,330 | -2,462 | 27,042 | 5,564 |
| 2028 | 1975 | 10,802 | 4,899 | 191 | 180 | 378 | 790 | 4,092 | 21,331 | 13,030 | 0 | 1,354 | 9,457 | 2,767 | 26,608 | -5,276 | 21,766 | 2,872 |
| 2029 | 1976 | 9,652 | 4,109 | 3,617 | 108 | 378 | 790 | 4,056 | 22,710 | 13,106 | 0 | 1,405 | 9,385 | 2,727 | 26,624 | -3,914 | 17,852 | 4,346 |
| 2030 | 1977 | 3,403 | 5,474 | 1,495 | 188 | 378 | 790 | 3,972 | 15,699 | 12,840 | 0 | 1,355 | 9,240 | 2,662 | 26,096 | -10,397 | 7,455 | -2,319 |
| 2031 | 1978 | 12,575 | 10,461 | 32,107 | 767 | 378 | 790 | 4,248 | 61,326 | 12,498 | 0 | 413 | 9,758 | 2,703 | 25,373 | 35,954 | 43,408 | 43,414 |
| 2032 | 1979 | 6,821 | 5,994 | 4,328 | 339 | 378 | 790 | 4,608 | 23,258 | 14,030 | 0 | 1,145 | 10,599 | 2,960 | 28,735 | -5,477 | 37,932 | 3,155 |
| 2033 | 1980 | 10,191 | 8,705 | 22,654 | 564 | 378 | 790 | 3,192 | 46,475 | 14,030 | 0 | 865 | 10,855 | 3,058 | 28,809 | 17,666 | 55,598 | 27,714 |
| 2034 | 1981 | 5,536 | 3,471 | 307 | 105 | 378 | 790 | 3,192 | 13,779 | 16,240 | 0 | 1,761 | 10,913 | 3,144 | 32,058 | -18,279 | 37,319 | -6,021 |
| 2035 | 1982 | 7,799 | 5,094 | 8,093 | 312 | 378 | 790 | 3,192 | 25,658 | 13,336 | 0 | 1,757 | 10,649 | 3,042 | 28,785 | -3,126 | 34,192 | 6,228 |
| 2036 | 1983 | 11,755 | 8,757 | 34,972 | 765 | 378 | 790 | 3,744 | 61,160 | 13,414 | 0 | 1,112 | 11,299 | 3,155 | 28,981 | 32,179 | 66,372 | 41,059 |
| 2037 | 1984 | 8,608 | 4,175 | 12,729 | 159 | 378 | 790 | 3,660 | 30,501 | 13,841 | 0 | 2,037 | 12,365 | 3,590 | 31,833 | -1,333 | 65,039 | 8,059 |
| 2038 | 1985 | 7,587 | 3,944 | 1,130 | 184 | 378 | 790 | 3,228 | 17,240 | 14,759 | 0 | 2,375 | 11,970 | 3,545 | 32,650 | -15,410 | 49,629 | -4,669 |
| 2039 | 1986 | 7,169 | 5,463 | 8,662 | 306 | 378 | 790 | 3,192 | 25,960 | 14,103 | 0 | 2,251 | 11,432 | 3,347 | 31,134 | -5,174 | 44,454 | 4,947 |
| 2040 | 1987 | 2,734 | 3,662 | 186 | 114 | 378 | 790 | 3,192 | 11,055 | 12,726 | 0 | 2,253 | 11,184 | 3,223 | 29,386 | -18,330 | 26,124 | -9,586 |
| 2041 | 1988 | 5,657 | 5,042 | 1,820 | 213 | 378 | 790 | 4,368 | 18,268 | 12,042 | 0 | 2,122 | 10,896 | 3,069 | 28,130 | -9,861 | 16,263 | -2,977 |
| 2042 | 1989 | 3,213 | 3,975 | 269 | 180 | 378 | 790 | 5,076 | 13,880 | 12,080 | 0 | 2,037 | 10,578 | 2,923 | 27,618 | -13,737 | 2,525 | -7,523 |
| 2043 | 1990 | 2,260 | 3,192 | 189 | 132 | 378 | 790 | 5,040 | 11,982 | 11,586 | 0 | 1,967 | 10,154 | 2,762 | 26,469 | -14,487 | -11,962 | -8,731 |
| 2044 | 1991 | 5,211 | 4,940 | 6,114 | 281 | 378 | 790 | 5,544 | 23,258 | 11,548 | 0 | 1,628 | 9,675 | 2,591 | 25,442 | -2,184 | -14,145 | 3,030 |
| 2045 | 1992 | 6,469 | 5,952 | 18,046 | 415 | 378 | 790 | 5,592 | 37,642 | 11,700 | 0 | 1,259 | 9,443 | 2,500 | 24,903 | 12,740 | -1,406 | 18,058 |
| 2046 | 1993 | 12,487 | 9,212 | 27,644 | 752 | 378 | 790 | 5,436 | 56,698 | 12,574 | 0 | 385 | 10,284 | 2,716 | 25,959 | 30,739 | 29,334 | 37,088 |
| 2047 | 1994 | 6,050 | 3,490 | 187 | 159 | 378 | 790 | 4,524 | 15,578 | 14,614 | 0 | 1,696 | 10,515 | 2,922 | 29,746 | -14,169 | 15,165 | -4,869 |
| 2048 | 1995 | 9,471 | 6,716 | 30,335 | 586 | 378 | 790 | 3,192 | 51,467 | 14,176 | 0 | 1,305 | 10,526 | 2,981 | 28,988 | 22,479 | 37,645 | 32,674 |
| 2049 | 1996 | 7,198 | 4,561 | 3,553 | 255 | 378 | 790 | 3,192 | 19,927 | 15,197 | 0 | 1,709 | 10,679 | 3,109 | 30,694 | -10,767 | 26,878 | 448 |
| 2050 | 1997 | 8,772 | 5,662 | 1,877 | 392 | 378 | 790 | 3,192 | 21,063 | 13,220 | 0 | 1,756 | 10,600 | 3,069 | 28,645 | -7,582 | 19,296 | 1,656 |
| 2051 | 1998 | 12,171 | 7,827 | 16,311 | 715 | 378 | 790 | 3,852 | 42,044 | 13,492 | 0 | 1,390 | 10,504 | 3,013 | 28,400 | 13,644 | 32,940 | 22,494 |
| 2052 | 1999 | 4,812 | 2,700 | 3,502 | 112 | 378 | 790 | 3,576 | 15,870 | 13,220 | 0 | 1,916 | 10,761 | 3,117 | 29,014 | -13,144 | 19,796 | -4,290 |
| 2053 | 2000 | 7,156 | 4,178 | 240 | 221 | 378 | 790 | 3,852 | 16,815 | 12,992 | 0 | 2,014 | 10,547 | 3,055 | 28,608 | -11,793 | 8,004 | -3,443 |
| 2054 | 2001 | 5,569 | 3,897 | 274 | 270 | 378 | 790 | 4,092 | 15,270 | 12,764 | 0 | 1,853 | 10,231 | 2,913 | 27,761 | -12,491 | -4,487 | -4,609 |
| 2055 | 2002 | 2,812 | 2,346 | 147 | 56 | 378 | 790 | 4,332 | 10,861 | 11,776 | 0 | 1,903 | 9,947 | 2,771 | 26,398 | -15,536 | -20,023 | -8,882 |
| 2056 | 2003 | 5,106 | 4,926 | 254 | 226 | 378 | 790 | 5,352 | 17,032 | 11,624 | 0 | 1,655 | 9,562 | 2,615 | 25,457 | -8,425 | -28,448 | -2,943 |
| 2057 | 2004 | 4,042 | 3,740 | 662 | 132 | 378 | 790 | 5,508 | 15,251 | 11,586 | 0 | 1,568 | 9,281 | 2,487 | 24,923 | -9,671 | -38,119 | -4,383 |
| 2058 | 2005 | 12,688 | 8,701 | 34,621 | 581 | 378 | 790 | 5,544 | 63,302 | 11,586 | 0 | 692 | 9,561 | 2,512 | 24,352 | 38,950 | 831 | 44,203 |
| 2059 | 2006 | 7,166 | 4,425 | 7,961 | 214 | 378 | 790 | 5,544 | 26,478 | 13,492 | 0 | 1,438 | 9,907 | 2,715 | 27,552 | -1,074 | -243 | 6,084 |
| 2060 | 2007 | 2,962 | 2,075 | 137 | 38 | 378 | 790 | 3,576 | 9,957 | 13,803 | 0 | 1,688 | 9,495 | 2,724 | 27,710 | -17,753 | -17,995 | -8,316 |
| 2061 | 2008 | 6,389 | 4,668 | 2,010 | 270 | 378 | 790 | 3,264 | 17,769 | 13,647 | 0 | 1,425 | 8,937 | 2,568 | 26,577 | -8,808 | -26,803 | 785 |
| 2062 | 2009 | 4,843 | 3,891 | 212 | 169 | 378 | 790 | 3,420 | 13,704 | 12,118 | 0 | 1,352 | 8,770 | 2,450 | 24,691 | -10,987 | -37,791 | -3,079 |
| 2063 | 2010 | 7,103 | 5,109 | 6,328 | 316 | 378 | 790 | 4,992 | 25,015 | 11,814 | 0 | 1,113 | 8,696 | 2,372 | 23,995 | 1,020 | -36,770 | 7,053 |
| 2064 | 2011 | 7,455 | 5,381 | 22,576 | 344 | 378 | 790 | 5,316 | 42,241 | 12,346 | 0 | 920 | 8,820 | 2,391 | 24,477 | 17,763 | -19,007 | 24,004 |
| 2065 | 2012 | 2,201 | 3,208 | 170 | 118 | 378 | 790 | 4,764 | 11,629 | 13,106 | 0 | 1,244 | 8,882 | 2,477 | 25,709 | -14,080 | -33,087 | -6,528 |
| 2066 | 2013 | 7,359 | 2,491 | 146 | 71 | 378 | 790 | 3,972 | 15,207 | 12,992 | 0 | 1,271 | 8,620 | 2,411 | 25,294 | -10,087 | -43,174 | -1,857 |
| Average | | 8,406 | 4,970 | 6,993 | 272 | 378 | 790 | 3,992 | 25,801 | 13,059 | 0 | 1,346 | 9,473 | 2,723 | 26,601 | -800 | | 7,478 |
| Median | | 7,497 | 4,522 | 1,848 | 211 | 378 | 790 | 3,852 | 21,197 | 12,992 | 0 | 1,330 | 9,528 | 2,731 | 26,523 | -5,377 | | 2,951 |
| Minimum | | 2,201 | 2,075 | 137 | 38 | 378 | 790 | 2,004 | 9,957 | 10,754 | 0 | 71 | 6,799 | 2,064 | 20,946 | -18,330 | | -9,586 |
| Maximum | | 21,504 | 10,461 | 34,972 | 767 | 378 | 790 | 5,592 | 63,302 | 16,240 | 0 | 2,375 | 12,365 | 3,590 | 32,650 | 38,950 | | 44,203 |
| Total | | 453,942 | 268,406 | 377,599 | 14,710 | 20,412 | 42,660 | 215,544 | 1,393,273 | 705,164 | 0 | 72,693 | 511,523 | 147,067 | 1,436,447 | -43,174 | | 403,785 |
| Total (%) | | 33% | 19% | 27% | 1% | 1% | 3% | 15% | 100% | 49% | 0% | 5% | 36% | 10% | 100% | na | | na |

## Table 3-5d
## Projected Water Budget for the Pomona Basin -- *Baseline Alternative*
*(acre-feet)*

| Fiscal Year | Historical Hydrologic Year Used in Simulation | Recharge | | | | | | | | | Discharge | | | Change in Storage | | Annual Developed Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Subsurface Boundary Inflow from the Claremont Heights Basins | Subsurface Boundary Inflow from the San Jose Hills | Subsurface Inflow from the Two Basins | Deep Infiltration of Precipitation and Applied Water | Storm-Water Infiltration at Spreading Grounds | Streambed Infiltration in Unlined Channels | Returns from Septic Systems | Artificial Recharge of Imported Water | Total Recharge | Groundwater Production | Subsurface Outflow to Chino Basin | Total Discharge | Annual | Cumulative | |
| 2013 | 1960 | 6,882 | 172 | 1,340 | 2,210 | 0 | 0 | 6 | 0 | 10,611 | 9,860 | 5,851 | 15,711 | -5,100 | -5,100 | 4,760 |
| 2014 | 1961 | 6,898 | 172 | 1,291 | 1,848 | 0 | 0 | 6 | 0 | 10,214 | 9,387 | 5,652 | 15,039 | -4,825 | -9,925 | 4,562 |
| 2015 | 1962 | 6,985 | 172 | 1,302 | 3,436 | 0 | 0 | 6 | 0 | 11,901 | 9,304 | 5,483 | 14,787 | -2,886 | -12,811 | 6,418 |
| 2016 | 1963 | 7,083 | 172 | 1,382 | 2,634 | 0 | 0 | 6 | 0 | 11,277 | 9,687 | 5,379 | 15,066 | -3,790 | -16,601 | 5,897 |
| 2017 | 1964 | 6,858 | 172 | 1,388 | 3,190 | 0 | 0 | 6 | 0 | 11,614 | 9,687 | 5,263 | 14,950 | -3,336 | -19,937 | 6,351 |
| 2018 | 1965 | 6,799 | 172 | 1,405 | 3,361 | 0 | 0 | 6 | 0 | 11,743 | 10,792 | 5,084 | 15,876 | -4,132 | -24,069 | 6,659 |
| 2019 | 1966 | 7,032 | 172 | 1,423 | 3,805 | 0 | 0 | 6 | 0 | 12,438 | 10,499 | 4,933 | 15,432 | -2,995 | -27,064 | 7,504 |
| 2020 | 1967 | 7,366 | 172 | 1,512 | 4,576 | 0 | 0 | 6 | 0 | 13,632 | 10,972 | 4,831 | 15,803 | -2,171 | -29,235 | 8,801 |
| 2021 | 1968 | 7,651 | 172 | 1,604 | 3,636 | 0 | 0 | 6 | 0 | 13,068 | 11,435 | 4,772 | 16,207 | -3,139 | -32,374 | 8,296 |
| 2022 | 1969 | 7,890 | 172 | 1,688 | 4,940 | 0 | 0 | 6 | 0 | 14,697 | 11,624 | 4,709 | 16,333 | -1,636 | -34,010 | 9,988 |
| 2023 | 1970 | 8,590 | 172 | 1,804 | 3,738 | 0 | 0 | 6 | 0 | 14,310 | 12,072 | 4,694 | 16,767 | -2,457 | -36,467 | 9,616 |
| 2024 | 1971 | 8,958 | 172 | 1,782 | 3,379 | 0 | 0 | 6 | 0 | 14,297 | 11,786 | 4,697 | 16,483 | -2,186 | -38,652 | 9,600 |
| 2025 | 1972 | 9,043 | 172 | 1,763 | 3,472 | 0 | 0 | 6 | 0 | 14,457 | 11,705 | 4,683 | 16,388 | -1,931 | -40,583 | 9,774 |
| 2026 | 1973 | 9,130 | 172 | 1,707 | 4,165 | 0 | 0 | 6 | 0 | 15,180 | 10,859 | 4,679 | 15,538 | -358 | -40,941 | 10,501 |
| 2027 | 1974 | 9,380 | 172 | 1,743 | 3,727 | 0 | 0 | 6 | 0 | 15,029 | 10,904 | 4,705 | 15,609 | -580 | -41,521 | 10,324 |
| 2028 | 1975 | 9,457 | 172 | 1,742 | 3,646 | 0 | 0 | 6 | 0 | 15,023 | 10,927 | 4,735 | 15,662 | -639 | -42,160 | 10,288 |
| 2029 | 1976 | 9,385 | 172 | 1,735 | 3,467 | 0 | 0 | 6 | 0 | 14,766 | 10,972 | 4,745 | 15,716 | -951 | -43,111 | 10,021 |
| 2030 | 1977 | 9,240 | 172 | 1,711 | 4,034 | 0 | 0 | 6 | 0 | 15,163 | 10,814 | 4,738 | 15,552 | -389 | -43,500 | 10,425 |
| 2031 | 1978 | 9,758 | 172 | 1,739 | 7,045 | 0 | 0 | 6 | 0 | 18,720 | 10,611 | 4,782 | 15,394 | 3,326 | -40,174 | 13,938 |
| 2032 | 1979 | 10,599 | 172 | 1,902 | 4,606 | 0 | 0 | 6 | 0 | 17,286 | 11,462 | 4,958 | 16,420 | 865 | -39,309 | 12,327 |
| 2033 | 1980 | 10,855 | 172 | 1,940 | 6,010 | 0 | 0 | 6 | 0 | 18,983 | 11,462 | 5,089 | 16,552 | 2,432 | -36,877 | 13,894 |
| 2034 | 1981 | 10,913 | 172 | 2,016 | 3,247 | 0 | 0 | 6 | 0 | 16,355 | 12,249 | 5,202 | 17,452 | -1,097 | -37,974 | 11,152 |
| 2035 | 1982 | 10,649 | 172 | 1,876 | 3,817 | 0 | 0 | 6 | 0 | 16,521 | 11,104 | 5,243 | 16,347 | 174 | -37,800 | 11,278 |
| 2036 | 1983 | 11,299 | 172 | 1,867 | 6,014 | 0 | 0 | 6 | 0 | 19,358 | 11,148 | 5,288 | 16,435 | 2,923 | -34,877 | 14,071 |
| 2037 | 1984 | 12,365 | 172 | 1,921 | 3,543 | 0 | 0 | 6 | 0 | 18,007 | 11,386 | 5,496 | 16,882 | 1,125 | -33,752 | 12,511 |
| 2038 | 1985 | 11,970 | 172 | 1,908 | 3,306 | 0 | 0 | 6 | 0 | 17,363 | 11,732 | 5,607 | 17,338 | 25 | -33,728 | 11,756 |
| 2039 | 1986 | 11,432 | 172 | 1,849 | 4,520 | 0 | 0 | 6 | 0 | 17,980 | 11,489 | 5,615 | 17,104 | 876 | -32,852 | 12,365 |
| 2040 | 1987 | 11,184 | 172 | 1,781 | 3,181 | 0 | 0 | 6 | 0 | 16,324 | 10,747 | 5,648 | 16,394 | -71 | -32,922 | 10,676 |
| 2041 | 1988 | 10,896 | 172 | 1,696 | 4,103 | 0 | 0 | 6 | 0 | 16,873 | 10,341 | 5,665 | 16,006 | 867 | -32,056 | 11,208 |
| 2042 | 1989 | 10,578 | 172 | 1,660 | 3,381 | 0 | 0 | 6 | 0 | 15,797 | 10,364 | 5,673 | 16,036 | -239 | -32,295 | 10,125 |
| 2043 | 1990 | 10,154 | 172 | 1,595 | 2,800 | 0 | 0 | 6 | 0 | 14,726 | 10,071 | 5,659 | 15,730 | -1,004 | -33,298 | 9,067 |
| 2044 | 1991 | 9,675 | 172 | 1,546 | 3,747 | 0 | 0 | 6 | 0 | 15,146 | 10,049 | 5,600 | 15,649 | -503 | -33,801 | 9,546 |
| 2045 | 1992 | 9,443 | 172 | 1,550 | 4,371 | 0 | 0 | 6 | 0 | 15,541 | 10,139 | 5,549 | 15,688 | -147 | -33,948 | 9,992 |
| 2046 | 1993 | 10,284 | 172 | 1,658 | 6,249 | 0 | 0 | 6 | 0 | 18,370 | 10,656 | 5,549 | 16,206 | 2,164 | -31,784 | 12,820 |
| 2047 | 1994 | 10,515 | 172 | 1,805 | 2,907 | 0 | 0 | 6 | 0 | 15,404 | 11,678 | 5,628 | 17,306 | -1,901 | -33,685 | 9,777 |
| 2048 | 1995 | 10,526 | 172 | 1,780 | 4,610 | 0 | 0 | 6 | 0 | 17,094 | 11,516 | 5,617 | 17,133 | -39 | -33,725 | 11,477 |
| 2049 | 1996 | 10,679 | 172 | 1,828 | 3,429 | 0 | 0 | 6 | 0 | 16,113 | 11,894 | 5,623 | 17,516 | -1,403 | -35,128 | 10,491 |
| 2050 | 1997 | 10,600 | 172 | 1,753 | 4,184 | 0 | 0 | 6 | 0 | 16,715 | 11,039 | 5,619 | 16,658 | 56 | -35,071 | 11,095 |
| 2051 | 1998 | 10,504 | 172 | 1,777 | 5,145 | 0 | 0 | 6 | 0 | 17,605 | 11,191 | 5,616 | 16,807 | 798 | -34,274 | 11,989 |
| 2052 | 1999 | 10,761 | 172 | 1,791 | 2,182 | 0 | 0 | 6 | 0 | 14,912 | 11,039 | 5,663 | 16,702 | -1,790 | -36,063 | 9,249 |
| 2053 | 2000 | 10,547 | 172 | 1,708 | 3,403 | 0 | 0 | 6 | 0 | 15,837 | 10,904 | 5,648 | 16,552 | -716 | -36,779 | 10,188 |
| 2054 | 2001 | 10,231 | 172 | 1,672 | 3,200 | 0 | 0 | 6 | 0 | 15,281 | 10,769 | 5,599 | 16,368 | -1,088 | -37,867 | 9,681 |
| 2055 | 2002 | 9,947 | 172 | 1,598 | 2,239 | 0 | 0 | 6 | 0 | 13,962 | 10,184 | 5,564 | 15,748 | -1,786 | -39,652 | 8,398 |
| 2056 | 2003 | 9,562 | 172 | 1,541 | 3,651 | 0 | 0 | 6 | 0 | 14,932 | 10,094 | 5,490 | 15,584 | -652 | -40,304 | 9,442 |
| 2057 | 2004 | 9,281 | 172 | 1,526 | 2,974 | 0 | 0 | 6 | 0 | 13,959 | 10,071 | 5,429 | 15,500 | -1,541 | -41,845 | 8,530 |
| 2058 | 2005 | 9,561 | 172 | 1,546 | 5,839 | 0 | 0 | 6 | 0 | 17,124 | 10,071 | 5,386 | 15,457 | 1,667 | -40,178 | 11,738 |
| 2059 | 2006 | 9,907 | 172 | 1,695 | 3,212 | 0 | 0 | 6 | 0 | 14,992 | 11,191 | 5,426 | 16,617 | -1,625 | -41,804 | 9,566 |
| 2060 | 2007 | 9,495 | 172 | 1,700 | 2,027 | 0 | 0 | 6 | 0 | 13,400 | 11,364 | 5,397 | 16,762 | -3,362 | -45,166 | 8,002 |
| 2061 | 2008 | 8,937 | 172 | 1,656 | 3,280 | 0 | 0 | 6 | 0 | 14,051 | 11,278 | 5,263 | 16,541 | -2,490 | -47,656 | 8,788 |
| 2062 | 2009 | 8,770 | 172 | 1,584 | 2,951 | 0 | 0 | 6 | 0 | 13,484 | 10,386 | 5,158 | 15,544 | -2,060 | -49,716 | 8,326 |
| 2063 | 2010 | 8,696 | 172 | 1,557 | 3,655 | 0 | 0 | 6 | 0 | 14,086 | 10,206 | 5,084 | 15,291 | -1,205 | -50,921 | 9,001 |
| 2064 | 2011 | 8,820 | 172 | 1,593 | 3,771 | 0 | 0 | 6 | 0 | 14,362 | 10,521 | 5,029 | 15,551 | -1,189 | -52,110 | 9,333 |
| 2065 | 2012 | 8,882 | 172 | 1,637 | 2,729 | 0 | 0 | 6 | 0 | 13,426 | 10,972 | 4,994 | 15,965 | -2,539 | -54,649 | 8,432 |
| 2066 | 2013 | 8,620 | 172 | 1,613 | 2,269 | 0 | 0 | 6 | 0 | 12,680 | 10,904 | 4,918 | 15,822 | -3,142 | -57,791 | 7,762 |
| Average | | 9,473 | 172 | 1,670 | 3,720 | 0 | 0 | 6 | 0 | 15,041 | 10,844 | 5,267 | 16,111 | -1,070 | | 9,774 |
| Median | | 9,528 | 172 | 1,695 | 3,508 | 0 | 0 | 6 | 0 | 15,007 | 10,904 | 5,382 | 16,021 | -1,092 | | 9,775 |
| Minimum | | 6,799 | 172 | 1,291 | 1,848 | 0 | 0 | 6 | 0 | 10,214 | 9,304 | 4,679 | 14,787 | -5,100 | | 4,562 |
| Maximum | | 12,365 | 172 | 2,016 | 7,045 | 0 | 0 | 6 | 0 | 19,358 | 12,249 | 5,851 | 17,516 | 3,326 | | 14,071 |
| Total | | 511,523 | 9,288 | 90,190 | 200,863 | 0 | 0 | 324 | 0 | 812,187 | 585,569 | 284,409 | 869,978 | -57,791 | | 527,778 |
| Total (%) | | 63% | 1% | 11% | 25% | 0% | 0% | 0% | 0% | 100% | 67% | 33% | 100% | na | | na |

## Table 3-5e
## Projected Water Budget for the Two Basins -- *Baseline Alternative*

*(acre-feet)*

| Fiscal Year | Historical Hydrologic Year Used in Simulation | Recharge | | | | | | | | | Discharge | | | | Change in Storage | | Annual Developed Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Subsurface Boundary Inflow from the San Gabriel Mountains | Subsurface Boundary Inflow from the San Jose Hills | Subsurface Inflow from Claremont Heights Basins | Deep Infiltration of Precipitation and Applied Water | Storm-Water Infiltration at Spreading Grounds | Streambed Infiltration in Unlined Channels | Returns from Septic Systems | Artificial Recharge of Imported Water | Total Recharge | Groundwater Production | Rising Groundwater Outflow to Storm Drains | Subsurface Outflow to the Pomona Basin | Total Discharge | Annual | Cumulative | |
| 2013 | 1960 | 57 | 57 | 1,193 | 941 | 64 | 0 | 16 | 0 | 2,327 | 1,830 | 0 | 1,340 | 3,170 | -843 | -843 | 987 |
| 2014 | 1961 | 35 | 57 | 1,137 | 800 | 29 | 0 | 16 | 0 | 2,075 | 1,830 | 0 | 1,291 | 3,121 | -1,046 | -1,889 | 784 |
| 2015 | 1962 | 252 | 57 | 710 | 1,566 | 612 | 0 | 16 | 0 | 3,213 | 1,830 | 0 | 1,302 | 3,132 | 81 | -1,807 | 1,911 |
| 2016 | 1963 | 69 | 57 | 898 | 1,115 | 78 | 0 | 16 | 0 | 2,233 | 1,830 | 0 | 1,382 | 3,212 | -979 | -2,786 | 851 |
| 2017 | 1964 | 68 | 57 | 947 | 1,363 | 89 | 0 | 16 | 0 | 2,540 | 1,830 | 0 | 1,388 | 3,218 | -678 | -3,464 | 1,152 |
| 2018 | 1965 | 87 | 57 | 913 | 1,424 | 201 | 0 | 16 | 0 | 2,698 | 1,830 | 0 | 1,405 | 3,235 | -537 | -4,001 | 1,293 |
| 2019 | 1966 | 313 | 57 | 582 | 1,674 | 581 | 0 | 16 | 0 | 3,223 | 1,830 | 0 | 1,423 | 3,253 | -30 | -4,031 | 1,800 |
| 2020 | 1967 | 529 | 57 | 442 | 1,968 | 747 | 0 | 16 | 0 | 3,758 | 1,830 | 0 | 1,512 | 3,342 | 416 | -3,615 | 2,246 |
| 2021 | 1968 | 109 | 57 | 869 | 1,554 | 118 | 0 | 16 | 0 | 2,724 | 1,830 | 0 | 1,604 | 3,434 | -710 | -4,325 | 1,120 |
| 2022 | 1969 | 1,421 | 57 | 71 | 2,210 | 1,203 | 0 | 16 | 0 | 4,978 | 1,830 | 0 | 1,688 | 3,518 | 1,460 | -2,865 | 3,290 |
| 2023 | 1970 | 101 | 57 | 800 | 1,551 | 155 | 0 | 16 | 0 | 2,680 | 1,830 | 0 | 1,804 | 3,634 | -954 | -3,819 | 876 |
| 2024 | 1971 | 88 | 57 | 1,119 | 1,452 | 140 | 0 | 16 | 0 | 2,873 | 1,830 | 0 | 1,782 | 3,612 | -739 | -4,558 | 1,091 |
| 2025 | 1972 | 46 | 57 | 1,308 | 1,476 | 61 | 0 | 16 | 0 | 2,964 | 1,830 | 0 | 1,763 | 3,593 | -629 | -5,188 | 1,201 |
| 2026 | 1973 | 264 | 57 | 1,115 | 1,876 | 508 | 0 | 16 | 0 | 3,837 | 1,830 | 0 | 1,707 | 3,537 | 300 | -4,888 | 2,130 |
| 2027 | 1974 | 121 | 57 | 1,198 | 1,548 | 269 | 0 | 16 | 0 | 3,209 | 1,830 | 0 | 1,743 | 3,573 | -364 | -5,252 | 1,466 |
| 2028 | 1975 | 75 | 57 | 1,354 | 1,565 | 121 | 0 | 16 | 0 | 3,189 | 1,830 | 0 | 1,742 | 3,572 | -383 | -5,635 | 1,447 |
| 2029 | 1976 | 60 | 57 | 1,405 | 1,525 | 69 | 0 | 16 | 0 | 3,132 | 1,830 | 0 | 1,735 | 3,565 | -433 | -6,068 | 1,397 |
| 2030 | 1977 | 75 | 57 | 1,355 | 1,754 | 135 | 0 | 16 | 0 | 3,392 | 1,830 | 0 | 1,711 | 3,541 | -149 | -6,217 | 1,681 |
| 2031 | 1978 | 1,185 | 57 | 413 | 3,035 | 1,459 | 0 | 16 | 0 | 6,165 | 1,830 | 76 | 1,739 | 3,646 | 2,520 | -3,697 | 4,350 |
| 2032 | 1979 | 232 | 57 | 1,145 | 1,967 | 557 | 0 | 16 | 0 | 3,974 | 1,830 | 407 | 1,902 | 4,139 | -166 | -3,862 | 1,664 |
| 2033 | 1980 | 1,311 | 57 | 865 | 2,620 | 1,105 | 0 | 16 | 0 | 5,973 | 1,830 | 708 | 1,940 | 4,478 | 1,495 | -2,368 | 3,325 |
| 2034 | 1981 | 98 | 57 | 1,761 | 1,426 | 80 | 0 | 16 | 0 | 3,437 | 1,830 | 776 | 2,016 | 4,622 | -1,184 | -3,552 | 646 |
| 2035 | 1982 | 195 | 57 | 1,757 | 1,736 | 423 | 0 | 16 | 0 | 4,185 | 1,830 | 614 | 1,876 | 4,320 | -135 | -3,687 | 1,695 |
| 2036 | 1983 | 837 | 57 | 1,112 | 2,601 | 1,366 | 0 | 16 | 0 | 5,989 | 1,830 | 810 | 1,867 | 4,507 | 1,482 | -2,205 | 3,312 |
| 2037 | 1984 | 138 | 57 | 2,037 | 1,550 | 190 | 0 | 16 | 0 | 3,989 | 1,830 | 978 | 1,921 | 4,729 | -740 | -2,945 | 1,090 |
| 2038 | 1985 | 89 | 57 | 2,375 | 1,427 | 141 | 0 | 16 | 0 | 4,105 | 1,830 | 909 | 1,908 | 4,648 | -543 | -3,487 | 1,287 |
| 2039 | 1986 | 111 | 57 | 2,251 | 1,972 | 282 | 0 | 16 | 0 | 4,689 | 1,830 | 868 | 1,849 | 4,547 | 142 | -3,345 | 1,972 |
| 2040 | 1987 | 78 | 57 | 2,253 | 1,365 | 82 | 0 | 16 | 0 | 3,850 | 1,830 | 864 | 1,781 | 4,475 | -624 | -3,970 | 1,206 |
| 2041 | 1988 | 101 | 57 | 2,122 | 1,755 | 205 | 0 | 16 | 0 | 4,256 | 1,830 | 767 | 1,696 | 4,292 | -37 | -4,006 | 1,793 |
| 2042 | 1989 | 84 | 57 | 2,037 | 1,479 | 159 | 0 | 16 | 0 | 3,832 | 1,830 | 714 | 1,660 | 4,205 | -373 | -4,379 | 1,457 |
| 2043 | 1990 | 59 | 57 | 1,967 | 1,201 | 92 | 0 | 16 | 0 | 3,393 | 1,830 | 604 | 1,595 | 4,029 | -636 | -5,016 | 1,194 |
| 2044 | 1991 | 214 | 57 | 1,628 | 1,562 | 435 | 0 | 16 | 0 | 3,911 | 1,830 | 502 | 1,546 | 3,879 | 33 | -4,983 | 1,863 |
| 2045 | 1992 | 414 | 57 | 1,259 | 1,823 | 730 | 0 | 16 | 0 | 4,299 | 1,830 | 515 | 1,550 | 3,895 | 404 | -4,579 | 2,234 |
| 2046 | 1993 | 1,665 | 57 | 385 | 2,789 | 1,630 | 0 | 16 | 0 | 6,541 | 1,830 | 933 | 1,658 | 4,421 | 2,120 | -2,459 | 3,950 |
| 2047 | 1994 | 103 | 57 | 1,696 | 1,225 | 94 | 0 | 16 | 0 | 3,192 | 1,830 | 925 | 1,805 | 4,560 | -1,368 | -3,827 | 462 |
| 2048 | 1995 | 681 | 57 | 1,305 | 2,106 | 1,052 | 0 | 16 | 0 | 5,217 | 1,830 | 872 | 1,780 | 4,482 | 736 | -3,091 | 2,566 |
| 2049 | 1996 | 254 | 57 | 1,709 | 1,476 | 407 | 0 | 16 | 0 | 3,920 | 1,830 | 874 | 1,828 | 4,532 | -612 | -3,703 | 1,218 |
| 2050 | 1997 | 222 | 57 | 1,756 | 1,830 | 491 | 0 | 16 | 0 | 4,372 | 1,830 | 796 | 1,753 | 4,379 | -7 | -3,710 | 1,823 |
| 2051 | 1998 | 607 | 57 | 1,390 | 2,311 | 1,065 | 0 | 16 | 0 | 5,446 | 1,830 | 884 | 1,777 | 4,491 | 955 | -2,755 | 2,785 |
| 2052 | 1999 | 104 | 57 | 1,916 | 954 | 92 | 0 | 16 | 0 | 3,139 | 1,830 | 919 | 1,791 | 4,540 | -1,401 | -4,157 | 429 |
| 2053 | 2000 | 78 | 57 | 2,014 | 1,511 | 186 | 0 | 16 | 0 | 3,861 | 1,830 | 677 | 1,708 | 4,215 | -354 | -4,510 | 1,476 |
| 2054 | 2001 | 108 | 57 | 1,853 | 1,349 | 290 | 0 | 16 | 0 | 3,673 | 1,830 | 596 | 1,672 | 4,097 | -425 | -4,935 | 1,405 |
| 2055 | 2002 | 38 | 57 | 1,903 | 978 | 26 | 0 | 16 | 0 | 3,019 | 1,830 | 478 | 1,598 | 3,907 | -887 | -5,822 | 943 |
| 2056 | 2003 | 133 | 57 | 1,655 | 1,578 | 285 | 0 | 16 | 0 | 3,724 | 1,830 | 327 | 1,541 | 3,698 | 26 | -5,797 | 1,856 |
| 2057 | 2004 | 75 | 57 | 1,568 | 1,306 | 123 | 0 | 16 | 0 | 3,146 | 1,830 | 256 | 1,526 | 3,612 | -466 | -6,263 | 1,364 |
| 2058 | 2005 | 1,186 | 57 | 692 | 2,601 | 1,138 | 0 | 16 | 0 | 5,690 | 1,830 | 440 | 1,546 | 3,816 | 1,874 | -4,389 | 3,704 |
| 2059 | 2006 | 111 | 57 | 1,438 | 1,461 | 210 | 0 | 16 | 0 | 3,293 | 1,830 | 505 | 1,695 | 4,030 | -737 | -5,125 | 1,093 |
| 2060 | 2007 | 36 | 57 | 1,688 | 907 | 14 | 0 | 16 | 0 | 2,718 | 1,830 | 336 | 1,700 | 3,865 | -1,147 | -6,273 | 683 |
| 2061 | 2008 | 123 | 57 | 1,425 | 1,494 | 337 | 0 | 16 | 0 | 3,451 | 1,830 | 0 | 1,656 | 3,486 | -35 | -6,308 | 1,795 |
| 2062 | 2009 | 78 | 57 | 1,352 | 1,301 | 141 | 0 | 16 | 0 | 2,946 | 1,830 | 0 | 1,584 | 3,414 | -468 | -6,776 | 1,362 |
| 2063 | 2010 | 160 | 57 | 1,113 | 1,613 | 466 | 0 | 16 | 0 | 3,425 | 1,830 | 0 | 1,557 | 3,387 | 38 | -6,738 | 1,868 |
| 2064 | 2011 | 301 | 57 | 920 | 1,660 | 627 | 0 | 16 | 0 | 3,580 | 1,830 | 0 | 1,593 | 3,423 | 157 | -6,580 | 1,987 |
| 2065 | 2012 | 71 | 57 | 1,244 | 1,209 | 69 | 0 | 16 | 0 | 2,666 | 1,830 | 0 | 1,637 | 3,467 | -801 | -7,381 | 1,029 |
| 2066 | 2013 | 35 | 57 | 1,271 | 1,005 | 23 | 0 | 16 | 0 | 2,408 | 1,830 | 0 | 1,613 | 3,443 | -1,036 | -8,417 | 794 |
| Average | | 279 | 57 | 1,346 | 1,621 | 394 | 0 | 16 | 0 | 3,713 | 1,830 | 369 | 1,670 | 3,869 | -156 | | 1,674 |
| Median | | 109 | 57 | 1,330 | 1,549 | 203 | 0 | 16 | 0 | 3,444 | 1,830 | 331 | 1,695 | 3,757 | -378 | | 1,452 |
| Minimum | | 35 | 57 | 71 | 800 | 14 | 0 | 16 | 0 | 2,075 | 1,830 | 0 | 1,291 | 3,121 | -1,401 | | 429 |
| Maximum | | 1,665 | 57 | 2,375 | 3,035 | 1,630 | 0 | 16 | 0 | 6,541 | 1,830 | 978 | 2,016 | 4,729 | 2,520 | | 4,350 |
| Total | | 15,088 | 3,078 | 72,693 | 87,545 | 21,254 | 0 | 864 | 0 | 200,522 | 98,820 | 19,929 | 90,190 | 208,939 | -8,417 | | 90,403 |
| Total (%) | | 8% | 2% | 36% | 44% | 11% | 0% | 0% | 0% | 100% | 47% | 10% | 43% | 100% | na | | na |

## Table 3-6
## Statistical Summary of the Water Budget for the Baseline Alternative

| Area or Sub-Basin | Total Recharge | | | Total Discharge | | |
|---|---|---|---|---|---|---|
| | Average | Min | Max | Average | Min | Max |
| ***Four Basins*** | | | | | | |
| Upper and Lower Claremont Heights and Canyon Basins | 25,801 | 9,957 | 63,302 | 26,601 | 20,946 | 32,650 |
| Pomona Basin | 15,041 | 10,214 | 19,358 | 16,111 | 14,787 | 17,516 |
| ***Sub-Total for the Four Basins*** | **31,369** | **13,861** | **70,865** | **33,239** | **29,047** | **38,596** |
| ***Two Basins*** | | | | | | |
| ***Sub-Total for the Two Basins*** | **3,713** | **2,075** | **6,541** | **3,869** | **3,121** | **4,729** |
| **Total for the Six Basins** | **32,066** | **13,191** | **74,317** | **34,092** | **29,780** | **39,441** |

**Table 3-7**
**Groundwater Storage in the Six Basins for the Baseline Alternative**

| Area or Sub-Basin | Storage *(acre-ft)* | | |
|---|---|---|---|
| | 2012 | 2036 | 2066 |
| ***Four Basins*** | | | |
| Upper and Lower Claremont Heights and Canyon Basins | 225,542 | 291,914 | 182,368 |
| Change from Initial Condition | | 66,372 | -43,174 |
| Percent Change from Initial Condition | | 29% | -19% |
| Pomona Basin | 383,810 | 348,932 | 326,019 |
| Change from Initial Condition | | -34,877 | -57,791 |
| Percent Change from Initial Condition | | -9% | -15% |
| ***Sub-Total for the Four Basins*** | **609,352** | **640,847** | **508,387** |
| Change from Initial Condition | | 31,494 | -100,965 |
| Percent Change from Initial Condition | | 5% | -17% |
| ***Two Basins*** | | | |
| ***Sub-Total for the Two Basins*** | **66,561** | **64,357** | **58,145** |
| Change from Initial Condition | | -2,205 | -8,417 |
| Percent Change from Initial Condition | | -3% | -13% |
| **Total for the Six Basins** | **675,913** | **705,203** | **566,531** |
| Change from Initial Condition | | 29,290 | -109,382 |
| Percent Change from Initial Condition | | 4% | -16% |

## Figure 3-1
## Historical and Projected Water Supplies of the City of La Verne

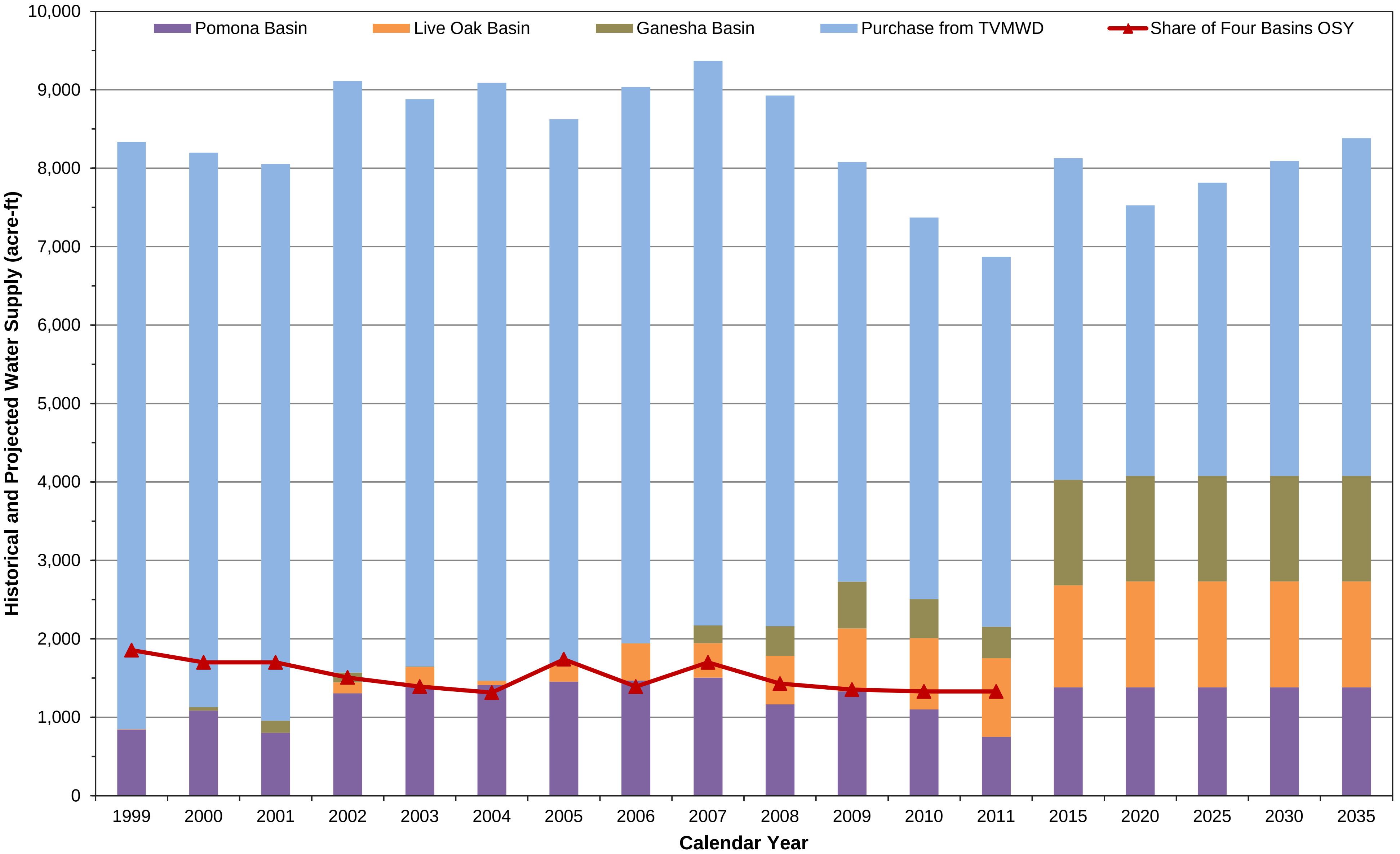
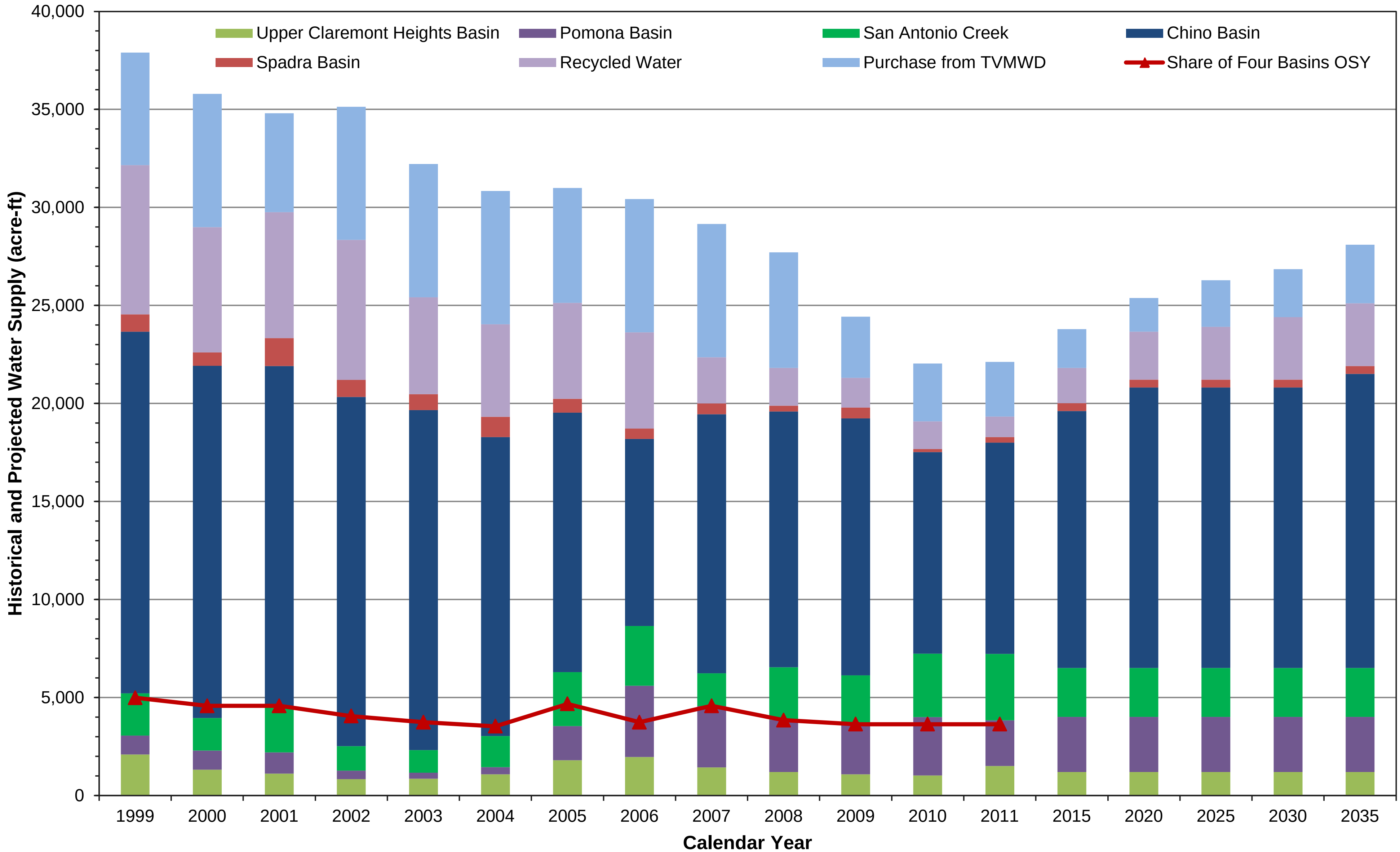


**Figure 3-2**
**Historical and Projected Water Supplies of the City of Pomona**



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## Figure 3-3
## Historical and Projected Water Supplies of the Golden State Water Company


Figure 2-22_3-1 thru 3-7_CS--Figure 3-3
5/7/2014

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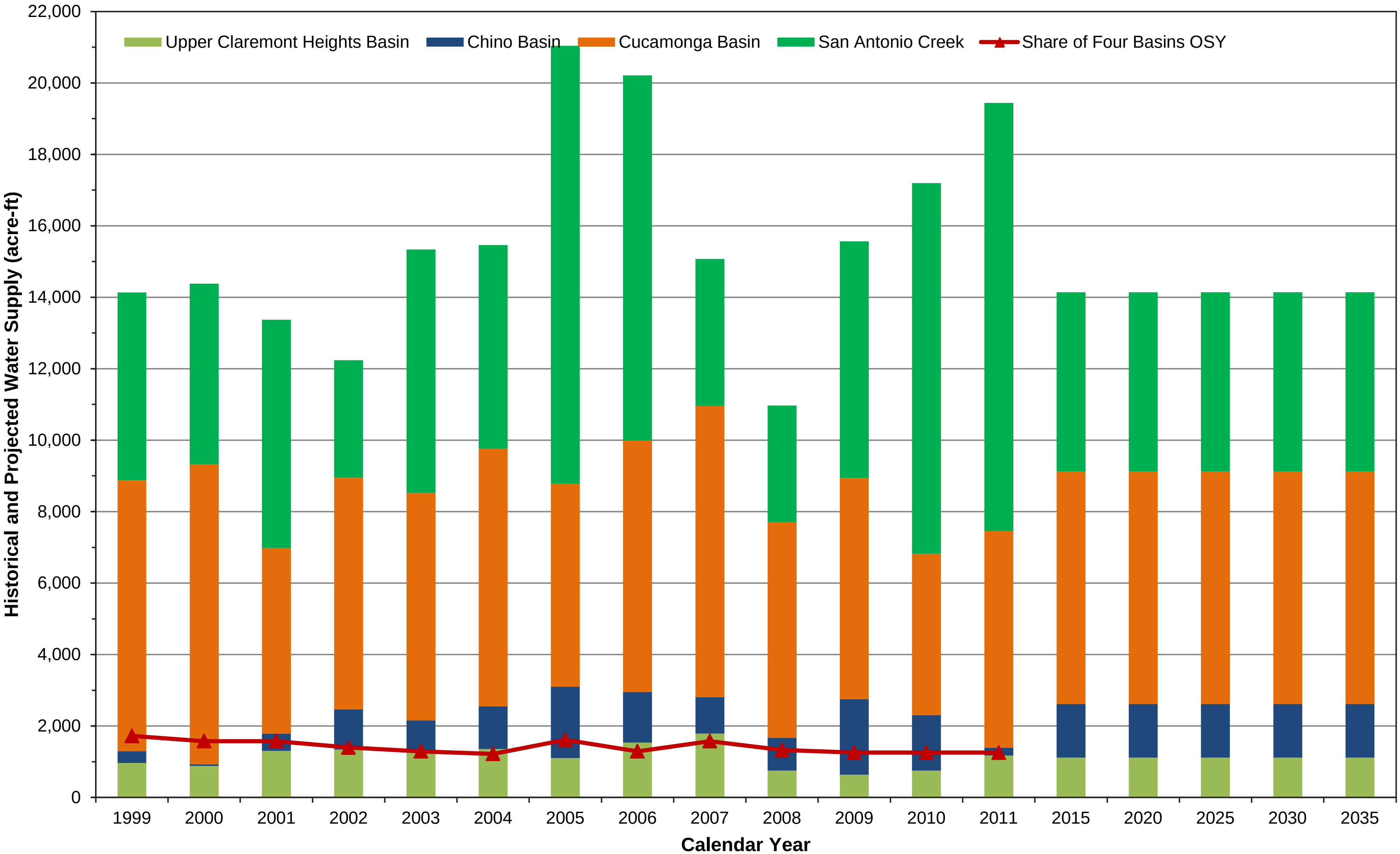
Wildermuth Environmental, Inc

**Figure 3-4**
**Historical and Projected Water Supplies of the San Antonio Water Company**



## Figure 3-5
## Historical and Projected Water Supplies of the City of Upland

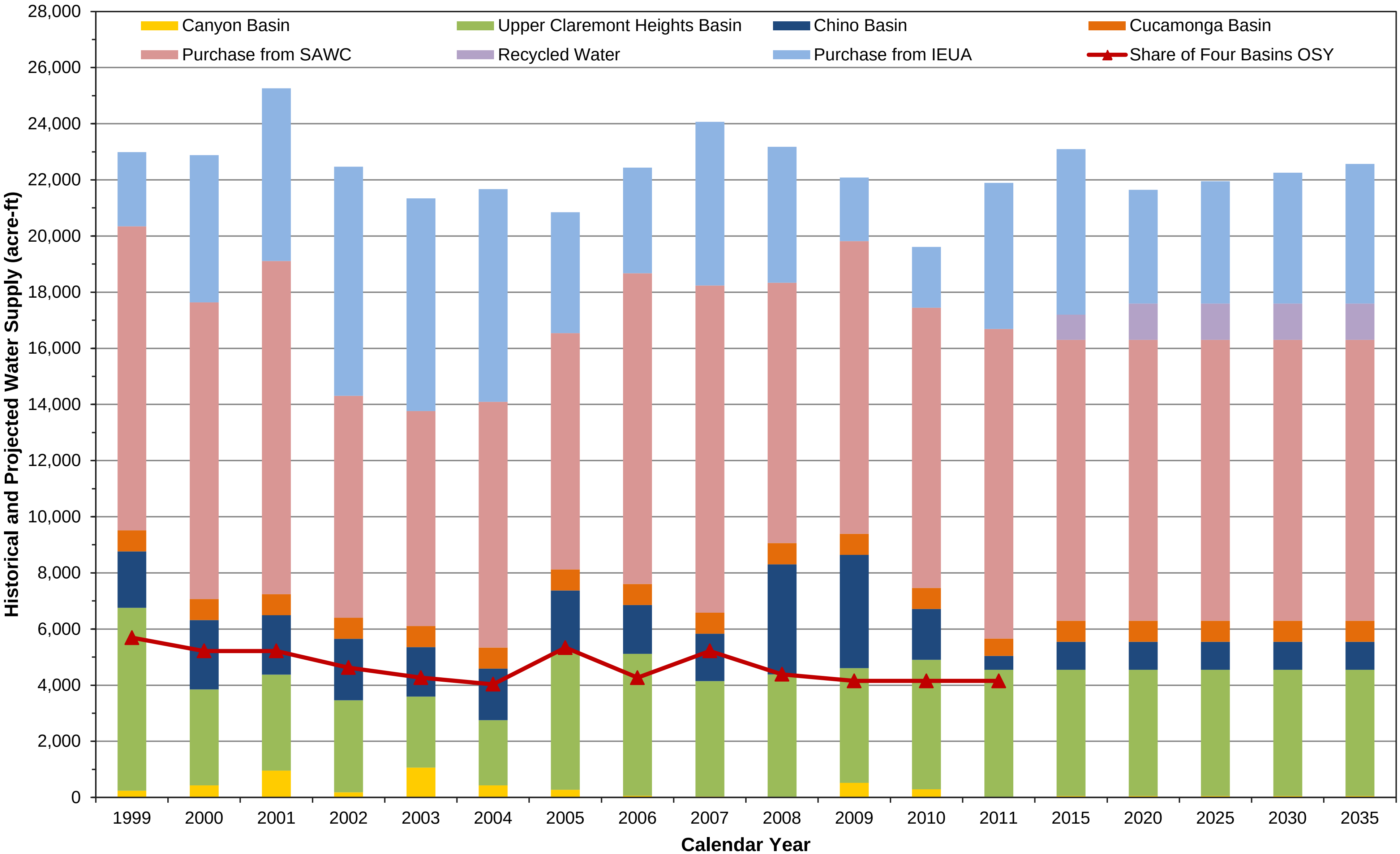



Figure 2-22_3-1 thru 3-7_CS--Figure 3-5
5/7/2014

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Figure 3-6
Historical and Projected Water Supplies of the Three Valleys Municipal Water District

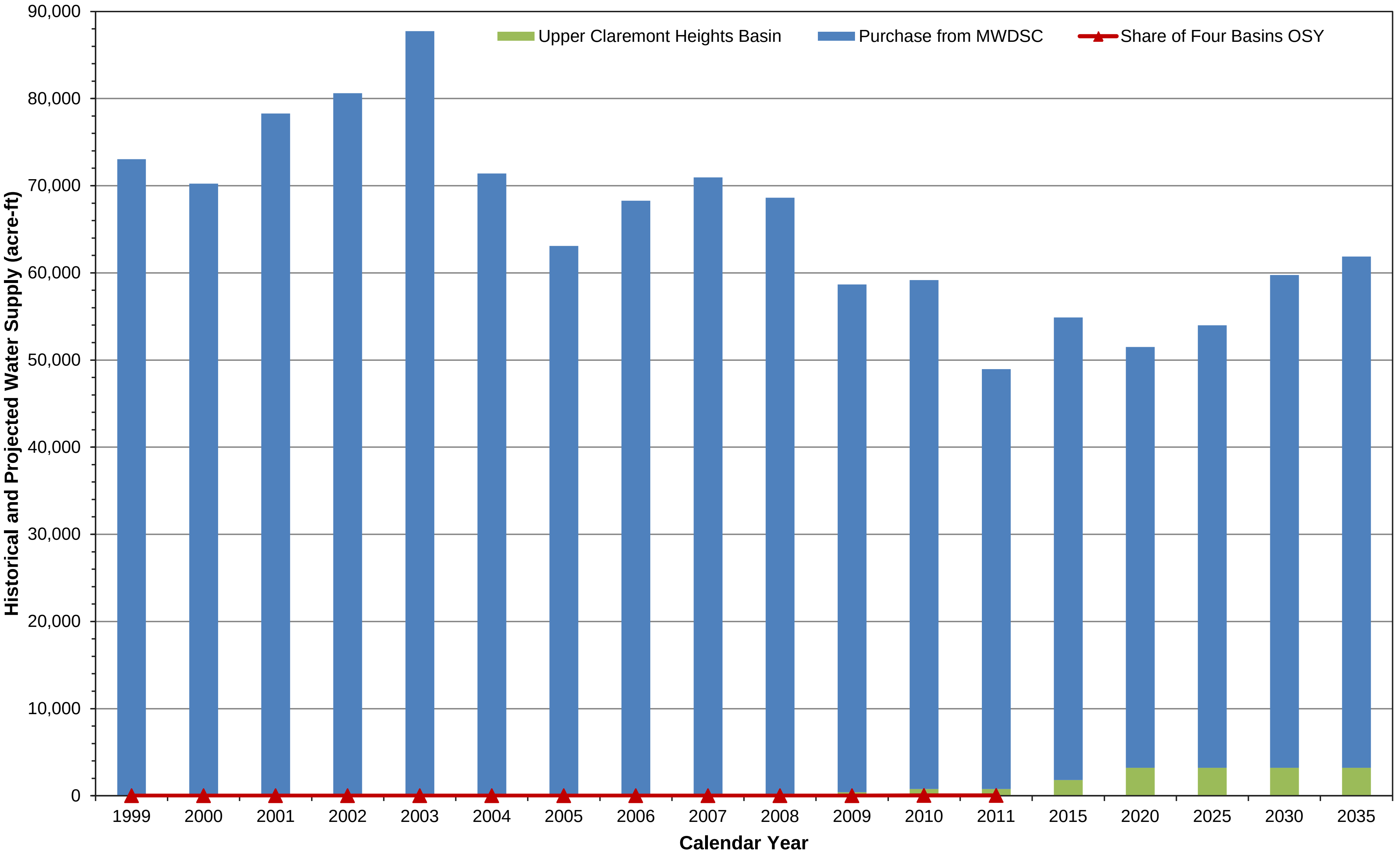


Figure 2-22_3-1 thru 3-7_CS--Figure 3-6
5/7/2014

## Figure 3-7
## Historical and Projected Water Production from the Six Basins

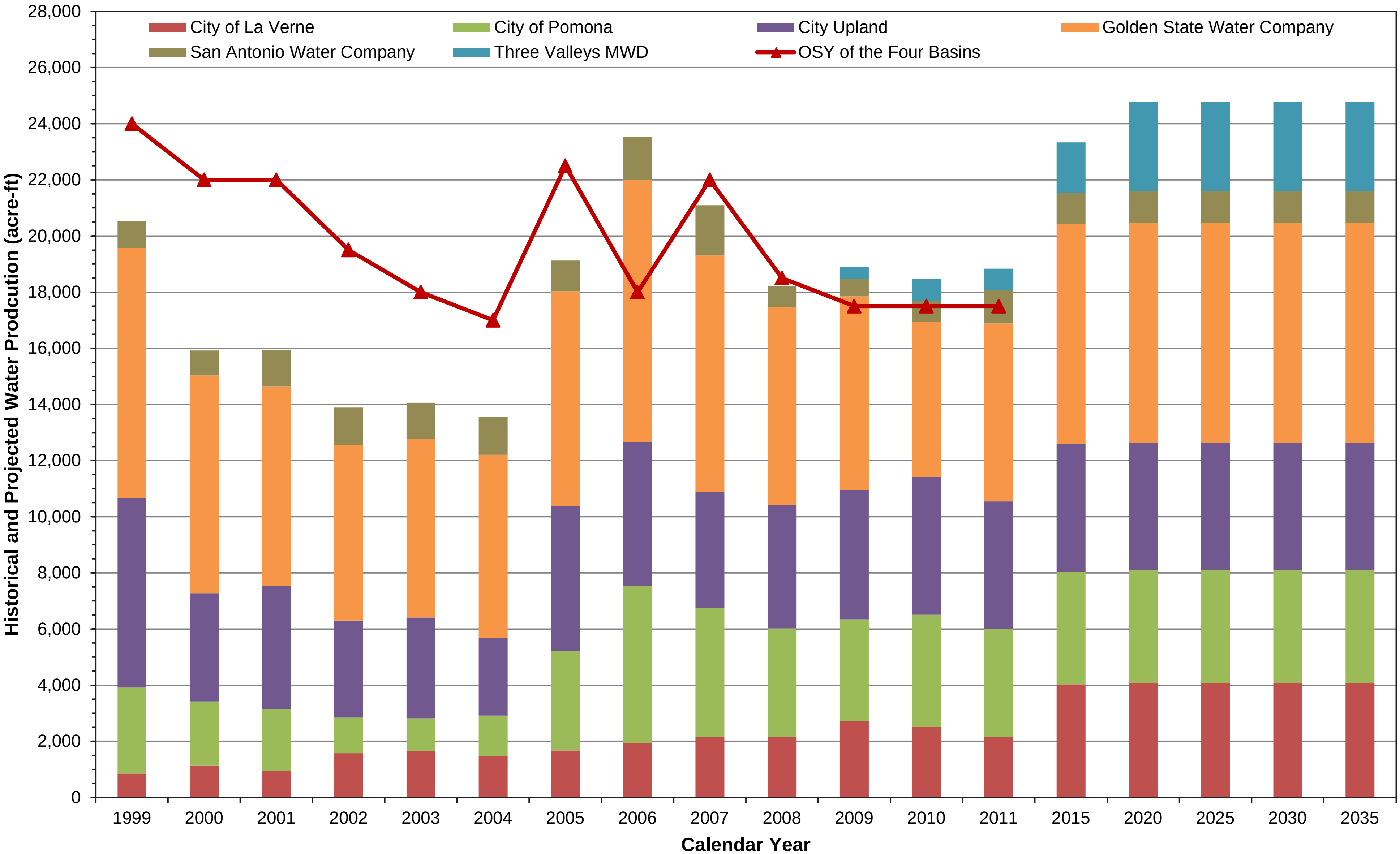


Figure 2-22_3-1 thru 3-7_CS--Figure 3-7
5/7/2014

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**Figure 3-8**
**Historical Precipitation of the Hydrologic Period Used for the Baseline Alternative**
*(Water Year 1960-2012)*

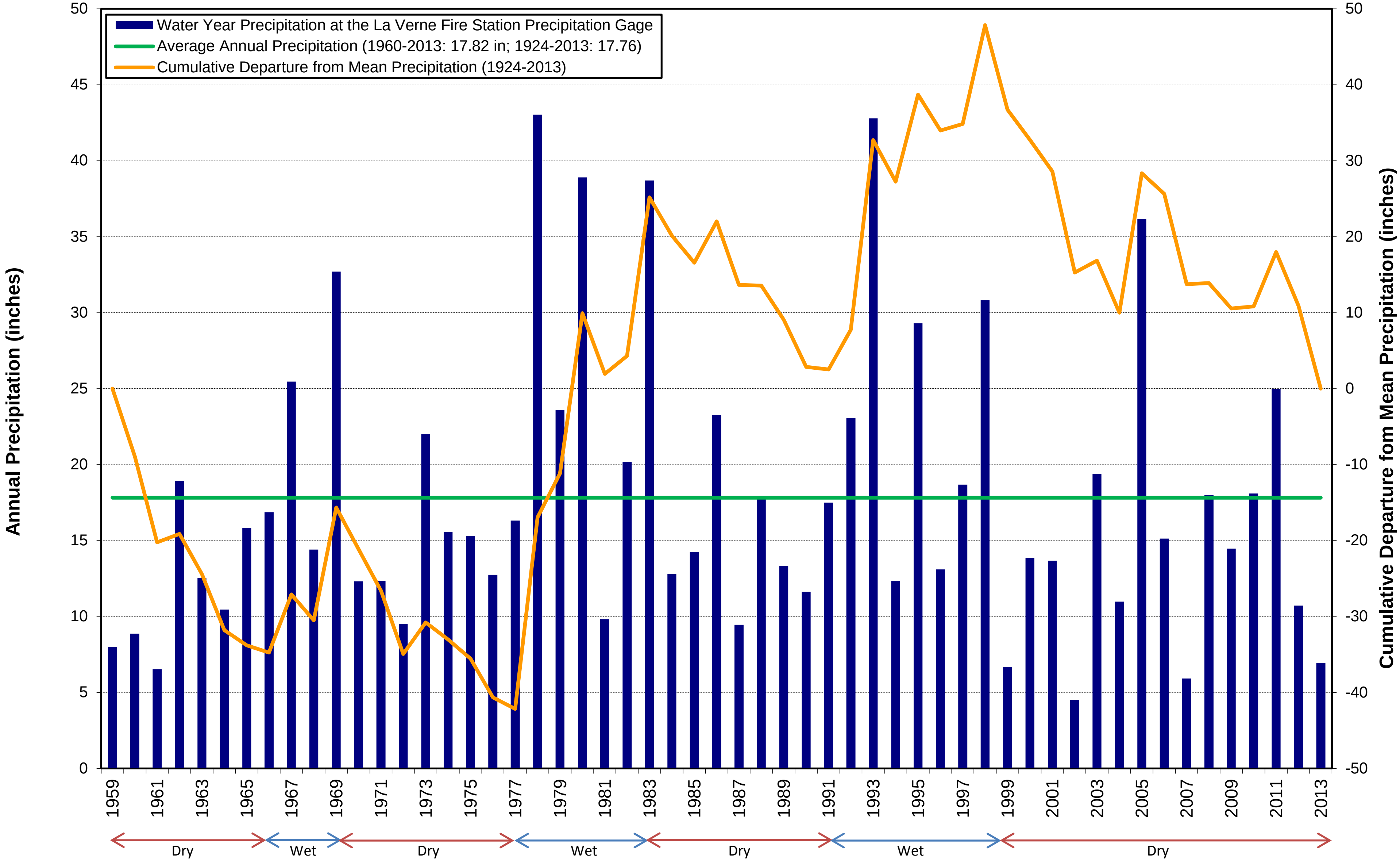


Figure 3-8 -- Figure 1
1/14/2015

**Figure 3-9**
**Operating Safe Yield of the Four Basins for the Baseline Alternative**

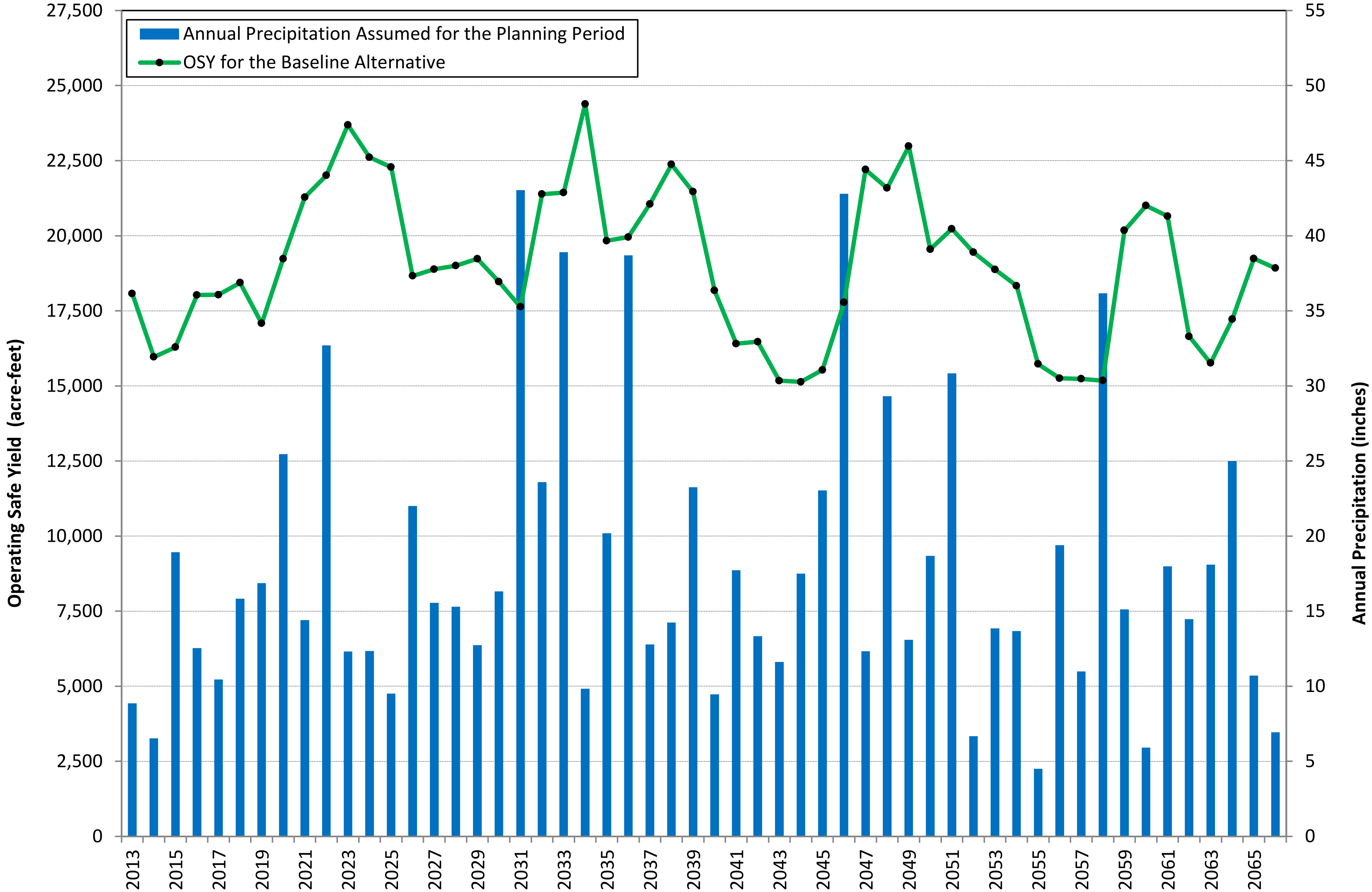


Figure 3-9 - 20141125_OSYCalculator--Chart_BaselineA
1/14/2015

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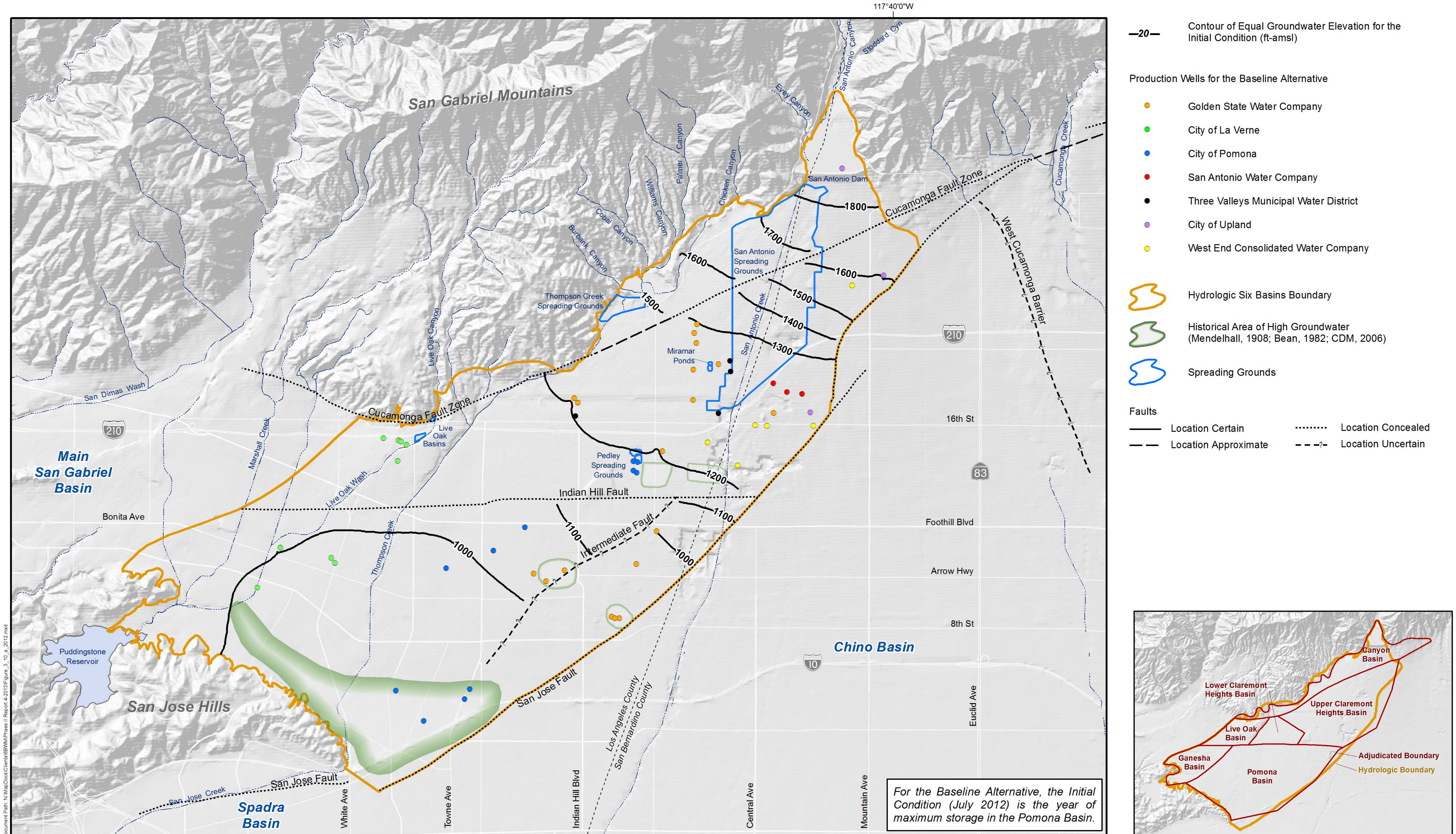



Prepared by:

WEI
Wildermuth Environmental, Inc.

Updated By: csanchez

Date: 20151207

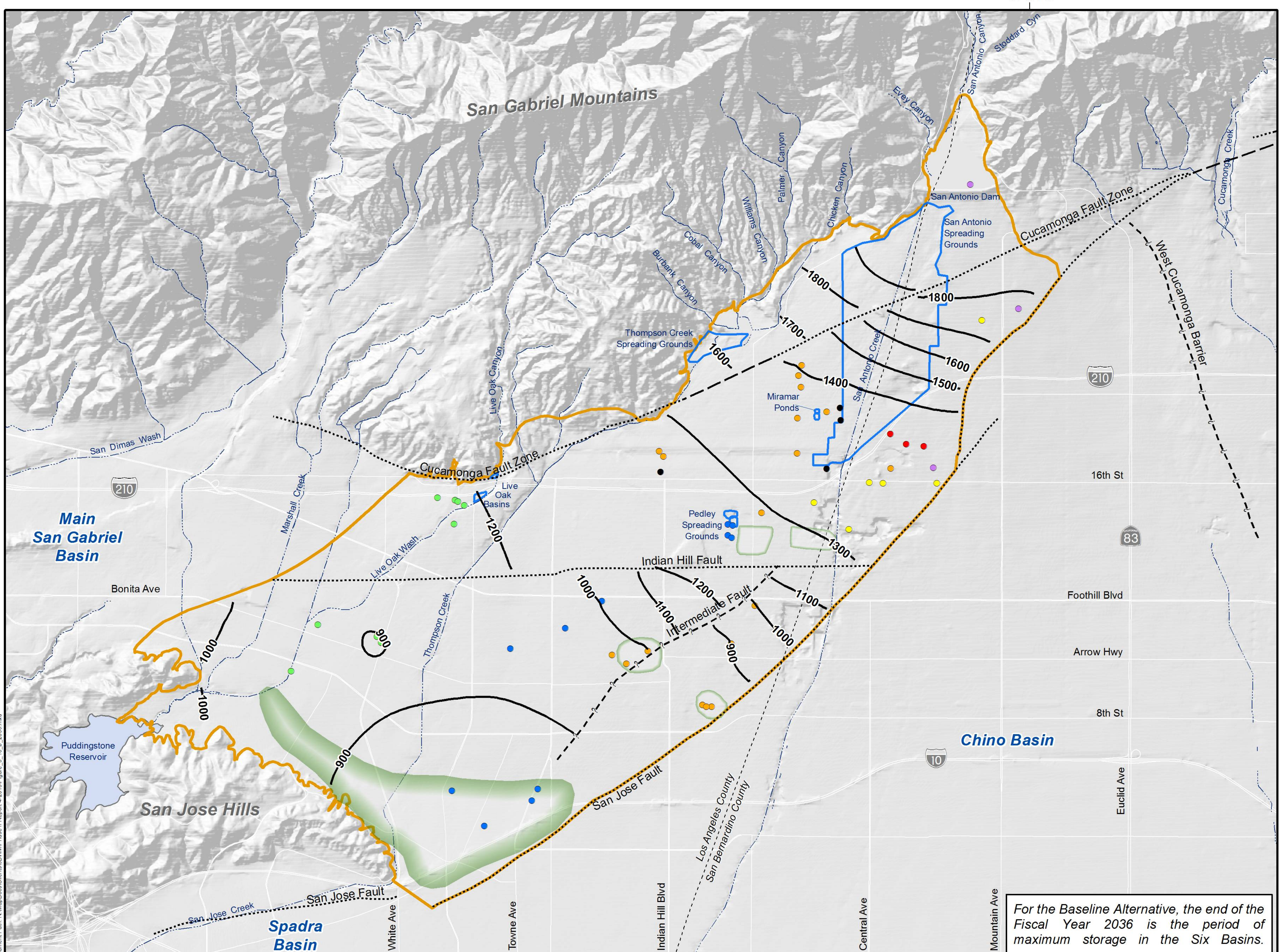
Six Basins Watermaster

Strategic Plan for the Six Basins

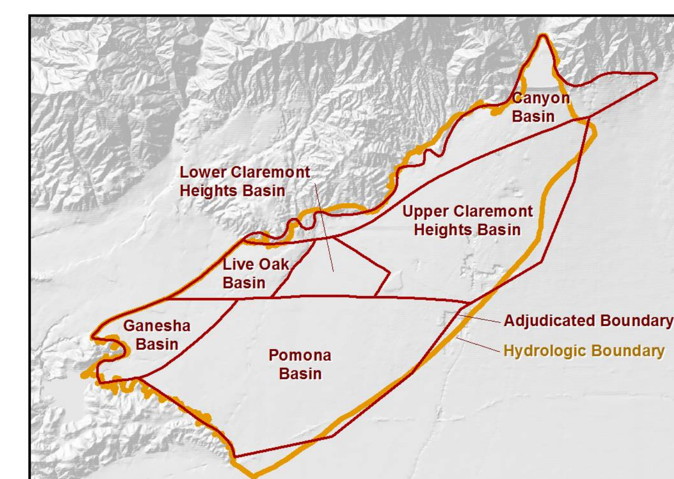
## Groundwater Elevation for the Initial Condition

*July 2012 - Layer 1*

**Figure 3-10a**




For the Baseline Alternative, the end of the Fiscal Year 2036 is the period of maximum storage in the Six Basins.




—20— Contour of Equal Groundwater Elevation for 2036 (ft-amsl)

Production Wells for the Baseline Alternative

- Golden State Water Company
- City of La Verne
- City of Pomona
- San Antonio Water Company
- Three Valleys Municipal Water District
- City of Upland
- West End Consolidated Water Company

Hydrologic Six Basins Boundary

Historical Area of High Groundwater (Mendelhall, 1908; Bean, 1982; CDM, 2006)

Spreading Grounds

Faults

Location Certain — Location Concealed

Location Approximate — Location Uncertain

Document Path: N:\MapDocs\Clients\6BWM\Phase II Report 4-2013\Figure_3_10_b_2036.mxd

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Updated By: csanchez

Date: 20151207

0 1 2 Miles

0 2 4 Kilometers

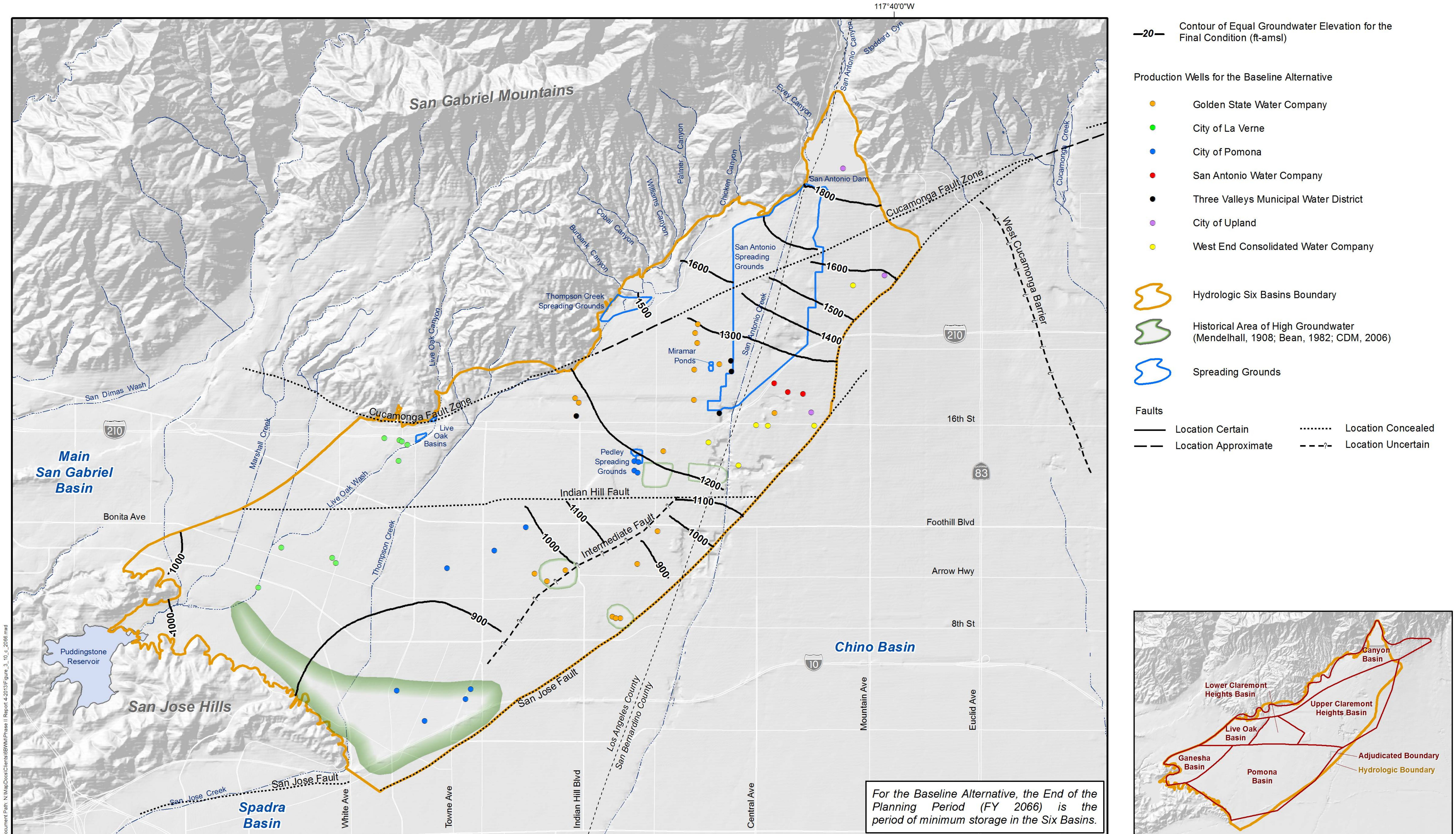
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

## Groundwater Elevation - End of Fiscal Year of Maximum Storage in the Six Basins

*July 2036 - Layer 1*

**Figure 3-10b**

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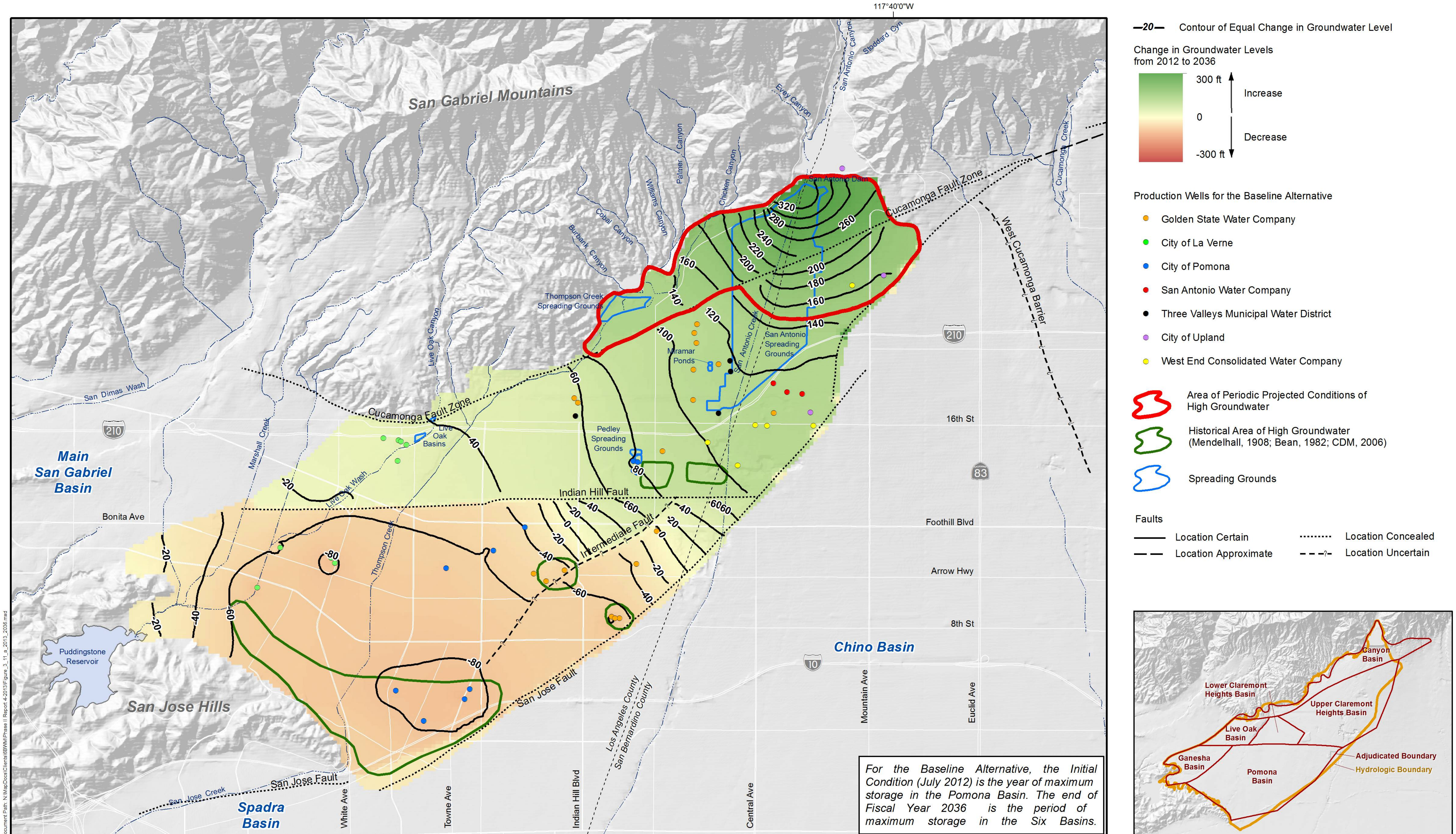
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

# Groundwater Elevation for the End of the Planning Period

*July 2066 - Layer 1*

**Figure 3-10c**

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0 1 2 Miles

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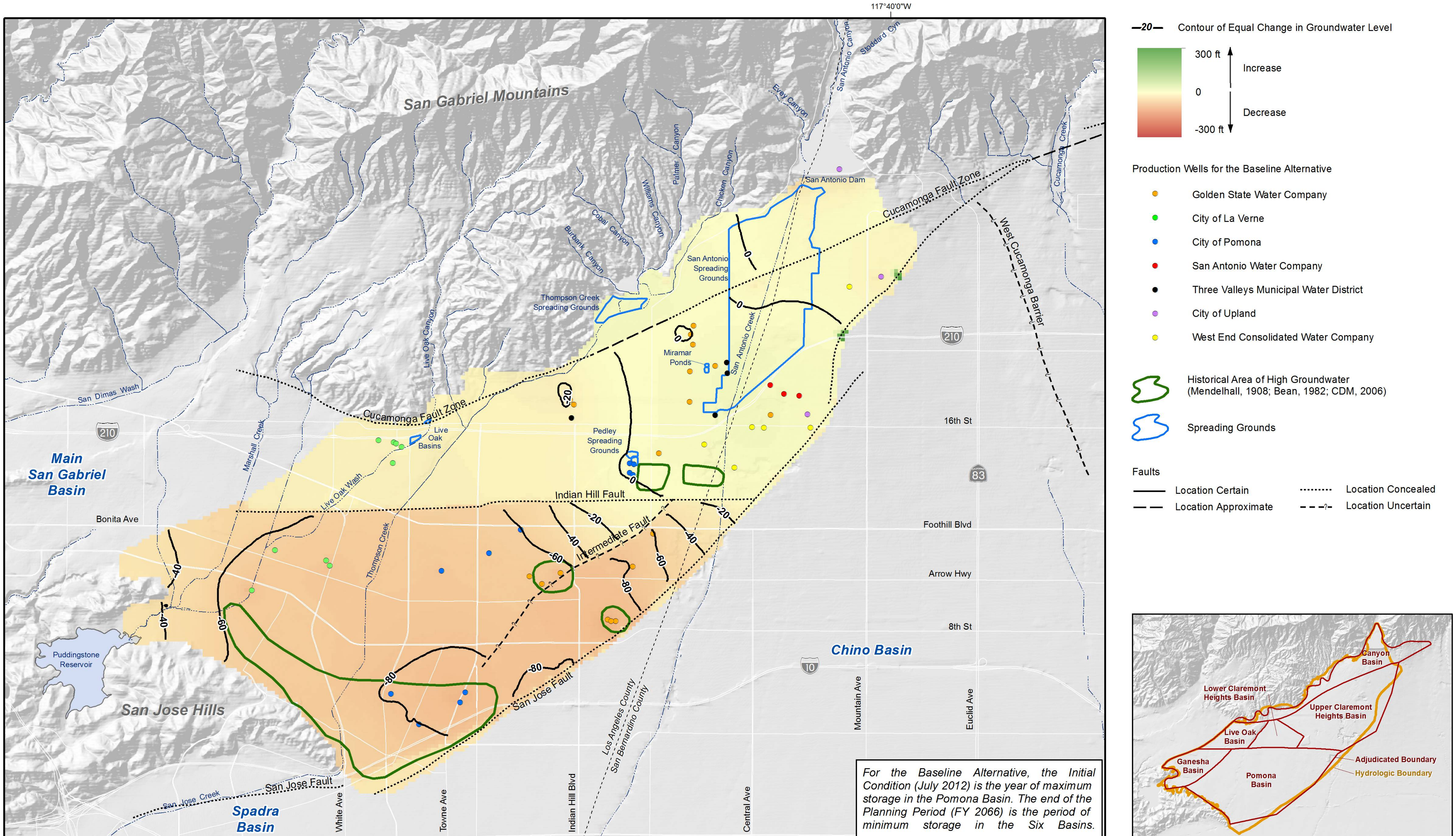
**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

## Groundwater-Level Change: Initial Condition vs. Maximum Storage

*Baseline Alternative (2012-2036)*

**Figure 3-11a**

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Updated By: csanchez

Date: 20151207

0 1 2 Miles

0 2 4 Kilometers

**Six Basins Watermaster**

**Strategic Plan for the Six Basins**

## Groundwater-Level Change: Initial Condition vs. End of Planning Period

*Baseline Alternative (2013-2066)*

**Figure 3-11b**

**Figure 3-12a**
**Cumulative Change in Storage and Subsurface Outflow for the Upper Claremont Heights, Lower Claremont Heigths, and Canyon Basins**
*Baseline Alternative*

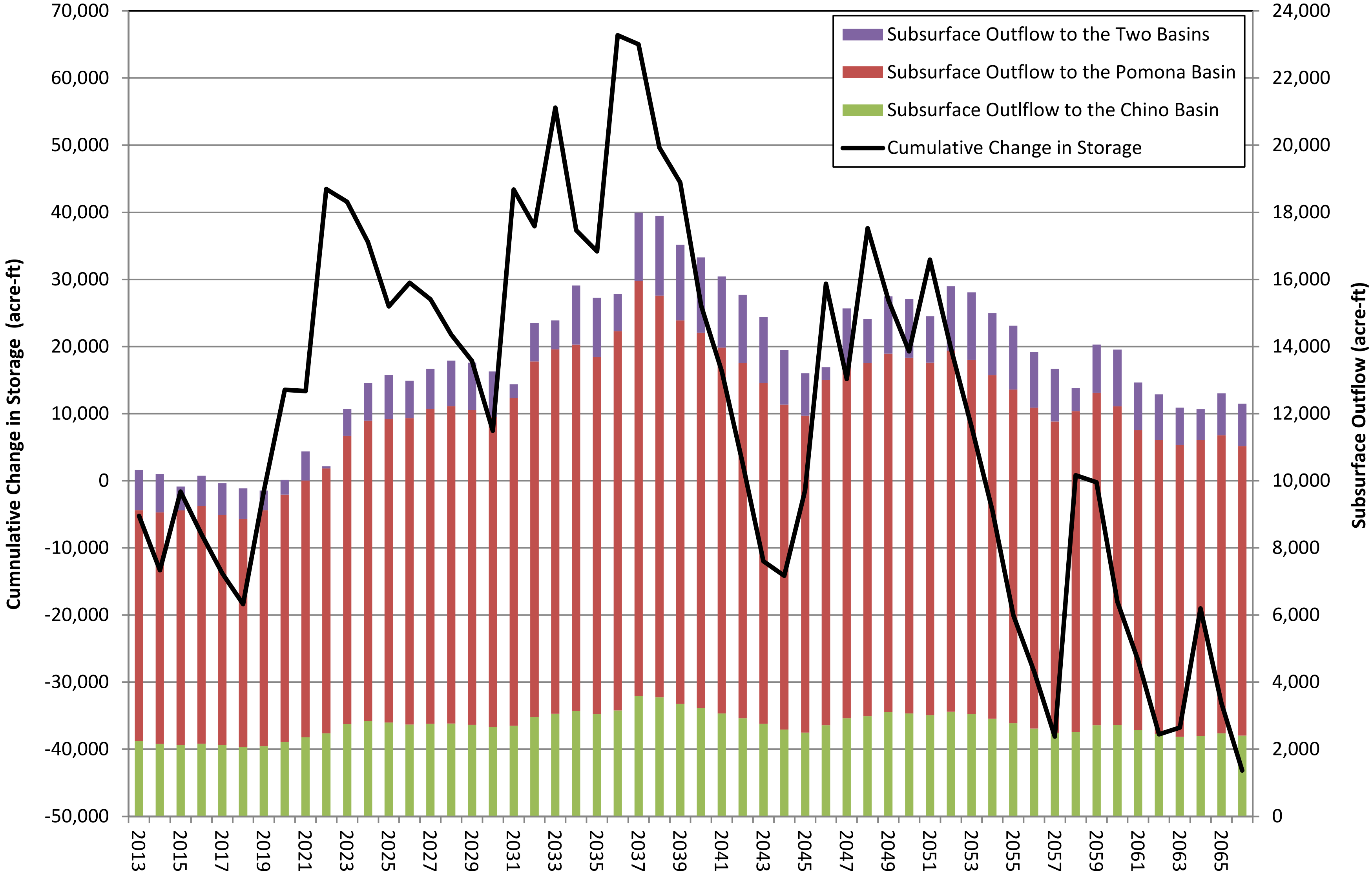


Figure-3-12-20150515_BaselineA1_6Basin_Water BudgetFigure_3-12a
7/2/2015

## Figure 3-12b
## Cumulative Change in Storage and Subsurface Outflow for the Pomona Basin
*Baseline Alternative*

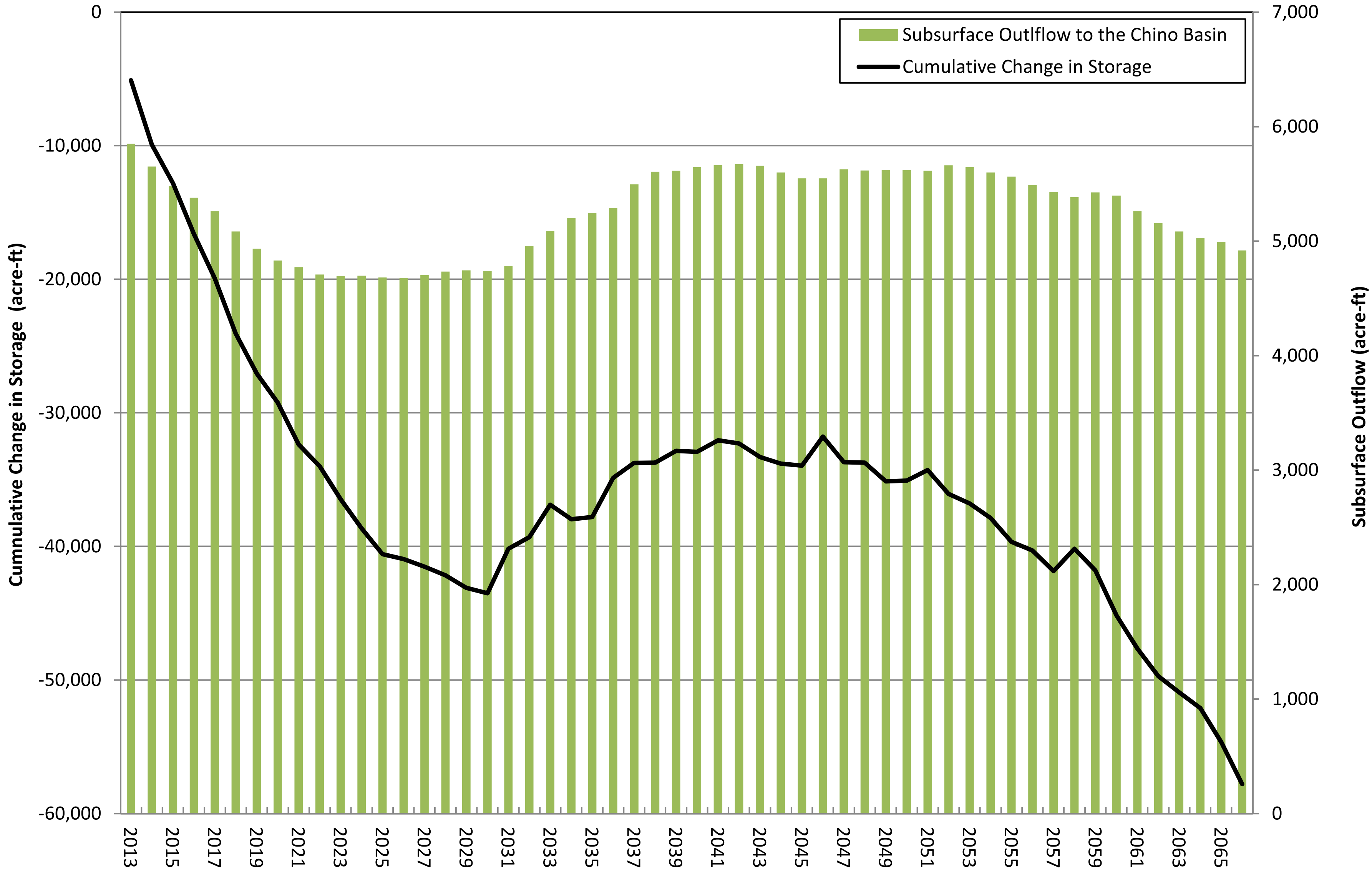


Figure-3-12-20150515_BaselineA1_6Basin_Water Budget.xlsxFigure_3-12b
12/13/2015

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**Figure 3-13**
**Melded Unit Cost of Water for the Six Basins Parties**
*2013-2040*

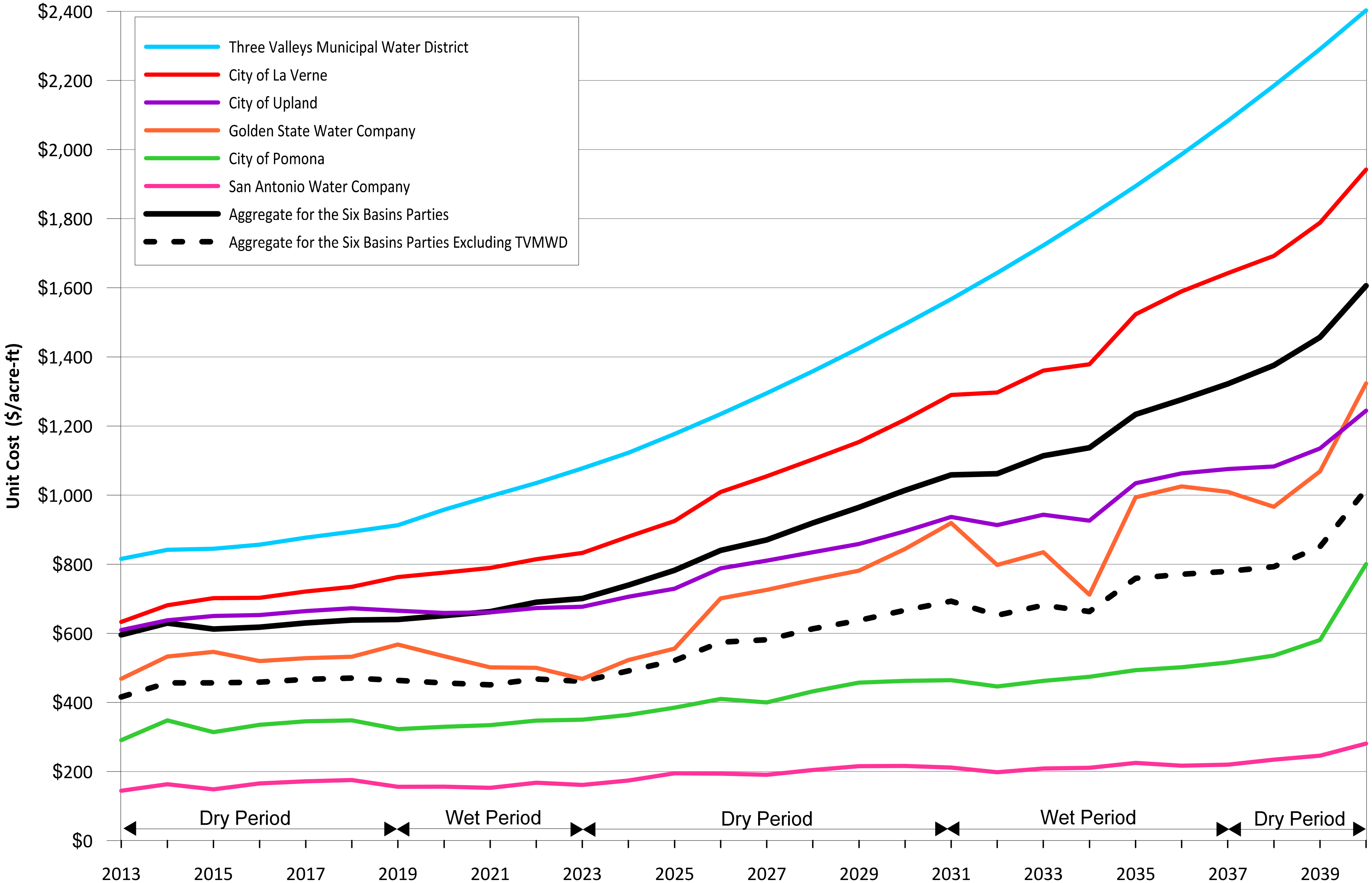


Figure-3-13_Melded-Unit-Cost
12/15/2014

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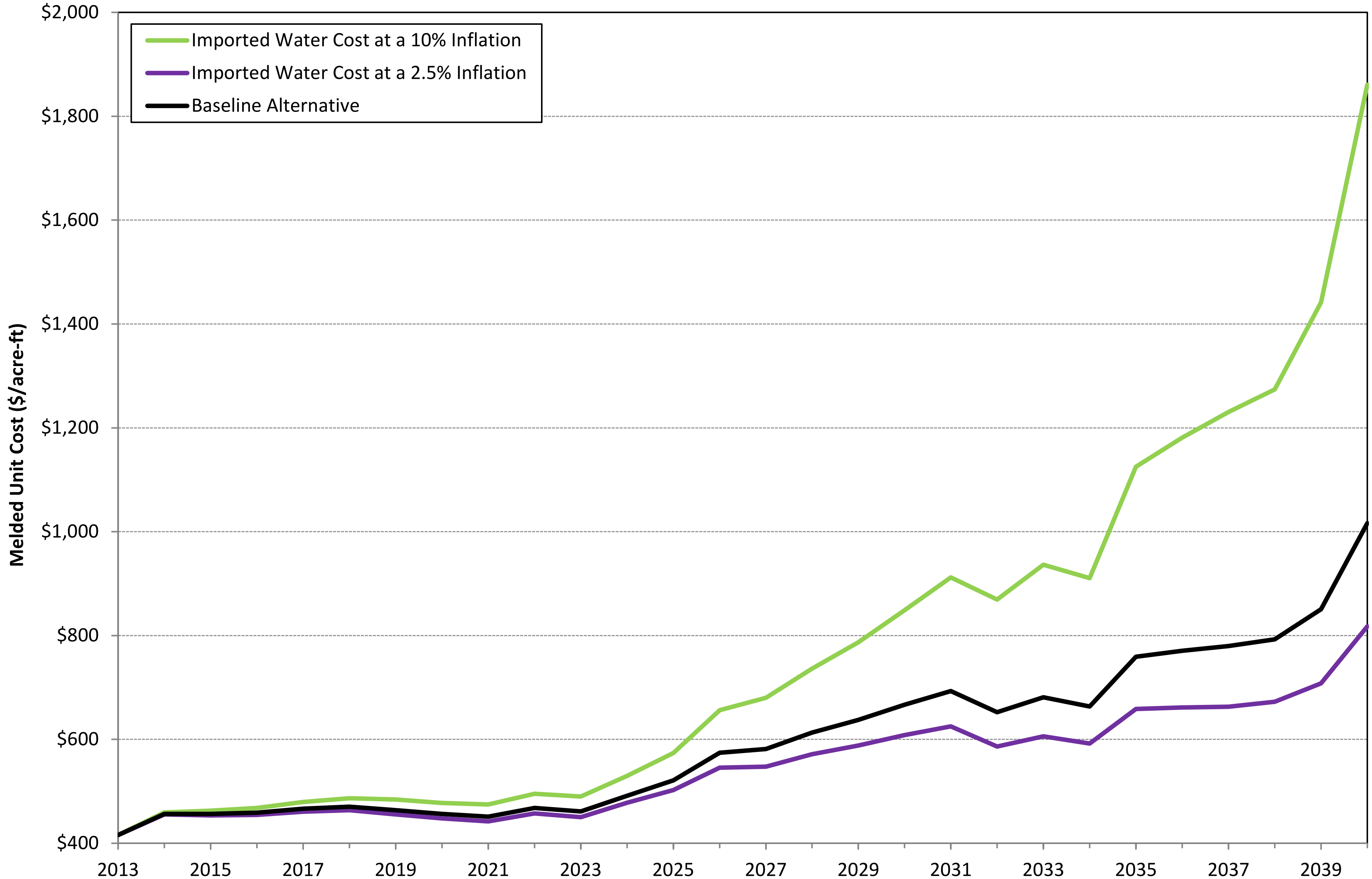
**Figure 3-14**

**Sensitivity Analysis for the Aggregated Melded Unit Cost of Water for Six Basins Parties[1]**




1. Excludes Three Valleys Municipal Water District.

Sensitivity_AnalysisFigure_3-14
1/16/2015

# Section 4 – Stakeholder Goals & Concepts for Improving Basin Management

This section describes the issues, needs and wants of the Parties, the Strategic Plan goals, the impediments to achieving the goals, and the concepts for improving basin management. The issues, needs and wants, and Strategic Plan goals (Sections 4.1 and 4.2) were published in January 2013, and the concepts for basin management (Section 4.3) were published in December 2015.

## 4.1 Issues, Needs and Wants of the Parties

In 2012, the Watermaster Parties described their individual and collective issues, needs, and wants. An *issue* was a concern of the stakeholder. A *need* was a requirement. A *want* was a desire. The process to describe the issues, needs, and wants involved the individual Parties submitting an initial list to staff. Staff compiled the list and distributed the list to the Parties for discussion and editing at Strategic Plan workshops. This was an iterative process that spanned multiple workshops held on February 22, March 28, and April 25, 2012.

Tables 4-1 through 4-6 are the final list of issues, needs, and wants of the Parties and other stakeholders with regard to water supply, recharge, groundwater levels and storage, water quality, monitoring and data management, and cost. Articulating the issues, needs, and wants helped to define and prioritize the common goals of the Parties, which are described below.

## 4.2 Strategic Plan Goals

In 2012, the Watermaster Parties developed the management goals for the Strategic Plan to address the issues, needs, and wants of the stakeholders. The process to develop the goals involved the proposal by Watermaster staff of an initial set of goals, followed by group discussion and group editing at Strategic Plan workshops held on April 25, May 23, and June 27, 2012. The management goals were agreed upon by consensus and are described below:

***Goal No. 1 – Enhance Water Supplies***. The Parties desire to have a diverse, cost-effective water supply portfolio that will allow them to reliably meet their water demands now and into the future. Imported water has long been a vital supply for water purveyors in Southern California. Imported water is becoming increasingly more expensive, and its reliability is threatened by natural disasters, climate change, and changing environmental regulations. Maximizing the sustainable use of local water supplies—including groundwater, surface water, and recycled water—to meet future demands is the focus of the Parties. In particular, enhancing the groundwater supply of the Six Basins means increasing the yield of the basin. To achieve this goal, the Parties must find ways to increase recharge, pump more, and reduce losses in a cost-effective manner.

***Goal No. 2 – Enhance Basin Management***. Enhancing the water supplies of the Six Basins will require advanced basin management beyond that which is provided for in the Judgment. Increasing the yield and reliability of the Six Basins to ensure the maximum and equitable availability of groundwater for all Parties requires coordinated plans for recharge, pumping, and storage. Maximizing the use of local water supplies may necessitate partnerships with other local groundwater basins or water-supply agencies to maximize the use of assets, such as surface-water availability, storage capacity, recharge capacity, and funding. No harm must come without mitigation to the Parties, the groundwater basin, or the environment from the activities to enhance basin management.

***Goal No. 3 – Protect and Enhance Water Quality***. The Parties desire to improve groundwater quality in the Six Basins and deliver water that is safe and suitable for the intended beneficial use and meets all applicable regulatory standards. Management of groundwater quality, through the cleanup of point-source contamination and control of salt and nutrient accumulation, is essential to ensuring the long-term reliability of the groundwater supply in a cost-effective manner.

***Goal No. 4 – Equitably Finance the Strategic Plan***. The primary source of revenue to finance the development and implementation of the Strategic Plan are the consumers of Six Basins groundwater, but other sources of revenue will be aggressively pursued. The policies and agreements to implement the Strategic Plan will ensure an equitable distribution costs relative to the benefits.

## 4.3 Concepts for Improving Basin Management

There are physical, institutional, and financial impediments to achieving the goals of the Strategic Plan. Section 2 of this report identified impediments associated with the physical characteristics of the Six Basins. Section 3 of this report identified impediments associated with the current water-supply plans of the Six Basins Parties. The issues, needs, and wants of the stakeholders shown in Tables 4-1 through 4-6 also recognize impediments to achieving the goals of the Parties.

Table 4-7 lists these goals, the impediments to achieving these goals, the actions required to remove the impediments, and the expected outcome or the implication of those actions. These columns in this table were developed during Phase 1 of the Strategic Plan (WEI, 2013), and were used to identify project concepts for removing the impediments to achieve the goals of the Strategic Plan:

- Increase the Use of Temporary Surplus and Increase Stormwater Recharge in the San Antonio Spreading Grounds
- Thompson Creek Spreading Grounds Improvements
- Supplemental Water Recharge in the Upper Claremont Heights Basin
- Pump and Treat Groundwater in the Pomona Basin
- Conjunctive Water Management in the Six Basins
- Expanded Groundwater and Surface-Water Monitoring Program

The last column in Table 4-7 lists the project concepts that address the individual impediments to the Strategic Plan goals. At a fundamental implementation level, the projects of the Strategic Plan will include changes in the current management of the basin and new facilities. Each project has elements of storage and yield management, recharge management and water-quality management; and will require new monitoring for both design and implementation. Section 5 of this report describes the development and evaluation of the projects that are designed to remove impediments to achieve the Strategic Plan goals, and contains a nexus statement demonstrating this.

**Table 4-1**
**Issues, Needs and Wants**

*Water Supply*

| Issues, Needs, and Wants | Six Basins Parties | | | | | | | | | Others | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Claremont | GSWC | La Verne | Pomona | Pomona College | PVPA | SAWCo | TVMWD | Upland/ West End | LA County Flood Control | Regional Board | |
| ***Groundwater Production, OSY, Basin Yield and Losses*** | | | | | | | | | | | | |
| Develop and implement a management strategy that minimizes losses from storage and maximizes OSY. This could be accomplished by managing groundwater levels. | ●● | ● | ● | ● | ● | | ●●● | ●● | | | | |
| Evaluate how much groundwater is lost from the Six Basins as outflow. | | ● | ● | ● | ● | | ●● | | ● | | | |
| Promote groundwater production in parts of the basin to protect and enhance basin yield and minimize losses. | | ● | ● | ● | ● | | | ● | | | | |
| Always have the ability to produce the OSY | ●●● | | | ● | | | ●●● | | ● | | | |
| Explore impacts to basin yield from the development of the basin | | ● | ● | ● | | | | ●● | | | | |
| Use past engineering studies to obtain ideas to increase basin yield | | ● | | ● | ● | | | ●●● | | | | |
| Develop a plan to maximize basin yield during MWD shortages, shutdowns, and peak-use periods | | ● | | ● | ● | | | ●● | | | | |
| Since the Six Basins is comprised of individual sub-basins that respond differently to recharge and pumping stresses, the parties should explore methods to manage OSY by sub-basin to optimize basin management. Quantify the benefits to the Parties. | ●● | | | ● | | | | ● | | | | |
| Coordinate/reduce/relocate production to ensure that OSY is produced | | ● | | ● | | | | | | | | |
| Develop knowledge to ensure water production is reliable | | ● | | ● | | | | | | | | |
| Collaborate with agencies in other groundwater basins to increase the reliability and volume of local water supplies and minimize cost. | | | | ● | | | | ●● | | | | |
| ***Six Basins Water Rights*** | | | | | | | | | | | | |
| Dedicate increases in OSY to agencies for specific basin-management projects, such as changed pumping patterns, pumping and treatment of poor quality groundwater, etc. | | ● | ● | ● | ● | | | | | | | |
| Allow the Parties to use the basin in their best interest and mitigate impacts | | ● | | ● | | | | ● | | | | |
| Establish and use a procedure to identify in a timely manner when surplus groundwater (in excess of established annual OSY) is available, and allow the Parties to pump this surplus. | | | | ● | ● | | | | ● | | | |
| Review the Judgment and the Operating Plan to identify and correct things that could "blow up" down the road | ●● | | ● | | | | | ● | | | | |
| Develop the ability to market basin losses. | | ● | | ● | | | | | | | | |
| Develop a means to export water (rights and/or storage). | | ● | | ● | | | | | | | | |
| Increase OSY and reallocation of production rights | | ● | | ● | | | | | | | | |
| Retain production rights to satisfy demands | | ● | | | | | | | | | | |
| ***Imported Water*** | | | | | | | | | | | | |
| Increase the use of groundwater to reduce dependence on imported water. | ●● | | ● | ● | ● | | | ●●● | | | | |
| Develop economical programs to store additional MWDSC imported water. | ●●● | ● | | ● | | | | ●● | | | | |
| Some water-supply agencies within the TVMWD service area are overly dependent on imported water, and desire to diversify their water supplies to include groundwater within the TVMWD service area. Develop a method where Six Basins groundwater can be a water supply for these agencies and simultaneously create mutual benefit for all Six Basins parties. | ●● | | | ● | ● | | | ●● | | | | |
| Increase the conjunctive use of imported surface waters and groundwater in the Six Basins to increase the reliability and volume of water supplies available to the area and to minimize cost. | ●● | | | ● | | | | ●●● | | | | |
| Fully utilize TVMWD's Tier 1 allocation of imported water from MWDSC. (*Example provided by Pomona* : explore ways to cooperate with other basins/agencies; revenue generated would be used to offset assessment costs) | | | | ● | | | | ●● | | | | |
| ***Recycled Water*** | | | | | | | | | | | | |
| Develop regional transmission systems for recycling projects. | ● | ● | | ● | | | | ● | | | | |
| Develop recycled water reuse and recharge projects to maximize use. | ● | ● | | | | | | ● | | | | |
| Provide incentives for the development of recycling projects. | ● | ● | | ● | | | | | | | | |
| Modify basin water-quality objectives to increase levels of water recycling. | ● | ● | | | | | | | | | | |
| ***Delivery and Infrastructure*** | | | | | | | | | | | | |
| Maximize interconnections between agencies | | | | ● | ● | | | ● | | | | |
| Increase flexibility of delivery system to customers | | | | | | | ●●● | ●● | | | | |
| ***Other*** | | | | | | | | | | | | |
| Increase water conservation within the basin | ● | ● | ● | ● | | | | ● | ● | | | |
| Prepare and implement a regional water-supply plan in the event of a major earthquake that interrupts imported water supplies for an extended period. | | | | ● | | | | ● | ● | | | |

Key: ● Issue ●●●Need ●● Want
(Claremont, SAWCo, and TVMWD are the only agency to have distinguished INW's per this key)

**Table 4-2**
**Issues, Needs and Wants**

*Recharge*

| Issues, Needs, and Wants | Six Basins Parties | | | | | | | | | Others | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Claremont | GSWC | La Verne | Pomona | Pomona College | PVPA | SAWCo | TVMWD | Upland/ West End | LA County Flood Control | Regional Board | |
| ***Replenishment Water*** | | | | | | | | | | | | |
| Capture and recharge as much storm water as possible for the benefit of the Parties | ● | | | ● | ● | ● | ●● | ●●● | ● | ● | | |
| Maximize capture of water in Spreading Grounds (to the extent the basins can take it). | ● | | ● | ● | | ● | | ●● | | | | |
| ***Imported Water Recharge*** | | | | | | | | | | | | |
| Recharge assets in the Six Basins are under-utilized—particularly with respect to recharge of imported waters. | | | | | | | | ●●● | | | | |
| Prevent the export/loss of native waters. | ● | | | | | ● | | ●● | | | | |
| Support sole and/or cooperative efforts to develop additional economically-feasible recharge facilities for both native and imported waters. | | ● | | | | | | ●● | | | | |
| Develop alternative and/or less expensive imported water options | | ● | | ● | | | | | | | | |
| Establish water-quality subsidy to encourage replenishment of high-quality imported water | | ● | | | | | | | | | | |
| ***Other Water Recharge*** | | | | | | | | | | | | |
| Recharge high-quality runoff and recycled water as hydrologically high as possible in the basin. | ● | ● | ● | ● | | | | ● | | | | |
| Develop program to increase recharge of native runoff and create a mechanism to pledge the value of the increase in basin yield from these "new water" sources to help pay for the construction of these facilities | | | | | | | | | | | | |
| ***Operations*** | | | | | | | | | | | | |
| Maximize the use of existing recharge facilities | ●● | ● | | ● | | | | ●●● | | | | |
| IEUA has expressed interest in modifying the operation of San Antonio Dam to increase the amount of San Antonio Creek diverted for recharge in the Chino Basin. The Six Basins parties should engage these downstream agencies to ensure that the water rights of the Parties are not adversely affected and potentially increased. | ●● | | ● | ● | | | | ●●● | | | | |
| Coordinate spreading activities at Live Oak Spreading Grounds--potentially using Live Oak Dam for storage. | | | ● | | | | | ●● | | | | |
| ***Basin Analyses*** | | | | | | | | | | | | |
| Characterize the recharge mechanisms that would improve recharge so that Pomona Basin benefits from recharge that occurs further to the north. | | ● | ● | | ● | | | ● | | | | |
| Determine the volumes of replenishment water required to meet demands on the groundwater basin. | | ● | ● | ● | | | | | | | | |
| Develop a recharge plan that is based on a good technical understanding of the groundwater basin, and that manages groundwater levels, the threat of rising groundwater, groundwater-quality, and cost. | | | | ● | | | | ●●● | | | | |
| ***Land Use*** | | | | | | | | | | | | |
| The City of Claremont wants the San Antonio Spreading Grounds in Los Angeles County (west side) to remain as "open space." It is the desire of the City that the entire acreage continues to be managed as open space dedicated to the replenishment of native and import waters for the benefit of the entire region. | ●●● | | | | | | | ●● | | | | |
| Allow flexibility in development of spreading grounds provided that spreading operations are paramount. | | | | | | ● | | | | | | |

Key: ● Issue ●●●Need ●● Want
(Claremont, SAWCo, and TVMWD are the only agency to have distinguished INW's per this key)

**Table 4-3**
**Issues, Needs and Wants**

*Groundwater Levels and Storage*

| Issues, Needs, and Wants | Six Basins Parties | | | | | | | | | Others | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Claremont | GSWC | La Verne | Pomona | Pomona College | PVPA | SAWCo | TVMWD | Upland/ West End | LA County Flood Control | Regional Board | |
| ***Groundwater Levels*** | | | | | | | | | | | | |
| Determine an operational range of groundwater levels to "optimize" basin management. | ● | | ● | | | | | ● | | | | |
| Reduce or dampen large fluctuations in groundwater levels. | | ● | | ● | | | | | | | | |
| ***Groundwater Storage*** | | | | | | | | | | | | |
| Develop and implement a management strategy that minimizes losses from storage, maximizes OSY, and mitigates rising groundwater before it occurs. | ● | ● | ● | ● | | | ● | ●●● | ● | | | |
| Develop a storage management program in the Six Basins that is based on a good technical understanding of the groundwater basin and will increase the long-term reliability and volume of water supplies to the Parties. | ● | ● | ● | ● | | | | ●●● | ● | | | |
| Determine and assess storage losses | | ● | | ● | | | ●●● | | ● | | | |
| Always have the ability to store water in the Six Basins | | | | ● | | | ●●● | ●● | | | | |
| Characterize unused storage space within the basin | | ● | | ● | | | | | | | | |
| ***Rising Groundwater*** | | | | | | | | | | | | |
| Avoid conditions of rising groundwater | | | | ● | ● | | ●● | ●● | | | | |
| Mitigate high groundwater conditions without incurring losses (*e.g.,* pump and discharge to storm drains) | | ● | | ● | ● | | | ● | | | | |
| In 1983, high groundwater damaged 11 buildings at the Pomona College and at residences at Pilgrim Place and neighboring locations. The College #2 well was located in an area to mitigate high groundwater conditions, and was successful during 2005-06. Evaluate the threat of rising groundwater in these areas in the future. Evaluate potential mitigation strategies, such as additional wells to control groundwater levels. | | | | | ● | | | ● | | | | |
| ***Other*** | | | | | | | | | | | | |
| Characterize currently un-mapped groundwater barriers (*e.g.,* those possibly present in the Pomona Basin). | | ● | ● | ● | ● | | | | | | | |

Key: ● Issue ●●●Need ●● Want
(Claremont, SAWCo, and TVMWD are the only agency to have distinguished INW's per this key)

**Table 4-4**
**Issues, Needs and Wants**

*Water Quality*

| Issues, Needs, and Wants | Six Basins Parties | | | | | | | | | Others | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Claremont | GSWC | La Verne | Pomona | Pomona College | PVPA | SAWCo | TVMWD | Upland/ West End | LA County Flood Control | Regional Board | |
| ***Groundwater Quality*** | | | | | | | | | | | | |
| Encourage basin activities to protect quality and quantity. | ● | ● | ● | ● | ● | | | ●● | ● | | | |
| Support and/or encourage the construction of treatment processes to clean-up non-potable groundwater for use. | ●● | ● | ● | ● | | | | ●● | | | | |
| Pump and treat groundwater from areas of the Six Basins that are not currently being pumped because of groundwater contamination. If appropriate, these areas could be targeted for Special Projects as defined in the Judgment to cause groundwater cleanup, create storage space, mitigate high groundwater conditions, and/or provide a water supply at a lower cost than treated imported water. | ●● | ● | ● | | | | | ●● | | | | |
| Develop a means to export water to encourage basin clean-up. | | ● | | ● | | | | ● | | | | |
| Pump non-potable water for irrigation uses. | ● | ● | | ● | | | | | | | | |
| ***Regulatory Issues*** | | | | | | | | | | | | |
| Develop a salt and nutrient management plan pursuant to the SWRCB's requirements in the Recycled Water Policy. | | ● | | ● | | | | ● | | | | |
| Permitting of discharge from well development/rehab is difficult due to groundwater quality. | ● | | ● | ● | | | | ● | | | | |
| Determine responsibility and/or accountability for existing water-quality or water-quantity issues. | | ● | | ● | | | | | | | ● | |
| Manage basin to maintain/improve water quality of water supply sources to meet discharge standards. | | ● | | ● | | | | | | | | |
| ***Basin Analyses*** | | | | | | | | | | | | |
| Assess the impacts of groundwater production and recharge on water quality of downgradient producers. | | ● | ● | ● | | | | | | | | |
| Re-examine basin water-quality objectives and establish naturally-occurring limits. | | ● | | | | | | | ● | | | |
| Develop a groundwater model to understand how contaminants are moving in the basin; then, strategic decisions can be made as to where to construct treatment facilities | | | | ● | | | | | | | | |

Key: ● Issue ●●●Need ●● Want
(Claremont, SAWCo, and TVMWD are the only agency to have distinguished INW's per this key)

**Table 4-5**
**Issues, Needs and Wants**

*Monitoring and Data Management*

| Issues, Needs, and Wants | Six Basins Parties | | | | | | | | | Others | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Claremont | GSWC | La Verne | Pomona | Pomona College | PVPA | SAWCo | TVMWD | Upland/ West End | LA County Flood Control | Regional Board | |
| Perform the requisite monitoring to identify basin issues | | ● | | ● | ● | | | ● | | | | |
| Assure complete and accurate reporting of water use in basin | | ● | | | | | | ● | ● | | | |
| Install additional monitoring wells to assist in basin management | ● | | ● | | | | | ● | | | | |
| Develop agreements (e.g. Non-Disclosure) with Wildermuth Environmental and between the Six Basin parties with regard to data stored in HydroDaVE. | | ● | | ● | | | | | | | | |
| Review and recommend any proposed changes to the monitoring efforts | | | | | | | | ● | | | | |

Key: ● Issue ●●●Need ●● Want
(Claremont, SAWCo, and TVMWD are the only agency to have distinguished INW's per this key)

**Table 4-6**
**Issues, Needs and Wants**
*Cost*

| Issues, Needs, and Wants | Six Basins Parties | | | | | | | | | Others | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Claremont | GSWC | La Verne | Pomona | Pomona College | PVPA | SAWCo | TVMWD | Upland/ West End | LA County Flood Control | Regional Board | |
| Seek financial aid to meet management goals, including grants and loans | ●● | | | | ● | | | ● | ● | | | |
| Increase the use of groundwater to reduce cost. | | | | | ● | | | ●● | | | | |
| Operate the Miramar Treatment Plant at maximum capacity to minimize the unit-cost of the product water. | | | | | | | | ● | | | | |

Key: ● Issue ●●●Need ●● Want
(Claremont, SAWCo, and TVMWD are the only agency to have distinguished INW's per this key)

**Table 4-7**

**Strategic Plan Goals, Impediments to the Goals, Actions to Remove the Impediments, Implications of Actions, and the Project Alternatives of the Strategic Plan**

| | Impediments | Actions to Remove Impediments | Implications of Actions | Project Alternatives of the Strategic Plan |
|---|---|---|---|---|
| **Goal 1 -- Enhance Water Supplies** | | | | |
| 1a | Not all of the available surface-water runoff from the San Antonio Creek, Thompson Creek, and Live Oak Wash watersheds is captured and recharged. Failure to divert and recharge stormwater is a permanently lost opportunity. | Improve operations and/or increase the capacity to divert and recharge surface-water runoff from the San Antonio Creek, Thompson Creek, and Live Oak Wash watersheds. | Increases the recharge of high-quality storm-water.<br><br>Increases the yield of the Six Basins. | TS / SASG Improvements<br><br>TCSG Improvements<br><br>Expanded Monitoring |
| 1b | The Two Basins and the Pomona Basin have very limited artificial-recharge capacity at spreading grounds. | Conduct a recharge master plan for the Six Basins with the goal of characterizing the storm, dry-weather, recycled, and imported water available for recharge, the existing recharge capacity, areas where recharge is desirable, recharge potential, recharge plan alternatives, and an implementation plan. | Identifies the universe of recharge opportunities so that new or improved recharge facilities can be constructed to increase recharge and better balance recharge and discharge. | Supplemental Recharge<br><br>TS / SASG Improvements<br><br>TCSG Improvements<br><br>Expanded Monitoring |
| 1c | The intermittent and variable nature of recharge that occurs at the spreading grounds limits the yield of the Six Basins--particularly the yield of the Upper Claremont Heights Basin and the Live Oak Basin. | Conduct a recharge master plan with the goal of characterizing the storm, dry-weather, recycled, and imported water available for recharge, the existing recharge capacity, areas where recharge is desirable, recharge potential, recharge plan alternatives, and an implementation plan. | Results in a greater and more consistent volume of recharge that causes higher and more stable groundwater levels in in the Upper Claremont Heights Basin and the Live Oak Basin. This will increase the yield of these basins and make them a more stable water-supply. | Supplemental Recharge<br><br>TS / SASG Improvements<br><br>TCSG Improvements<br><br>Expanded Monitoring |
| 1d | Virtually all surface-water runoff that occurs downstream of the spreading grounds exits the Six Basins in lined channels and is a lost opportunity for recharge. | Characterize the amount of stormwater captured from MS4 facilities and develop programs to incentivize MS4 compliance through recharge. | Potentially increases the yield of any or all of the Six Basins. | N/A |
| 1e | High groundwater levels in the Upper Claremont Heights Basin can lead to maximum sub-surface outflow to the Chino Basin, which is lost yield. High groundwater levels also cause losses from rising groundwater outflow and evapotranspiration. | Increase the production capacity in key areas of the Upper Claremont Heights Basin to control groundwater levels where high groundwater is unacceptable or undesirable. | Reduces losses and thereby increases the yield of the Upper Claremont Heights Basin.<br><br>Protects against unacceptable high groundwater conditions.<br><br>Creates an exportable supply that can be sold to fund other Strategic Plan initiatives. | Supplemental Recharge<br><br>TS / SASG Improvements<br><br>Conjunctive Management |
| 1f | Groundwater levels have increased and stayed generally high in the Pomona Basin because the Parties would rather pump elsewhere to avoid the cost of treating Pomona Basin groundwater for municipal uses. Chronic high groundwater levels have reduced the yield of the Pomona Basin by maximizing sub-surface outflow to the Chino and Spadra Basins and causing surface outflow of rising groundwater. | Construct groundwater-treatment systems to convert contaminated groundwater to potable groundwater and initiate a program of controlled overdraft of the Pomona Basin to lower groundwater levels--especially in the southern portion of the Pomona Basin. This could involve the use of the "Special Projects" provision in the Judgment. | Increases the yield of the Pomona Basin by decreasing uncontrolled losses of sub-surface outflow to the Chino Basin and rising groundwater.<br><br>Protects against unacceptable high groundwater conditions.<br><br>Removes groundwater contaminants.<br><br>Creates an exportable supply that can be sold to fund other Strategic Plan initiatives. | Pump and Treat<br><br>Conjunctive Management |
| 1g | Sub-surface outflow across the San Jose Fault from the Six Basins to the Chino Basin is thought to be large but is heretofore uncharacterized. | Conduct research to verify the amounts, identify preferential pathways of sub-surface outflow, and develop strategies to reduce or eliminate sub-surface outflow. | Increases the yield of the Four Basins. | Pump and Treat<br><br>TS / SASG Improvements<br><br>Conjunctive Management<br><br>Expanded Monitoring |
| 1h | Concerns over lost yield and rising groundwater have limited the recharge and storage of imported water. | Develop an integrated plan for the storage of native, recycled, and imported waters that provides a shared benefit to all Parties and manages high groundwater levels. | Creates more reliable local supplies--especially during dry periods. | Conjunctive Management |
| 1i | There is a surplus of recycled water available in the Six Basins that is not being put to beneficial use, which is a loss of a low-cost local water supply. No studies have been performed to evaluate regional recycled water recharge projects that could benefit all the parties. | Conduct a recharge master plan with the goal of characterizing the storm, dry-weather, recycled, and imported water available for recharge, the existing recharge capacity, areas where recharge is desirable, recharge potential, recharge plan alternatives, and an implementation plan. | Results in a new, consistent volume of recharge that will increase the yield of the Six Basins and better balance recharge and discharge. | Supplemental Recharge |

**Table 4-7**

**Strategic Plan Goals, Impediments to the Goals, Actions to Remove the Impediments, Implications of Actions, and the Project Alternatives of the Strategic Plan**

| | Impediments | Actions to Remove Impediments | Implications of Actions | Project Alternatives of the Strategic Plan |
|---|---|---|---|---|
| **Goal 2 -- Enhance Basin Management** | | | | |
| 2a | The Six Basins are situated in an area that can receive and recharge large volumes of surface water, but they are a relatively small series of groundwater sub-basins with limited storage capacity. | Conduct research and develop a set of alternative storage and yield management plans. Evaluate the alternatives and select and implement a preferred alternative(s) that provides the lowest cost and greatest benefit to all parties, maximizes yield, and manages high groundwater levels. | Increases the yield of the Six Basins.<br><br>Manages high-groundwater levels.<br><br>Potentially creates an exportable supply that can be sold to fund other Strategic Plan initiatives. | Pump and Treat<br><br>TS / SASG Improvements<br><br>TCSG Improvements<br><br>Conjunctive Management |
| 2b | The groundwater-flow, groundwater-level, and storage conditions in the Six Basins area are only partially understood with the greatest unknowns in the Pomona Basin due to basin complexity and a lack of data. | Conduct research, including the construction of new monitoring wells and new groundwater-level and quality monitoring programs to improve the understanding of the hydrology, structure, and yield of the basins, and to verify the performance of future management programs. | The parties will be able to make adaptive management decisions and monitor the performance of the implementation of the Strategic Plan. | Expanded Monitoring |
| 2c | During dry periods, the spreading grounds are largely un-utilized and groundwater levels decline--especially in the Upper Claremont Heights and Live Oak Basins. The parties that pump from these basins have to reduce groundwater production because of lower groundwater levels and switch to alternate water-supply sources that can be more expensive. Lower groundwater levels in these basins also reduce sub-surface outflow to the Pomona and Ganesha Basins, which is an important source of recharge to these sub-basins. | Conduct research and develop a set of alternative storage and yield management plans that, in particular, result in consistently higher groundwater levels in the Upper Claremont Heights and Live Oak Basins. Evaluate the alternatives and select and implement a preferred alternative(s) that provides the lowest cost and greatest benefit to all parties and manages high groundwater levels. | Creates more reliable local supplies--especially during dry periods--and better balances recharge and discharge.<br><br>Manages high-groundwater levels.<br><br>Potentially creates an exportable supply that can be sold to fund other Strategic Plan initiatives. | Supplemental Recharge<br><br>TS / SASG Improvements<br><br>TCSG Improvements<br><br>Conjunctive Management |
| 2d | The development and implementation of programs for the conjunctive use of native, imported, and recycled waters is hindered by the relatively small size of the sub-basins, current high groundwater levels, the uncoordinated management of the sub-basins, and a lack of knowledge of the hydrology of the individual sub-basins. | Conduct research and develop a set of alternative storage and yield management plans. Evaluate the alternatives and select and implement a preferred alternative(s) that provides the lowest cost and greatest benefit to all parties and manages high groundwater levels. | Creates more reliable local supplies--especially during dry periods.<br><br>Manages high-groundwater levels.<br><br>Potentially creates an exportable supply that can be sold to fund other Strategic Plan initiatives. | Pump and Treat<br><br>Supplemental Recharge<br><br>TS / SASG Improvements<br><br>Conjunctive Management |
| 2e | The storage capacity is greatest in the Pomona Basin, but high groundwater levels due to past management limit its use for the conjunctive use of native, imported, and recycled waters. | Conduct research and develop a set of alternative storage and yield management plans. Evaluate the alternatives and select and implement a preferred alternative(s) that provides the lowest cost and greatest benefit to all parties and manages high groundwater levels. | More reliable local supplies--especially during dry periods.<br><br>Protects against unacceptable high groundwater conditions. | Pump and Treat<br><br>Conjunctive Management |
| 2f | High groundwater levels in the Pomona Basin also increase the threat of rising groundwater, maximize sub-surface outflow to the Chino and Spadra Basins, which is loss of yield, and allow groundwater contaminants to spread to other areas or down-gradient basins. | Construct groundwater-treatment systems to convert contaminated groundwater to potable groundwater and initiate a program of controlled overdraft of the Pomona Basin to lower groundwater levels--especially in the southern portion of the Pomona Basin. | Increases the yield of the Pomona Basin by decreasing uncontrolled losses of sub-surface outflow to the Chino Basin and rising groundwater.<br><br>Removes groundwater contaminants.<br><br>Potentially creates an exportable supply that can be sold to fund other Strategic Plan initiatives. | Pump and Treat<br><br>Conjunctive Management |

**Table 4-7**

**Strategic Plan Goals, Impediments to the Goals, Actions to Remove the Impediments, Implications of Actions, and the Project Alternatives of the Strategic Plan**

| | Impediments | Actions to Remove Impediments | Implications of Actions | Project Alternatives of the Strategic Plan |
|---|---|---|---|---|
| 2g | Provisions in the Judgment related to storage management and setting a single OSY for the Four Basins allows for production patterns and practices that do not optimize the yield of the Four Basins and may lead to other basin-management problems, such as rising groundwater. | Conduct research and develop a set of alternative storage and yield management plans. Evaluate the alternatives and select and implement a preferred alternative(s) that provides the lowest cost and greatest benefit to all Parties and manages high groundwater levels. | Increases the yield of the Four Basins.<br><br>Protects against unacceptable high groundwater conditions.<br><br>May require an amendment to the Judgment, Operating Plan, or both. | Conjunctive Management |
| 2h | Watermaster's current rules for Storage and Recovery Agreements do not include estimating and accounting for sub-surface losses from storage, and hence, can result in overdraft. | Build and calibrate numerical computer-simulation tools to simulate groundwater flow. Use the tools to update Watermaster's procedures for storage and recovery to account for losses from storage. | Prevents overdraft.<br><br>May require an amendment to the Judgment, Operating Plan, or both. | Conjunctive Management<br><br>Expanded Monitoring |
| 2i | Watermaster's existing computer-simulation tools are not up-to-date and are not sufficient to implement the Judgment--specifically regarding the curtailment of replenishment to avoid rising groundwater--or to evaluate Strategic Plan alternatives. | Build and calibrate numerical computer-simulation tools to simulate surface water and groundwater. Use the tools to update the procedures for curtailment of replenishment and to evaluate Strategic Plan alternatives. | Maximizes replenishment, and hence, the yield of the Four Basins.<br><br>Protects against unacceptable high groundwater conditions.<br><br>May require an amendment to the Judgment, Operating Plan, or both. | TS / SASG Improvements<br><br>Conjunctive Management<br><br>Expanded Monitoring |
| 2j | Sub-surface outflow across the San Jose Fault from the Six Basins to the Chino Basin is thought to be large but is heretofore uncharacterized. | Conduct research to verify the amounts, identify preferential pathways of sub-surface outflow, and develop strategies to reduce or eliminate the sub-surface outflow. | Increases the yield of the Four Basins. | Pump and Treat<br><br>TS / SASG Improvements<br><br>Conjunctive Management<br><br>Expanded Monitoring |
| 2k | The current methods and protocols being employed by the USACE, LACFCD, and the PVPA to monitor the surface-water resources may not be returning accurate data for surface-water discharge and diversions for recharge. The completeness and accuracy of these datasets are crucial to measuring replenishment, to estimating the availability of stormwater for recharge, and to developing and implementing programs to maintain or enhance yield. | Improve the monitoring of discharge, diversions, and recharge at the spreading grounds. | More accurate measurements of replenishment.<br><br>Better estimates of the availability of replenishment water.<br><br>More accurate computer-simulation of the basin.<br><br>Potentially increases recharge and yield, if not all surface water is being diverted and recharged. | Expanded Monitoring |
| 2l | Future projections of groundwater production from the Two Basins may not be sustainable without a plan to increase recharge and yield. | Conduct research and develop a set of alternatives for recharge and yield management plans. Evaluate the alternatives and select and implement the preferred alternative(s) that provides the lowest cost and greatest benefit to all parties. | Increases the yield of the Two Basins. | N/A |
| 2m | There is an area within the City of Pomona along the boundary between the Pomona Basin and Chino Basin that has experienced differential land subsidence of at least one foot from 1993-2012. This is an area of potential ground fissuring because monitoring data suggest that the differential subsidence is ongoing. The causes of the differential subsidence are not entirely understood but are most likely groundwater pumping. The only current effort to address this situation is limited monitoring of ground motion conducted by the Chino Basin Watermaster, and there is no guarantee that these efforts will continue. | Collaborate with the Chino Basin Watermaster on monitoring efforts and investigations to identify and characterize the causes of differential land subsidence in this area and the threat of ground fissuring, and develop mitigative management solutions to prevent additional subsidence and/or ground fissuring. | Improves the understanding of the hydrogeology of the Pomona and Chino basins in this area. Identifies the specific causes of differential land subsidence such that management solutions can be developed and implemented to minimize the threat of ground fissuring and potential damage to vulnerable overlying infrastructure. | Expanded Monitoring |

**Table 4-7**

**Strategic Plan Goals, Impediments to the Goals, Actions to Remove the Impediments, Implications of Actions, and the Project Alternatives of the Strategic Plan**

| | Impediments | Actions to Remove Impediments | Implications of Actions | Project Alternatives of the Strategic Plan |
|---|---|---|---|---|
| **Goal 3 -- Protect and Enhance Water Quality** | | | | |
| 3a | TDS and nitrate concentrations at wells in the Pomona, Live Oak, and Ganesha Basins suggest that there is no assimilative capacity for TDS or nitrate. A finding of no assimilative capacity could restrict the reuse and/or recharge of recycled water in the Six Basins. | Conduct research and develop a set of alternative salt and nutrient management plans. Evaluate the alternatives and select and implement a preferred alternative(s) that provides the lowest regulatory compliance cost and greatest benefit to all parties, maximizes the use of recycled water, and maintains and/or improves groundwater quality. Engage with stakeholders that are developing the SNMP in the San Gabriel Basin as necessary. | Expands the use of recycled water with the minimum cost for regulatory compliance. | Pump and Treat<br><br>Conjunctive Management |
| 3b | The Pomona Basin is the terminal basin of the Six Basins and is partially closed, which can lead to the concentration of dissolved salts and other contaminants--especially if the Pomona Basin is operated at lower groundwater levels in the future. | Conduct research and develop a set of alternative salt and nutrient management plans. Evaluate the alternatives and select and implement a preferred alternative(s) that provides the lowest regulatory compliance cost and greatest benefit to all parties, maximizes the use of recycled water, and maintains and/or improves groundwater quality. Engage with stakeholders that are developing the SNMP in the San Gabriel Basin as necessary. | Maintains or enhances groundwater quality. | Pump and Treat<br><br>Conjunctive Management<br><br>Expanded Monitoring |
| 3c | Historic irrigated agricultural practices left behind a legacy of high nitrate and perchlorate concentrations in the Lower Claremont Heights, Live Oak, Ganesha, and Pomona Basins. The parties produce less groundwater than they otherwise would from these basins because the cost of groundwater treatment is greater than the cost of acquiring other supplies. This creates high groundwater levels, allows contamination to spread, leaves large areas of the basin unused, and results in loss of yield. | Construct groundwater-treatment systems to convert contaminated groundwater to potable groundwater. This could involve the use of the "Special Projects" provision in the Judgment. | Removes groundwater contaminants.<br><br>Increases the yield of the Six Basins.<br><br>Potentially creates an exportable supply that can be sold to fund other Strategic Plan initiatives. | Pump and Treat<br><br>Conjunctive Management |
| 3d | Groundwater contamination from point-sources of PCE, TCE, 1,1,-DCE, and hexavalent chromium in the Six Basins is not being adequately addressed by potentially responsible parties or the Los Angeles RWQCB. | Conduct research to identify the sources and extent of contamination and the potentially responsible parties. Work with the Los Angeles RWQCB to force potentially responsible parties to clean-up contamination and share in the cost to pump and treat impaired groundwater. | Removes groundwater contaminants.<br><br>Provides a funding source for facilities needed to pump and treat impaired groundwater. | Expanded Monitoring |
| 3e | Groundwater in the Live Oak, Ganesha and Pomona Basins is contaminated with TCE, PCE, 1,1-DCA, and hexavalent chromium. The Parties produce less groundwater than they otherwise could from these basins because the cost of groundwater treatment is greater than the cost of acquiring other supplies. This creates high groundwater levels, allows contamination to spread, leaves large areas of the basin unused, and results in loss of yield. | Develop a regional plan to characterize all water quality limiting issues in the Six Basins, work with regulatory agencies to force potentially responsible parties to clean-up contamination, and subsequently develop a plan to pump and treat impaired groundwater. This could involve the use of the "Special Projects" provision in the Judgment. | Removes groundwater contaminants.<br><br>Increases the yield of the Six Basins.<br><br>Provides a funding source for facilities needed to pump and treat impaired groundwater.<br><br>Potentially creates an exportable supply that can be sold to fund other Strategic Plan initiatives. | Pump and Treat<br><br>Conjunctive Management<br><br>Expanded Monitoring |
| 3f | The recharge of high-quality stormwater in the Six Basins is not as high as it could be--in particular, in the Pomona Basin and the Two Basins, where groundwater-quality problems are greatest. | Conduct a recharge master plan for the Six Basins with the goal of characterizing the storm, dry-weather, recycled, and imported water available for recharge, the existing recharge capacity, areas where recharge is desirable, recharge potential, recharge plan alternatives, and an implementation plan. | Maintains or enhances groundwater quality.<br><br>Increases the yield of the Six Basins. | TS / SASG Improvements<br><br>TCSG Improvements<br><br>Expanded Monitoring |
| 3g | The hydrologic, hydrogeologic, and water-quality conditions in the Six Basins are only partially understood with the greatest unknowns in the Pomona Basin due to basin complexity and a lack of data. | Conduct research, including the construction of new monitoring wells and groundwater-level and water-quality monitoring programs to improve water-quality characterization, to provide data for use in planning and designing groundwater treatment facilities, and to verify the performance of the implementation of the Strategic Plan. | The Parties will be able to make informed water quality management decisions and monitor the performance of Strategic Plan implementation. | Expanded Monitoring |

**Table 4-7**

**Strategic Plan Goals, Impediments to the Goals, Actions to Remove the Impediments, Implications of Actions, and the Project Alternatives of the Strategic Plan**

| | Impediments | Actions to Remove Impediments | Implications of Actions | Project Alternatives of the Strategic Plan |
|---|---|---|---|---|
| **Goal 4 -- Equitably Finance the Strategic Plan** | | | | |
| 4a | The equitable distribution of cost associated with the implementation of the Strategic Plan is not defined. | Identify an equitable approach to spread the cost of Strategic Plan implementation either on a per acre-ft basis or some other equitable means. | This action will improve the likelihood that the Strategic Plan will be implemented. | N/A |
| | | Identify ways to recover value from utilizing basin assets, including recharge capacity, storage, export, and sub-surface outflow. | This action will lower the cost of the Strategic Plan to producers and improve the likelihood that the Strategic Plan will be implemented. | |
| 4b | Limit resources may restrict the implementation of the Strategic Plan. | Evaluate project and management components and rank components with equal consideration given to water quantity, water quality, and cost. | Results in the implementation of the optimum set of project and management components of the Strategic Plan. | N/A |
| | | Aggressively pursue outside sources of funding (grants, etc.). | This action will lower the cost of the Strategic Plan to producers and improve the likelihood that the Strategic Plan will be implemented. | |

Abbreviations for Project Alternatives:

TS / SASG Improvements = Increase the Use of Temporary Surplus and Increase Stormwater Recharge in the San Antonio Spreading Grounds
TCSG Improvements = Thompson Creek Spreading Grounds Improvements
Supplemental Recharge = Supplemental Water Recharge in the Upper Claremont Heights Basin
Pump and Treat = Pump and Treat Groundwater in the Pomona Basin
Conjunctive Management = Conjunctive Water Management in the Six Basins
Expanded Monitoring = Expanded Groundwater and Surface-Water Monitoring Program

# Section 5 – Development and Evaluation of Conceptual Strategic Plan Projects

This section describes and analyzes a series of projects that were conceptualized for consideration in the Strategic Plan that attempt to overcome the impediments and achieve the Strategic Plan goals described in Section 4. Each project is described in terms of its goals and nexus to the Strategic Plan, the alternative projects considered, the required operational changes and facility improvements, the groundwater basin response to operating the project, the new groundwater yield and associated capital and unit cost, and required implementation steps. The projects described herein are not definitive – they are each illustrative of families of projects that can be pursued to achieve the Strategic Plan goals. Thus, the section concludes with a set of recommendations on how the Watermaster can proceed with further refinement and evaluation of projects that meet the goals of the Strategic Plan. This section was originally published in December 2015; Section 5.8 was published in October 2017.

## 5.1 Conceptual Strategic Plan Projects Evaluated

Six projects were evaluated and are reported on herein in sections 5.2 through 5.7. Figure 5-1 shows the location of some of these projects. They include:

- Increase the Use of Temporary Surplus and Increase Stormwater Recharge in the San Antonio Spreading Grounds
- Thompson Creek Spreading Grounds Improvements
- Supplemental Water Recharge in the Upper Claremont Heights Basin
- Pump and Treat Groundwater in the Pomona Basin
- Conjunctive Water Management in the Six Basins
- Expanded Groundwater and Surface-Water Monitoring Program

An investigation into recharge improvements at Live Oak Spreading Grounds was undertaken, but was screened out early in the evaluation process as cost prohibitive.

The conceptual projects have a varying range of features[25] and benefits, which are summarized below. The specific features and benefits that apply to each project and its alternatives are characterized in Table 5-1.

| Project Features Include: | Project Benefits Include: |
|---|---|
| • Recharge improvements | • New yield |
| • Wells and conveyance | • Dry-year supply |
| • Water treatment | • Production sustainability |

[25] The features are project requirements.

| Project Features Include: | Project Benefits Include: |
|---|---|
| • Recycled water conveyance | • Enhanced reliability |
| • Expanded groundwater or surface water monitoring | • Mitigates high groundwater |
| • Potentially requires changes to Watermaster's operating plans | • Water quality improvements |
| | • Improved management |
| | • Improved basin knowledge |

## 5.2 Increase the Use of Temporary Surplus and Increase Stormwater Recharge in the San Antonio Spreading Grounds

Figure 5-2 shows the location of San Antonio Creek, San Antonio Dam, the PVPA diversion structure and the SASG. The San Antonio Dam is operated by the Army Corps of Engineers pursuant to rigid operating rules that are meant to provide flood protection. Releases from San Antonio Dam are coordinated with the operation of Prado Dam, which is located downstream of San Antonio Dam and is also operated by the US Army Corps of Engineers (USACE).

Just downstream of the San Antonio Dam outlet is the San Antonio Creek diversion works that is owned and operated by the PVPA. The San Antonio Creek diversion works splits the SASG into two parts, the San Bernardino County side on the east side of the creek and the Los Angeles County side on the west side of the creek. Within these diversion works are six slide gates, four of which divert stormwater to the east side of the SASG and two gates that divert stormwater to the west side of the SASG.

The west side of the spreading grounds contain a series of low-level berms and diversion works that attempt to spread water over the west side at relatively shallow depths – recharge is accomplished as a managed sheet flow. There are five cascading shallow basins on the northern edge of the area.

The east side of the SASG contains a series of three cascading bermed-areas in the north and a series of gravel pits, one of which is owned by the City of Ontario and is not used (Pit 6), and one pit is actively operated as sand and gravel mine. Water is diverted for recharge to the bermed areas in the north, to three of the four inactive pits, and to a series of low-level bermed areas located further south. Recharge on this side of San Antonio Creek can be limited due to flooding of Pit 6 and Pit 3, the latter of which interferes with sand and gravel operations. There are future plans to expand Pits 1 through 5 further west towards San Antonio Creek which would possibly create more storage and recharge capacity. These future plans, if implemented, are likely decades away.

The recharge capacity of the existing spreading grounds are not precisely known. Table 5-2 shows the annual time history of stormwater discharged from San Antonio Dam and the stormwater recharged and not recharged at the SASG for the 1961 to 2011 period (based on the water year of October 1 to September 30). Figure 5-3 shows the annual time history of stormwater discharged from San Antonio Dam for 2001 to 2011. For the 1961 to 2011 period, the annual amount of stormwater diversions was estimated by the PVPA. The amount of stormwater discharged from San Antonio Dam that was not diverted for recharge at the SASG ranged from a low of 0 acre-ft/yr to a maximum of about 44,900 acre-ft/yr and averaged about 4,800 acre-ft/yr. The instantaneous diversion capacity is about 400 cfs to the west side of the SASG and 800 cfs to the east side. Instantaneous diversion rates of 500 to 800 cfs to the SASG have occurred in the past[26] prior to the adjudication of the Six Basins. Based on the information that was available during this investigation, the PVPA does not routinely monitor instantaneous diversion rates.

High groundwater problems have occurred in the City of Claremont and in the active sand and gravel mining pit on the east side of the SASG[27]. The Judgment requires that Watermaster provide direction to the PVPA regarding the operation of the SASG to avoid high groundwater problems. Thus, there are two impediments to increasing recharge at the SASG: the physical capacity for recharge and the requirements to avoid high groundwater conditions. The limitation on physical capacity for recharge is caused by limitations on the diversion capacity at the diversion works and the infiltration capacity of the SASG. Expanding the diversion capacity involves structural modifications to the diversion works and the San Antonio Channel and/or changes in the operation of San Antonio Dam. Expanding the diversion capacity was not evaluated herein due to the institutional complexity involved in working with the USACE and likely conflicts with downstream appropriative water rights holders. Improvements in increasing infiltration capacity within the SASG are investigated herein.

The potential for high groundwater conditions downgradient from the SASG limits the cumulative recharge during wet years or wet periods. Recharge limitations due to high groundwater can be mitigated in part, and perhaps completely, by managing groundwater production. The Temporary Surplus provision in the Judgment can be employed to increase groundwater production to manage problematic high groundwater conditions provided that the production to recover the Temporary Surplus is done in the Upper Claremont Basin. Producing the Temporary Surplus may require construction of new wells. Improvements in the management of diverted stormwater and water management facilities within the SASG could also be employed to increase stormwater recharge.

The alternatives considered herein bracket the range of alternatives that can be implemented to increase the recharge at the SASG; the optimum alternative for the present time[28] being somewhere among them.

### 5.2.1 Basic Goals and Nexus to Strategic Plan Goals

The basic goal of the Increase the Use of Temporary Surplus and Increase Stormwater Recharge in the San Antonio Spreading Grounds project is to increase the amount of

[26] Personal communication from Cecil McAllister to Mark Wildermuth (1988).

[27] See Section 2 for a discussion of high groundwater problems in the Six Basins.

[28] As used herein *optimum alternative for the present time* is meant to imply that at another time and set of economic conditions that the *optimum alternative* could be different.

groundwater that can be produced without a replacement obligation in wet years through the use of the Temporary Surplus provision in the Judgment, increased stormwater recharge in the SASG, or both. This in turn will reduce the demand for supplemental water in wet years and provide the Parties more flexibility in managing their water supply. Increasing recharge at the SASG also helps to maintain water quality through the increased recharge of high-quality stormwater. The table below shows the nexus of this project to the goals of the strategic plan.

| Project | …removes the following impediments in Table 4-7… | …to achieve the following Strategic Plan Goals |
|---|---|---|
| Increase the Use of Temporary Surplus and Increase Stormwater Recharge in the SASG[29] | 1a, 1b, 1c, 1e, 1g | Goal 1 – Enhance Water Supplies |
| | 2a, 2c, 2d, 2i, 2j | Goal 2 – Enhance Basin Management |
| | 3f | Goal 3 – Protect and Enhance Water Quality |

### 5.2.2 Alternatives Considered and Analyzed

Four alternatives were considered herein and include:

- TS-1 – Increasing the use of Temporary Surplus using existing and planned wells and potentially up to four new wells in the Upper Claremont Heights Basin to produce the full Temporary Surplus
- TS-2 – Increasing the use of Temporary Surplus using the existing and planned wells and potentially up to seven new wells in the Upper Claremont Heights Basin to produce the full Temporary Surplus
- SASG-1 – Includes TS-2 plus minor improvements to the facilities and operations at the SASG to increase stormwater recharge
- SASG-2 – Includes TS-2 plus major improvements to the facilities and operations at the SASG to increase stormwater recharge

Figure 5-4 shows the location of the existing and new wells that would be required and used for TS-1 and TS-2.

As to the SASG-1 alternative, the recharge capacity of the SASG is not well known nor are there data that can be used to precisely define it.[30] To implement this alternative, the PVPA and Watermaster would need to construct minor conveyance and control improvements throughout the SASG and install additional monitoring equipment to enable the PVPA operators to efficiently and safely distribute stormwater throughout the SASG facilities and

[29] *Increase Recharge in the San Antonio Spreading Grounds* is referred to as Project Alternative 3 in Appendix A

[30] While there are some prior investigations that contain estimates of the recharge capacity of the SASG, there has never been a definitive analysis of its recharge capacity. The recharge capacity of the SASG, and the physics that constrain it, needs to be definitively determined to enable the Watermaster and the PVPA to make prudent investments in recharge improvements.

maximize recharge. The information collected through monitoring would also enable prioritization of recharge to avoid impacting sand and gravel operations. Once installed, the monitoring data would be reviewed continuously, and through experience the PVPA operators will be able to safely divert more stormwater and recharge it.

The intent of Alternative SASG-2 is to create storage capacity that would enable stormwater to be diverted to the SASG at rates greater than the SASG instantaneous recharge capacity, and to subsequently recharge the stored stormwater as recharge capacity becomes available. The basins shown in Figure 5-4 and analyzed herein can store between 500 acre-ft to 1,500 acre-ft. To fully utilize the storage created by this alternative, it may be necessary to increase the diversion capacity of the SASG diversion to the Los Angeles County (west) side of the SASG. There is not enough information available to reliably design and evaluate SASG-2. There may be other alternative versions of this project that are less expensive or more hydraulically efficient. Should the Watermaster desire to pursue the SASG-2 alternative, additional monitoring and engineering work should be pursued to optimize it.

### 5.2.3 Alternatives Considered and Not Analyzed

The PVPA is considering expanding the sand and gravel mining limits on the east side of the SASG and a subsequent mine reclamation plan that will result in ability to divert and store more San Antonio Creek water for recharge on the east side of the SASG. The PVPA plan could take decades to implement.

The USACE operates the San Antonio Dam for flood control, and not for water conservation. The operating rules for the dam could be revised to incorporate water conservation. This would involve the creation of a temporary conservation pool behind the dam that would exist for all but the most severe storms. During severe storms, the dam would be operated pursuant to its current operating rules. For all other storm events, the USACE would operate the dam to release stormwater at the rate that the PVPA can safely recharge it. This alternative should be pursued regardless of any improvements in the SASG. Based on the experience of the Orange County Water District in revising the operating rules for Prado Dam to achieve a similar goal, it could take several years to decades for the USACE to revise its San Antonio Dam operating rules to improve water conservation at the SASG.

These alternatives for increasing recharge at the SASG were not analyzed because they cannot likely be achieved in the next 20 years.

### 5.2.4 Operational Changes

#### 5.2.4.1 TS-1 – Increasing Temporary Surplus and Recovery of it with Four New Production Wells

During the development of the Baseline Alternative, a time history of daily stormwater outflow from the San Antonio Dam was prepared for the planning period. This daily record was used to estimate monthly diversion and recharge volumes at the SASG based on the best available information about the current operation and configuration of the SASG. For wet years, when stormwater is diverted for recharge, the monthly records were analyzed to develop a rule-based method for invoking a Temporary Surplus of up to 7,500 acre-ft. The following table describes the rules for invoking the Temporary Surplus in TS-1:

| Month | Cumulative Water-Year Spreading at SASG on the Last Day of the Month (acre-ft) | Temporary Surplus for the Calendar Year (acre-ft) |
|---|---|---|
| March | 15,000 | 5,000 |
| April | 20,000 | 6,250 |
| May | 25,000 | 7,500 |

The Temporary Surplus is invoked in seven years over the 54-year planning period for a total increase in pumping of 46,250 acre-ft (850 acre-ft/yr) compared to the Baseline Alternative. Existing wells in the Upper Claremont Heights Basin can be used to produce a portion of the Temporary Surplus, but the total capacity of the existing wells is not sufficient to produce the entire Temporary Surplus. Four new wells are needed to produce about 3,000 acre-ft of the Temporary Surplus; the existing wells are assumed to produce the remaining portion of the Temporary Surplus. The Temporary Surplus is applied as follows for TS-1 over the planning period:

| Planning Year | Baseline Stormwater Recharge for the Associated Water Year (acre-ft) | Temporary Surplus (acre-ft) | Production at Four New Wells (acre-ft) | Production at Existing Wells (acre-ft) |
|---|---|---|---|---|
| 2031 | 31,984 | 7,500 | 2,988 | 4,512 |
| 2033 | 22,193 | 5,000 | 2,988 | 2,012 |
| 2036 | 36,602 | 7,500 | 2,988 | 4,512 |
| 2046 | 27,004 | 6,250 | 2,988 | 3,262 |
| 2048 | 29,847 | 7,500 | 2,988 | 4,512 |
| 2058 | 34,096 | 7,500 | 2,988 | 4,512 |
| 2064 | 22,241 | 5,000 | 2,988 | 2,012 |

#### 5.2.4.2 TS-2 – Increasing Recharge and Temporary Surplus and Recovery of it with Seven New Production Wells

This alternative is an expanded version of TS-1 and includes additional stormwater recharge in wet years and an increased Temporary Surplus of up to 10,000 acre-ft. The following table describes the rules for invoking the Temporary Surplus in TS-2:

| Month | Cumulative Water-Year Spreading at SASG on the Last Day of the Month (acre-ft) | Temporary Surplus for the Calendar Year (acre-ft) |
|---|---|---|
| March | 15,000 | 5,000 |
| April | 20,000 | 7,500 |
| May | 25,000 | 10,500 |

The Temporary Surplus is invoked in eight years over the 54-year planning period for a total increase in pumping of 78,500 acre-ft (1,450 acre-ft/yr) compared to the Baseline Alternative. Existing wells in the Upper Claremont Heights Basin can be used to produce a portion of the Temporary Surplus, but the total capacity of the existing wells is not sufficient to produce the entire Temporary Surplus. Seven new wells are needed to produce about 6,000 acre-ft of the Temporary Surplus; the existing wells are assumed to produce the remaining portion of the Temporary Surplus. The Temporary Surplus is applied as follows for TS-2 over the planning period:

| Planning Year | Baseline Storm-water Recharge for the Associated Water Year (acre-ft) | Additional Storm-Water Recharge for the Associated Water Year (acre-ft) | Total Storm-Water Recharge for the Associated Water Year (acre-ft) | Temporary Surplus (acre-ft) | Production at Seven New Wells (acre-ft) | Production at Existing Wells (acre-ft) |
|---|---|---|---|---|---|---|
| 2022 | 20,374 | 12,688 | 33,062 | 10,500 | 5,988 | 4,512 |
| 2031 | 31,984 | 19,687 | 51,671 | 10,500 | 5,988 | 4,512 |
| 2033 | 22,193 | 897 | 23,090 | 10,500 | 5,988 | 4,512 |
| 2036 | 36,602 | 8,812 | 45,414 | 10,500 | 5,988 | 4,512 |
| 2046 | 27,004 | 17,458 | 44,462 | 10,500 | 5,988 | 4,512 |
| 2048 | 29,847 | 0 | 29,847 | 10,500 | 5,988 | 4,512 |
| 2058 | 34,096 | 7,962 | 42,058 | 10,500 | 5,988 | 4,512 |
| 2064 | 22,241 | 0 | 22,241 | 5,000 | 2,988 | 2,012 |

#### 5.2.4.3 SASG-1 – Improved Monitoring and Optimization of Recharge Operations of the Existing SASG

In this alternative, the PVPA would utilize an improved SASG internal distribution system and monitoring data to fully utilize all the recharge capabilities of the SASG. The PVPA operators would be able to precisely control the amount of stormwater being diverted to and throughout the SASG, communicate that information to the Watermaster, and provide Watermaster the information to enable the determination of a Temporary Surplus.

Watermaster would declare larger and perhaps more frequent Temporary Surpluses to maximize the amount of groundwater that can be produced as a result of increased recharge and to manage high groundwater levels.

#### 5.2.4.4 SASG-2 – Construction of New Basins on the West Side of the SASG

In this alternative, the SASG would be operated to distribute stormwater throughout the SASG as in the SASG-1 except that in very large events, when the discharge from San Antonio Dam exceeds the SASG instantaneous recharge rate, stormwater would be diverted into the SASG in excess of the SASG instantaneous recharge rate with the excess inflow stored in the new stormwater basins located on the west side of the SASG. Afterwards, the stored water would be allowed to recharge in the new basins and/or diverted to other spreading assets on the west side of the SASG. During lesser storms, the new basins would be operated at low storage levels mimicking how the area was used for recharge in the absence of the new basins. During large storm events, the SASG would be operated as in the past except that diversions would be increased with some of the diverted water stored in the new basins for subsequent recharge.

### 5.2.5 Facility Improvements

#### 5.2.5.1 TS-1 – Increasing Temporary Surplus and Recovery of it with Four New Production Wells

This alternative includes the construction of four new 800-gpm wells to enable the production of 3,000 acre-ft of the Temporary Surplus and new conveyance facilities to route the groundwater to existing water supply lines to enable the transfer of water to all agencies. The new well locations assumed for this alternative are shown in Figure 5-4 and were sited based on professional judgment and the information available to WEI during the development of the Strategic Plan.

#### 5.2.5.2 TS-2 – Increasing Recharge and Temporary Surplus and Recovery of it with Seven New Production Wells

This alternative includes the construction of seven new 800-gpm wells to enable the production of 5,300 acre-ft of the Temporary Surplus and new conveyance facilities to route the groundwater to existing water supply lines to enable the transfer of water to all agencies. The new well locations assumed for this alternative are shown in Figure 5-4 and were sited based on professional judgment and the information available to WEI during the development of the Strategic Plan.

#### 5.2.5.3 SASG-1 – Improved Monitoring and Optimization of Recharge Operations of the Existing SASG

This alternative includes minor grading throughout the SASG to improve internal conveyance and maximize wet-able area, installing new water control facilities, enabling new automation, installing stage and discharge monitoring equipment, and installing a supervisory control and data acquisition (SCADA) system. The intent is to optimize the ability to move stormwater throughout the SASG to maximize recharge and to ensure it can be done safely.

#### 5.2.5.4 SASG-2 – Construction of New Basins on the West Side of the SASG

This alternative includes the improvements in SASG-1 and the construction of a series of new storage and recharge basins. Figure 5-4 shows the locations of the new basins to store and subsequently recharge stormwater. For purposes of evaluating the feasibility of this project, preliminary facility plans were developed that would store up to 1,500 acre-ft of stormwater that would otherwise be not diverted. Stormwater would be diverted to the existing upper basins along the northern periphery of the SASG and conveyed through them into the new basins.

### 5.2.6 Groundwater Basin Response

The groundwater responses to these alternatives were evaluated with the 2015 Six Basins Groundwater-Flow Model and are described in detail in Appendix A as Alternatives 3A and 3B therein. The groundwater response to Alternative 3A is reflective of TS-1. The groundwater response to Alternative 3B is reflective of TS-2 and the stormwater recharge improvements associated with SASG-2.

The most important groundwater responses predicted by the groundwater-flow model for TS-1 are summarized below:

- Groundwater elevations are projected to decline across most of the Six Basins over the planning period (2012-2066). By the end of the planning period, groundwater-elevation declines are projected to range from zero in the Canyon Basin to about -120 feet in the southeastern portion of the Pomona Basin. The projected changes in groundwater elevations are not substantially different compared to the Baseline Alternative[31]—they are about 10 to 30 feet lower across most of the Six Basins.
- The developed yield of the Six Basins is projected to be about 19,400 acre-ft/yr, which is about 460 acre-ft/yr greater than in the Baseline Alternative. The increase in developed yield is primarily due to the increased pumping associated with the Temporary Surplus and reduced subsurface outflow to the Chino Basin.
- Several wells in the Upper Claremont Heights and Pomona Basins are projected to experience periodic challenges with production sustainability, particularly during dry periods when the volume of stormwater recharge is relatively small. These challenges with production sustainability are also projected to occur in the Baseline Alternative at about the same frequency and duration. It is likely that some of these challenges are artifacts of the assumptions made about how and where recharge and production occur. To the extent that these challenges materialize they may be mitigated by optimizing production patterns at wells and/or lowering the pumping equipment in the affected wells.
- The northeast portion of the Upper Claremont Heights Basin is projected to experience periodic challenges with rising groundwater and/or liquefaction potential, particularly during wet periods when the volume of stormwater recharge is relatively large. These threats are also projected to occur in the Baseline Alternative at about the same frequency and duration. These threats can be mitigated through optimizing the locations and/or amount of groundwater production and recharge.

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[31] The groundwater response to the Baseline Alternative is described in Section 3 of this Report.

The most important groundwater responses predicted by the groundwater-flow model for TS-2 are summarized below:

- Groundwater elevations are projected to decline across most of the Six Basins over the planning period (2012-2066). By the end of the planning period, groundwater-elevation declines are projected to range from zero in the Canyon and Upper Claremont Heights basins to about -100 feet in the southeastern portion of the Pomona Basin. The projected changes in groundwater elevations are not substantially different compared to the Baseline Alternative—they are about 5 to 20 feet lower across most of the Six Basins.
- The developed yield of the Six Basins is projected to be about 20,250 acre-ft/yr, which is about 1,300 acre-ft/yr greater than in the Baseline. The increase in developed yield is primarily due to the enhanced stormwater recharge in very wet years and the increased pumping associated with the Temporary Surplus.
- Several wells in the Upper Claremont Heights and Pomona Basins are projected to experience periodic challenges with production sustainability, particularly during dry periods when the volume of stormwater recharge is relatively small. It is likely that some of these challenges are computational artifacts of the assumptions made as to how and where recharge and production occur. To the extent that these challenges materialize they may be mitigated by optimizing production patterns at wells and/or lowering the pumping equipment in the affected wells.
- The northeast portion of the Upper Claremont Heights Basin is projected to experience periodic challenges with rising groundwater and/or liquefaction potential, particularly during wet periods when the volume of stormwater recharge is relatively large. These threats are also projected to occur in the Baseline Alternative, but in this alternative they occur at a slightly higher frequency and duration. These threats can be mitigated through optimizing the location and amount of groundwater production.

### 5.2.7 Yield Enhancement and Cost

The yield and unit cost of the yield generated from logical permutations of the increased use of Temporary Surplus and new stormwater recharge are listed below. In the evaluation of additional yield created by the Temporary Surplus without SASG recharge improvements, it became clear that there were two other cost-efficient alternatives that should be evaluated and that could be implemented immediately. These new alternatives TS-1/1 and TS-2/1 are identical to TS-1 and TS-2, respectively, except that no new wells would be constructed and the resulting increase in developed yield would decrease. The yield produced by TS-1/1 and TS-2/1 were estimated based on the modeling results for TS-1 and TS-2, respectively, and the operational assumptions in those alternatives. Appendix C-1 contains Class 5 cost opinions[32] for these alternatives based on reconnaissance-level engineering work completed by Civiltec Engineering Inc. The capital cost to construct new wells and conveyance facilities for the recovery of the Temporary Surplus and new recharge is listed below:

[32] See AACE International Recommended Practice No. 18R97 Cost Estimate Classification System as Applied in Engineering, Procurement and Construction for the Process Industries. www.aacei.org/toc/toc_18R-97.pdf

| Alternative | Capital Cost |
|---|---|
| TS-1 – Supply to Six Basins Parties and Export – Four Wells | $12,460,000 |
| TS-2 – Supply to Six Basins Parties and Export – Seven Wells | $21,850,000 |

The capital and unit cost for the recharge alternatives are summarized below:

| Alternative | New Surface Storage (acre-ft) | Capital Cost | | | |
|---|---|---|---|---|---|
| | | Internal Conveyance Improvements and SCADA | Basin Construction | | |
| | | | Balanced Cut and Fill | Export | Export and Sell Sand and Gravel |
| SASG-1 | 0 | $2,700,000 | $0 | $0 | $0 |
| SASG-2 500 | 500 | $2,000,000 | $13,684,000 | $17,901,000 | $16,461,000 |
| SASG-2 1000 | 1,000 | $2,000,000 | $28,028,000 | $36,355,000 | $33,110,000 |
| SASG-2 1500 | 1,500 | $2,000,000 | $51,550,000 | $48,240,000 | $44,565,000 |

The yield and cost for each alternative project are listed below:

| Recharge Alternative | SASG Recharge Facility Improvements | Production and Yield (acre-ft/yr) | | Unit Cost ($/acre-ft) |
|---|---|---|---|---|
| | | Average Increase in Production | Increase in Developed Yield | |
| TS-1/1 | None | 510 | 270 | $280 |
| TS-1 | None | 850 | 460 | $2,050 |
| TS-1 | SASG-1 | unknown | unknown | unknown |
| TS-2/1 | None | 620 | 560 | $280 |
| TS-2 | None | 1,450 | 1,300 | $1,380 |
| TS-2 | SASG-1 | unknown | unknown | unknown |
| TS2 | SASG-2 with Balanced Cut and Fill | unknown | unknown | unknown |

For TS-1/1 and TS-2/1, the unit cost is assumed to be the variable operations and maintenance cost of existing wells that have capacity available to produce the temporary surplus.

The unit cost of the other Temporary Surplus alternatives listed above vary over a range of about $1,400 to $2,000 per acre-ft. The relatively high unit cost is due to the infrequent use of the new wells constructed to recover the Temporary Surplus. If these same new wells could be used for other purposes, and the cost allocated in part to these other purposes, then the unit cost of increasing the Temporary Surplus could be substantially reduced.

No unit costs were prepared to increase the recharge capacity of the SASG as there is no reliable estimate of the current recharge capacity from which to determine the new recharge benefit. Watermaster and the PVPA need to implement a monitoring program to assess the recharge capacity and to determine the processes that constrain it. Once this is done then the Watermaster can complete an investigation to determine the feasibility of constructing improvements to increase the recharge capacity of the SASG. The capital costs for the SASG-1 and SASG-2, $2,700,000 and $52,000,000, respectively, bracket the expected range of construction costs.

### 5.2.8 Institutional Arrangements

The following institutional issues will need to be resolved to increase the use of Temporary Surplus and to pursue stormwater recharge improvements:

- *Watermaster Operating Plan.* Pursuant to the Judgment, Watermaster "may declare a Temporary Surplus of groundwater to be available for production" for the control of high groundwater, water quality remediation, or other reasons."[33] To date, the Watermaster has not defined criteria or rules for determining when and how much of a Temporary Surplus should be declared. Watermaster should amend the Watermaster Operating Plan to incorporate such operating criteria and procedures for invoking a Temporary Surplus. Defining the process would provide greater certainty to the Parties to invest in new wells and related facilities when planning seasonal operations.
- *Water Exchange Agreements.* Just as with OSY, the Temporary Surplus is to be allocated to the Parties in proportion to their share of the Base Annual Production Right. Based on the results of the modeling work performed for the Strategic Plan, the Temporary Surplus should be declared specifically for the Upper Claremont Heights Basin. Because not all Parties have facilities to produce water in the Upper Claremont Heights Basin, agreements to share in the cost of new well or conveyance facilities, or exchange agreements, will be needed to ensure all parties are able to utilize their share of the Temporary Surplus.
- *Right to Divert.* The PVPA has been diverting stormwater from the San Antonio Creek to the SASG since the early 1900s. After the completion of San Antonio Dam, the PVPA has been diverting stormwater as shown in Table 5-2. In 2002, the Chino Basin Watermaster applied for and subsequently obtained a permit to divert stormwater into the College Heights, Upland, Montclair and Brooks Basins. The Chino Basin Watermaster diversion rights were based on available stormwater and historical diversions by the PVPA. As of this writing, it is not clear if the PVPA rights to divert stormwater greater than historical amounts would be permitted by the State and/or potentially challenged by the Chino Basin Watermaster or others. This applies to the SASG-1 and SASG-2 alternatives.

[33] See Section VI.B.12 of the Judgment.

- *Easements and Agreements*. Acquire the easements and agreements to construct and operate new wells and related conveyance facilities and to construct improvements at the SASG.
- *Habitat Impacts*. Construction of either SASG-1 or SASG-2 improvements will temporarily disturb the soils in the construction areas, and will result in the removal of vegetation. As of this writing, the value of the habitat in the area impacted by construction of the new basins is unknown. There could be mitigation requirements if significant habit is determined to be present in the SASG. This applies to the SASG-1 and SASG-2 alternatives.

### 5.2.9 Implementation Steps

Considering the cost of implementation of increasing recharge at the SASG and the unknowns regarding the required number of new wells and the recharge capacity of the SASG, the implementation steps required to increase recharge need to include information gathering and subsequent refinement and optimization of the alternatives outlined above. That said, the recharge capacity of the SASG can only be accurately defined through experimentation and thus the implementation steps need to include a process to progressively learn how to operate the SASG and maximize recharge: one way to do this is to implement SASG-1, operate it for a number of years, and determine if it is necessary to implement some version of SASG-2. Three different sets of implementation steps are listed below to: (i) describe actions that should be taken regardless of whether or not new facilities are needed to implement the Temporary Surplus, (ii) the actions that should be taken if increasing Temporary Surplus is implemented without recharge improvements at the SASG, and (iii) the actions that should be taken if recharge improvements at the SASG are implemented.

The following implementation steps should be undertaken to exploit the Temporary Surplus regardless of whether or not new wells are constructed and/or recharge improvements are constructed:

- *Update the Watermaster Operating Plan*. Watermaster should revise its Operating Plan to precisely define the rules for determining a Temporary Surplus while still reserving discretion for the Watermaster to review and approve it. This would provide greater certainty to the Parties to invest in new wells and related facilities and planning seasonal operations.
- *Implement enhanced surface water monitoring program*. PVPA and Watermaster should develop a monitoring program to determine the recharge capacity of the SASG and the processes that constrain it. This would involve improved metering at the San Antonio Creek diversion to the SASG, the construction of internal gaging stations to measure the rate of discharge occurring through each control structure and at intermediate locations, and the construction of stage sensors in areas where water is impounded. This monitoring program would provide the PVPA and the Watermaster information required to safely maximize the recharge at the SASG.

The following implementation steps should be taken to exploit the Temporary Surplus:

- *Develop memorandum of understanding (MOU) with entities to implement the project*. All the Parties that have an interest in the project need to be identified and participate in the MOU. The MOU is a precursor to implementation agreements that follow the selection of the final project alternative. The MOU will define a preliminary governance structure for project investigation and allocate cost of preliminary engineering, the California Environmental Quality Act (CEQA) process, and development of financing alternatives.

- *Prepare preliminary design report*. The objective of this task to develop groundwater production and conveyance alternatives including an alternative to exploit the Temporary Surplus without new wells. This will involve obtaining new topographic mapping, surveying the existing facilities and key hydraulic features, engineering, and geotechnical investigations.
- *Complete CEQA*. Based on the PDR, a CEQA process would be completed on the project alternatives that are included in the PDR. Habitat and other environmental challenges, if any, would be articulated during the CEQA process and mitigation would be identified and subsequently incorporated into the project design and construction.
- *Develop financing plan and implementation agreements*.
- *Select a preferred alternative*.
- *Obtain permits*.
- *Finalize design of facilities improvements*.
- *Construct improvements*.

The following implementation steps should be undertaken to construct stormwater recharge improvements at the SASG:

- *Determine water rights*. Determine if there is water rights issue related to increasing the stormwater recharge above historical amounts, and if there is an issue, then determine the limitations on increasing stormwater recharge.
- *Develop MOU to implement the project*. All the parties that have an interest in improvements of the SASG need to be identified and to participate in the MOU. The MOU is a precursor to implementation agreements that follow the selection of the final project alternative. The MOU will define a preliminary governance structure for project investigation, and will allocate cost for preliminary engineering, the CEQA process, and the development of financing alternatives.
- *Conduct surface water monitoring and investigations*. This monitoring program will define the existing recharge capacity and the processes that constrain it.
- *Prepare preliminary design report for SASG-1 and SASG-2*. The PDR will identify and refine alternatives, inform the CEQA process, and provide the basis for final design. The PDR will also include an analysis of existing SASG hydraulics, assess conveyance capabilities, identify hydraulic constraints, and design improvements to improve stormwater conveyance within the SASG. The PDR will itemize each recharge site within the SASG, describe how it precisely works, how water is diverted into it, how frequently each site it is used, and define the range of expected infiltration rates. This will involve obtaining new topographic mapping, surveying the existing diversion works and key hydraulic features, and researching the field notes and operational data compiled by PVPA operators over the years. Alternative grading plans would be developed to maximize wet-able area for recharge. Finally, the PDR would identify specific alternatives for consideration by the PVPA and Watermaster.

- *Complete CEQA*. Based on the PDR, a CEQA process would be completed on the project alternatives that are included in the PDR. Habitat and other environmental challenges, if any, would be articulated during the CEQA process, and mitigation would be identified and subsequently incorporated into the project design and construction.
- *Develop financing plan and implementation agreements.*
- *Select a preferred alternative.*
- *Obtain permits.*
- *Finalize design of facilities improvements.*
- *Construct improvements*.

## 5.3 Thompson Creek Spreading Grounds Improvements

Figure 5-5 shows the current layout of the Thompson Creek Dam, spillway and outlet works to Thompson Creek, the diversion structure and conveyance ditch to the spreading grounds on the downstream side of the dam (Coyote Pits). Currently, stormwater is diverted upstream of Thompson Creek Dam through the diversion structure to a perched outlet works that, when the turbidity of the diverted water is low, can be diverted to the Coyote Pits for recharge. Thus, the diversion is limited by the capacity of the diversion structure, turbidity, the capacity of the conveyance ditch, and the capacity of the Coyote Pits. The recharge capacity and the processes that constraint it are not precisely known. These diversion constraints limit the amount of water conservation that can occur in the TCSG. The TCSG are operated by the PVPA subject to the dam operations and diversion constraints of the LACFCD. Not all of the available surface-water runoff from the Thompson Creek watershed is captured and recharged. Failure to divert and recharge stormwater is a permanently lost recharge opportunity.

Presently, the PVPA cannot divert all the stormwater available coming into the diversion structure because of conveyance limitations in the diversion structure and conveyance ditch that runs along the east side of the flood-control reservoir behind the dam. The LACFCD operates the diversion and favors diverting stormwater to the flood-control reservoir. Stormwater stored in the reservoir is released through the dam's outlet works into the "wasteway" channel that goes directly into Thompson Creek and thus there is no opportunity to recharge any of the water that is captured in the flood control reservoir. The existing spreading grounds have limited storage and it is not presently hydraulically feasible to divert stormwater held in the reservoir to the TCSG. Figure 5-6 shows the annual time history of stormwater that is believed to have been captured and recharged in the TCSG and the stormwater not captured from 2000 to 2011. The annual volume of stormwater that was not captured between 2000 and 2011 ranged from a low of 0 acre-ft to a maximum of about 1,630 acre-ft, and averaged about 165 acre-ft/yr.

### 5.3.1 Basic Goals and Nexus to Strategic Plan Goals

The basic goal of the TCSG improvements is to increase the yield of the Six Basins by increasing the capacity to divert and recharge stormwater runoff from the Thompson Creek watershed. Enhanced recharge at the TCSG will improve water quality in the area of recharge through the recharge of high-quality stormwater. The table below shows the nexus of this project to the goals of the Strategic Plan.

| Project | …removes the following impediments in Table 4-7… | …to achieve the following Strategic Plan Goals |
|---|---|---|
| Thompson Creek Spreading Grounds Improvements | 1a, 1b, 1c, 1e, 1g | Goal 1 – Enhance Water Supplies |
| | 2a, 2c, 2d, 2i, 2j | Goal 2 – Enhance Basin Management |
| | 3f | Goal 3 – Protect and Enhance Water Quality |

### 5.3.2 Alternatives Considered and Analyzed

One alternative was developed and analyzed herein. This alternative is shown in Figure 5-7. In this alternative, the diversion structure and the existing inlet to the Coyote Pits are abandoned and all the stormwater is impounded behind the dam; the TCSG are expanded and deepened creating multiple basins; hydraulic structures are constructed to move among the new basins; and a floating pump station is constructed within the flood-control reservoir to divert stormwater to the improved spreading grounds. There may be alternative versions of the project that could be less expensive or more hydraulically efficient. Should the Watermaster desire to pursue this project, additional engineering work should be pursued to optimize it.

### 5.3.3 Alternatives Considered and Not Analyzed

The facility improvements developed for stormwater recharge in the TCSG could also be used for recharge of supplemental water. The supplemental water recharge capacity was not estimated, nor were the improvements required to recharge supplemental water.

### 5.3.4 Operational Changes

The existing diversion structure and the perched outlet to the Coyote Pits would be abandoned and all stormwater runoff from the Thompson Creek watershed would accumulate behind the dam. The PVPA would, when the surface water behind the dam is low in turbidity, convey water from the flood-control reservoir around the dam to newly constructed recharge basins via a floating pump situated in the reservoir.

### 5.3.5 Facility Improvements

This project consists of the following improvements:

- New recharge basins downstream of the Thompson Creek Dam in the same area that PVPA presently uses for recharge. These basins would temporarily store stormwater and subsequently infiltrate it.
- Construction of a floating pump system behind the dam and conveyance works to convey surface water from the reservoir behind the dam to the new recharge basins.
- New outlet works for the Thompson Creek Dam to divert stormwater directly from the reservoir to the new recharge basins.

For purposes of evaluating the feasibility of this project, a preliminary facility plan was developed. Figure 5-7 shows the location of the proposed improvements. Stormwater would be stored in the reservoir at the discretion of the LACFCD and either pumped to the recharge basins when the turbidity is low enough to recharge, released to the wasteway channel and Thompson Creek, or both. The existing diversion structure and the perched outlet to the Coyote Pits would be abandoned. No new wells will be required to recover the new stormwater recharge.

### 5.3.6 Groundwater Basin Response

The 2015 Six Basins groundwater model was not used to assess the groundwater basin response to the new recharge created by this project. It was judged that the average annual increase in recharge is relatively small and could be readily produced from existing wells located proximate to it. The expected groundwater response is a slight increase in groundwater elevation near the TCSG, an increase in yield of 230 acre-ft/yr, and an improvement in groundwater quality due to the stormwater recharge.

### 5.3.7 Yield Enhancement and Cost

A stormwater diversion and routing scheme was developed based on the existing reservoir operating rules and the proposed improvements to calculate the yield of this project. The new yield attributable to the proposed improvements ranges from a low of 0 acre-ft/yr to a maximum of 1,410 acre-ft/yr and averages about 230 acre-ft/yr.

Appendix C-2 contains a Class 5 cost opinion for this alternative based on reconnaissance-level engineering work completed by Civiltec Engineering Inc. The capital cost of this project is estimated to be about $7,170,000. The associated annual operations and maintenance cost was assumed to be $10,000 per year. Therefore, the annual cost of this alternative will be about $475,000 per year and the unit cost of new recharge is about $2,100 per acre-ft.

Utilizing the new recharge capacity created by this project for supplemental recharge could reduce the unit cost of the project, depending on the cost to convey supplemental water to the TCSG.

### 5.3.8 Institutional Arrangements

The following institutional issues will need to be resolved if the TCSG alternative were to be implemented.

- *Right to Divert*. As of this writing, it is not clear if the PVPA water rights to divert stormwater greater than historical amounts would be permitted by the State.
- *Thompson Creek Dam Operations*. The dam's primary mission is flood protection. This project will require new reservoir operating rules that accommodate water conservation without compromising flood protection. The new stormwater recharge estimates reported above are based on the existing operating rules. Watermaster and the PVPA should work with the LACFCD to develop new operating rules to maximize recharge subject to meeting the LACFCD flood protection requirements.
- *Easements and Agreements*. Easements and agreements will need to be acquired to construct recharge improvements and the related conveyance facilities.

- *Habitat Impacts*. The construction of the new recharge basins on the downstream side of the Thompson Creek Dam will temporarily disturb the soils in the construction area and will result in the removal of vegetation. There is a known sensitive vegetation community, the Riversidean Alluvial Fan Sage Scrub, in the vicinity of Thompson Creek that might be impacted by construction.

### 5.3.9 Implementation Steps

Regardless of whether or not improvements to the TCSG are pursued, PVPA and Watermaster should develop a monitoring program to determine the recharge capacity of the TCSG and the processes that constrain the recharge capacity. This would involve improved metering at the Thompson Creek diversion, the construction of internal gaging stations to measure the rate of discharge occurring through each control structure and intermediate locations, and the construction of stage sensors in areas where water is impounded. This monitoring program would provide the PVPA and the Watermaster information required to safely maximize the recharge at the TCSG.

The following implementation steps should be undertaken to implement recharge improvements at the TCSG:

- *Determine water rights*. Determine if there is a water rights issue related to increasing the stormwater recharge above historical amounts, and if there is an issue, then determine the limitations on increasing stormwater recharge.
- *Develop MOU to implement the project*. All the parties that have an interest in improvements of the TCSG need to be identified and participate in the MOU. The MOU is a precursor to implementation agreements that follow the selection of the final project alternative. The MOU will define a preliminary governance structure for project investigation and allocate cost of preliminary engineering, the CEQA process, and development of financing alternatives.
- *Conduct surface water monitoring and investigations*. This monitoring program will define the existing recharge capacity and the processes that constrain it.
- *Prepare preliminary design report*. The objective of this task to develop the optimum configuration of new recharge basins and their storage capacity, and to identify and size hydraulic structures and define how they would operate. This will involve obtaining new topographic mapping, surveying the existing facilities and key hydraulic features, and geotechnical investigations. Alternative grading plans would be developed. Cost opinions will need to be prepared.
- *Complete CEQA*. Based on the PDR, a CEQA process would be completed on the project alternatives that are included in the PDR. Habitat and other environmental challenges, if any, would be articulated during the CEQA process and mitigation would be identified and subsequently incorporated into the project design and construction.
- *Develop financing plan and implementation agreements.*
- *Select a preferred alternative.*
- *Obtain permits.*
- *Finalize design of facilities improvements.*

- *Construct improvements*.

## 5.4 Supplemental Water Recharge in the Upper Claremont Heights Basin

There is surplus supplemental water available to the Watermaster Parties that is not being utilized. The sources of supplemental water include recycled water that originates from Six Basins parties at the Pomona WRP, imported water from the MWDSC served through the IEUA for City of Upland and served through the TVMWD for the cities of La Verne and Pomona and the Golden State Water Company.

There are from time to time production sustainability problems at wells in the Upper Claremont Heights Basin that could be mitigated in part if a reliable supply of supplemental water could be recharged at the SASG on a predictable basis. The limitation on this recharge is that the Upper Claremont Heights Basin cannot store water for significant periods of time and that a new continuous supplemental water recharge project would need to be produced in the same year that the supplemental water recharge occurs.

### 5.4.1 Basic Goals and Nexus to Strategic Plan Goals

The goal of this project is to recharge supplemental water in the Six Basins to increase the sustainable production capabilities of the Six Basins Parties, specifically in the Upper Claremont Basin. Supplemental water recharge would help maintain groundwater levels high enough to ensure sustainable groundwater production. The table below shows the nexus of this project to the goals of the strategic plan.

| Project Alternative | …removes the following impediments in Table 4-7… | …to achieve the following Strategic Plan Goals |
|---|---|---|
| Supplemental Water Recharge in the Upper Claremont Heights Basin | 1b, 1c, 1e, 1i | Goal 1 – Enhance Water Supplies |
| | 2c, 2d | Goal 2 – Enhance Basin Management |

### 5.4.2 Alternatives Considered and Analyzed

Two alternatives were analyzed herein to bracket supplemental water recharge. The alternative are shown in Figure 5-8. The first alternative would convey recycled water from the Pomona WRP to the SASG for recharge. Based on the Department of Drinking Water's (DDW) current Title 22 regulations for Groundwater Recharge and Recovery, preliminary work suggests that compliance with the regulations is feasible. The second alternative would recharge imported water from TVMWD in the SASG. In general, the same amount of water would be recharged each year and the volume recovered would equal the amount recharged, although more could be recharged when surplus water is more abundant and subsequently recovered from the Pomona Basin during dry years. The intent is to increase the sustainable production capacity in the Upper Claremont Heights Basin, and not to store large quantities of water for long periods of time. This would enable groundwater producers in the Upper Claremont Heights Basin to produce more groundwater during dry periods.

### 5.4.3 Alternatives Considered and Not Analyzed

There are many possible variants to alternatives described above and so it is not possible to describe all the alternatives not considered. There is one alternative that is worth mentioning. The recycled water produced at the Pomona WRP that originates from the Six Basins area could be exchanged with IEUA for a like amount of imported water delivered through TVMWD. This would convert an underutilized asset (the recycled water) into water served at a high elevation in the Six Basins (the imported water) and would avoid the great expense of constructing and operating the infrastructure required to pump recycled water from the Pomona WRP to the SASG for recharge.

### 5.4.4 Operational Changes

#### 5.4.4.1 3,500 acre-ft/yr of Recycled Water Recharge in the SASG

In this alternative, 3,500 acre-ft/yr of recycled water would be pumped from the Pomona WRP to the SASG for recharge. Recycled water would be recharge throughout the year except when stormwater recharge operations would conflict with it. The recycled water recharged in this alternative will be recovered each year through existing wells located in the Upper Claremont Heights Basin. New groundwater monitoring and reporting will be required by DDW and the Regional Board for wells in the vicinity of the recycled water recharge.

#### 5.4.4.2 3.500 acre-ft/yr of Imported Water Recharge in the SASG

In this alternative, 3,500 acre-ft/yr of imported SWP water would be recharged in the SASG at the existing TVMWD recharge basins throughout the year, except when stormwater recharge operations would conflict with it. The water recharged in this alternative will be recovered each year through existing wells located in the Upper Claremont Heights Basin.

### 5.4.5 Facility Improvements

#### 5.4.5.1 3,500 acre-ft/yr of Recycled Water Recharge in the SASG

The following new facilities are required to recharge 3,500 acre-ft/yr of recycled water in the SASG:

- A new 5.0 mgd pump station constructed at the Pomona WRP and new booster pump stations:
- a 1,400 horsepower (hp) pump station at the Pomona WRP, and
- a 1,500 hp booster pump station at the Pedley Treatment Plant.
- A new 20-inch diameter, 68,000-ft long pipeline to convey 5.0 mgd of recycled water from the Pomona WRP to the SASG.
- Minor improvements at the SASG to discharge and manage the recycled water conveyed to the SASG.

#### 5.4.5.2 3,500 acre-ft/yr of Imported Water Recharge in the SASG

It was assumed herein that the TVMWD recharge facilities in the SASG would be available to recharge imported water. No new facilities are required to deliver and recharge imported water at the SASG.

### 5.4.6 Groundwater Basin Response

The groundwater response to these alternatives were evaluated with the 2015 Six Basins Groundwater-Flow Model and is described in detail in Appendix A, as Alternative 2 therein. Both supplemental water recharge alternatives recharge the same amount of water in the SASG and therefore the groundwater response to these alternatives can be assumed to be the same. The most important groundwater responses predicted by the groundwater model are summarized below:

- The projected changes in groundwater elevations over the planning period (2012-2066) range from +60 feet in the northern portion of the Upper Claremont Heights Basin in the area of supplemental water recharge, to about -20 feet in the southern portion of the Upper Claremont Heights Basin where the recovery of the recharge occurs at wells. Compared to the Baseline Alternative, groundwater elevations are projected to be up to 60 feet higher in the area of supplemental water recharge over the planning period.
- Some wells in the Upper Claremont Heights Basin are projected to experience periodic challenges with production sustainability primarily due to the recovery of the recharge. It is highly likely that these challenges are artifacts created by assumed production rates in existing wells and can be eliminated by adjusting production patterns at wells to ensure sustainable production at all wells. To the extent that these challenges materialize, they may be mitigated by lowering the pumping equipment in the affected wells.
- The northeast portion of the Upper Claremont Heights Basin is projected to experience periodic challenges with high groundwater levels. These challenges can be mitigated through spreading out supplemental water recharge across the SASG, optimizing the location and amount of groundwater production, and/or reducing the amount of supplemental water recharge when high groundwater level conditions arise. For example, in wet years, supplemental water recharge could be reduced to ensure that high groundwater levels are managed.

### 5.4.7 Yield Enhancement and Cost

Increasing supplemental water recharge as proposed herein does not increase the yield of the Six Basins per se. Increasing supplemental water recharge increases the amount of groundwater that can be sustainably produced, and in the case of recycled water recharge, uses a new supply of water that is not currently utilized in the Six Basins. The two supplemental water recharge alternatives recharge 3,500 acre-ft/yr and recover it during the same year. The Watermaster Parties participating in the project would reduce their use of other sources of water in order to produce the water recharged in these alternatives.

Appendix C-3 contains Class 5 cost opinions for these alternatives based on reconnaissance-level engineering work completed by Civiltec Engineering Inc. The capital and unit cost of water for these alternatives are summarized below:

| Recharge Alternative | Capital Cost | Commodity Cost to Acquire Recharge Water ($/acre-ft) | Supply (acre-ft/yr) | Unit Cost ($/acre-ft) |
|---|---|---|---|---|
| Recycled Water | $83,000,000 | $83 | 3,500 | $2,060 |
| Imported Water | 0 | $584[34] | 3,500 | $684 |

The capital cost for the recycled water includes pumping and conveyance facilities. There are no capital costs associated with the imported water recharge alternative

### 5.4.8 Institutional Arrangements

The following institutional issues will need to be resolved if the recycled water recharge alternative were to be implemented.

- *Watermaster Storage and Recovery Agreements*. A storage and recovery agreement will be required to implement this project. Because the Upper Claremont Heights Basin cannot store water for significant periods of time, the new continuous supplemental water recharge project would need to be produced in the same year that the supplemental water recharge occurs. The storage and recovery agreement will need to include provisions for how water that is not produced within the same year it was recharged can be stored and produced from the Pomona Basin.
- *Lead Agency.* Determine whom will be the lead agency on the project.
- *Financing*. Obtain agreement to cover the cost of acquiring recycled water and repayment of the debt and operating cost of the project.
- *Water Rights*. Acquire the rights to the recycled water.
- *Easements and Agreements*. Acquire the easements and agreements to construct and operate the conveyance facilities required to transport the recycled water from the Pomona WRP to the SASG.
- *Permitting*. Obtain permits from the DDW and the Regional Board to implement a recycled water recharge project.

The following institutional issues will need to be resolved if the imported water recharge alternative were to be implemented.

- *Easements and Agreements*. Obtain an agreement with TVMWD and PVPA for the use of the TVMWD recharge facilities in the SASG.

[34] Commodity cost for SWP water delivered through TVMWD is equal to the 2015 untreated full service Tier 1 rate from Metropolitan plus TVMWD administrative cost.

- *Financing*. Obtain an agreement with the Watermaster parties to fund the purchase of the imported water from TVMWD and assess the parties.

### 5.4.9 Implementation Steps

The following implementation steps need to be completed for this project:

- Watermaster to amend its Operating Plan to update the criteria for entering into Storage and Recovery Agreements.
- Obtain a Storage and Recovery Agreement from the Watermaster.
- Develop memorandum of understanding (MOU) with entities to implement the project. All the parties that have an interest this alternative need to be identified and to participate in the MOU. The MOU is a precursor to implementation agreements that follow the selection of the final project alternative. The MOU will define a preliminary governance structure for project investigation and allocate cost of preliminary engineering, the CEQA process and development of financing alternatives.
- For the recycled water recharge alternative:
    - *Prepare Title 22 Report*. Prepare preliminary Title 22 engineering report pursuant to the Title 22 Groundwater Recycled Reuse Project regulations.
    - *Prepare preliminary design report*. The objective of this task to design the recycled water conveyance, recharge facilities, and recovery wells. This will involve obtaining new topographic mapping, surveying the existing facilities and key hydraulic features, and geotechnical investigations.
    - *Easements and Agreements*. Acquire the easements and agreements to construct and operate the conveyance facilities required to transport the recycled water from the Pomona WRP and recharge the recycled water in the SASG.
    - *Complete CEQA*. Based on the PDR, a CEQA process would be completed on the project alternatives that are included in the PDR. Environmental challenges, if any, would be articulated during the CEQA process and mitigation would be identified and subsequently incorporated into the project design and construction.
    - *Prepare final Title 22 engineering report*.
    - *Select preferred alternative.*
    - *Develop financing plan and final implementation agreements.*
    - *Obtain permits.*
    - *Finalize design of facilities improvements.*
    - *Construct improvements.*
- For the imported water recharge alternative:
    - *Easements and Agreements*. Develop an agreement with TVMWD and PVPA for the use of the TVMWD recharge facilities in the SASG. The agreement will address the use of the facilities, use fees, priority of use, and the terms for the purchase of imported water.

- *Financing*. Develop an agreement to pay for the imported water purchased for recharge.

## 5.5 Pump and Treat Groundwater in the Pomona Basin

An impediment to increasing groundwater production in the Pomona Basin is poor water quality. Groundwater levels have increased and generally remained high in the Pomona Basin as the Parties have shifted away from pumping to avoid the cost of treating groundwater for municipal use. The high groundwater levels have reduced the yield of the Pomona Basin by increasing subsurface outflow to the Chino Basin, and have increased the threat of rising groundwater and liquefaction potential.

### 5.5.1 Basic Goals and Nexus to Strategic Plan Goals

The basic goals of this project are to increase the yield of Pomona Basin (and hence the Four Basin area) by reducing subsurface outflow to the Chino Basin; remove contaminants from groundwater and put the groundwater to beneficial use; lower groundwater elevations to reduce the threat of rising groundwater and liquefaction potential; and accommodate other Six Basins management strategies by creating operational storage space. The table below shows the nexus of this project to the goals of the Strategic Plan.

| Project | …removes the following impediments in Table 4-7… | …to achieve the following Strategic Plan Goals |
|---|---|---|
| Pump and Treat Groundwater in the Pomona Basin | 1a, 1b, 1c, 1e, 1g | Goal 1 – Enhance Water Supplies |
| | 2a, 2c, 2d, 2i, 2j | Goal 2 – Enhance Basin Management |
| | 3f | Goal 3 – Protect and Enhance Water Quality |

### 5.5.2 Alternatives Considered and Analyzed

This project is a pump and treat program in the Pomona Basin. The Four Basins OSY and groundwater pumping for this project are the same as in the Baseline Alternative except for the pumping of the additional 1,000 acre-ft/yr of groundwater from the Pomona Basin. The 1,000 acre-ft/yr of treated product water is delivered to the City of Pomona to meet its water demands or by other water suppliers within or outside the Six Basins. Regardless of the user, the demand for imported water supplies is reduced by 1,000 acre-ft/yr. It is assumed that this is a "Special Project" pursuant to the Six Basins Judgment and the additional 1,000 acre-ft/yr of groundwater pumping can be exempted from replacement obligations by Watermaster. The 1,000 acre-ft/yr of groundwater production developed with this project is, in a practical sense, new yield.

### 5.5.3 Alternatives Considered and Not Analyzed

Other project capacities (production rates, location and number of wells, conveyance schemes) and delivery points were considered and their permutations were numerous. For purposes of the Strategic Plan, consideration of other alternatives was deferred to the future. Should the Watermaster Parties be interested in pursuing this type of project, then further evaluations of the project capacity and design should be considered.

### 5.5.4 Operational Changes

Imported water deliveries would be reduced by 1,000 acre-ft/yr. Groundwater production in the Pomona Basin would be increased by 1,000 acre-ft/yr, this water would be treated at the City of Pomona's Reservoir 5 treatment facility, and the product water would be served to the City of Pomona.

### 5.5.5 Facility Improvements

Figure 5-9 shows the wells, treatment, and conveyance facilities used in this project. This project consists of the following improvements:

- The existing groundwater-treatment system at the City of Pomona's Reservoir 5 is expanded and improved to remove VOCs, perchlorate, and nitrate from the additional groundwater produced at these wells, and produce a potable water supply.

### 5.5.6 Groundwater Basin Response

The groundwater response to this alternative was evaluated with the 2015 Six Basins Groundwater-Flow Model and is described in detail in Appendix A as Alternative 1 therein. The most important groundwater responses predicted by the groundwater model are summarized below:

- Groundwater levels are projected to decline in greater amounts across the Pomona Basin over the planning period (2012-2066) compared to the Baseline Alternative. The projected declines in groundwater levels over the planning period reach about -140 feet in the southern portion of the Pomona Basin. Because groundwater elevations in the 1960s were up to 200 feet lower in the Pomona Basin, the model projection suggests that this project is feasible from a physical standpoint. That said, a monitoring and testing program should accompany the development and implementation of this project. The objectives of the monitoring and testing program would be: to improve the hydrogeologic understanding of the Pomona Basin (including the threat of land subsidence), to help refine the project description, and to support the ability to adapt the project during implementation if necessary to avoid adverse impacts and/or better achieve its objectives.
- The developed yield of the Four Basins is projected to be about 700 acre-ft/yr greater than in the Baseline, mainly because of lower subsurface outflow to the Chino Basin.
- The developed yield of the Two Basins is about 175 acre-ft/yr less than in the Baseline Alternative; this is mainly due to more subsurface outflow to the Pomona Basin and less subsurface inflow from the Lower Claremont Heights Basin. Measures to mitigate

this projected decline in developed yield will need to be included in the implementation plan.

- Several wells in the Pomona Basin are projected to experience periodic challenges with production sustainability. It is likely that some of these projected challenges are computational artifacts created by assumed production rates in existing wells and can be eliminated by optimizing production patterns at all wells. To the extent that these challenges materialize, they can be mitigated by lowering the pumping equipment in the affected wells.

### 5.5.7 Yield Enhancement and Cost

Based on the groundwater model simulations, the projected yield in the Four Basins area is projected to increase by about 700 acre-ft/yr.

Appendix C-4 contains a Class 5 cost opinion for this alternative based on reconnaissance-level engineering work completed by Civiltec Engineering Inc. The capital and unit cost of water for this alternative is summarized below:

| Project Alternative | Capital Cost | Groundwater Produced (acre-ft/yr) | Increase in Yield (acre-ft/yr) | Unit Cost ($/acre-ft) |
|---|---|---|---|---|
| Pump and Treat Groundwater from the Pomona Basin | $4,000,000 | 1,000 | 700 | $830 |

### 5.5.8 Institutional Arrangements

The following institutional issues will need to be resolved to pursue the *Pump and Treat Groundwater in the Pomona Basin* project.

- *Lead Agency*. Determine whom will be the lead agency on the project.
- *Special Projects Determination.* Pursuant to the Judgment, Watermaster may approve Special Projects for controlling water levels or for remediation of water quality problems[35]. Pursuant to the Watermaster Operating Plan, "Watermaster may exempt the water produced from being debited against the producer's share of the Operating Safe Yield if Watermaster deems the project's extractions benefit the overall management of the Six Basins. The specific terms of the exemption shall be included in Watermaster's finding and conditions for approval. Watermaster may place specific limitations on the quantity and/or time for which such exempted production is allowed for the Special Project"[36] To date, the Watermaster has not defined criteria or rules for determining if and how much of a Special Project could be declared exempt from replacement obligations. Defining the process would provide greater certainty to the parties to invest in facilities and operating plans.

[35] See Section VI.B.11 of the Judgment.

[36] See Section 7.2.1 of the Operating Plan.

- *Easements and Agreements*. Acquire the easements and agreements to construct and operate the treatment facilities.
- *Permitting*. Obtain permits from the DDW to treat and serve water from an impaired source.

### 5.5.9 Implementation Steps

The following implementation steps will be required to implement the *Pump and Treat Groundwater in the Pomona Basin* project:

- Watermaster to amend its Operating Plan to update the criteria for approving Special Projects and the criteria for exempting production under a Special Project, or a portion thereof, from replacement water obligations.
- Apply for and obtain approval from Watermaster for a Special Project and a determination that the water produced under this project, or a portion thereof, is free of a Replacement Water obligation.
- *Develop MOU with entities to implement the project*. All the parties that have an interest in improvements of the project need to be identified and participate in the MOU. The MOU is a precursor to implementation agreements that follow the selection of the final project alternative. The MOU will define a preliminary governance structure for project investigation and allocate cost of preliminary engineering, the CEQA process, and the development of financing alternatives.
- *Prepare preliminary design report*. The objective of this task to develop groundwater production, raw water conveyance, treatment and product water conveyance alternatives; and mitigation alternatives if necessary to address potential groundwater level and subsidence impacts. This will involve obtaining new topographic mapping, surveying the existing facilities and key hydraulic features, engineering, and geotechnical investigations.
- *Complete CEQA*. Based on the PDR, a CEQA process would be completed on the project alternatives that are included in the PDR. Environmental challenges, including and not limited to production sustainability and subsidence, would be articulated during the CEQA process and mitigation would be identified and subsequently incorporated into the project design and construction.
- *Select preferred alternative.*
- *Develop financing plan and implementation agreements.*
- *Obtain permits.*
- *Finalize design of facilities improvements.*
- *Construct improvements.*

## 5.6 Conjunctive Water Management in the Six Basins

Conjunctive water management, as defined herein, is the coordinated use and management of all surface water and groundwater supply sources to enhance yield and improve water-supply reliability during dry periods. Conjunctive water management is currently practiced in the Six

Basins—largely through PVPA's efforts to divert and recharge stormwater and the Parties' efforts to recover that recharge via groundwater production pursuant to the physical solution in the Judgment. In practice, conjunctive water management has worked well with two exceptions: (i) the PVPA generally diverts all the stormwater discharge from San Antonio Creek except for the largest storm events and when the threat high groundwater conditions are manifested; and (ii) existing production capacity and conveyance are not adequate to manage high and low groundwater conditions. Stated another way, the recharge capability at the SASG is large compared to the storage space in the basin to regulate recharge, and the location and production capacity of wells are not optimized to prevent high groundwater conditions in wet periods and maintain production during dry periods.

The investigative results of projects described previously in this section demonstrate that there are projects that can be implemented to increase the yield of the Six Basins in wet and dry periods while protecting against the problems of high groundwater. These findings were leveraged to develop the *Conjunctive Water Management in the Six Basins* project, which includes elements from *Pump and Treat Groundwater in the Pomona Basin* (Section 5.5) and from *Increase the Use of Temporary Surplus and Increase Stormwater Recharge in the San Antonio Spreading Grounds* (Section 5.2). This project maximizes the use of surface water during wet years, such that groundwater will be more available and reliable during dry periods.

### 5.6.1 Basic Goals and Nexus to Strategic Plan Goals

The goal of the this project is to implement a conjunctive use program in the Pomona Basin that would provide a dry-year yield benefit to the Watermaster parties, the TVMWD service area, the MWDSC service area, and the State. The Pomona Basin was chosen because has the greatest regulatable storage potential in the Six Basins[37]. The table below shows the nexus of this project to the goals of the Strategic Plan:

| Project Alternative | …removes the following impediments in Table 4-7… | …to achieve the following Strategic Plan Goals |
|---|---|---|
| Conjunctive Water Management in the Six Basins | 1e, 1f, 1g, 1h | Goal 1 – Enhance Water Supplies |
| | 2a, 2d, 2e, 2f, 2g, 2h, 2i, 2l | Goal 2 – Enhance Basin Management |
| | 3a, 3b, 3c, 3e | Goal 3 – Protect and Enhance Water Quality |

### 5.6.2 Alternatives Considered and Analyzed

This project stores water or "puts" water into storage during wet years, "holds" water until needed, and produces or "takes" the stored water when imported water supplies are reduced due to drought or otherwise not available. The project includes the following features:

37 The Pomona Basin is largest and best storage reservoir in the Six Basins for conducting long-term storage programs. See the Conclusions and Recommendation sub-section in Section 3 – Development and Evaluation of the Baseline Alternative.

- Create a dry-year storage account large enough to offset the imported water demands of the three largest imported water users for four consecutive years. The imported water demand is about 9,000 acre-ft/yr for the City of La Verne, the City of Pomona, and the Golden State Water Company. Thus, a dry-year storage account of at least 36,000 acre-ft is required to withstand four consecutive dry years.
- 50,000 acre-ft of the groundwater currently in storage in the Pomona Basin is dedicated to the dry-year storage program to evacuate operational storage space because groundwater elevations in the Pomona Basin are relatively high.
- Construct pump-and-treat capacity of 9,000 acre-ft/yr in the Pomona Basin for dry-year takes from storage that are in addition to the Baseline OSY.
- The "put" or recharge to the dry-year storage account is accomplished through in-lieu recharge. In-lieu recharge is the addition of water to the groundwater basin using other surplus surface water supplies "in-lieu" of producing groundwater within the OSY rights of the recharging parties. The put is accomplished by reducing groundwater production in the Pomona Basin by as much as 9,000 acre-ft/yr and increasing the use of other sources of water by the same amount. The other sources of water could include imported water or water made available through a Temporary Surplus.

### 5.6.3 Alternatives Considered and Not Analyzed

Other project capacities (production rates, location and number of wells, conveyance schemes) and operating rules were considered and their permutations were numerous. For purposes of the Strategic Plan, consideration of other alternatives were deferred to the future. Should the conjunctive water manage project be pursued in the future, then further evaluations of the project capacity should be considered.

### 5.6.4 Operational Changes

Based on a statistical characterization of the precipitation and recharge records of the planning period hydrology, the following operating rules were developed for the conjunctive water management project:

| Conjunctive Water Management Operating Rules | | |
|---|---|---|
| **Criteria** | **Alternative 4 Action** | **Put (+) or Take (-)** |
| If more than 6,000 acre-ft of stormwater is recharged at the SASG from October through February | Put water in dry-year storage account by reducing OSY production in Pomona Basin and replacing production with imported water | + 9,000 acre-ft |
| If more than 4,000 acre-ft of stormwater is recharged at the SASG from October through March | Put water in dry-year storage account by reducing OSY production in Pomona Basin from April to December and replacing production with imported water | + 4,500 acre-ft |
| If less than 4,000 acre-ft of stormwater is recharged at the SASG from October through March | Hold water in dry-year storage account (no action) | 0 acre-ft |
| If stormwater recharge at the SASG is zero and precipitation is less than 18 inches by March 31 | Take water from dry-year storage account by increasing production in Pomona Basin over planned OSY production from April to December | - 9,000 acre-ft |

Based on these rules, over the 54-year planning period, water was put into the dry-year storage account in 14 years, for a total of 108,000 acre-ft. Takes from the storage account occurred in 18 years, for a total increase in pumping of 162,000 acre-ft (3,000 acre-ft/yr) compared to the Baseline Alternative. Water was held in storage (no put or take) in 21 out of 54 years. It was assumed that 50,000 acre-ft of water currently in storage in the Pomona Basin would be dedicated to the dry-year storage account. The entire storage account balance was only completely depleted once over the planning period, occurring at the very end of the planning period (Year 54). However, the account balance was never replenished above 32,000 acre-ft after being depleted to 9,500 in the first seven years of the planning period, which included five dry-year takes. The put, takes, holds, and storage account balance for the planning period are shown in Table 5-3.

Producing water from the dry-year storage account requires new well capacity in the amount of 9,000 acre-ft/yr. The water will require treatment before being conveyed and delivered to the project participants.

### 5.6.5 Facility Improvements

Figure 5-10 shows the wells, treatment, and conveyance facilities used in this project. This project consists of the following improvements:

- Twelve new 800-gpm wells
- New conveyance facilities to route the raw groundwater to the new groundwater treatment plants. The conveyance facilities will include pipelines, two reservoirs, and two booster pump stations.
- Two new treatment plants that will remove chrome VI, perchlorate, VOCs (DCE and TCE) and nitrate.

### 5.6.6 Groundwater Basin Response

The groundwater response to this alternative was evaluated with the 2015 Six Basins Groundwater-Flow Model and is described in detail in Appendix A as Alternative 4 therein[38]. The most important groundwater responses predicted by the groundwater model are summarized below:

- Groundwater levels are projected to decline across most of the Six Basins over the planning period (2012-2066)—particularly in the Pomona Basin. By the end of the planning period, groundwater level declines are projected to range from zero in the Canyon Basin to about -240 feet in the southern portion of the Pomona Basin. Because groundwater elevations in the 1960s were up to 100 feet lower than this in the Pomona Basin, the model projection suggests that the project is feasible from a physical standpoint. That said, a monitoring and testing program should accompany the development and implementation this project. The objectives of the monitoring and testing program are: to improve the hydrogeologic understanding of the Pomona Basin (including the threat of land subsidence), to help refine the project description, and to support the ability to adaptively manage the project during implementation if necessary to avoid adverse impacts and/or better achieve its objectives.
- The developed yield of the Four Basins is projected to be about 18,750 acre-ft/yr, which is about 1,500 acre-ft/yr greater than in the Baseline Alternative. Of this 1,500 yield increase, the yield attributable to the conjunctive water management is about 800 acre-ft/yr. This increase in developed yield is primarily due to increased pumping, reduced subsurface outflow to the Chino Basin, and the reduced outflow of rising groundwater.
- Several wells in the Upper Claremont Heights and Pomona Basins are projected to experience periodic challenges with production sustainability, particularly during dry periods when the volume of stormwater recharge is relatively small. These challenges with production sustainability are also projected to occur in the Baseline Alternative but are projected to occur at more wells and with longer duration with this project. Potential mitigation measures to address the challenges with production sustainability include: the redistributing or curtailment of production; lowering of pumping equipment in the affected wells; and exchange agreements among the Parties that allow parties to produce and convey water to Parties experiencing production limitations.
- The northeast portion of the Upper Claremont Heights Basin is projected to experience periodic challenges with high groundwater and/or liquefaction potential, particularly during wet periods when the volume of stormwater recharge is relatively large. These

[38] Alternative 4 assumed that the Temporary Surplus (TS-1) and 1,000 pump-and-treat project were also operating together with the put and takes.

threats are also projected to occur in the Baseline Alternative at about the same frequency and duration as in project. No mitigation specific to this project is projected to be required.

### 5.6.7 Yield Enhancement and Cost

This project produces a 9,000 acre-ft/yr dry-year yield based on the design and operations of the project. During the 54-year planning period, the project produced about 162,000 acre-ft and averaged about 3,000 acre-ft/yr.

Appendix C-5 contains a Class 5 cost opinion for this project based on reconnaissance-level engineering work completed by Civiltec Engineering Inc. The capital and unit cost of water for this project is summarized below.

| Project Alternative | Capital Cost | Increase in Dry-Year Yield (acre-ft/yr) | Dry-Year Yield Unit Cost ($/acre-ft) |
|---|---|---|---|
| Conjunctive Water Management in the Six Basins | $121,000,000 | 3,000 | $5,430 |

The high unit cost is due to allocating the entire project cost to the dry-year yield, and assumes the facilities are otherwise not in use. If the new wells, conveyance, and treatment facilities were used for other purposes during non dry-year-yield take years, and the cost allocated to those other uses, then the unit cost of conjunctive water management could be substantially reduced.

### 5.6.8 Institutional Arrangements

The following institutional issues will need to be resolved to pursue the *Conjunctive Water Management in the Six Basins* project.

- *Storage and Recovery Agreement*. A storage and recovery agreement will need to be proposed and approved by the Watermaster.
- *Implementation Agreement*. An agreement will need to be developed to precisely define the decision process to determine how and when put and takes occur and who determines them, and to commit all the participating Parties to comply.
- *Easements and Agreements*. Easements and agreements will need to be acquired to construct and operate the groundwater production, conveyance, and treatment facilities.
- *Permitting*. Permits will need to be obtained from the DDW to treat and serve water from an impaired source.

### 5.6.9 Implementation Steps

The following steps will be required to implement the *Conjunctive Water Management in the Six Basins* project:

- *Develop MOU with entities to implement the project*. All the Parties that have an interest in improvements of the project need to be identified and participate in the MOU. TVMWD and MWDSC should be participants as the project benefits them and they may be able to bring funding to the project. The MOU is a precursor to implementation agreements that follow the selection of the final project alternative. The MOU will define a preliminary governance structure for project investigation and allocate the cost of preliminary engineering, the CEQA process, and development of financing alternatives.
- *Prepare preliminary design report*. The objective of this task to develop groundwater production, raw water conveyance, treatment, and product water conveyance alternatives; and mitigation alternatives if necessary to address potential groundwater level and subsidence impacts. This will involve obtaining new topographic mapping, surveying the existing facilities and key hydraulic features, engineering, and geotechnical investigations.
- *Complete CEQA*. Based on the PDR, a CEQA process will be completed on the project that is included in the PDR. Environmental challenges, including and not limited to production sustainability and subsidence, will be articulated during the CEQA process and mitigation will be identified and subsequently incorporated into the project design and construction.
- *Select preferred alternative.*
- *Develop financing plan and implementation agreements.*
- *Obtain storage agreement from Watermaster.*
- *Obtain permits.*
- *Finalize design of facility improvements.*
- *Construct improvements.*

## 5.7 Expanded Groundwater and Surface-Water Monitoring Program

The project alternatives described and evaluated earlier in this section are designed to achieve the goals of the Strategic Plan through new programs of coordinated recharge, pumping, treatment, and storage management. Most of these project alternatives will require new facilities and/or operations. The groundwater responses to these alternatives were evaluated with the 2015 Six Basins Groundwater-Flow Model and are described in detail in Appendix A. Appendix A contains a section on model limitations, which recognizes that the numerical results of the model, when used for future projections, have an associated but un-quantified uncertainty. A sense of model uncertainty will develop as groundwater conditions are monitored in the future and compared to model projections. Continued monitoring and enhanced understanding of hydrologic conditions in the basin is crucial to enhanced basin management, as is being proposed in the Strategic Plan projects.

The Watermaster Parties should develop and implement a monitoring and testing program to support (1) engineering work to refine, plan and implement projects and (2) an adaptive approach to implementation of the Strategic Plan projects, whereby management strategies can change if observations differ from model projections. The monitoring and testing program will also provide enhanced conceptual understanding of the Six Basins and additional calibration data that can be used in the future to reduce model error and uncertainty through model refinement.

### 5.7.1 Basic Goals and Nexus to Strategic Plan Goals

The objectives of the expanded monitoring programs are to support the necessary engineering investigations to (i) design the new facilities, (ii) develop the operating plans for the new and existing facilities, and (iii) adapt operations in the future to achieve the project goals. The expanded monitoring programs will include improved monitoring methods at existing facilities and the construction of new monitoring facilities at specific locations. It is probable that the expanded monitoring programs described below will evolve over time as data are collected and analyzed during project implementation.

The table below shows the nexus of this project to the goals of the Strategic Plan:

| Project Alternative | ...removes the following impediments in Table 4-7... | ...to achieve the following Strategic Plan Goals |
|---|---|---|
| Expanded Groundwater and Surface-Water Monitoring Program | 1g | Goal 1 – Enhance Water Supplies |
| | 2b, 2k | Goal 2 – Enhance Basin Management |
| | 3g | Goal 3 – Protect and Enhance Water Quality |

### 5.7.2 Monitoring Programs to Support the Strategic Plan

#### 5.7.2.1 Groundwater Monitoring Program

The objectives of the expanded the Groundwater Monitoring Program are to:

- Support the design of capital facilities associated with the implementation of Strategic Plan projects, such as new wells and treatment facilities.
- Support required monitoring and mitigation requirements associated with Strategic Plan projects.
- Improve the hydrogeologic conceptual understanding of the aquifer system(s) and the fault barriers, which can be used to improve the Watermaster's groundwater model.
- Provide groundwater-production and water-level data of high accuracy and resolution, which can be used to improve the Watermaster's groundwater model.

- Support well-siting investigations for the Parties that plan on installing new or replacement wells.
- Provide information on the causes of high groundwater.
- Provide information to develop mitigation or management strategies to minimize or abate high groundwater.
- Support ongoing monitoring efforts to verify that the Strategic Plan project(s) are achieving their goals, including the mitigation of high groundwater and land subsidence, and to adapt operations if necessary.

The expanded Groundwater Monitoring Program includes:

- The groundwater producers in the Six Basins will record on/off times and pumping rates for all production wells. The exact date and time for on/off will be recorded. Pumping rates will be recorded at the highest practicable frequency. To the extent possible, the SCADA systems of the producers in the Six Basins will be used. The producers will deliver the data to Watermaster staff monthly.
- Watermaster staff will measure and record water-levels by pressure transducer at wells in the areas shown on Figure 5-11. To the extent possible, the existing transducers and SCADA systems of the producers in the Six Basins will be used. If necessary, Watermaster staff will install pressure transducers in all other wells. Water levels will be recorded once every 15 minutes.
- The groundwater producers in the Six Basins will measure and record water levels monthly at all other wells in the Six Basins that are not being monitored by transducer. The producers will deliver the data to Watermaster staff monthly.
- Construction of three new multi-depth clustered monitoring wells in the Pomona Basin. Figure 5-11 shows the general locations where the new monitoring wells are proposed. These locations are within areas of historical high groundwater in Pomona and Claremont, and within the areas where Strategic Plan projects are contemplated for pumping-and-treating groundwater and for conjunctive water management. The monitoring wells will consist of at least two piezometers within a deep borehole. One piezometer will be completed in the shallow aquifer system, and the other piezometer will be completed in the deep aquifer system. The monitoring wells will be designed and constructed so that a cable extensometer can be installed for monitoring of land subsidence, if necessary.

#### 5.7.2.2 Surface-Water Monitoring Program.

The objectives of the expanded Surface-Water Monitoring Program are to:

- Resolve discrepancies between of the volume of releases from San Antonio Dam as measured and recorded by the USACE and the volume of diversions from San Antonio Creek as measured and recorded by the PVPA. This will better characterize the opportunities for enhancing storm-water recharge at the spreading grounds.
- Provide data to improve the operations and maintenance activities within the spreading grounds to maximize recharge, maximize basin yield, and avoid high groundwater conditions.
- Provide data to improve the surface-water and groundwater models.

The expanded Surface-Water Monitoring Program includes:

- Work with the USACE to:
    - obtain their data and calculations to establish the elevation-storage curve and outlet rating curve for the San Antonio Dam, review them, and update and coordinate the update with the USACE, and
    - conduct a test to determine the correlation of the measured discharge at the dam outlet with the diversion into the SASG to validate the discharge estimates from the dam and to develop a relationship to correct the dam discharges.
- Update the data collection and reporting done by PVPA to include continuous discharge measurements (as cubic feet per second at a six-minute sampling rate) at each gate in the San Antonio Creek diversion to the SASG and the Thompson Creek Dam to diversion to the TCSG.
- Update the topographic maps for the SASG and TCSG.
- Review the internal hydraulics of the SASG and subsequently develop a monitoring program with the goal of determining the existing recharge capacity and the processes that constrain it, the areal distribution of recharge throughout the SASG, and identifying the improvements that can be made to increase the stormwater recharge capacity. This will involve the development of a monitoring program that will include construction of internal gaging stations to measure the rate of discharge occurring through each control structure and at intermediate locations, and construction of stage sensors in areas where water is impounded for recharge.
- Review the internal hydraulics of the TCSG and subsequently develop a monitoring program with the goal of determining the existing recharge capacity and the processes that constrain it, the areal distribution of recharge throughout the TCSG, and identifying the improvements that can be made to increase the stormwater recharge capacity. This will involve the development of a monitoring program that will include construction of internal gaging stations to measure the rate of discharge occurring through each control structure and at intermediate locations, and construction of stage sensors in areas where water is impounded for recharge.
- Prepare annual monitoring report.
- At the end of the third year of monitoring, prepare a report to document the existing recharge capacity and the processes that constrain it.

### 5.7.3 Cost

#### 5.7.3.1 Groundwater Monitoring Program

Year 1 of implementation of the Groundwater Monitoring Program is described in the sub-section below on Implementation Steps. The cost to implement Year 1 of the Groundwater Monitoring Program is approximately $122,000. The annual cost thereafter to conduct the Groundwater Monitoring Program is approximately $30,000. The future capital cost to install and equip the new monitoring wells will be estimated in Year 1 during well-siting and well-design.

#### 5.7.3.2 Surface-Water Monitoring Program

Years 1 through 3 of implementation of the Surface-Water Monitoring Program are described in the sub-section below on Implementation Steps. The surface water monitoring costs in Year 1 will be about $60,000 to $80,000, and the subsequent cost to implement the surface water monitoring is unknown.

### 5.7.4 Institutional Arrangements

Agreements will be required involving the Watermaster, the Parties, PVPA, LACFCD and the USACE, among others, regarding data sharing and to acquire easements to install monitoring equipment and to routinely visit monitoring sites.

### 5.7.5 Implementation Steps

As to the Groundwater Monitoring Program, the implementation steps in Year 1 include the following:

- Canvass wells in the Six Basins in target areas, and select approximately 30 wells for transducer installation.
- Establish monitoring and reporting protocols for production and groundwater levels with the well owners.
- Install transducers in approximately 30 wells and begin data collection.
- Collect groundwater level data from the 30 new transducers within two weeks of installation to ensure functionality.
- Perform quarterly data collection from 30 new and 5 existing transducers. Compile, check and upload the data from the transducers to the database.
- Collect, compile, check and upload well production data from all active production wells quarterly.
- Conduct well-siting investigation to identify three (3) potential new monitoring well sites, and prepare draft technical specifications for the new monitoring wells.
- Installation and equipping of the new monitoring wells will occur in future years based on the well-siting investigation and other potential monitoring and mitigation requirements.

As to the Surface-Water Monitoring Program, the implementation steps include the following:

- Year 1 – Conduct investigation to update San Antonio Dam outlet rating curve and correlate it with the San Antonio Creek diversion records. This enables validation of the amount of water diverted by the PVPA, and the determination of how much stormwater was not diverted, the latter being necessary to support recharge improvements at the SASG.
- Year 1 – Design monitoring program for the SASG and the TCSG.
- Year 2 – Conduct San Antonio Dam outlet works calibration test with the SASG diversion works meters.
- Year 2 – Install monitoring stations in the SASG and TCSG.

- Year 3 and thereafter – Conduct surface water monitoring in the SASG and TCSG.

## 5.8 Recommendations for Next Steps

All of the projects investigated herein improve the ability to produce water in the Six Basins either by managing production, increasing recharge of native and supplemental waters, or by recovering impaired water that would have otherwise not been used. The expanded groundwater and surface water monitoring program is an exception, but it supports (1) the engineering work to refine, plan and implement projects and (2) an adaptive approach to implementation of the Strategic Plan projects, whereby management strategies can change if observations differ from model projections.

With the exception of the increased use of the Temporary Surplus and expanded monitoring, the projects as described and evaluated herein are not refined enough for implementation. The engineering and cost opinions are reconnaissance level, and more work needs to be done to further evaluate the feasibility of these projects, or variations of these projects. And, there may be substantial cost savings if the projects described herein were integrated into the water systems of the Watermaster Parties—for example, if the facilities were used by project participants for more than just accomplishing the specific project goals. The project descriptions and evaluations are at a "first-order" level; it is likely that they can be refined to better meet the needs of the Watermaster Parties in terms of the benefits they provide to participants and the associated costs to implement. For example:

- *SASG Improvements*. The existing recharge capacity, while not precisely known, is relatively large. Improvements to the SASG will increase recharge only in the wettest years. No improvements should be made until the existing recharge capacity is determined and the amount of stormwater that is presently escaping the SASG diversion works has been determined. Based on the present level of understanding, it will take at least five years of monitoring and study to develop the information necessary to determine if the SASG diversion works and recharge facilities should be improved to increase stormwater recharge. The monitoring and investigation should begin as soon as practical.
- *TCSG Improvements*. The issues with increasing the stormwater recharge at the TCSG are almost identical to the issues at SASG, except that the likely improvements in stormwater recharge will be more modest. The monitoring and investigation should begin as soon as practical.
- *Supplemental Water Recharge in the Upper Claremont Heights Basin*. The availability of recycled water from the LACSD Pomona WRP, while more reliable as a recharge source than imported SWP water, comes at greater cost. The questions for the Watermaster Parties to resolve are:
    - Do the Parties value the ability to pump their wells more sustainably in the Upper Claremont Heights Basin over taking direct deliveries of treated imported water from TVMWD and IEUA?
    - If so, do they value the incremental reliability from using recycled water in this project over SWP water?
- *Pump and Treat Groundwater in the Pomona Basin*. The high groundwater levels in the Pomona Basin result in decreased yield and the unused groundwater is a stranded

asset. This project was conceived to be a Special Project where the water (or a portion thereof) can be produced without counting the production against the OSY and be free of a Replacement Water obligation. The project as described herein produces about 1,000 acre-ft/yr but the optimal capacity and facility plan has not been determined. The Watermaster Parties may consider larger versions of this project, alternative facility designs and/or operations, and inclusion of this project into a larger conjunctive water management project.

- *Conjunctive Water Management in the Six Basins*. The project evaluated herein was developed to leverage poor quality water currently in storage and the storage capacity of Pomona Basin to create a dry-year supply that benefits the Watermaster Parties, TVMWD, MWDSC and the State. The unit cost of the dry-year yield for the project as conceptualized herein is high at $5,300 per acre-ft. There was no attempt to optimize the project to find the least cost project, that effort being beyond the scope of the investigation. Given the hydrogeologic characteristics of the Four Basins area, it is unlikely that a larger project than conceived herein (9,000 acre-ft/yr put and takes and 50,000 acre-ft of storage) would be developed. There may be more cost-efficient alternatives that utilize more of the existing and planned water infrastructure of the overlying water agencies. Recognizing that the benefit of such a project would extend beyond the Watermaster Parties, MWDSC and the State may have an incentive to financially participate in the project.

Although not fully developed and optimized, all of the projects evaluated herein can be refined to achieve the Strategic Plan goals. As recommended in the December 2015 draft of the Strategic Plan report, the Watermaster undertook such an effort in 2016. The refinement of the Strategic Plan projects is described in the next section of this report (Section 6).

**Table 5-1**

**Features and Benefits of the Conceptual Strategic Plan Projects**

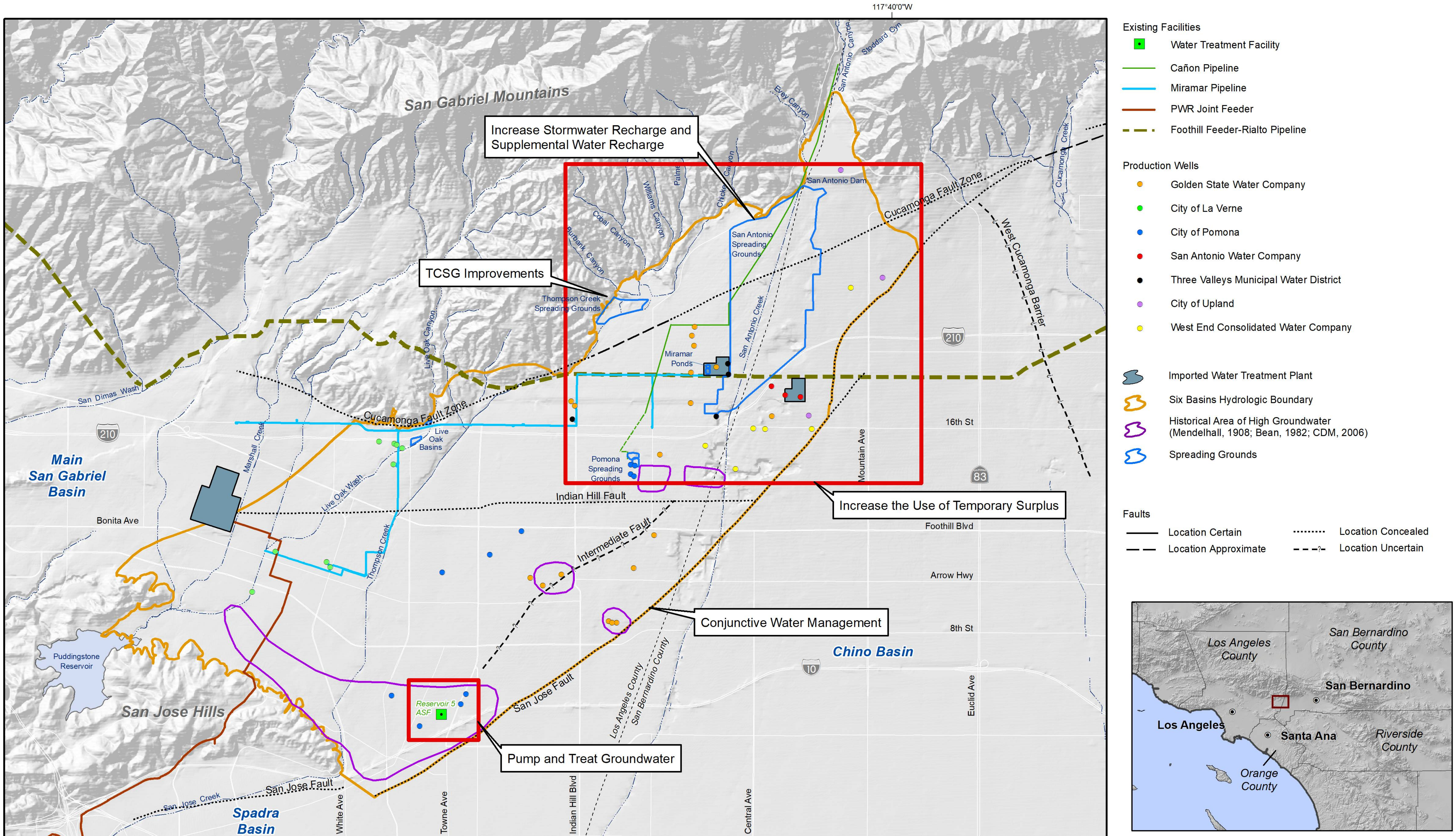
| Projects | Features: Recharge Improvements | Features: Wells and Conveyance | Features: Water Treatment | Features: Recycled Water Conveyance | Features: Expanded Monitoring | Features: Changes in Watermaster Operating Plans | Benefits: New Yield | Benefits: Dry-Year Supply | Benefits: Production Sustainability | Benefits: Enhances Reliability | Benefits: Mitigates High Groundwater | Benefits: Water Quality Improvements | Benefits: Improved Management | Benefits: Improved Basin Knowledge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Increase the Use of Temporary Surplus and Increase Stormwater Recharge in the San Antonio Spreading Grounds (SASG) | | | | | | | | | | | | | | |
| TS 1-1 (TS with no new wells) | | | | | | X | X | | | | X | | X | |
| TS 1 (TS with 4 new wells) | | X | | | | X | X | | | | X | | X | |
| TS 1 plus SASG 1 (4 new wells) | X | X | | | X | X | X | | | | X | X | X | |
| TS 2-1 (TS with no new wells) | | | | | | X | X | | | | X | | X | |
| TS 2 plus SASG 1 (up to 7 new wells) | X | X | | | X | X | X | | | | X | X | X | |
| TS 2 plus SASG 2 (up to 7 new wells) | X | X | | | X | X | X | | | | X | X | X | |
| Thompson Creek Spreading Grounds Improvements | X | | | | X | | X | | | | | X | X | |
| Supplemental Water Recharge in the Upper Claremont Heights Basin | | | | | | | | | | | | | | |
| 3,500 acre-ft/yr of Recycled Water Recharge in the SASG | | | | X | X | X | | X | X | X | | | X | |
| 3,500 acre-ft/yr of Imported Water Recharge in the SASG | | | | | | X | | | X | | | | X | |
| Pump and Treat Groundwater in the Pomona Basin | | | X | | | X | X | | | X | X | X | X | |
| Conjunctive Water Management | | X | X | | | X | X | X | | X | X | X | X | |
| Expanded Groundwater and Surface-Water Monitoring Program | | X | | | X | | | | | | X | | X | X |

## Table 5-2
## Surface Water Diversions by the PVPA to the San Antonio Spreading Grounds
*1961-2011*

| Water Year | Outflow from San Antonio Dam (acre-ft) | Diversions Reported by PVPA (acre-ft) | Water Lost to San Antonio Channel (acre-ft) |
|---|---|---|---|
| 1961 | 0 | 0 | 0 |
| 1962 | 11,487 | 2,525 | 8,962 |
| 1963 | 0 | 0 | 0 |
| 1964 | 0 | 0 | 0 |
| 1965 | 17 | 0 | 17 |
| 1966 | 13,774 | 13,056 | 718 |
| 1967 | 12,460 | 10,727 | 1,733 |
| 1968 | 161 | 549 | 0 |
| **1969** | **67,891** | **22,960** | **44,931** |
| 1970 | 2,086 | 365 | 1,721 |
| 1971 | 100 | 26 | 74 |
| 1972 | 247 | 45 | 202 |
| 1973 | 6,900 | 6,725 | 175 |
| 1974 | 334 | 330 | 4 |
| 1975 | 8 | 27 | 0 |
| 1976 | 595 | 153 | 442 |
| 1977 | 1,175 | 273 | 903 |
| **1978** | **64,540** | **30,152** | **34,389** |
| 1979 | 4,914 | 2,686 | 2,228 |
| **1980** | **30,224** | **23,125** | **7,099** |
| 1981 | 273 | 39 | 234 |
| 1982 | 9,866 | 7,538 | 2,328 |
| **1983** | **49,719** | **33,370** | **16,349** |
| 1984 | 14,194 | 2,449 | 11,745 |
| 1985 | 2,134 | 229 | 1,906 |
| 1986 | 10,522 | 6,521 | 4,001 |
| 1987 | 24 | 13 | 12 |
| 1988 | 2,855 | 1,500 | 1,355 |
| 1989 | 298 | 243 | 55 |
| 1990 | 0 | 1 | 0 |
| 1991 | 7,363 | 482 | 6,881 |
| 1992 | 19,630 | 14,416 | 5,214 |
| **1993** | **59,328** | **26,488** | **32,840** |
| 1994 | 67 | 11 | 56 |
| **1995** | **32,060** | **26,052** | **6,008** |
| 1996 | 4,206 | 4,241 | 0 |
| 1997 | 2,383 | 1,187 | 1,196 |
| **1998** | **22,315** | **24,227** | **0** |
| 1999 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 |
| 2001 | 46 | 0 | 46 |
| 2002 | 0 | 0 | 0 |
| 2003 | 0 | 0 | 0 |
| 2004 | 553 | 129 | 424 |
| **2005** | **52,540** | **31,362** | **21,179** |
| 2006 | 9,355 | 5,804 | 3,551 |
| 2007 | 0 | 0 | 0 |
| 2008 | 2,556 | 577 | 1,979 |
| 2009 | 0 | 0 | 0 |
| 2010 | 8,253 | 1,260 | 6,993 |
| 2011 | 24,560 | 7,306 | 17,254 |
| Average | 10,824 | 6,062 | 4,808 |
| Min | 0 | 0 | 0 |
| Max | 67,891 | 33,370 | 44,931 |
| Total | 552,015 | 309,166 | 245,203 |

## Table 5-3
## Dry-Year Storage Program Accounting in Conjunctive Water Management

| Planning Period Year | Historical Hydrologic Year Used in Simulation | Precipitation (inches) | Stormwater Recharge at SASG (acre-ft) | Take (acre-ft) | Put (acre-ft) | End of Year Dry-Year Storage Program Account Balance (acre-ft) |
|---|---|---|---|---|---|---|
| | | | | | | 50,000 |
| 2013 | 1960 | 12.3 | 0 | -9,000 | 0 | 41,000 |
| 2014 | 1961 | 9.0 | 0 | -9,000 | 0 | 32,000 |
| 2015 | 1962 | 25.5 | 10,057 | 0 | 4,500 | 36,500 |
| 2016 | 1963 | 12.8 | 0 | -9,000 | 0 | 27,500 |
| 2017 | 1964 | 17.2 | 0 | -9,000 | 0 | 18,500 |
| 2018 | 1965 | 17.2 | 0 | -9,000 | 0 | 9,500 |
| 2019 | 1966 | 25.8 | 12,038 | 0 | 4,500 | 14,000 |
| 2020 | 1967 | 38.1 | 7,484 | 0 | 4,500 | 18,500 |
| 2021 | 1968 | 14.9 | 0 | -9,000 | 0 | 9,500 |
| 2022 | 1969 | 47.1 | 20,374 | 0 | 9,000 | 18,500 |
| 2023 | 1970 | 13.8 | 1,803 | 0 | 0 | 18,500 |
| 2024 | 1971 | 17.4 | 112 | 0 | 0 | 18,500 |
| 2025 | 1972 | 10.1 | 59 | -9,000 | 0 | 9,500 |
| 2026 | 1973 | 26.5 | 5,609 | 0 | 4,500 | 14,000 |
| 2027 | 1974 | 18.3 | 211 | 0 | 0 | 14,000 |
| 2028 | 1975 | 17.5 | 0 | -9,000 | 0 | 5,000 |
| 2029 | 1976 | 11.9 | 3,439 | 0 | 0 | 5,000 |
| 2030 | 1977 | 20.1 | 1,272 | 0 | 0 | 5,000 |
| 2031 | 1978 | 49.1 | 31,520 | 0 | 9,000 | 14,000 |
| 2032 | 1979 | 25.2 | 4,023 | 0 | 0 | 14,000 |
| 2033 | 1980 | 45.4 | 22,193 | 0 | 9,000 | 23,000 |
| 2034 | 1981 | 12.1 | 143 | -9,000 | 0 | 14,000 |
| 2035 | 1982 | 25.5 | 7,794 | 0 | 0 | 14,000 |
| 2036 | 1983 | 49.0 | 34,396 | 0 | 9,000 | 23,000 |
| 2037 | 1984 | 16.5 | 12,528 | 0 | 0 | 23,000 |
| 2038 | 1985 | 17.6 | 930 | 0 | 0 | 23,000 |
| 2039 | 1986 | 24.8 | 8,385 | 0 | 0 | 23,000 |
| 2040 | 1987 | 15.3 | 0 | -9,000 | 0 | 14,000 |
| 2041 | 1988 | 22.0 | 1,594 | 0 | 0 | 14,000 |
| 2042 | 1989 | 18.3 | 49 | 0 | 0 | 14,000 |
| 2043 | 1990 | 14.4 | 0 | -9,000 | 0 | 5,000 |
| 2044 | 1991 | 24.5 | 5,812 | 0 | 0 | 5,000 |
| 2045 | 1992 | 28.1 | 17,657 | 0 | 9,000 | 14,000 |
| 2046 | 1993 | 53.9 | 27,004 | 0 | 9,000 | 23,000 |
| 2047 | 1994 | 15.5 | 0 | -9,000 | 0 | 14,000 |
| 2048 | 1995 | 41.1 | 29,847 | 0 | 9,000 | 23,000 |
| 2049 | 1996 | 19.9 | 3,273 | 0 | 0 | 23,000 |
| 2050 | 1997 | 23.8 | 1,565 | 0 | 0 | 23,000 |
| 2051 | 1998 | 45.8 | 15,759 | 0 | 9,000 | 32,000 |
| 2052 | 1999 | 13.5 | 3,346 | 0 | 0 | 32,000 |
| 2053 | 2000 | 17.5 | 0 | -9,000 | 0 | 23,000 |
| 2054 | 2001 | 22.1 | 0 | 0 | 0 | 23,000 |
| 2055 | 2002 | 9.2 | 0 | -9,000 | 0 | 14,000 |
| 2056 | 2003 | 27.3 | 0 | 0 | 0 | 14,000 |
| 2057 | 2004 | 14.8 | 443 | 0 | 0 | 14,000 |
| 2058 | 2005 | 53.4 | 34,096 | 0 | 9,000 | 23,000 |
| 2059 | 2006 | 24.4 | 7,714 | 0 | 0 | 23,000 |
| 2060 | 2007 | 5.3 | 0 | -9,000 | 0 | 14,000 |
| 2061 | 2008 | 22.1 | 1,741 | 0 | 0 | 14,000 |
| 2062 | 2009 | 16.5 | 0 | -9,000 | 0 | 5,000 |
| 2063 | 2010 | 25.0 | 6,005 | 0 | 0 | 5,000 |
| 2064 | 2011 | 31.6 | 22,241 | 0 | 9,000 | 14,000 |
| 2065 | 2012 | 12.2 | 0 | -9,000 | 0 | 5,000 |
| 2066 | 2013 | 8.1 | 0 | -9,000 | 0 | -4,000 |

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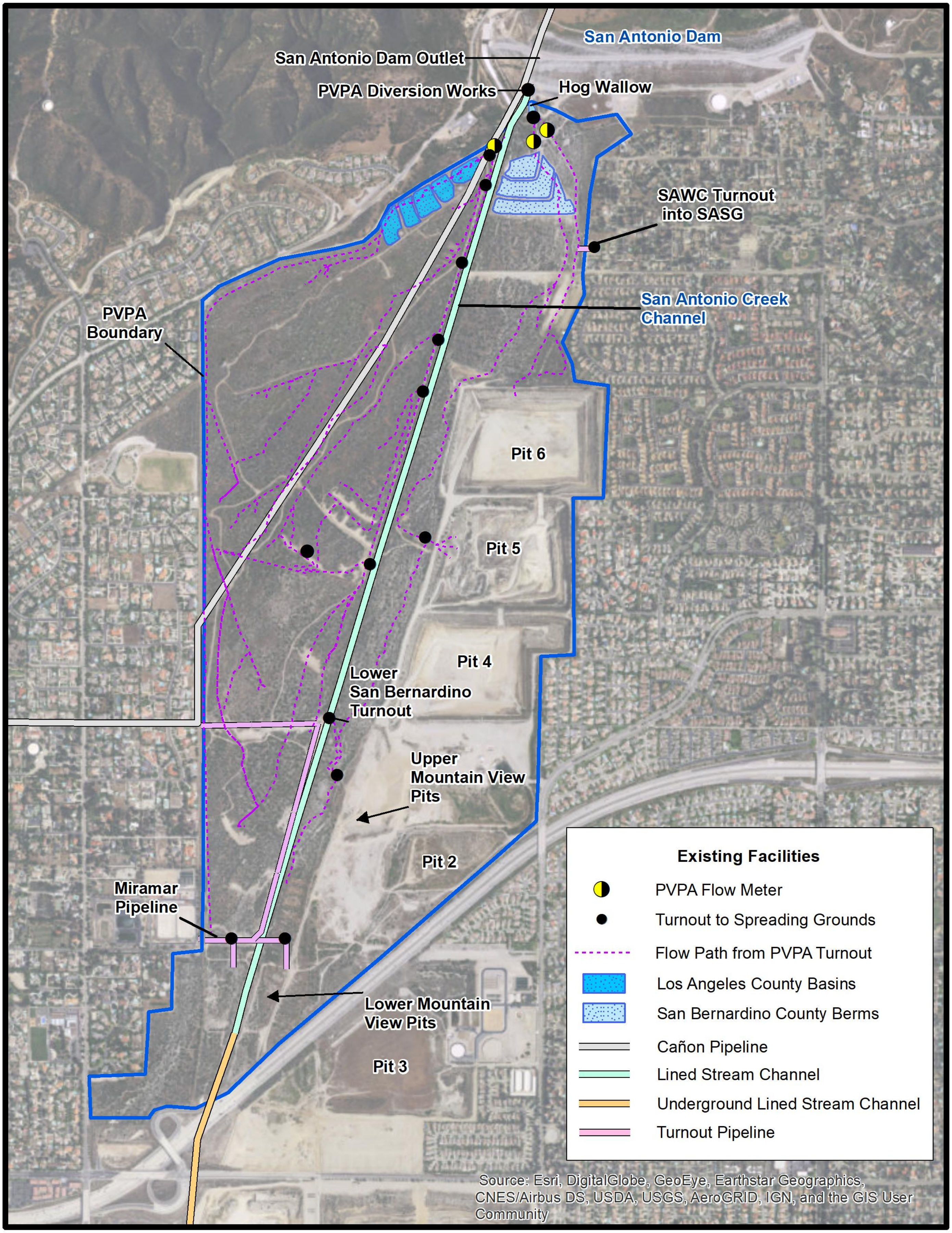
Six Basins Watermaster
**Strategic Plan for the Six Basins**

**Strategic Plan Conceptual Projects**
*Location Map*

**Figure 5-1**

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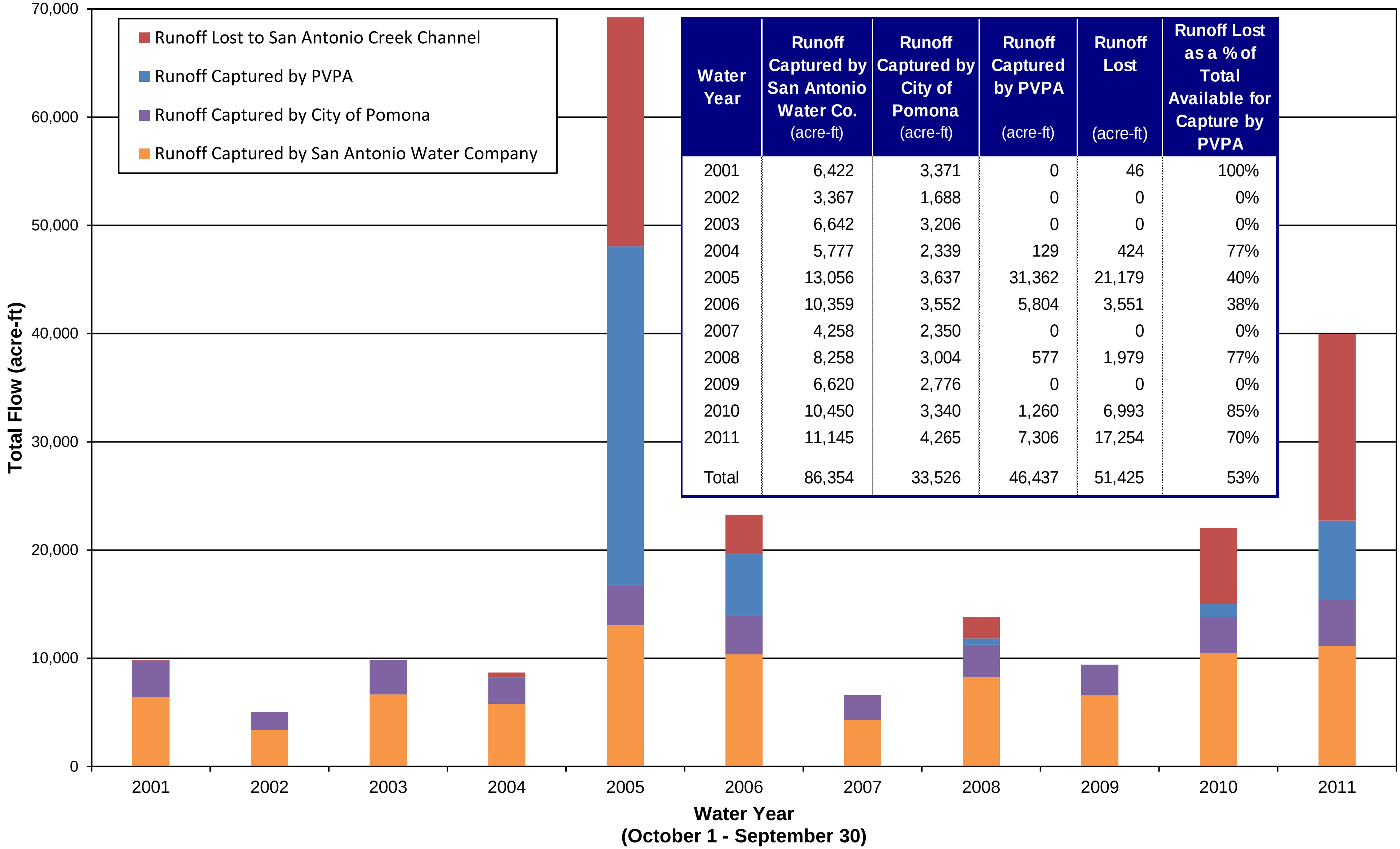
**Six Basins Watermaster**

State of the Basin Report

**San Antonio Spreading Grounds Facilities Map**

**Figure 5-2**

**Figure 5-3**
**Surface Water Runoff Captured and Lost from San Antonio Creek**




| Water Year | Runoff Captured by San Antonio Water Co. (acre-ft) | Runoff Captured by City of Pomona (acre-ft) | Runoff Captured by PVPA (acre-ft) | Runoff Lost (acre-ft) | Runoff Lost as a % of Total Available for Capture by PVPA |
|---|---|---|---|---|---|
| 2001 | 6,422 | 3,371 | 0 | 46 | 100% |
| 2002 | 3,367 | 1,688 | 0 | 0 | 0% |
| 2003 | 6,642 | 3,206 | 0 | 0 | 0% |
| 2004 | 5,777 | 2,339 | 129 | 424 | 77% |
| 2005 | 13,056 | 3,637 | 31,362 | 21,179 | 40% |
| 2006 | 10,359 | 3,552 | 5,804 | 3,551 | 38% |
| 2007 | 4,258 | 2,350 | 0 | 0 | 0% |
| 2008 | 8,258 | 3,004 | 577 | 1,979 | 77% |
| 2009 | 6,620 | 2,776 | 0 | 0 | 0% |
| 2010 | 10,450 | 3,340 | 1,260 | 6,993 | 85% |
| 2011 | 11,145 | 4,265 | 7,306 | 17,254 | 70% |
| Total | 86,354 | 33,526 | 46,437 | 51,425 | 53% |

Figure 5-3 SASG Loss Analysis.xlsx--Figure 5-3
12/15/2015

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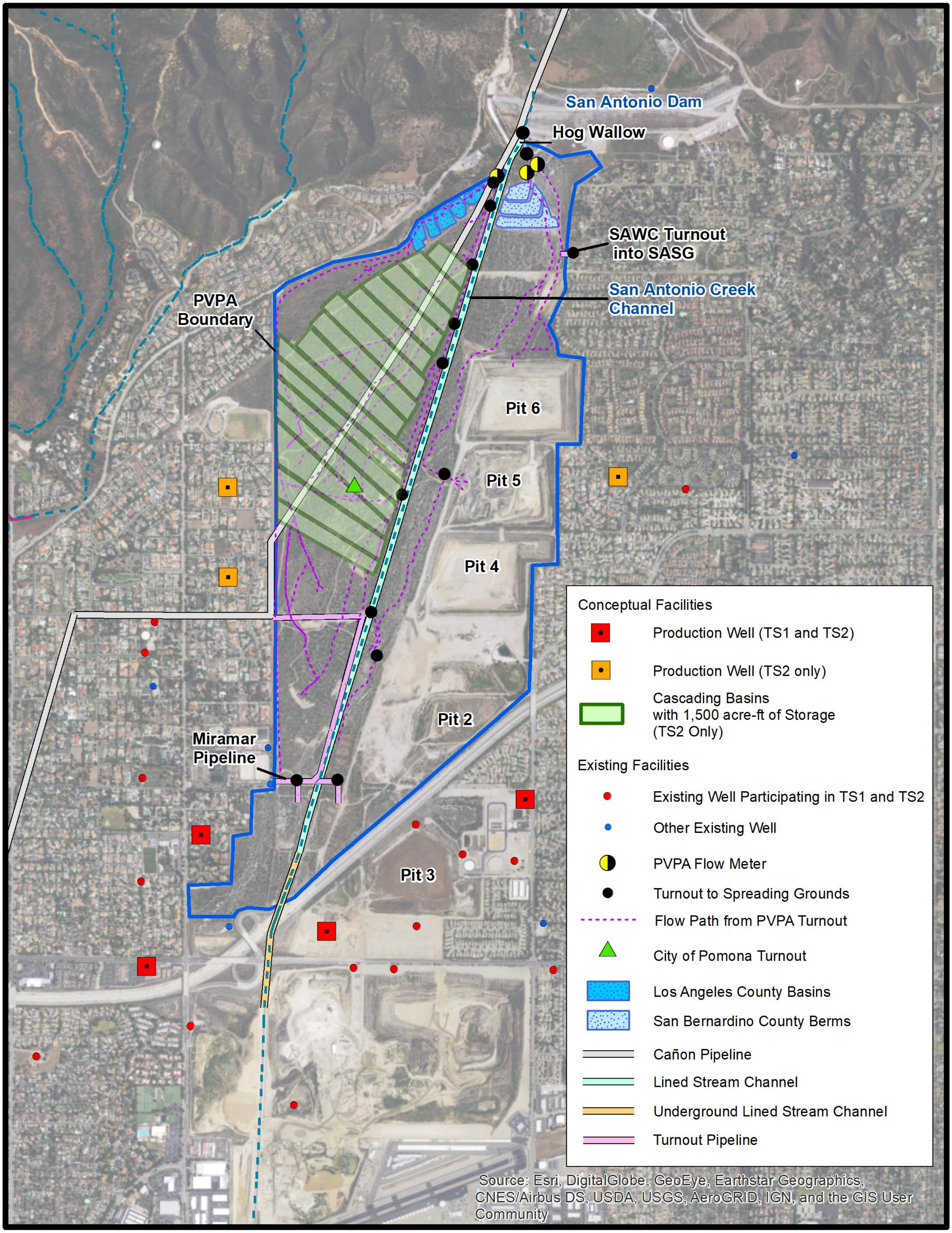


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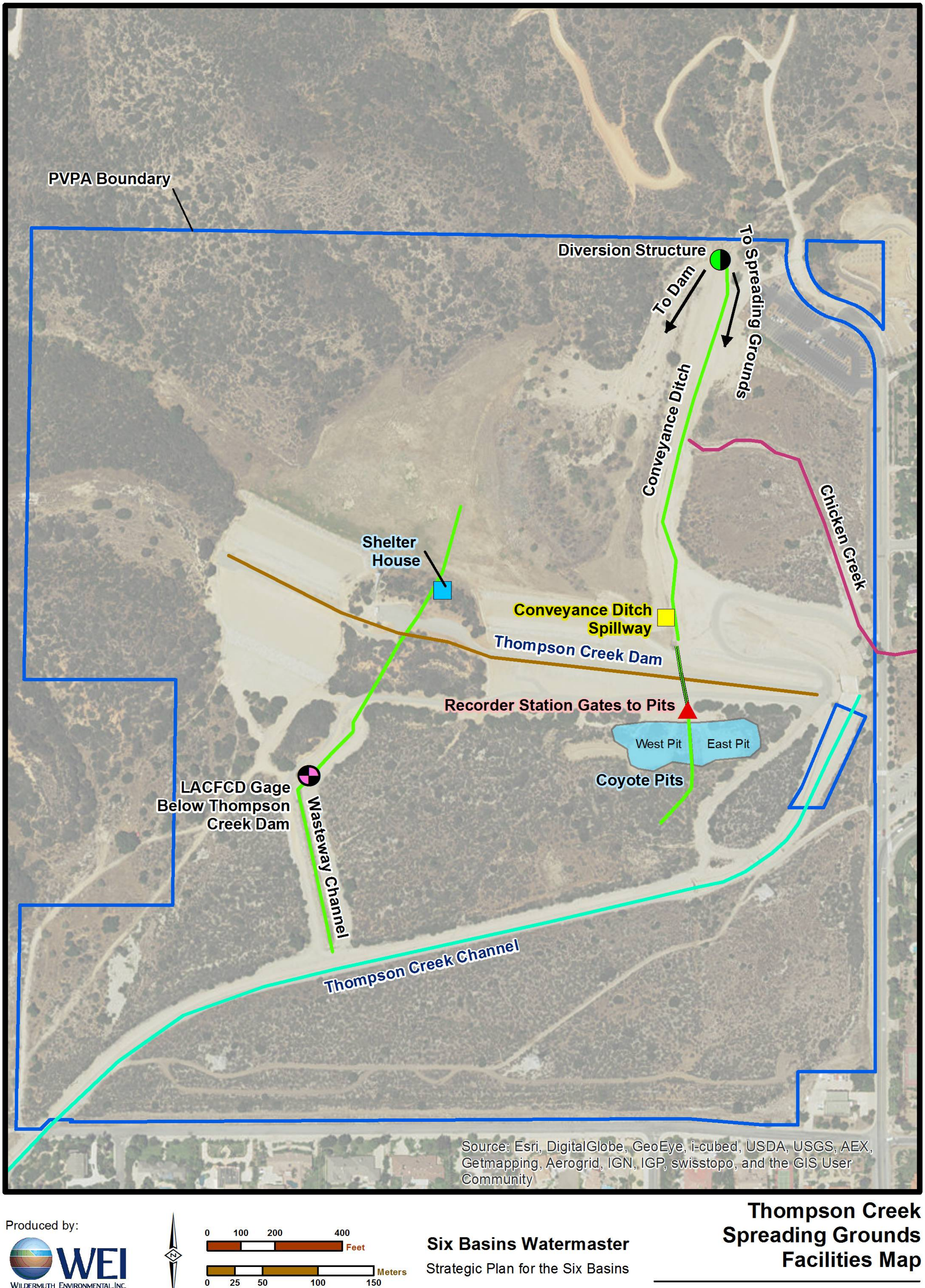
**Six Basins Watermaster**

State of the Basin Report

## Facilities Map

*Increase the Use of Temporary Surplus and Increase Stormwater Recharge in the SASG*

**Figure 5-4**

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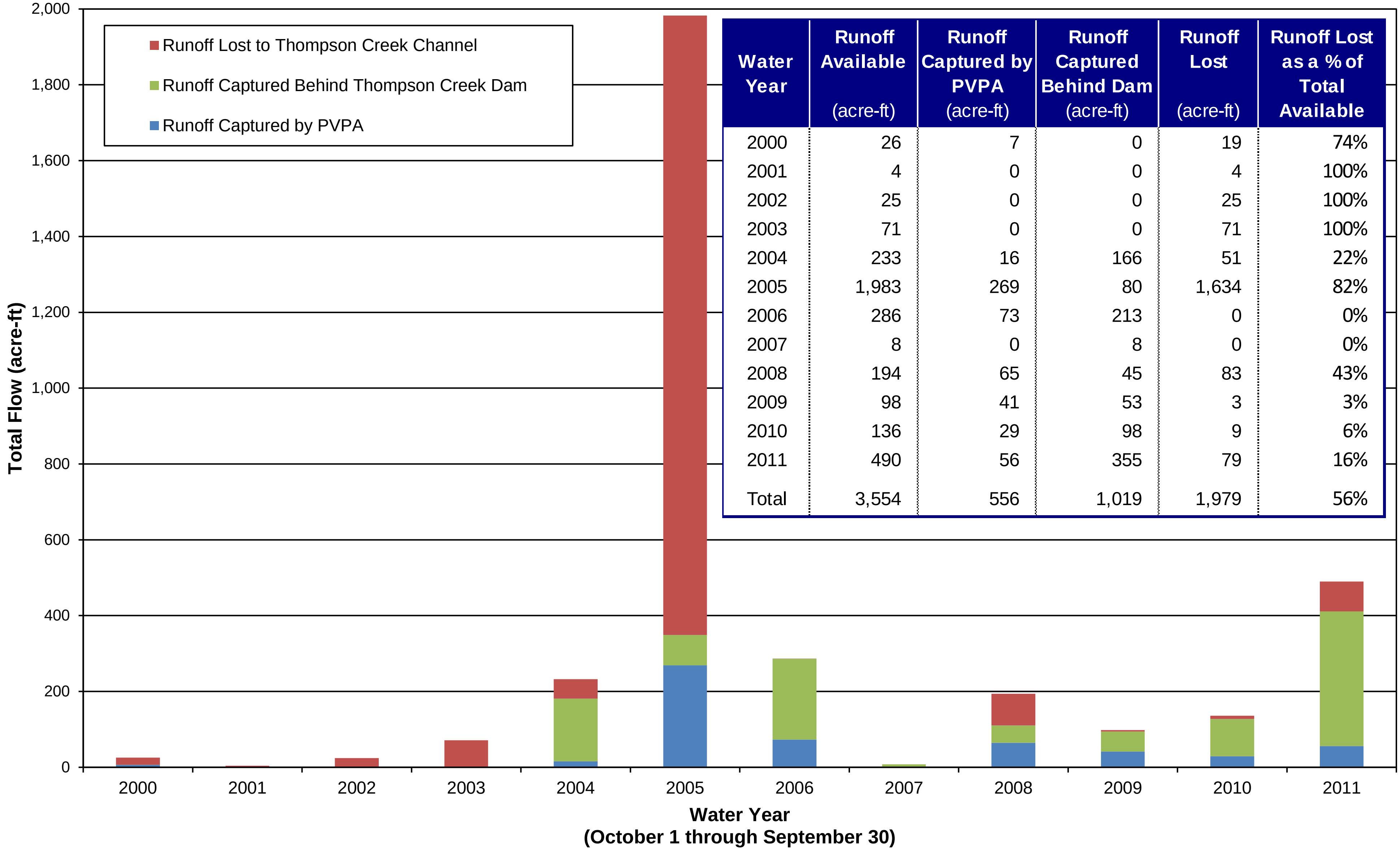
**Six Basins Watermaster**

Strategic Plan for the Six Basins

**Thompson Creek Spreading Grounds Facilities Map**

**Figure 5-5**

## Figure 5-6
## Surface Water Runoff Captured and Lost from Thompson Creek




| Water Year | Runoff Available (acre-ft) | Runoff Captured by PVPA (acre-ft) | Runoff Captured Behind Dam (acre-ft) | Runoff Lost (acre-ft) | Runoff Lost as a % of Total Available |
|---|---|---|---|---|---|
| 2000 | 26 | 7 | 0 | 19 | 74% |
| 2001 | 4 | 0 | 0 | 4 | 100% |
| 2002 | 25 | 0 | 0 | 25 | 100% |
| 2003 | 71 | 0 | 0 | 71 | 100% |
| 2004 | 233 | 16 | 166 | 51 | 22% |
| 2005 | 1,983 | 269 | 80 | 1,634 | 82% |
| 2006 | 286 | 73 | 213 | 0 | 0% |
| 2007 | 8 | 0 | 8 | 0 | 0% |
| 2008 | 194 | 65 | 45 | 83 | 43% |
| 2009 | 98 | 41 | 53 | 3 | 3% |
| 2010 | 136 | 29 | 98 | 9 | 6% |
| 2011 | 490 | 56 | 355 | 79 | 16% |
| Total | 3,554 | 556 | 1,019 | 1,979 | 56% |

Figure 5-6 Thompson Creek Loss Analysis.xlsx--Figure 5-6
12/14/2015

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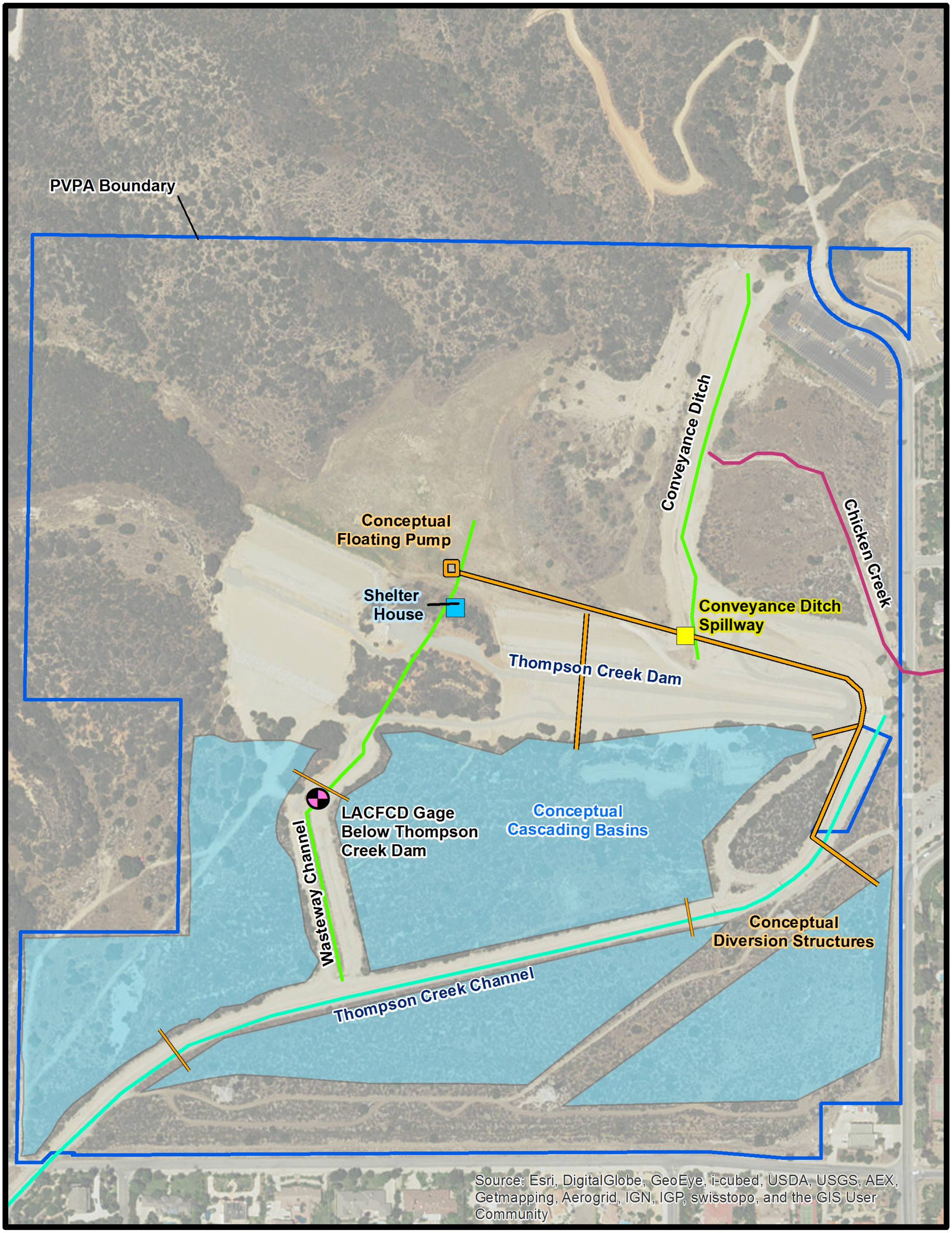



Produced by: WEI Wildermuth Environmental, Inc.

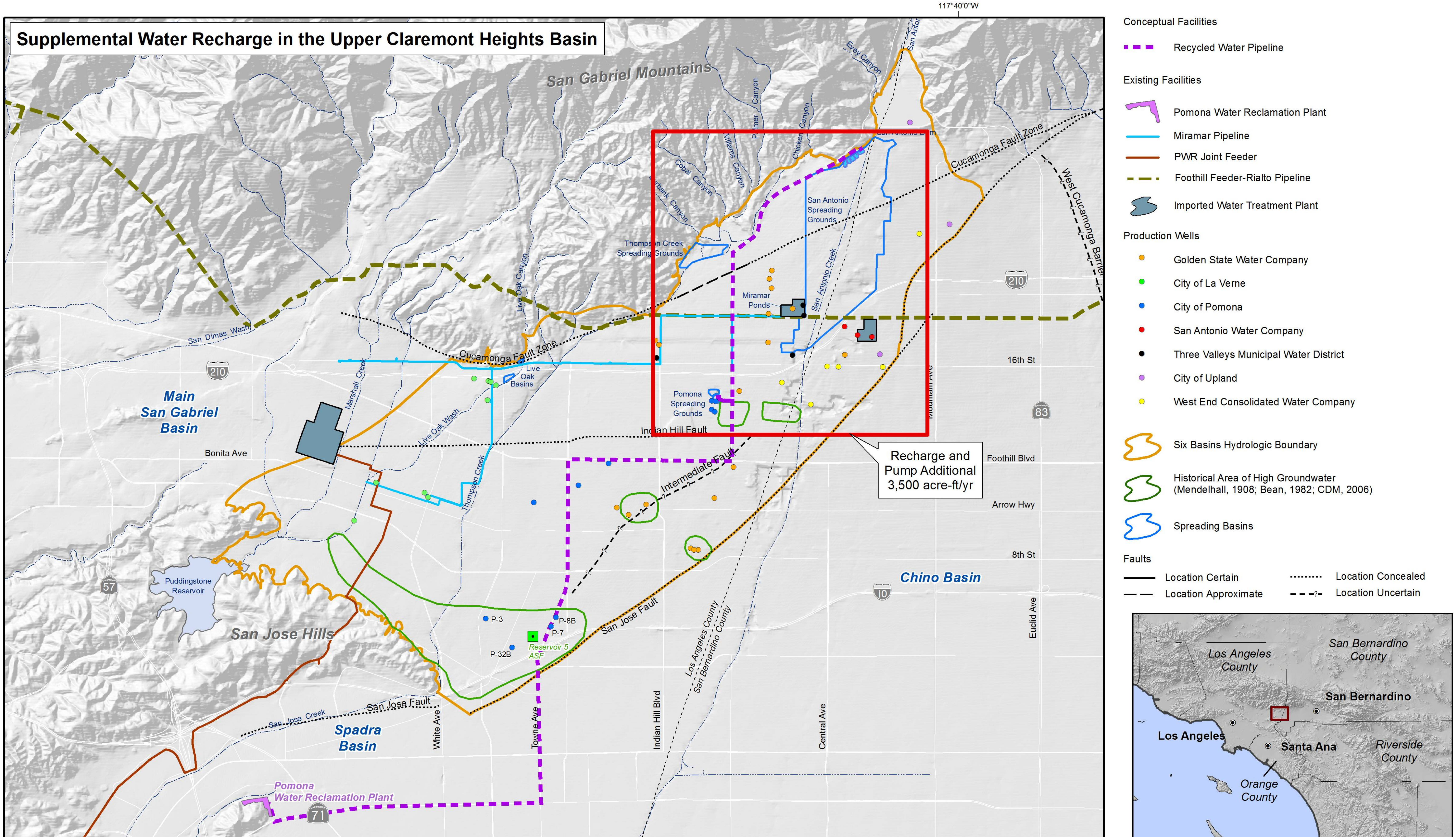
**Six Basins Watermaster**

State of the Basin Report

**Facilities Map**

*Thompson Creek Spreading Grounds Improvements*

**Figure 5-7**




Produced by:

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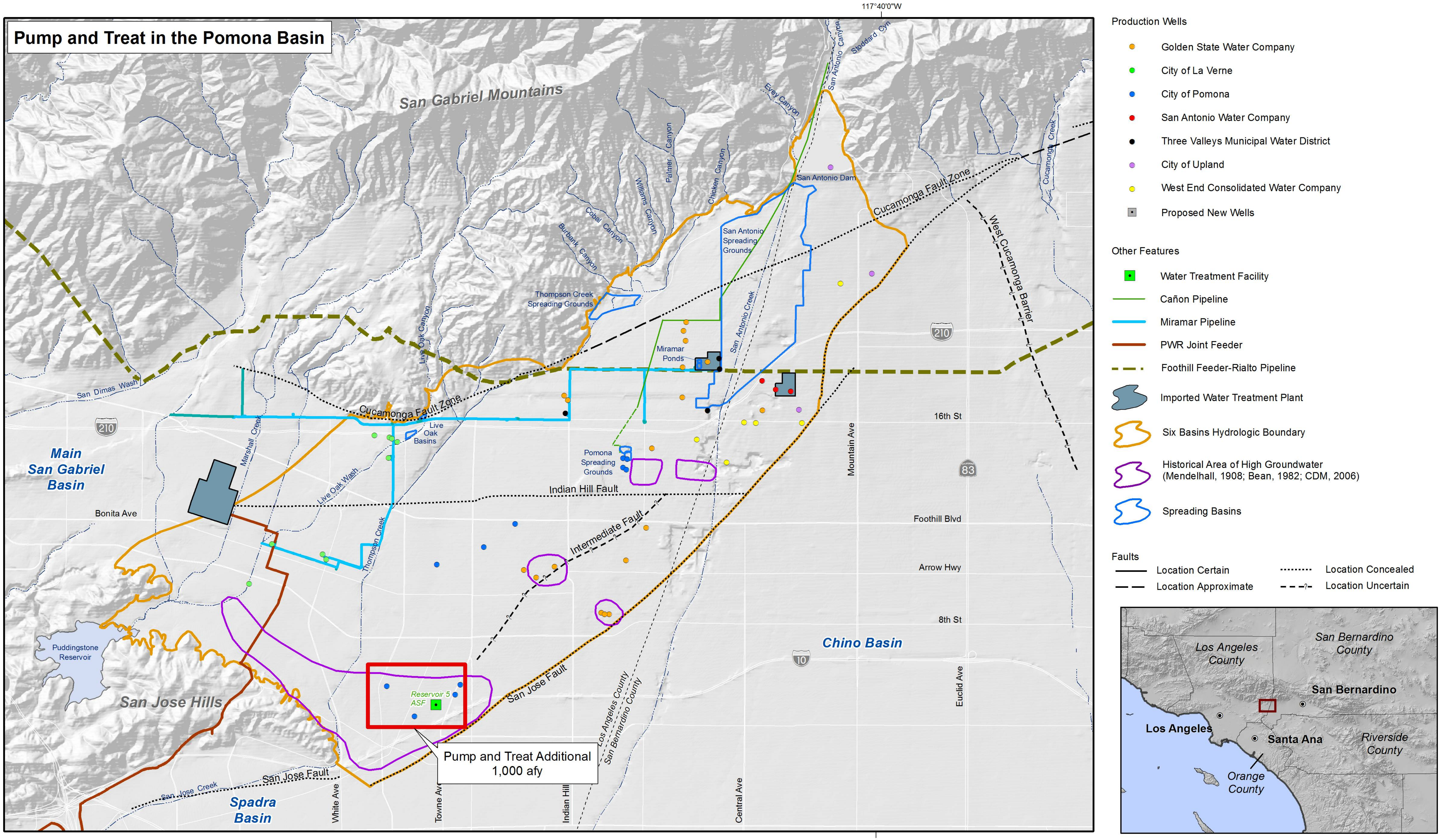
WILDERMUTH ENVIRONMENTAL, INC.

Author: CS
Date: 20141110
File: Figure_5_8_RW_Facilities.mxd

0 1 2 Miles
0 2 4 Kilometers

Six Basins Watermaster
**Strategic Plan for the Six Basins**

**Facilities Map**
*Supplemental Water Recharge*
**Figure 5-8**




Produced by:

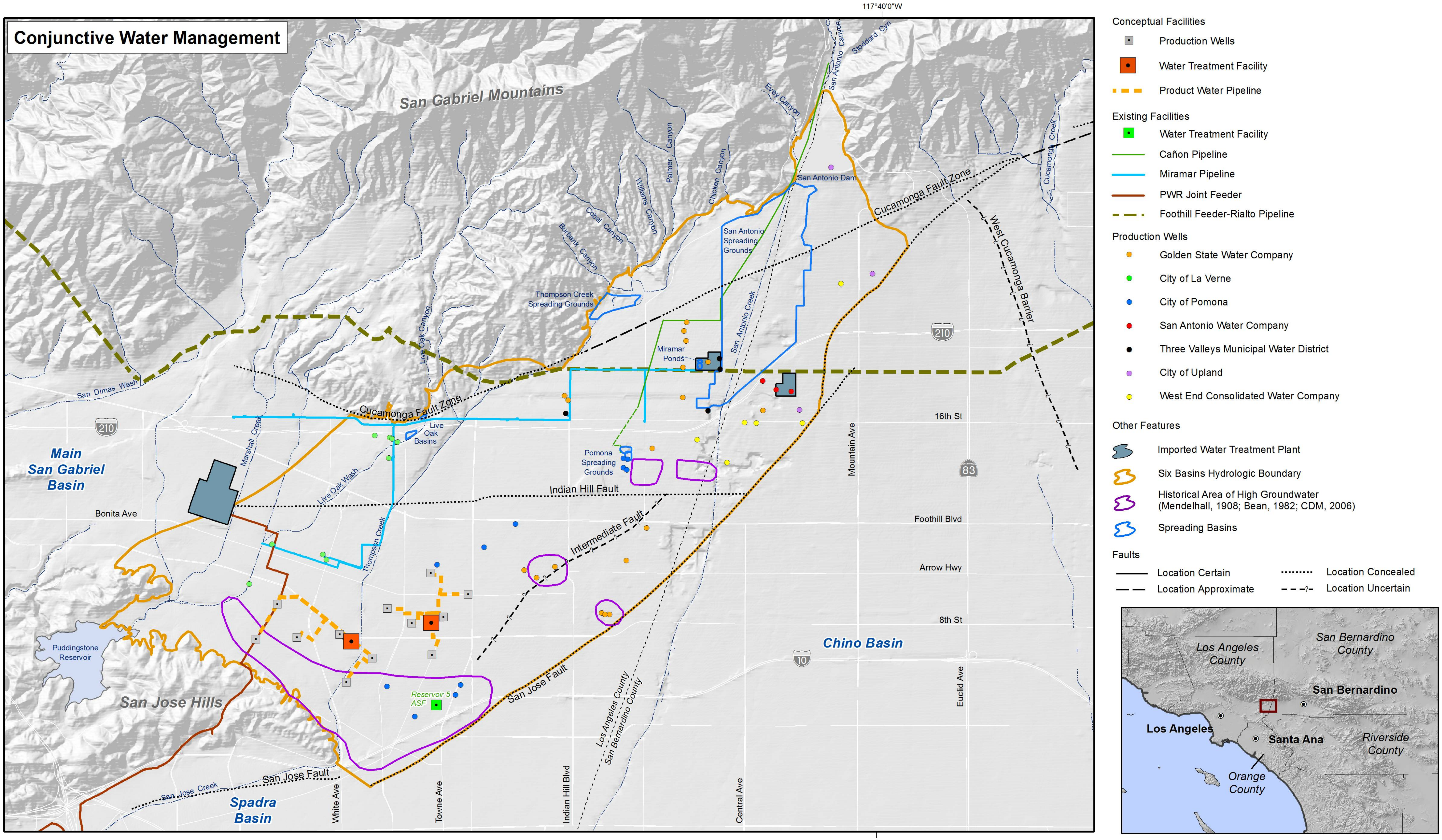
WEI
WILDERMUTH ENVIRONMENTAL, INC.

Author: CS
Date: 20141110
File: Figure_5_9_PT_Pomona.mxd

Six Basins Watermaster
**Strategic Plan for the Six Basins**

**Facilities Map**
*Pump and Treat in the Pomona Basin*

**Figure 5-9**




Produced by:

WILDERMUTH ENVIRONMENTAL, INC.

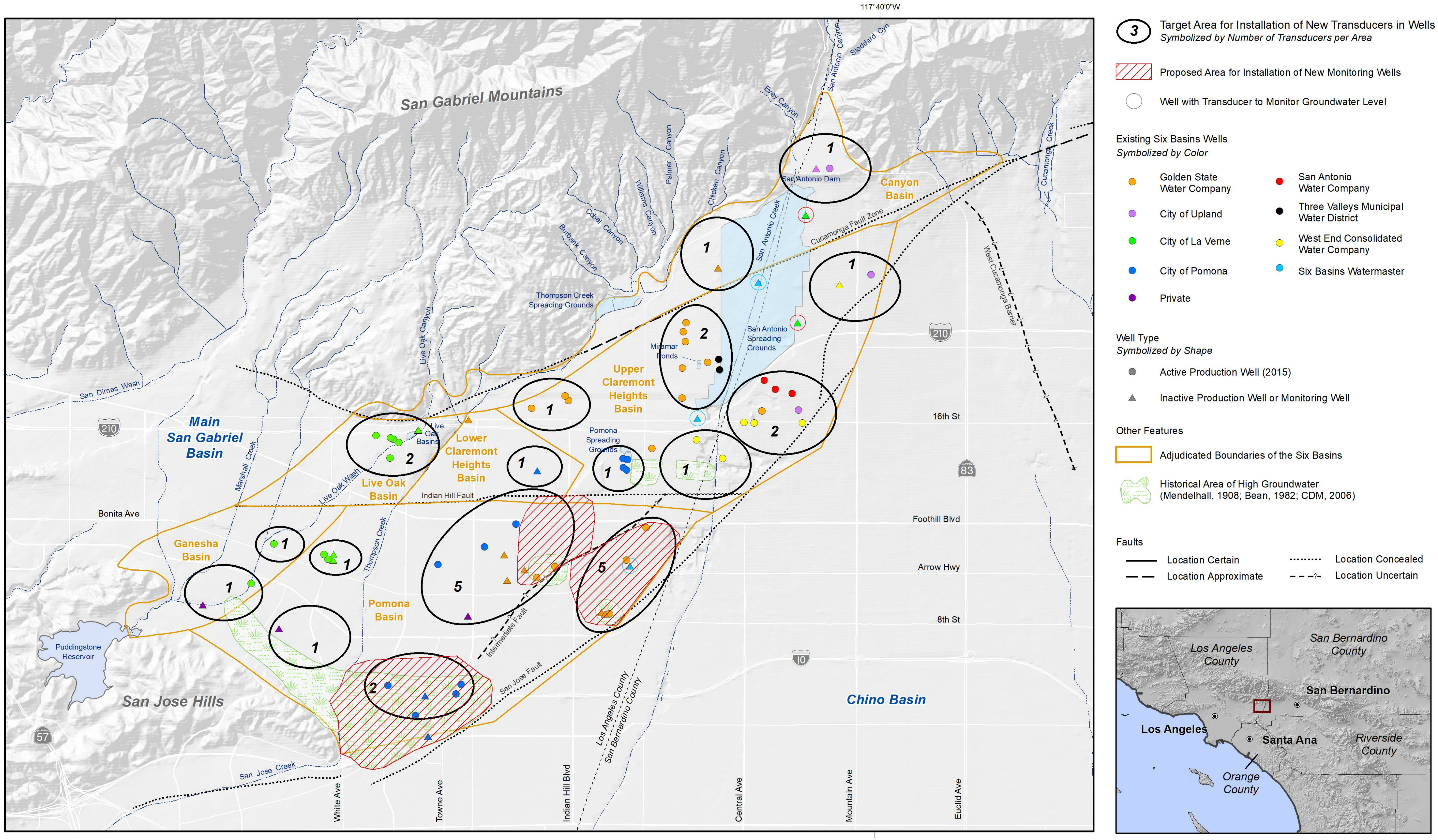
Author: CS
Date: 20141110
File: Figure_5_10_CU_Facilities.mxd

0 1 2 Miles
0 2 4 Kilometers

Six Basins Watermaster
**Strategic Plan for the Six Basins**

**Facilities Map**
*Conjunctive Water Management*

**Figure 5-10**




Prepared by:

WEI
Wildermuth Environmental, Inc.

Author: TCR
Date: 20151021
File: Figure_5-11_proposed monitoring.mxd

0 2 Miles
0 2 4 Kilometers

Six Basins Watermaster
**Strategic Plan for the Six Basins**

**Expanded Groundwater Monitoring Network**
*Conceptual*

**Figure 5-11**

# Section 6 – Refinement of the Strategic Plan: 2016 to 2017

This section summarizes the work that was performed in 2016 and 2017 to expand the Watermaster's groundwater monitoring programs and to refine the Strategic Plan projects that were evaluated at a conceptual level as described in Section 5 of this report. This section was published in October 2017.

## 6.1 Overview of Activities

During 2016 and 2017, Watermaster undertook two major tasks to refine the Strategic Plan: the development and implementation of the expanded groundwater monitoring program and the refinement of project descriptions for inclusion in the Strategic Plan. An overview of each activity is provided below.

### 6.1.1 Expanded Groundwater Monitoring Program

The intent of the expanded groundwater monitoring program is to collect and analyze high-frequency water-level and production data at wells across all areas of the Six Basins for the purposes of: supporting the design of capital improvements associated with the implementation of Strategic Plan projects, such as new wells and treatment facilities; supporting required monitoring and mitigation requirements that may be associated with Strategic Plan projects; improving the hydrogeologic conceptual understanding of the aquifer systems and the fault barriers, which can be used to improve the Watermaster's groundwater model; providing groundwater-production and groundwater-level data of high accuracy and resolution, which can be used to improve the Watermaster's groundwater model; supporting well-siting investigations for the Parties that plan on installing new or replacement wells; providing information on the causes of high groundwater; and, providing information to develop mitigation or management strategies to minimize or abate high groundwater. The monitoring program is meant to be adapted over time to fill data gaps, maximize efficiency and minimize costs. The focus in the first two years was to expand or improve monitoring efforts at existing wells and use the data collected, in part, to determine if new monitoring wells are needed to further characterize the hydrogeology of the Six Basins.

Watermaster staff (WEI) worked with each of the Parties to identify potential well candidates for high-frequency water-level monitoring. A total of 22 wells were identified and field visits were made to each site to determine the feasibility for installation of pressure transducers with an on-board data logger. Ultimately a total of 19 new transducers were installed in wells across the Basin. An additional 33 wells were identified as already equipped to measure and record high-frequency groundwater-level and production data, and WEI developed a protocol with each agency to collect and review these data on a quarterly basis. Figure 6-1 shows the monitoring frequency at each well in the Six Basins as of October 2017.

### 6.1.2 Refinement of the Strategic Plan Projects

In the first half of 2016, Watermaster staff conducted a series of meetings with individual Parties and other stakeholders to identify specific projects that are of interest for implementation and are consistent with the project types described and evaluated herein in

Section 5, and which were originally published in the December 2015 draft of the Strategic Plan report (WEI, 2015). At a special Advisory Committee Workshop on June 8, 2016, the Watermaster Board received a presentation summarizing the results of those meetings and discussions, including a list and map of the proposed projects. The proposed projects are listed in Table 6-1. A conclusion of the meeting was that all of the proposed projects, at the conceptual level, are consistent with the Strategic Plan and should continue to be further evaluated for potential implementation. The Board also concluded that the Strategic Plan is best described as a conjunctive water management program for the region that coordinates the use and management of all surface water and groundwater resources available to the Parties to enhance yield and improve water-supply reliability during dry periods. During subsequent workshops, the list of projects in Table 6-1 was refined to 16 projects that could participate in an optimized conjunctive water management program. The proposed projects are listed in Table 6-2 and their locations are shown on Figure 6-2.

From November 2016 through July 2017, a project description for 14 of the 16 projects in Table 6-2 was developed to characterize the project's goals, operating scheme(s), necessary capital improvements, and how it enables conjunctive water management. The remaining two projects *Enhance Stormwater Recharge through MS-4 Compliance*[39] and *Create a Conservation Pool Behind San Antonio Dam*[40] were ultimately screened out of the process. The 14 refined Strategic Plan projects, which are described in detail later in this section, are characterized within the following project types:

- Pump and treat projects (described in Section 6.3)
- Stormwater and supplemental water recharge projects (described in Section 6.4)
- Temporary surplus projects (described in Section 6.5)

## 6.2 Conjunctive Water Management

As previously noted, an outcome of the Strategic Plan Workshops conducted from 2016 to 2017 was to characterize the Strategic Plan as a regional conjunctive water management program to coordinate the use and management of all surface-water and groundwater resources available to the Parties to enhance yield and improve regional water-supply reliability during dry periods. The operational concept is to maximize the use of surplus local and imported surface water when it is available in greater volumes during wet periods, so that groundwater will be

[39] This project was proposed as a collaboration between Watermaster and the Cities responsible for compliance with the Municipal Separate Storm Sewer System (MS4) Order No. R4-2012-0175 (Order) issued by the Los Angeles Regional Water Quality Control Board, the objective of which is to control stormwater and non-stormwater discharges to channels. Compliance with MS4 could result in an increase in recharge to the Six Basins. This was project was screened out because the interest of the two groups to collaborate has not been fully formalized and potential projects have not been described.

[40] The San Antonio Dam is operated by the USACE pursuant to rigid operating rules that are meant to provide flood protection. The USACE operates the San Antonio Dam primarily for flood control and secondarily for water conservation. This project was proposed for its potential to enhance stormwater recharge. Due to the institutional and technical complexities associated with the process of modifying the operations of the USACE and uncertainty as to the capacity to increase recharge at the SASG, this project was screened out. The duration required to conduct the investigations could be decades.

more available and reliable during dry periods when surface-water supplies are reduced. A key feature of the program is to utilize the Pomona Basin, which has the greatest regulatable storage potential in the Six Basins, as a storage reservoir for a dry-year storage account. The ability to implement a conjunctive water management program under the current operating rules and practices is constrained by the following impediments:

- Not all storm water can be diverted and recharged by PVPA during very wet years, which is a permanently lost opportunity.
- The threat of high groundwater conditions can limit the amount of stormwater spread by PVPA in wet years, which limits the ability to "maximize" the use of local and imported surface-water resources during wet periods.
- The location, production capacity, and operation of wells are not coordinated or optimized among the Parties to increase production during dry periods or to prevent high groundwater conditions in wet periods.
- Poor groundwater quality in the Pomona Basin is a barrier to increasing production capacity to facilitate increased pumping during dry periods.
- High groundwater in the Pomona Basin limits its unused storage space that is necessary to store water during wet periods.
- There is no Watermaster-approved Storage and Recovery Agreement for managing groundwater storage in the Pomona Basin.

To implement a program of conjunctive water management, Watermaster must develop and implement policies and projects that will remove these impediments, and thereby achieve the goals of this Strategic Plan. The projects are described herein through the remainder of this Section 6. The implementation plan is described in Section 7.

## 6.3 Pump and Treat Projects

As previously described, the Pomona Basin is an under-utilized water resource that could be better managed to achieve the goals of the Strategic Plan. An impediment to increasing groundwater production in the Pomona Basin is poor groundwater quality. Groundwater levels have increased and generally remained high in portions of the Pomona Basin as the Parties have shifted away from pumping to avoid the cost of treating groundwater for municipal use. This has reduced the yield of the Pomona Basin by increasing subsurface outflow to the Chino Basin, and has increased the threat of rising groundwater and liquefaction potential. The pump and treat projects were conceptualized to remove these impediments and achieve the following:

- Increase the yield of Pomona Basin by reducing subsurface outflow to the Chino Basin.
- Remove contaminants from groundwater, and put the treated groundwater to beneficial use.
- Lower groundwater levels to reduce the threat of rising groundwater and liquefaction potential.

In addition, the pump and treat projects described below facilitate the implementation of a conjunctive water management program in the Six Basins by creating unused storage space in the Pomona Basin to facilitate the implementation of a storage and recovery program, and by increasing groundwater-production capacity to enable increased production during take years.

### 6.3.1 Increase Groundwater Production and Treatment Capacity at Reservoir 5 Treatment Facility

**Current Operations.** The Reservoir 5 treatment facility is an air stripping facility owned by the City of Pomona and is located at 10th and Towne St (see PID *a* on Figure 6-2). Groundwater from the P-3, P-7, P-8B and P-32B wells is conveyed to the facility to remove dichloroethene (DCE), and blended with treated imported water via a static mixer to reduce chromium-6 (Cr-6), nitrate, and perchlorate concentrations. The P-3, P-7, P-8B and P-32B wells have a combined capacity of about 3,000 gpm, and if operated at maximum capacity,[41] can produce a total of 3,625 afy. From 2010-2015, the City of Pomona produced about 1,500 afy from the P-3, P-7, P-8B and P-32B wells. The wells currently are not operated at their full capacity because the capacity of the treatment facility is 1,800 gpm.

**Project Description.** The proposed project is to increase groundwater production and treatment capacity in the southeast portion of the Pomona Basin by increasing production from the P-3, P-7, P-8B and P-32B wells, and increasing the treatment capacity of the Reservoir 5 treatment facility. The project could decrease the volume of treated imported water needed for treatment through blending to zero. By operating the P-3, P-7, P-8B and P-32B wells at their maximum capacity, groundwater production will be increased by about 2,100 afy compared to the average production rate over the past five years of about 1,500 afy. If the project's production exceeds the water demands of the City of Pomona, the excess water can be supplied to other water-supply agencies. The project could include combinations of various treatment methods to produce potable water, depending on the ultimate project capacity and the desire to minimize the use of treated imported water for blending.

Potential facility improvements are:

- Construct ion exchange (IX) or biological treatment facilities at the Reservoir 5 treatment facility to remove Cr-6, nitrate and perchlorate.
- Expand the existing air stripping facility or construct a granular activated carbon (GAC) facility to remove DCE.
- Construct conveyance facilities to supply the product water to other agencies, if necessary.

The proposed operating scheme is:

***Groundwater Production***. Production at P-3, P-7, P-8B and P-32B wells is increased to produce up to 3,625 afy.

***Groundwater Treatment***. All groundwater production is treated at the Reservoir 5 treatment facility. A goal of this project is to not increase, and possibly reduce, the demand for imported water.

***Distribution***. The product water is used by the City of Pomona through its existing distribution system or is supplied to other water-supply agencies via interconnections and/or exchanges.

[41] Maximum capacity assumes 75 percent well utilization.

***Water Rights***. Operation of the project may result in production volumes that exceed the annual Operating Safe Yield (OSY) of the Four Basins. The exceedance of OSY rights can be addressed in the following ways:

- **Replacement**. The production that exceeds the OSY rights is replaced through wet-water recharge with imported water in the following year.
- **Special Projects**. The project is approved under the Special Projects provision of the Judgment so some or all of the production that exceeds the OSY rights would not require replacement. The volume and schedule for groundwater production under a designated Special Project would be defined by a Watermaster-approved plan.
- **Storage and Recovery Agreement**. The production that exceeds the OSY rights is debited from a Watermaster-approved storage account, which could include a dry-year storage account held by all of the Parties. For a dry-year storage account, the debit would occur only during "take" years as defined in a dry-year storage and recovery agreement.

### 6.3.2 Increase Groundwater Production and Treatment Capacity at Lincoln/Mills Treatment Facility

**Current Operations.** The Lincoln/Mills treatment facility is an air-stripping facility owned by the City of La Verne and is located at 6th and White St (see PID *b* on Figure 6-2). Groundwater pumped by the Lincoln and Mills Tract wells is conveyed to the facility to remove TCE, and is blended with treated imported water via a static mixer to reduce nitrate and perchlorate concentrations. The Lincoln and Mills Tract wells have a combined capacity of about 2,000 gpm, and if operated at maximum capacity, can produce a total of 2,400 afy. From 2010-2015, the City of La Verne produced about 1,100 afy of from the Lincoln and Mills Tract wells. The wells are not currently operated at their full capacity because the capacity of the treatment facility is 1,200 gpm, and it is not economically feasible for the City of La Verne to buy replacement water if doing so would incur a Replacement obligation.

**Project Description.** The proposed project is to increase groundwater production and treatment capacity in the western portion of the Pomona Basin by increasing production from the Lincoln and Mills Tract wells and other wells, and increasing the treatment capacity of the Lincoln and Mills treatment facility. The project could decrease the volume of treated imported water needed for treatment through blending to zero, depending on the project's design and capacity.

By operating the Lincoln and Mills Tract wells at their maximum capacity, groundwater production will be increased by about 1,300 afy compared to the average production rate over the past five years of about 1,100 afy. Increased production from existing and/or new wells, conveyance pipelines, and expansion of the treatment facility would increase project's capacity. For example, the Old Baldy well could be rehabilitated and connected to the Lincoln and Mills treatment facility. If the project's production exceeds the water demands of the City of La Verne, the surplus water could be supplied to other water-supply agencies.

The project could include combinations of various treatment methods to produce potable water, depending on the project's capacity and the desire to minimize the use of treated imported water for blending.

Potential facility improvements include:

- Construct IX or biological treatment facilities at the Lincoln and Mills treatment facility to remove nitrate and perchlorate.
- Expand the existing air-stripping facility or construct a GAC facility to remove TCE.
- Construct conveyance facilities to connect other wells to the treatment facility, if necessary.
- Construct conveyance facilities to supply product water to other agencies, if necessary.

The proposed operating scheme is:

***Groundwater Production***. Production at the Lincoln and Mills Tract wells is increased to 2,400 afy.

***Groundwater Treatment***. All groundwater production is treated at the Lincoln and Mills treatment facility. A goal of this project is to not increase, and possibly reduce, the demand for imported water.

***Distribution***. The product water is used by the City of La Verne through its existing distribution system or is supplied to other water-supply agencies via interconnections and/or exchanges.

***Water Rights***. Operation of the project may result in groundwater production that exceeds the annual OSY rights of the Four Basins. The exceedance of OSY rights can be addressed in the following ways:

- **Replacement**. The production that exceeds the OSY rights is replaced through wet-water recharge with imported water in the following year.
- **Special Projects**. The project is approved under the Special Projects provision of the Judgment and some or all of the production that exceeds the OSY rights would not require replacement. The volume and schedule for producing groundwater under a designated Special Project would be defined by a Watermaster-approved plan.
- **Storage and Recovery Agreement**. The production that exceeds the OSY rights is debited from a Watermaster-approved storage account, which could include a dry-year storage account held by all of the Parties. For a dry-year storage account, the debit would occur only during "take" years as defined in a dry-year storage and recovery agreement.

### 6.3.3 Rehabilitate Del Monte 4 and Add Arsenic Treatment

**Current Operations.** The Del Monte treatment facility is a GAC facility owned by GSWC and is located at College Avenue and 1st Street (see PID *c* on Figure 6-2). Groundwater from the Del Monte 4 well is conveyed to the facility to remove TCE and is blended with treated imported water. The Del Monte 4 well has a design capacity of 700 gpm, and if operated at maximum capacity, can produce a total of 850 afy. GSWC has not produced groundwater from the Del Monte 4 well since 2005 due to high arsenic concentrations.

**Project Description.** The proposed project is to increase groundwater production and treatment capacity in the eastern portion of the Pomona Basin by rehabilitating the Del Monte 4 well and adding a wellhead treatment system to remove arsenic. By rehabilitating and operating the Del Monte 4 well at its maximum capacity, groundwater production capacity will be increased by about 850 afy. If the project's production exceeds the water demands of the GSWC, the excess water can be supplied to other water-supply agencies.

Potential facility improvements include:

- Construct an arsenic treatment system at the Del Monte 4 well.

- Construct conveyance facilities to supply product water to other agencies, if necessary.

The proposed operating scheme is:

***Groundwater Production***. Produce up to 850 afy at the Del Monte 4 well.

***Groundwater Treatment***. All groundwater production from Del Monte 4 is treated at a wellhead treatment system to reduce arsenic concentrations, and is then conveyed to the Del Monte treatment facility to reduce TCE concentrations.

***Distribution***. The product water is used by GSWC through its existing distribution system or is supplied to other water-supply agencies via interconnections and/or exchanges.

***Water Rights***. Operation of the project may result in groundwater production that exceeds the annual OSY rights of the Four Basins. The exceedance of OSY rights can be addressed in the following ways:

- **Replacement**. The production that exceeds the OSY rights is replaced through wet-water recharge of imported water in the following year.
- **Special Projects**. The project is approved under the Special Projects provision of the Judgment so some or all of the production that exceeds the OSY rights would not require replacement. The volume and schedule for producing groundwater under a designated Special Project would be defined by a Watermaster-approved plan.
- **Storage and Recovery Agreement**. The production that exceeds the OSY rights is debited from a Watermaster-approved storage account, which could include a dry-year storage account held by all of the Parties. For a dry-year storage account, the debit would occur only during "take" years as defined in a dry-year storage and recovery agreement.

### 6.3.4 Construct Durward 2 Well and a Wellhead Treatment Facility

**Current Operations.** This project involves the construction of new facilities adjacent to the abandoned Durward well site. Historical groundwater-quality data from the Durward well indicates that high concentrations of nitrate, perchlorate, and TCE are present in the underlying groundwater.

**Project Description.** The proposed project is to increase groundwater production and treatment capacity in the southwest portion of the Pomona Basin by constructing a new well, Durward 2, and constructing a wellhead treatment facility to reduce nitrate, perchlorate, and TCE concentrations (see PID *d* on Figure 6-2). By constructing the Durward 2 well and operating it at an estimated maximum capacity of 500 gpm, groundwater production will be increased by about 600 afy. If the project's production exceeds the water demands of GSWC, the surplus water can be supplied to other water-supply agencies. A goal of this project is to not increase, and possibly reduce, the demand for imported water.

Potential facility improvements include:

- Construct a new well adjacent to the Durward well site.
- Construct air stripping, GAC, IX and/or biological treatment facilities at the new well site to remove nitrate, perchlorate, and TCE.
- Construct conveyance facilities to supply the product water to its ultimate demand.

The proposed operating scheme is:

***Groundwater Production***. Produce up to 600 afy at the Durward 2 well.

***Groundwater Treatment***. All groundwater production is treated at the Durward 2 well site to reduce nitrate, perchlorate, and TCE concentrations.

***Distribution***. The product water is used by GSWC through its existing distribution system or is supplied to other water-supply agencies via interconnections and/or exchanges.

***Water Rights***. Operation of the project may result in groundwater production that exceeds the annual OSY rights of the Four Basins. The exceedance of OSY rights can be addressed in the following ways:

- **Replacement**. The production that exceeds the OSY rights is replaced through wet-water recharge with imported water in the following year.
- **Special Projects**. The project is approved under the Special Projects provision of the Judgment so some or all of the production that exceeds the OSY water rights would not require replacement. The volume and schedule for producing groundwater under a designated Special Project would be defined by a Watermaster-approved plan.
- **Storage and Recovery Agreement**. The production that exceeds the OSY rights is debited from a Watermaster-approved storage account, which could include a dry-year storage account held by all of the Parties. For a dry-year storage account, the debit would occur only during "take" years as defined in a dry-year storage and recovery agreement.

### 6.3.5 Rehabilitate Old Baldy Well and Construct Wellhead Treatment Facility

**Current Operations.** The Old Baldy well is owned by the City of La Verne and is located in the northeast portion of the Ganesha Basin (see PID *e* on Figure 6-2). The Old Baldy well has a capacity of 650 gpm, and if operated at maximum capacity, can produce a total of 800 afy. The City has not produced groundwater from the Old Baldy well since 2002 due to high nitrate and perchlorate concentrations.

**Project Description.** The proposed project is to increase groundwater production and treatment capacity in the northeast portion of the Ganesha Basin by rehabilitating the Old Baldy well and constructing new treatment facilities to reduce nitrate and perchlorate concentrations in the produced groundwater. A goal of this project is to not increase, and possibly reduce, the demand for imported water.

By rehabilitating and operating the Old Baldy well at its maximum capacity, groundwater production will be increased by about 800 afy. If the project's production exceeds the water demands of the City of La Verne, the surplus water can be supplied to other water-supply agencies.

Potential facility improvements include:

- Construct IX or biological treatment facilities at the Old Baldy well site to remove nitrate and perchlorate.
- Construct conveyance facilities to supply product water to other agencies, if necessary.

The proposed operating scheme is:

***Groundwater Production***. Produce up to 800 afy at the Old Baldy well.

***Groundwater Treatment***. All groundwater production is treated at the Old Baldy well site to reduce nitrate and perchlorate concentrations.

***Distribution***. The product water is used by the City of La Verne through its existing distribution system or is supplied to other water-supply agencies via interconnections and/or exchanges.

***Water Rights***. Although pumping by La Verne is not constrained by water rights in the Ganesha Basin, the project could cause drawdown at other wells in the Live Oak, Ganesha and Pomona Basins. Drawdown would be identified in project development or CEQA and, if deemed excessive, mitigation may be required.

## 6.4 Stormwater and Supplemental Water Recharge

Impediments to enhancing the recharge of storm and supplemental water[42] include: incomplete understanding of the limiting factors for increasing storm-water recharge from the San Antonio Creek and Thompson Creek; limited sources and availability of supplemental water; the potential for the occurrence of rising groundwater and liquefaction potential; and the lack of a coordinated program to re-capture the enhanced recharge. The storm and supplemental water recharge projects were conceptualized to remove these impediments and achieve the following:

- Enhance the yield of the Six Basins by increasing the capacity to divert and recharge storm-water.
- Improve groundwater quality through the recharge of high-quality storm water.
- Increase the volume of groundwater that can be sustainably pumped from the Six Basins via recharge of supplemental water.

In addition, the recharge projects described below facilitate the implementation of a conjunctive water management program in the Six Basins by maximizing the use of surplus local and imported surface water when they are available in greater volumes during wet periods, so that groundwater will be more available and reliable during dry periods when the surface-water supplies are reduced.

### 6.4.1 Enhance Stormwater Recharge at the San Antonio Spreading Grounds

**Current Operations.** Runoff from the San Antonio Creek watershed that is exceeds what can be diverted and used by SAWCo and the City of Pomona at the 60/40 splitter is captured behind the San Antonio Dam. Except under the most critical conditions, water impounded behind the Dam is discharged in a controlled manner into the PVPA diversion works. The diversion works consist of six slide gates that divert water into the San Antonio Spreading Grounds (SASG), each with a capacity to divert up to 200 cfs. Two gates on the west side of the diversion works direct water to the Los Angeles County side of the SASG through a 72-inch diameter reinforced concrete pipeline. Four gates on the east side of the diversion works direct water to the San Bernardino County side of the SASG through two 72-inch diameter reinforced concrete pipelines. Flow meters are installed in each 72-inch pipeline to record the diversions to the

[42] Supplemental water is defined as recycled and imported water.

SASG. Discharge from the Dam that exceeds the PVPA's diversion capacity by-passes the diversion works and enters the concrete-lined San Antonio Creek Channel. Water discharged to the concrete-lined San Antonio Creek Channel has one more opportunity to be diverted to the SASG via the Lower San Bernardino Turnout. The turnout is a drop-inlet structure that diverts water to the San Bernardino County side of the SASG. When the gate is fully open, this turnout can divert water at a maximum rate of approximately 300 cfs. The Lower San Bernardino Turnout is not metered by the PVPA.

Based on PVPA records, from 1961 to 2015 annual diversions to the SASG ranged from 0 to 33,370 afy. Based on historical discharge measurements made by the USACE, Watermaster has estimated that the volume of storm water discharged from San Antonio Dam that was not diverted by the PVPA ranged from a low of 4 afy to a maximum of about 44,900 afy. However, based on anecdotal information from the USACE, the discharge measurements at the Dam are not accurate in low-flow conditions and may over-estimate outflow from the Dam under such conditions.

**Project Description.** The proposed project is to enhance stormwater recharge at the SASG (see PID *f* on Figure 6-2). There are three limitations on total diversions to the SASG for recharge: the physical capacity of the diversion works, the recharge capacity of the spreading grounds, and the requirement in the Judgment to manage recharge to avoid high groundwater conditions. The recharge capacity at the SASG under its current configuration of unlined channels, berms, ponds, deep mining pits, and unimproved land is not precisely known. And, the amount of stormwater available for capture is not well understood, so the optimal facilities and operating schemes to accomplish recharge enhancement cannot yet be defined. The first step in the development of alternatives to enhance recharge is to implement a monitoring program to improve the characterization of the water available for diversion and the factors that limit recharge capacity.

### 6.4.2 Enhance Supplemental-water Recharge at the SASG

**Current Operations.** Stormwater recharge occurs at the SASG when the USACE releases runoff from behind the San Antonio Dam, and otherwise the SASG remains unused except for relatively minor recharge activities conducted by SAWCo, the City of Pomona and TVMWD. In 32 of the last 55 years, stormwater diversions to the SASG were less than 1,000 afy, and in 15 of those years, there were no stormwater diversions.

**Imported Water.** TVMWD is the only Watermaster Party that recharges supplemental imported water at the SASG. The source of the imported water is MWDSC's Rialto Feeder Pipeline that conveys water to the west side of the SASG through an 80 cfs pipeline constructed by TVMWD in 2011 (maximum of 5,000 af per month). Because the facilities to recharge supplemental water at the SASG are already in place, there is no proposed scope of work for planning facilities to increase imported water recharge. However, Task 1 includes a line-item to perform an economic analysis for the purchase and recharge of imported water at the SASG as part of the conjunctive water management program engineering analysis.

**Recycled Water.** Currently, there are no facilities to deliver recycled water for recharge at the SASG.

**Project Description.** The proposed project is to recharge tertiary-treated recycled water at the SASG to increase the amount of groundwater that can be sustainably pumped from the Six Basins and to increase groundwater production in the UCHB to capture this recharge (see PID *g* on Figure 6-2).

The potential sources of the recycled water supply include: the Pomona Water Reclamation Plant (WRP), the IEUA's recycled water distribution system in the Chino Basin, a potential satellite water reclamation plant, and/or the MWDSC's proposed recycled water treatment project in Los Angeles County. Exchange agreements are also possible; for example, the recycled water from the Pomona WRP could be exchanged for like amounts of untreated imported water delivered through TVMWD to the SASG. In the draft Strategic Plan report, one project was evaluated that assumed recycled water was delivered from the Pomona WRP to the SASG at a rate of 3,500 acre-ft/yr with an accompanying groundwater extraction program of 3,500 acre-ft/yr.

Potential facility improvements include:

- New pipelines and booster pumping stations to convey recycled water from its source to the SASG.
- New wells to recover the recharge.

The Parties participating in this project could either produce groundwater in excess of their OSY rights in an amount equal to the annual supplemental water recharge or store the water for recovery in dry periods (pursuant to a Watermaster-approved Storage and Recovery agreement).

### 6.4.3 Enhance Stormwater Recharge at the Thompson Creek Spreading Grounds

**Current Operations.** Runoff generated from the Thompson Creek watershed enters the PVPA property through a diversion structure upstream of the Thompson Creek dam. The diversion structure and dam are operated by the Los Angeles County Flood Control District (LACFD) in cooperation with PVPA. At the diversion structure, stormwater can be diverted to the reservoir behind the dam and/or the PVPA's conveyance ditch that subsequently discharges to the Thompson Creek Spreading Grounds (TCSG) through a tunnel with a capacity of approximately 75 cfs. Water that accumulates behind the Thompson Creek Dam does not contribute to the recharge of the Six Basins because the dam is partly grouted to bedrock and the reservoir is not maintained for recharge.

The PVPA requests the LACFCD to divert as much stormwater as possible into the TCSG, but the diversion is constrained by the LACFCD operating rules that focus primarily on flood control operations.

Based on PVPA records, from 2000 to 2015 annual diversions to the TCSG ranged from 0 to 269 afy. Based on historical discharge measurements made by the LACFD, Watermaster has estimated that the volume of stormwater captured at or discharged from Thompson Creek Dam, and therefore not diverted by the PVPA, ranged from a low of 3 afy to a maximum of about 1,634 afy.

**Project Description.** The proposed project is to enhance stormwater recharge at the TCSG (see PID *h* on Figure 6-2). The ability to increase recharge is constrained by the diversion capacity of the conveyance facilities to the TCSG, the recharge capacity of the TCSG, and the requirement in the Judgment to manage recharge to avoid high groundwater conditions. Neither the recharge capacity, the amount of stormwater available for capture, nor the hydrogeology underlying the TCSG are well understood and so the optimal facilities and operating schemes to accomplish recharge enhancement cannot yet be defined. The first step in the development of alternatives to enhance recharge is to implement a monitoring program to improve the characterization water available for diversion and the of the factors that limit recharge capacity.

### 6.4.4 Supplemental-water recharge at the TCSG: Imported Water

**Current Operations.** The TCSG are currently used when the LACFCD allows the PVPA to divert stormwater into the recharge facilities instead of to behind the Thompson Creek Dam. In 10 of the last 16 years, stormwater diversions to the TCSG totaled less than 50 afy, and in eight of those years, there were no stormwater diversions. The TCSG are not used to recharge supplemental water, nor are there existing facilities to convey supplemental water to the TCSG.

**Project Description.** The proposed project is to recharge untreated imported water at the TCSG to increase the amount of groundwater that can be sustainably pumped from the Six Basins (see PID *i* on Figure 6-2). The source of the untreated imported water would be MWDSC's Rialto Feeder Pipeline. A new pipeline would need to be constructed from the Rialto Pipeline to the TCSG. To the extent possible, the water would be conveyed to the TCSG by pressure head in the Rialto Pipeline. A booster pump station may be necessary to convey the imported water to the TCSG, at least at times when pressure head is low in the Rialto Pipeline.

The Parties participating in this project could either produce groundwater in excess of their OSY rights in an amount equal to the annual supplemental water recharge or store the water for recovery in dry periods (pursuant to a Watermaster-approved Storage and Recovery agreement).

### 6.4.5 Enhance Stormwater Recharge at the Pedley Spreading Grounds

**Current Operations.** San Antonio Creek water diverted by the City of Pomona at the 60/40 splitter box that exceeds the treatment capacity of the Pedley Treatment Plant, or does not meet turbidity standards for treatment, is recharged at the SASG or at the Pedley Spreading Grounds (PSG). Currently, the PSG does not receive stormwater or dry-weather runoff from the surrounding urbanized areas for recharge.

**Project Description.** The proposed project is to enhance recharge at the PSG to include stormwater and dry-weather runoff from the surrounding urbanized areas (see PID *j* on Figure 6-2). The amount of stormwater and dry-weather runoff available for diversion into the PSG has not yet been characterized. Additionally, the recharge capacity at the PSG is not precisely known and so the facilities and operating schemes to accomplish recharge enhancement cannot yet be defined.

### 6.4.6 Recharge Stormwater and Supplemental Water at the LA County Fairplex

**Current Operations.** There are no storm or supplemental water recharge facilities at the site.

**Project Description.** The proposed project is to utilize a 20-acre area at the LA County Fairplex to construct facilities to recharge stormwater and dry-weather runoff, and supplemental water into the Pomona Basin (see PID *k* on Figure 6-2). The proposed project could also help the City of Pomona to comply with the MS4 permit as a regional stormwater diversion and recharge project. Three potential sources of water are considered for recharge at the Fairplex:

- **Stormwater and Dry-Weather Runoff**. Divert stormwater and dry-weather runoff from the LA County Fairplex and the Thompson Creek channel into new recharge basins at the Fairplex.
- **Recycled Water**. Pump recycled water from the Pomona WRP to the new recharge basins at the Fairplex. Recycled water would be recharged throughout the year except when stormwater recharge operations would conflict with it.
- **Imported Water**. Untreated imported water from the Rialto Feeder can be discharged to Thompson Creek and diverted to the new recharge basins at the Fairplex. Imported water can be recharged throughout the year except when stormwater recharge operations would conflict with it.

The potential facility improvements include:

- Construct new recharge basins at the Fairplex.
- Construct necessary facilities to divert and convey stormwater and dry weather runoff and imported water to the new recharge basins.
- Construct necessary conveyance facilities to deliver recycled water to the new recharge basins.
- Construct and install monitoring facilities necessary to comply with the Department of Drinking Water Title 22 regulations.

## 6.5 Temporary Surplus Projects

Historically, high groundwater problems have occurred in the Six Basins because during wet periods, high volumes of stormwater recharge within the SASG cause groundwater levels to rapidly increase in the UCHB. The mound of high groundwater migrates to the south and can cause or contribute to high groundwater conditions in the southern portion of the UCHB, the LCHB, and the northern portion of the Pomona Basin. High groundwater conditions are undesirable because they increase the threat of rising groundwater and liquefaction potential, and they reduce the yield of the Six Basins by increasing subsurface outflow to the Chino Basin and by limiting the volume of stormwater recharge that can occur during wet periods.

The potential for high groundwater can be mitigated by managing groundwater production. The Temporary Surplus provision in the Judgment can be employed to increase groundwater production during wet periods to minimize the potential for high groundwater conditions, provided that the production to recover the Temporary Surplus is located in areas that will mitigate the potential for high groundwater (i.e. UCHB and LCHB). The physical impediments to implementing a Temporary Surplus in a manner that minimizes the potential for high groundwater conditions include: the lack of local water demands to utilize the Temporary Surplus when it needs to be extracted, the lack of facilities to convey the Temporary Surplus to areas of demand, and potentially insufficient pumping capacity. The Temporary Surplus projects described below were conceptualized to remove these impediments.

In addition, the Temporary Surplus projects facilitate the implementation of a conjunctive water management program in the Six Basins by increasing the use of surplus stormwater during wet periods, which can enable in-lieu recharge of the Pomona Basin so that groundwater is more available during dry periods.

### 6.5.1 Construct Interconnections

**Current Operations.** N/A.

**Project Description.** The proposed project is to increase the flexibility in conveying water to water-supply agencies in the region to facilitate the use of Six Basins groundwater during a Temporary Surplus.

Potential facility improvements include:

- Interconnections of wells and/or distribution systems to the regional treated-water pipelines (e.g. Benson Avenue feeder; Miramar system).
- Interconnection of the WFA Agua de Lejos and TVMWD Miramar water treatment plants.
- Other interconnections necessary to ensure all Parties have the ability to:
    - convey and receive water from all other Parties
    - export water to the Chino Basin
    - export water through the PWR pipeline

### 6.5.2 Rehabilitate P-20 and a Wellhead Treatment Facility

**Current Operations.** The P-20 well is owned by the City of Pomona and is the only well located in the Lower Claremont Heights Basin (see PID *m* on Figure 6-2). The P-20 well has a capacity of 800 gpm, and if operated at maximum capacity, can produce a total of 80 af per month. The City has not produced groundwater from the P-20 well since 2000 due to high nitrate concentrations.

**Project Description.** The proposed project is to increase groundwater production and treatment capacity in the Lower Claremont Heights Basin by rehabilitating the P-20 well and constructing new treatment facilities to reduce nitrate concentrations in the produced water.

Rehabilitating and operating the P-20 well increases the groundwater production capacity in the Lower Claremont Heights Basin to better ensure that the Temporary Surplus can be produced when invoked. If the project's production exceeds the water demands of the City of

Pomona, the excess water can be supplied to other water-supply agencies through interconnections or by exchange.

Potential facility improvements include:

- Construct IX or biological treatment facilities at the P-20 well site to remove nitrate.
- Construct conveyance facilities to supply product water to other water-supply agencies, if necessary.

The proposed operation scheme is described below:

***Groundwater Production***. Produce 960 afy.

***Groundwater Treatment***. All groundwater production is treated at the P-20 well site to reduce nitrate concentrations.

***Distribution***. The product water is used by the City of Pomona through its existing distribution system or is supplied to other water-supply agencies via interconnections and/or exchanges.

***Water Rights***. Operation of the project may result in production that exceeds the annual OSY rights of the Four Basins. The exceedance of OSY rights can be addressed in the following ways:

- **Replacement**. The production that exceeds the OSY rights is replaced through wet-water recharge in the following year.
- **Temporary Surplus**. In wet years, groundwater produced under a Temporary Surplus would not be subject to replacement.

### 6.5.3 Construct New Production Wells

**Current Operations.** N/A.

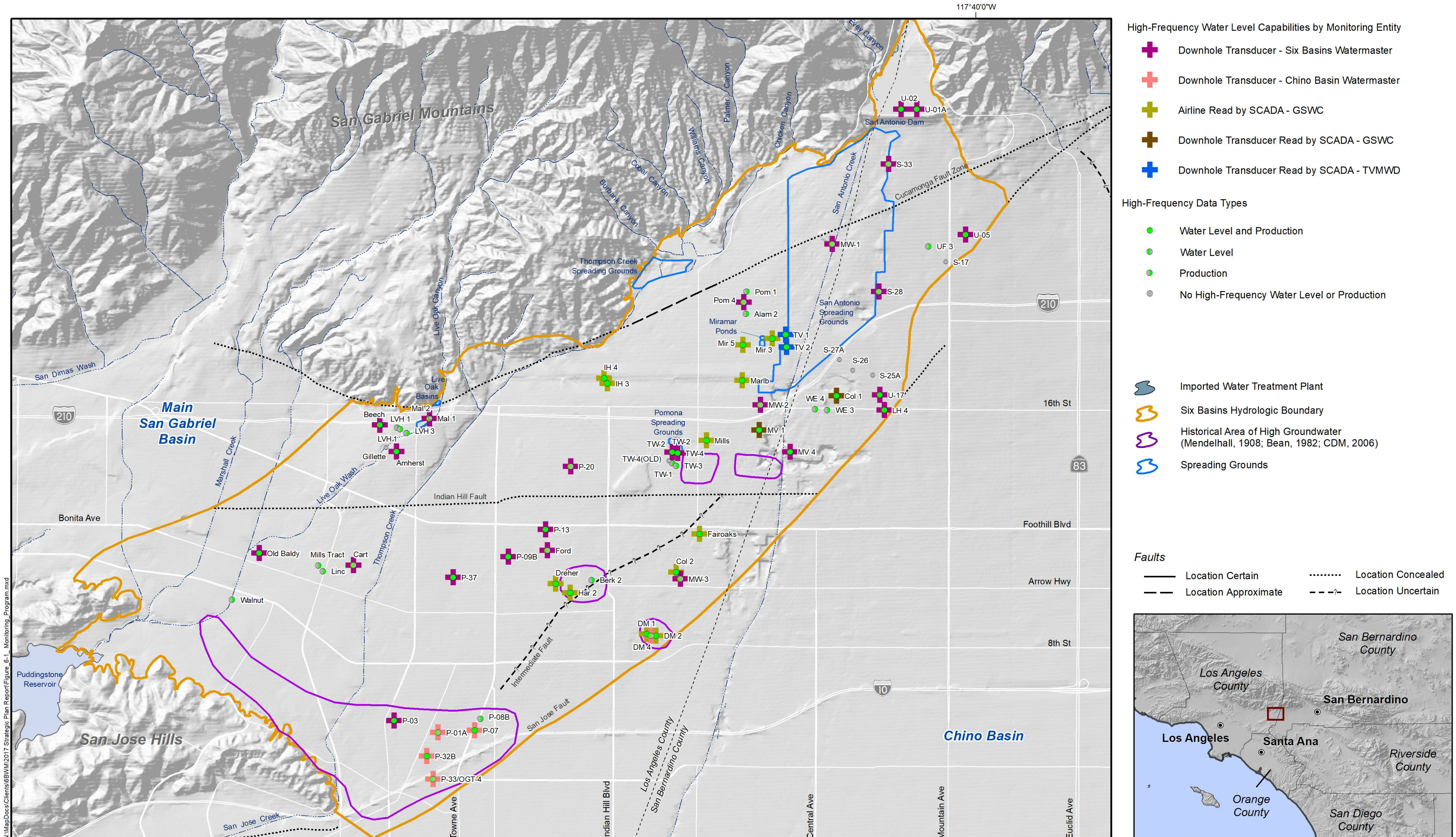
**Project Description.** The proposed project is to create surplus production capacity in the UCHB to maximize Temporary Surplus takes by constructing new production wells. However, given that Watermaster has yet to develop and test a plan to implement a Temporary Surplus utilizing existing well capacity, and the agencies do not yet have the interconnections to pump and deliver the Temporary Surplus to places of demand, there is no proposed scope of work for this project herein. This project should be revisited after the Watermaster has approved a plan to invoke a Temporary Surplus and it is demonstrated that additional capacity is needed.

## Table 6-1
## Proposed Projects that are Consistent with the Strategic Plan

| Project Description | Proposing Agency |
|---|---|
| **Pump and Treat** | |
| Treat groundwater and/or tie wells into Miramar system to deliver to high demand areas | TVMWD |
| Construct a regional treatment plant facility to pump and treat groundwater in the Pomona Basin | City of Pomona |
| Re-habilitate Durward well | GSWC |
| Re-habilitate Old Baldy well | City of La Verne |
| Expand treatment at Mills and Lincoln wells to participate in pump and treat | City of La Verne |
| Pump and treat in the Pomona Basin to exercise storage programs | SAWCo |
| **Recharge Improvements** | |
| Enhance recharge through storm-water (MS4 compliance) and supplemental water recharge projects | City of Claremont |
| Recycled water projects | City of Claremont |
| Enhance supplemental water recharge in the UCHB | Pomona College |
| SASG Upper Area: develop additional spreading basins to improve storm water recharge capability | TVMWD, City of Upland |
| SASG Lower Area: develop engineered spreading basins network to maximize imported water spreading | TVMWD, City of Upland |
| TCSG Investigate potential to deliver imported and recycled water behind Thompson Creek Dam and into TCSG | TVMWD |
| Improve Pomona/SAWCo infrastructure to better allow them to spread in SASG | TVMWD |
| Create "conservation pool" behind San Antonio Dam to conserve storm water for recharge in wet years | City of Upland |
| Improve TCSGs spreading basins to maximize storm water recharge | City of Upland |
| Recharge recycled water and storm water at LA County Fairplex | City of Pomona |
| Enhance storm water recharge at the Pedley Spreading Grounds | City of Pomona |
| Enhance recharge in the Pomona Basin through regional recharge projects | City of La Verne |
| Supplemental water recharge at the Live Oak Spreading Grounds | City of La Verne |
| **Temporary Surplus** | |
| Construct new production well in the Pomona Basin tomitigate high groundwater conditions and participate in a conjunctive-use program. | Pomona College |
| Utilize unused and seasonal production capacity in a coordinated manner to maximize production as recommended by CDM's 2010 study | TVMWD |
| Interconnect wells south of 210 Fwy to Benson feeder | TVMWD |
| Interconnect wells north of 210 Fwy to Miramar system | TVMWD |
| Interconnect treated water at WFA Agua de Lejos and TVMWD Miramar WTPs | TVMWD |
| Tie-in Upland and SAWCo wells | TVMWD |
| Develop new wells to increase extraction capabilities for Temporary Surplus | TVMWD |
| Participate in Temporary Surplus | Pomona College, TVMWD, City of Upland, and SAWCo |
| Enhance production in the CHB at Tunnel wells and/or P-20 | City of Pomona |
| **Conjuctive Use** | |
| Increase storage and recovery programs | SAWCo |

## Table 6-2
## Proposed Projects to Optimize Conjunctive Water Management

| PID | Project Description |
|---|---|
| **Pump and Treat** | |
| a | Increase Groundwater Production and Treatment Capacity at Reservoir 5 Treatment Facility |
| b | Increase Groundwater Production and Treatment Capacity at Lincoln/Mills Treatment Facility |
| c | Rehabilitate Del Monte 4 and Add Arsenic Treatment |
| d | Construct Durward 2 Well and a Wellhead Treatment Facility |
| e | Rehabilitate Old Baldy Well and Construct Wellhead Treatment Facility |
| **Recharge Improvements** | |
| f | Enhance Stormwater Recharge at the San Antonio Spreading Grounds |
| g | Enhance Supplemental-water Recharge at the SASG |
| h | Enhance Stormwater Recharge at the Thompson Creek Spreading Grounds |
| i | Supplemental-water recharge at the TCSG |
| j | Enhance Stormwater Recharge at the Pedley Spreading Grounds |
| k | Recharge Stormwater and Supplemental Water at the LA County Fairplex |
| n | Enhance Stormwater Recharge through MS-4 Compliance |
| o | Create a Conservation Pool Behind San Antonio Dam |
| **Temporary Surplus** | |
| l | Construct Interconnections |
| m | Rehabilitate P-20 and a Wellhead Treatment Facility |
| p | Construct New Production Wells |




Prepared by:

WEI
Wildermuth Environmental, Inc.

Author: CS
Date: 20170925

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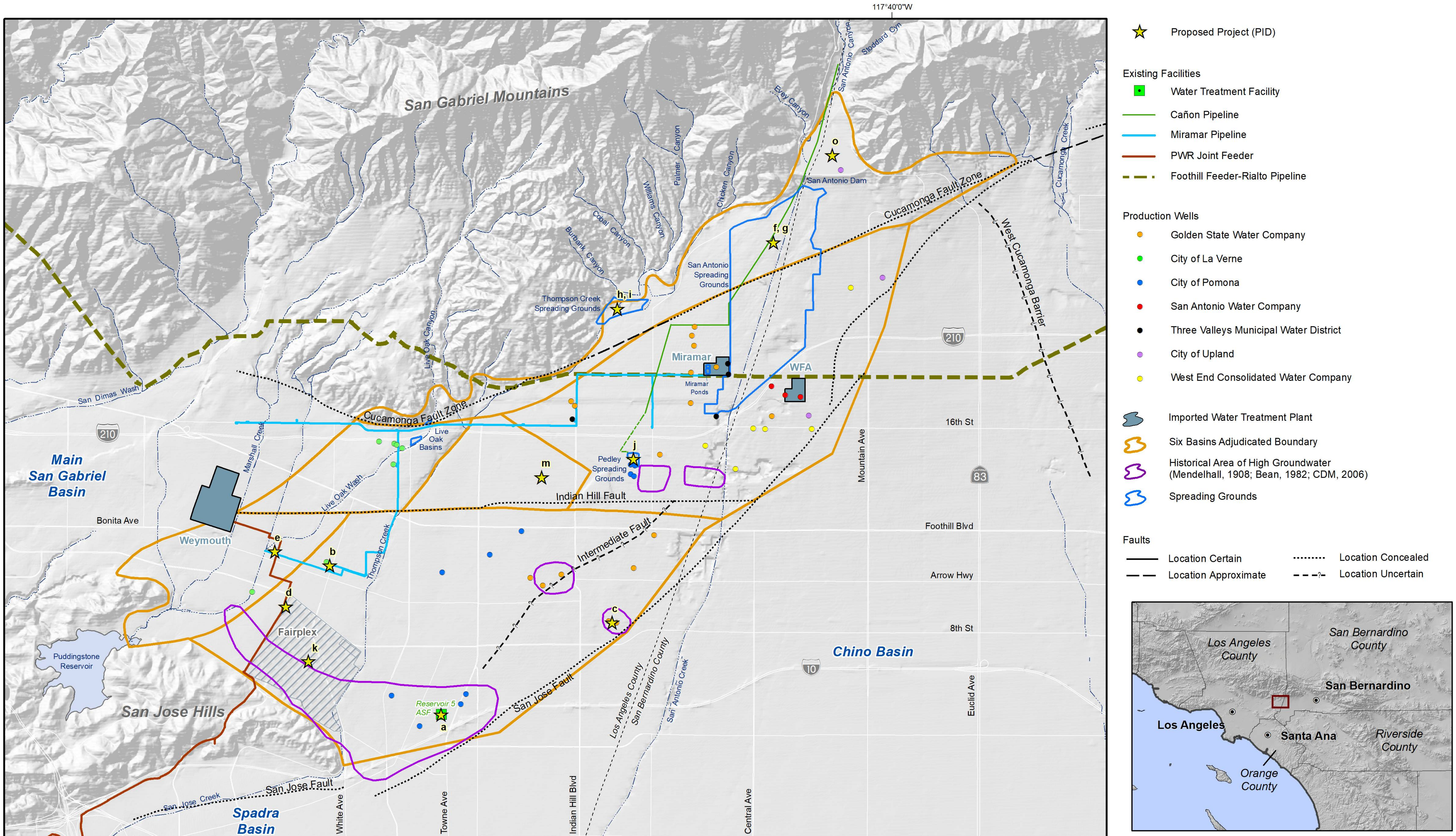
0 1 2 Kilometers

Six Basins Watermaster
**Strategic Plan for the Six Basins**

**Expanded Groundwater Monitoring Network**
*2016 Implementation*

**Figure 6-1**

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Author: CS
Date: 20170925
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Six Basins Watermaster
**Strategic Plan for the Six Basins**

**Projects to Optimize Conjunctive Water Management**
*Location Map*

**Figure 6-2**

This section describes the role of the Watermaster in implementing the Strategic Plan and the activities that will be performed to fulfill this role. Section 7 was published in October 2017.

## 7.1 Role of the Six Basins Watermaster in Implementing the Strategic Plan

The Six Basins Watermaster has developed and will support the implementation of the Strategic Plan. However, the Watermaster will not construct and operate the individual projects; the projects will be implemented by the Parties or other stakeholders, subject to Watermaster review and approval (if approval is required by the Judgment). To support the implementation of the Strategic Plan, the Watermaster must:

1. Support the programmatic environmental review of the Strategic Plan under CEQA, including:
    a. develop and evaluate a range of conjunctive water management scenarios to "bookend" the potential scales of operations;
    b. provide other as-needed technical support to the Lead Agency and CEQA consultant to characterize the Six Basins and the Strategic Plan projects; and
    c. provide a forum for the Parties, interested stakeholders and the public to participate in the CEQA process.
2. Develop an updated Operating Plan for:
    a. Storage and Recovery Agreements;
    b. Special Projects; and
    c. Temporary Surplus.
3. Develop and publish standardized planning criteria for project planning.
4. Provide technical support to project proponents and their consultants.
5. Review and approve projects under Watermaster jurisdiction, if required.
6. Continue to implement and expand its groundwater and surface-water monitoring programs, as necessary.

The following sections describe these implementation actions in greater detail.

## 7.2 Support Programmatic Environmental Review of the Strategic Plan

CEQA requires that any public agency making a decision on a project (*e.g.* to approve, permit, implement) must first consider the project's potential environmental impacts and evaluate mitigation measures, if appropriate. It also requires that the cumulative environmental effects and impacts of all known projects be considered when evaluating the project and the need for mitigation measures. The project description and the assessment of the environmental impacts are documented in an Environmental Impact Report (EIR). The EIR must be certified by the Lead Agency taking action on the project.

The optimal way to evaluate the environmental impacts of the Strategic Plan projects under CEQA is to evaluate them cumulatively in a Programmatic Environmental Impact Report (PEIR). A PEIR is beneficial to all the Watermaster Parties because they can then use the information developed in the PEIR to: streamline their project-specific environmental reviews; obtain Watermaster approval, when required; and identify any mitigation measures required to minimize the cumulative environmental impacts of the Strategic Plan. This information will also enable to parties to better characterize and allocate the costs and benefits of the projects and any mitigation measures. Watermaster will support the development of the PEIR by providing technical and administrative support to the Lead Agency and its CEQA consultant. This includes performing new technical work to develop and evaluate a range of conjunctive water management scenarios to "bookend" the potential scales of operation.

In the draft Strategic Plan report (WEI, 2015 – see also Section 5 of this report), a single conjunctive water management project was described and evaluated, which included a 36,000 acre-foot dry-year storage account in the Pomona Basin. This project was just one potential size and operational scheme. Some or all of the Strategic Plan projects described herein in Section 6 will enable the development and implementation of a conjunctive water management program, and will provide a basis for developing its scale and operation. Thus, to support the PEIR, Watermaster will perform the technical work to:

- Define the potential range of volumes for a dry-year storage account in the Pomona Basin. The criteria to define this volume include: total pumping capacity in the Pomona Basin including new pump-and-treat facilities, target volumes for offsetting imported water (*e.g.* as percent of imported water demand), and the number of dry years the account should be able to support.
- Define the operating scheme for when and how to put, hold, and take water in and out of the storage account. This will involve defining the sources of water and the methods for recharge during puts, and the methods of extractions for takes.
- Evaluate and refine the scale of the dry-year storage program and the operating scheme using the Watermaster's groundwater model to assess the physical impacts of the project and the need for mitigation.

This work will be published as part of the PEIR and as an addendum to this Strategic Plan report.

## 7.3 Develop Updated Operating Plans for Storage and Recovery Agreements, Special Projects and Temporary Surplus

To enable the Parties to effectively plan and implement projects, the Watermaster must have clear operation plans and rules for: entering into Storage and Recovery Agreements which define the operating and accounting rules; reviewing and approving Special Projects; and declaring a Temporary Surplus. These rules and regulations must be developed and implemented based on sound technical evaluations. Prior to developing the updated operating plans and rules, Watermaster will use its groundwater model to:

- Estimate the physical storage space available for new Storage and Recovery Agreements and evaluate the current storage and recovery operations. This information will be used to develop a draft and final operating plan for storage recovery agreements, and to update existing storage and recovery agreements, if appropriate and agreeable to those holding the existing agreements.

- Determine the amount of water potentially available for production through the Special Projects provision of the Judgment (*i.e.* free of replacement obligation) and to develop a policy for reviewing and approving applications for Special Projects.

- The modeling results of (1) and (2) above will be used to develop an operating scheme to invoke a Temporary Surplus.

## 7.4 Develop and Publish Standardized Planning Criteria for Project Planning

The agencies have finite resources and may not be able to implement or participate in all of the projects described herein. The agencies require the best possible information on economics and project benefits to determine how best to spend their limited resources. To ensure consistency in evaluating project economics and assigning costs and benefits for project construction and operation agreements, Watermaster will work with an engineering consultant to prepare a standard criteria document for use by project proponents and their consultants. The information will be made available on Watermaster's website and updated periodically, as deemed necessary.

## 7.5 Provide Technical Support to Project Proponents

Through the development of the Strategic Plan, the Watermaster has expanded and improved its technical and analytical tools for assessing the physical state of the Six Basins and evaluating the physical impacts of projects. To support the implementation of the Strategic Plan, Watermaster will include funds in its annual Operating Budget to provide as-needed support for project planning efforts performed by the Parties or other project proponents, such as respond to data and information requests, attend meetings, and provide recommendations for project operations to ensure that the project planning is consistent with the Strategic Plan. Ensuring that all projects implemented as part of the Strategic Plan are consistent with its goals is to the benefit of all Watermaster Parties.

## 7.6 Review and Approve Projects under Watermaster Jurisdiction

As projects are developed, the projects may require review and approval by the Watermaster. This could include performance of Substantial Injury analyses; review and approval of new storage and recovery agreements; and review and approval of applications for Special Projects. Watermaster will include funds in its annual Operating Budget to perform such reviews and approvals to ensure that the projects are consistent with the Strategic Plan, the Watermaster Operating Plan, and the Judgment.

## 7.7 Continue to Implement Watermaster Data Collection and Monitoring Programs

The objectives of the Watermaster's cooperative data collection and monitoring programs are to support the implementation of the Judgment, improve the understanding of the Six Basins hydrogeology, and support the implementation of the Strategic Plan projects. Data from the monitoring program will be evaluated annually in the fall by Watermaster staff. Based on the evaluation, Watermaster staff will recommend modifications to the monitoring program, if any, which may include new monitoring facilities and/or techniques to achieve the objectives of the program and to maximize monitoring efficiencies. The recommendations will include cost estimates to support Watermaster's budgeting process for the subsequent calendar year. A description of the monitoring program, and any changes made to it, will be included in the Annual Report of the Six Basins Watermaster, which is typically published in March of each year. All data collected will be made available to the Parties, or interested stakeholders, upon request, to support the development and implementation of projects or other capital improvements.

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## Appendices (CD)