FINAL | December 2023

Puente Basin Groundwater Management Plan

Technical Memorandum 1: Description of the Puente Basin Groundwater Management Plan Area and Basin Setting

PREPARED FOR

Puente Basin Water Agency
established 1971

PREPARED BY

West Yost
Water. Engineered.

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Prepared for

Puente Basin Water Agency

Project No. 1032-80-22-01

12/4/2023

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12/4/2023

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LIST OF ACRONYMS AND ABBREVIATIONS

µgl	Micrograms Per Liter
af	Acre-Feet
afy	Acre-Feet Per Year
AGR	Agricultural Supply
Annual Report	Annual Report for The Elsinore Valley Subbasin
CASGEM	California Statewide Groundwater Elevation Monitoring
CDFM	Cumulative Departure from Mean
cis-1,2-DCE	cis-1,2-dichloroethylene
CRA	Colorado River Aqueduct
CVP	Central Valley Project
DDW	State Water Resources Control Board Division of Drinking Water
DIPAW	Deep Infiltration of Precipitation and Applied Water
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
ET	Evapotranspiration
ft	Foot or Feet
ft/d	Feet Per Day
ft-amsl	Feet Above Mean Sea Level
ft-bgs	Feet Below Ground Surface
fy	Fiscal Year
GDE	Groundwater Dependent Ecosystem
GIS	Geographic Information System
gpm	Gallons Per Minute
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GMP	Groundwater Management Plan
IND	Industrial Service Supply
Industry Successor Agency	Successor Agency to the Industry Urban Development Agency
InSAR	Interferometric Synthetic-Aperture Radar
Judgment	Puente Basin Judgment
LA Basin Plan	Water Quality Control Plan Los Angeles Region
LA Regional Board	California Regional Water Quality Control Board Los Angeles Region
LAC	Los Angeles County Public Works Department
LACDPW	Los Angeles County Department of Public Works
LACSD	Los Angeles County Sanitation Districts
LADPH	Los Angeles Department of Public Health
MCL	Maximum Contaminant Limit
Metropolitan	Metropolitan Water District of Southern California
mgd	Million Gallons Per Day
mgl	Milligrams Per Liter
MUN	Municipal and Domestic Supply
NCCAG	Natural Communities Commonly Associated with Groundwater

NEXRAD	Next-Generation Radar
NL	Notification Level
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OSY	Operating Safe Yield
PBWA	Puente Basin Water Agency
PCE	Tetrachlorethylene
PFAS	Polyfluoroalkyl Substances
PHG	Public Health Goal
PRISM	PRISM Climate Group
PROC	Industrial Process Supply
QA/QC	Quality Assurance and Quality Control
Recycled Water Policy	State 2009 Policy for Water Quality Control for Recycled Water
RWD	Rowland Water District
SCAG	Southern California Association of Governments
SGMA	Sustainable Groundwater Management Act
SNMP	Salt And Nutrient Management Plan
State Water Board	State Water Resources Control Board
SWP	State Water Project
TCE	Trichlorethylene
TDS	Total Dissolved Solids
TM	Technical Memorandum
TVMWD	Three Valleys Municipal Water District
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
UWMPs	Urban Water Management Plans
VOC	Volatile Organic Compounds
WDR	Waste Discharge Requirements
WEI	Wildermuth Environmental, Inc.
WQS	Water Quality Standard
WRD	Water Replenishment District of Southern California
WRP	Water Reclamation Plant
WRRs	Water Reclamation Requirements
WTP	Water Treatment Plant
WVWD	Walnut Valley Water District

Description of the Puente Basin GMP Area and Basin Setting

1.0 INTRODUCTION

The Puente Basin is a small groundwater basin located between the San Jose and Puente Hills in eastern Los Angeles County in Southern California that is approximately 20 square miles (12,800 acres). In 1971, the Puente Basin Water Agency (PBWA) was formed as a joint powers authority between the Walnut Valley Water District (WVWD) and the Rowland Water District (RWD) to oversee the protection and utilization of local, imported, and recycled water within the Puente Basin. The following year in 1972, the PBWA entered into the Puente Narrows Agreement with the Upper San Gabriel Valley Municipal Water District to ensure that water management activities in the Puente Basin do not interfere with the subsurface groundwater outflow from the Puente Basin to the adjacent Main San Gabriel Basin. In 1986, the pumping rights in the Puente Basin were adjudicated pursuant to the Puente Basin Judgment (Judgment) which set a physical solution for the management of the Basin. The Judgment provided for the creation of the Puente Basin Watermaster to administer the Judgment and manage the Basin in accordance with the Physical Solution. Groundwater in the Puente Basin is pumped by five "Primary Parties" that are parties to the Judgment, including the WVWD and RWD, and the water is primarily used as a non-potable supply.

In 2022, the PBWA initiated the process to develop a Groundwater Management Plan (GMP) for the Puente Basin to enhance the management of the Puente Basin beyond the execution of the Judgment and the Puente Narrows Agreement. The primary objectives of the GMP are to maximize the beneficial use of the Puente Basin, optimize the groundwater supply in conjunction with other available water supplies, and decrease dependence on less reliable imported water supplies. The GMP is being development in three Phases:

- **Phase 1 – Describe the State of the Puente Basin and Establish GMP Goals**. The objective of this phase is to develop an understanding of the physical state of the basin and articulate stakeholder goals for improved management of the Puente Basin. To achieve this objective, this phase includes:
  - Establishing the stakeholder group and the stakeholder process.
  - Preparing a detailed description of the physical conditions and water-management setting of the Puente Basin, for both historical and current conditions. A solid understanding of the Puente Basin is essential for the PBWA and stakeholder education and developing consensus on the goals for basin management.
  - Preparing a description of the goals for improved management of the Puente Basin.
- **Phase 2 – Evaluate Alternatives for Basin Management**. The objective of this phase is to define and evaluate management alternatives and select a preferred management alternative that will become the GMP for the Puente Basin. To achieve this objective, this phase includes:
  - Developing modeling tools to evaluate the physical impacts of the basin-management alternatives. These tools may include a surface-water model, groundwater model, and a water-supply cost model. The scope and complexity of the tools needed to evaluate the alternatives will be determined based on the results and recommendations of Phase 1.
  - Defining and evaluating the "Baseline Scenario" which represents the current water-supply plans and groundwater management activities in the Puente Basin over a defined planning horizon.

  - Defining and evaluating several "Management Alternatives" over a defined planning horizon. Each alternative will include a mix of one or more projects or programs to enhance groundwater management and achieve the goals defined in Phase 1.
  - Selecting a preferred Management Alternative for the GMP.
- **Phase 3 – Prepare GMP and Implementation Plan**. The objective of this phase is to publish a final GMP for the Puente Basin, which will include:
  - A description of all work performed to prepare the final GMP.
  - A GMP Implementation Plan, which will include:
    - A description of the elements of the management plan
    - A description of the roles of the PBWA, its member agencies, and other stakeholders in GMP implementation.
    - An opinion on the need for programmatic environmental review.
    - A description of the institutional and regulatory arrangements that will be necessary for GMP implementation.
    - An implementation schedule and cost estimates.
    - A description of potential funding sources.

This *Technical Memorandum 1 – Conceptual Understanding of the Puente Basin* (TM-1) provides a detailed description of the physical conditions and water-management setting of the Puente Basin, for both historical and current conditions. The remainder of TM-1 is organized as follows:

- **Section 2.0 GMP Area.** This section provides an overview of existing jurisdictions and existing management programs, including the Puente Narrows Agreement and Judgment; and describes the wells, monitoring programs, land use, and water supplies of the Basin.
- **Section 3.0 Basin Setting.** This section describes the surface-water and groundwater hydrology of the Puente Basin over a long-term historical period through current conditions, including the identification of data gaps and uncertainty in the hydrogeologic conceptualization.

2.0 GMP AREA

The GMP Area is a description of the geographic area for the GMP and the interaction of the GMP with existing jurisdictions, monitoring and management plans, and land uses. The GMP Area description includes the following elements:

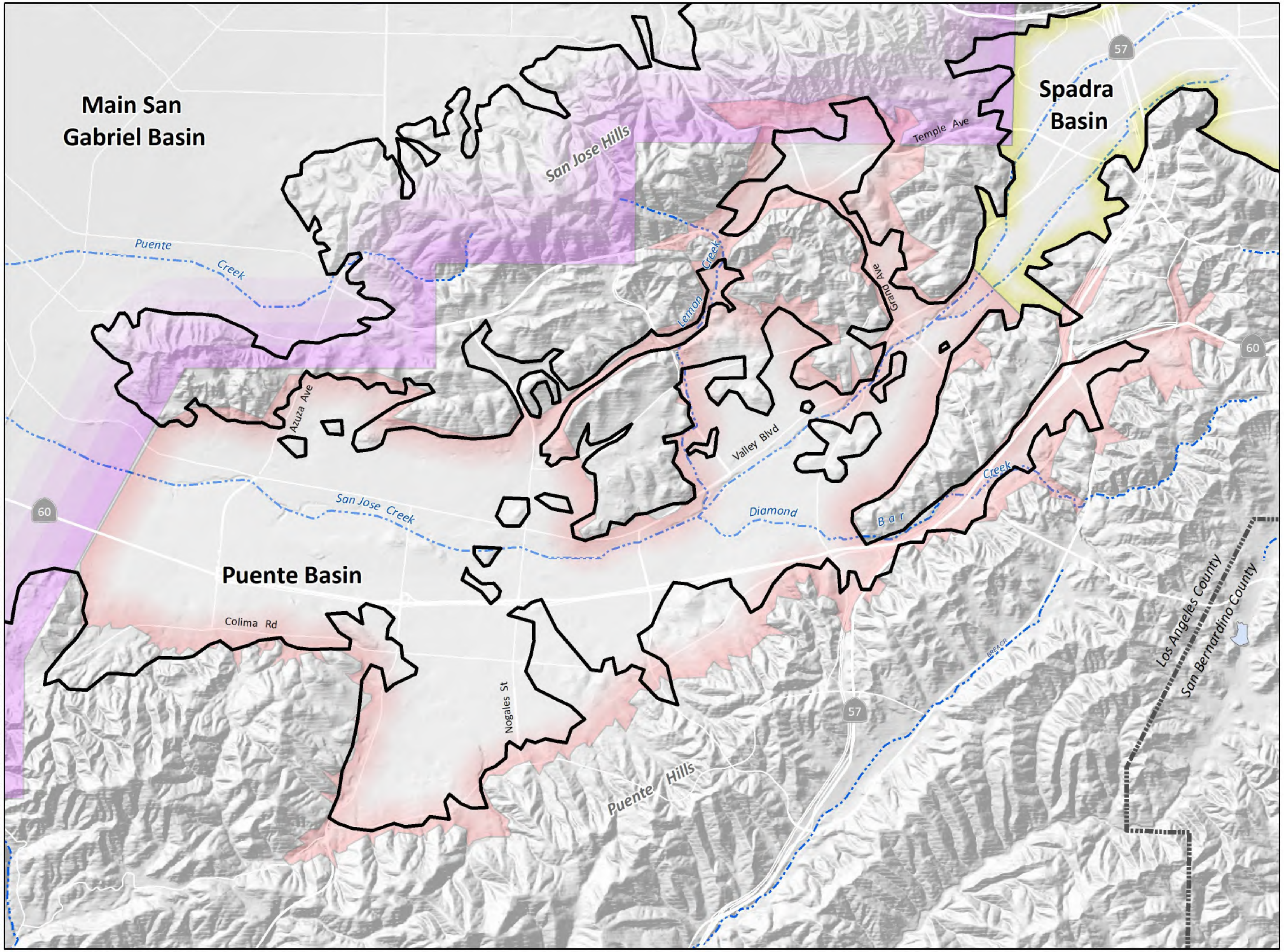
- A description of jurisdictional areas and other features.
- A description of the existing groundwater management programs.
- A description of the existing wells and monitoring.
- A description of historical and current land use, water use, and water disposal.
- Water demands and water supply plans.

2.1 Jurisdictional Area and Other Features

Figure 2-1 shows the location of the Puente Basin. It is located in the eastern portion of the San Gabriel Valley Basin, Basin No. 4-013 as defined by California Department of Water Resources (DWR) in *Bulletin 118 California's Groundwater Update 2020.* (DWR, 2021). The inset map in Figure 2-1 shows the location of the San Gabriel Valley Basin. The Puente Basin boundary shown on Figure 2-1 is the boundary defined in the Judgment. The eastern boundary of the Puente Basin is the western boundary of the unadjudicated Spadra Basin. The western boundary of the Puente Basin is the eastern boundary of the adjudicated Main San Gabriel Basin.

Figure 2-2 shows the location of the water purveyors within the Puente Basin boundary. WVWD and RWD are the primary local water purveyors that pump Puente Basin groundwater and their service area boundaries overly most of the Basin. WVWD's service area generally overlies the eastern portion of the Puente Basin and extents to the east into Spadra Basin. RWD's service area generally overlies the western portion of the Puente Basin and extends outside the Puente Basin to the south towards the Puente Hills. WVWD and RWD obtain water supplies from multiples sources including groundwater, treated imported water delivered from the State Water Project and Colorado River Aqueduct, and recycled water. WVWD and RWD purchase imported water from the Three Valleys Municipal Water District (TVMWD), a sub-agency of the Metropolitan Water District of Southern California (Metropolitan). The inset map in Figure 2-2 shows the TVMWD service area in relation to the Puente Basin. There are multiple water purveyors with service area boundaries that overly small portions along the fringes of the Puente Basin, including La Puente Valley County Water District, City of West Covina Water Department, Suburban Water Systems, Mt San Antonio College, California State Polytechnic University of Pomona, La Habra Heights County Water District, and Golden State Water Company - San Dimas. These water purveyors do not utilize the Puente Basin as a source of water supply.

Figure 2-2 also shows the location of cities and unincorporated communities of the Los Angeles County within and immediately adjacent to the Puente Basin, which include portions of the Cities of Walnut, Diamond Bar, Industry, La Puente, and West Covina; and portions of the unincorporated communities of Rowland Heights, South San Jose Hills, and Hacienda Heights. WVWD serves customers in the City of Diamond Bar, and portions of the City of Walnut, City of Industry, City of Pomona, and Rowland Heights. RWD serves customers in portions of the City of Industry, City of La Puente, City of West Covina, South San Jose Hills, Rowland Heights and Hacienda Heights.



DWR Bulletin 118 California Groundwater Basin Boundaries

San Gabriel Valley Basin No. 4-013

Groundwater Basin Boundaries

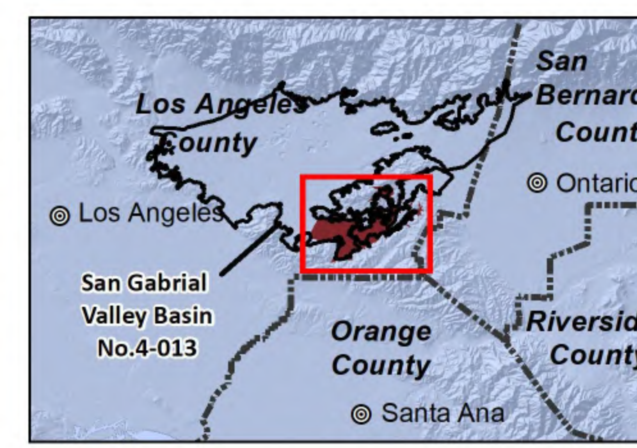
Puente Basin (Adjudicated)

Main San Gabrial Basin (Adjudicated)

Spadra Basin

Hydrologic Features

Streams & Flood Control Channels



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0 1 2 Miles

0 1 2 Km

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Puente Basin Water Agency

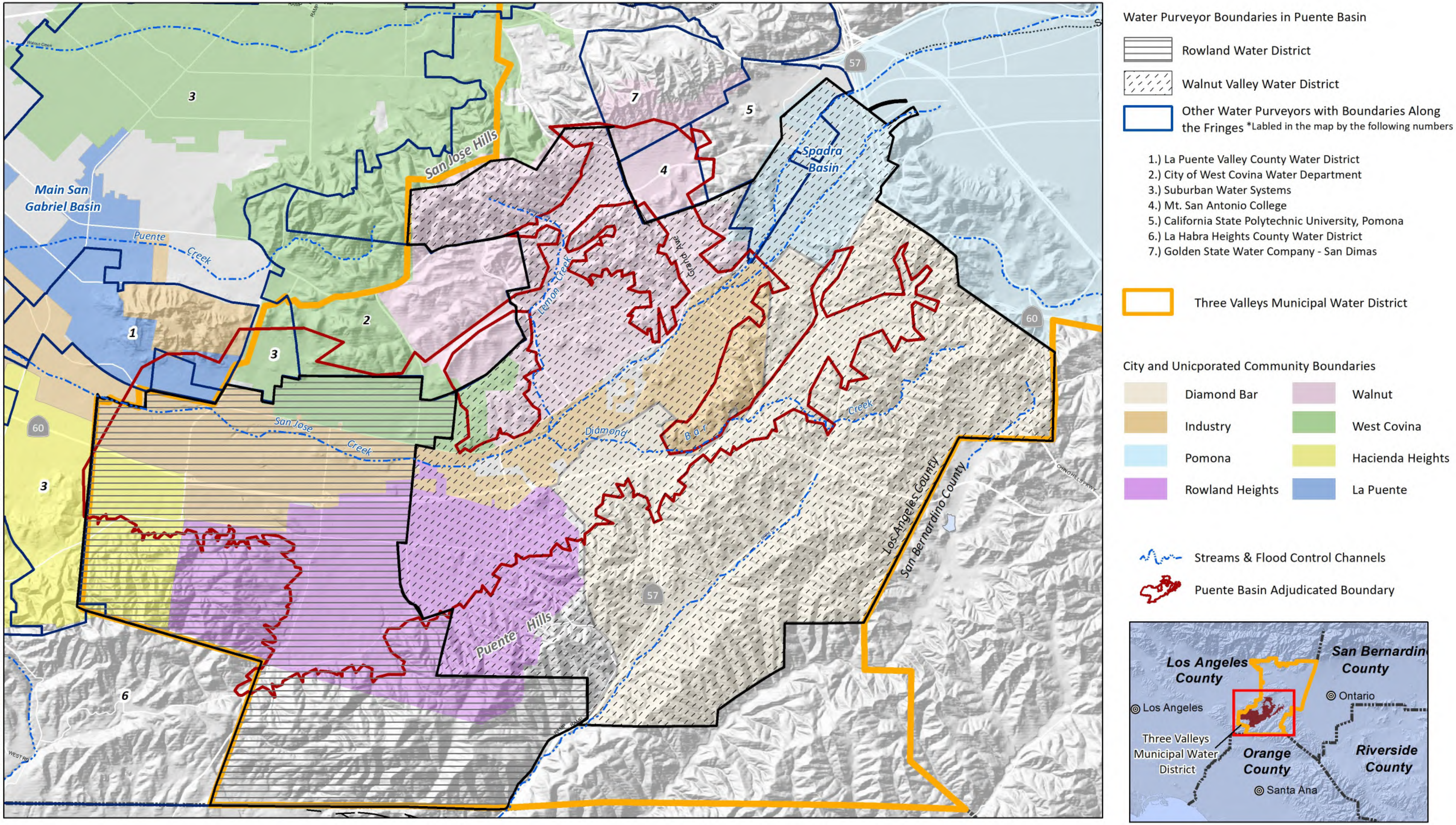
Groundwater Management Plan

TM-1 Description of Plan Area and Basin Setting

PUENTE BASIN WATER AGENCY established 1971

Puente Basin and Nearby Groundwater Basins

Figure 2-1



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Groundwater Management Plan
TM-1 Description of Plan Area and Basin Setting

PUENTE BASIN WATER AGENCY established 1971

Water Purveyors and Jurisdictional Boundaries in the Puenta Basin Area

Figure 2-2

2.2 Existing Management Programs

2.2.1 Puente Narrows Agreement

Soon after the PBWA was formed by the WVWD and RWD, the PBWA entered into the Puente Narrows Agreement on May 8, 1972 with the Upper San Gabriel Valley Water District to ensure that the water management activities within the Puente Basin would not interfere with the surface flows in San Jose Creek or impair subsurface outflow from the Puente Basin to the adjacent Main San Gabriel Basin. The Puente Basin Narrows agreement was developed as part of the adjudication process for the Main San Gabriel Basin and is included as Exhibit J of the Judgment in the *Upper San Gabriel Valley Municipal Water District v. City of Alhambra, et al. Superior Court of the State of California for the County of Los Angeles, Case No. 924128*, filed January 2, 1968 (San Gabriel Basin Judgment).

Per the Puente Narrows Agreement, the PBWA is obligated to ensure: 1) an average "Base Underflow" of 580 acre-feet per year (afy) from Puente Basin to the Main San Gabriel Basin through the Puente Narrows; and 2) that PBWA or entities within its boundaries do not interfere or utilize natural surface runoff flows within the San Jose Creek.

The Puente Narrows Agreement defines engineering criteria to measure and calculate underflow through the Puente Narrows, which designates two specific wells to be measured for groundwater elevations; the Tony Poli well (2S/10W-9Q) in the Puente Basin and Puente Narrows well (2S/10W-8E3) in the Main San Gabriel Basin (see Figure 2-4 for locations),which are used to compute the underflow volume. The Puente Narrows Agreement calls for a two member Puente Narrows Watermaster, with one engineering consultant selected by PBWA and the other by the Upper San Gabriel Valley Water District, to calculate subsurface flow, report on any interference with surface flows in San Jose Creek, and perform perpetual accounting and reporting in accordance with the agreement.

Each year, based on the calculated underflow, the PBWA is credited or debited in the amount of annual underflow that is above or below PBWA's 580 afy obligation, and credited or debited based on interference with surface water flows. A report is prepared to document the annual and accumulated credits/debits in meeting the obligation to the Upper San Gabriel Valley Water District. The most recent annual report prepared by the Puente Narrows Watermaster is for Fiscal Year (FY) 2022/23 (Stetson, 2023). The underflow calculation, history of underflow calculation results, and the accumulated credits and debits of the PBWA are described in Section 3.2.13.

On November 30, 1989, the PBWA and Upper San Gabriel Valley Water District entered into the Agreement Re: Determination of Impact of "Clean-up" Production by Carrier Corporation Upon "Subsurface Outflow" Under Puente Narrows Agreement (Clean-up Production Agreement). This agreement gives credit to the PBWA for the clean-up pumping by Carrier BDP Corporation in the Puente Basin that is then discharged to the San Jose Creek (not delivered to RWD) less discharges to the sanitary the sewer, evaporative losses, and unusable flow that makes it to the ocean. The cleanup pumping credit accounting is incorporated with the annual and accumulated accounting of underflow credits and debits by the Puente Narrows Watermaster and is also included in the discussion in Section 3.2.13.

2.2.2 Puente Basin Judgment.

On June 1, 1981, a complaint was filed by PBWA as plaintiff to determine the right to pump groundwater from the Puente Basin. The principal defendants were the City of Industry, Industry Urban Development Agency (now known as the Successor Agency to the Industry Urban Development Agency [Industry Successor Agency]), and Los Angeles Royal Vista Golf Course (Royal Vista Golf Course). The original complaint named multiple other defendants that were later dismissed because they either do not pump groundwater from the Puente Basin or were given the status of minimum water users. On May 30, 1986 the pumping rights for the Puente Basin for Principal Parties were adjudicated through a Judgment entered into the Superior Court of the State of California for the County of Los Angeles, entitled *Puente Basin Water Agency, a joint powers agency, et. al vs. City of Industry, a municipal corporation, et al*. Case No. C 369 220. The Principal Parties include the WVWD, RWD, City of Industry, Industry Successor Agency, and Royal Vista Golf Course. The Judgment prescribes a physical solution for the management of the Puente Basin to be managed and administered by the court-ordered Puente Basin Watermaster. The Puente Basin Watermaster is a three-member body that consists of one appointee nominated by WVWD and RWD, one appointee nominated by the City of Industry and Industry Successor Agency, and one appointee nominated jointly by the other two Watermaster appointees.

The Judgment defined a "Declared Safe Yield" for the Puente Basin as 4,400 afy and assigned a share of the safe yield to each of the Principal Parties. Pursuant to the Judgment, annual pumping from the Basin is managed on an Operating Safe Yield that is determined annually by the Puente Basin Watermaster. The Judgment indicates that the Puente Basin Watermaster consider criteria to determine an Operating Safe Yield that maintains water levels that will in turn maintain an accrued credit of 1,000 af for the Puente Narrows underflow obligation. Historically, the Operating Safe Yield has ranged from 1,000 afy to 3,400 afy. The Principal Parties share of the Operating Safe Yield is 306 afy for Royal Vista Golf Course, and the remaining Operating Safe Yield is divided equally amongst the four other Principal Parties (WVWD, RWD, City of Industry, and Industry Successor Agency). The minimum water users are limited by the Judgment to pumping three af or less per year.

Pumping in excess of a Principal Party's annual pumping right is categorized in two ways:

- Allowable Excess Pumping, which is up to ten percent of the Pumper's share of the annual Operating Safe Yield; or
- Unauthorized Excess Pumping, which is charged against pumping for the following year and may be subject to other remedies as deemed appropriate by the Court.

In addition to each Principal Party's share of the Operating Safe Yield, the following additional pumping rights are provided by the Judgment:

- Return Flow Credits for imported waters delivered and applied for use on lands overlying the Puente Basin (both for imported surface water from Metropolitan or recycled water from Los Angeles County Sanitation Districts [LACSD]). A Return Flow Credit is allocated to the Primary Pumpers who import and apply these waters in the Puente Basin that are in excess of the quantity imported in fiscal year (FY) 1984/85. The Primary Pumpers are jointly issued a Return Flow Credit for use in the succeeding year. The RWD and WVWD are the Primary Pumpers who import and apply these waters in the Puente Basin.
- Carry-over Rights for underproduced rights. The portion of a Primary Pumper's Operating Safe Yield that is not pumped in a given year can be carried over to the succeeding year. These Carry-over Rights are entitled to be used first in the succeeding year and will be lost if not used that year.

The Judgment charges the Puente Basin Watermaster with performing the following duties:

- On or before the first Monday in April, make a preliminary determination of Operating Safe Yield for the succeeding five years.
- On the first Monday in May, hold a hearing to receive comments from Primary Pumpers on the preliminary Operating Safe Yield and determine the final Operating Safe Yield.
- Sixty days prior to July 1, prepare a tentative operating budget for the succeeding FY.
- Within three months of the end of the FY, notify the Court and Principal Parties of the annual pumping rights and components thereof.

Allowable excess pumping, unauthorized excess pumping, return flow credits for imported waters delivered and applied for use on lands overlying the Puente Basin, and Carry-over Rights for underproduced rights are all tracked on an annual basis, and over time, in the Puente Basin Watermaster Annual Reports.

2.2.3 Sustainable Groundwater Management Act

The DWR designates the San Gabriel Valley Groundwater Basin (DWR Basin No. 4-13) as a “low-priority” basin since most of the subbasins, including the Puente Basin, have been adjudicated. The California Sustainable Groundwater Management Act (SGMA) of 2014 named the Puente Basin as an adjudicated groundwater basin that is exempt from the SGMA requirements to develop a Groundwater Sustainability Plan, and the basin is also exempt from the requirements as a low-priority basin. Pursuant to SGMA requirements for adjudicated basins (California Water Code Section 10720.8(f)), the Puente Basin Watermaster prepares and submits annual reporting data and information to the DWR on annual pumping, water use, groundwater levels, and change in storage.

2.2.4 Urban Water Management Plans

Pursuant to requirements in the California Water Code (§10610 – §10656 and §10608), Urban Water Management Plans (UWMPs) are prepared every five years by urban water purveyors who serve more than 3,000 customers or supply more than 3,000 afy of water. These plans support the water purveyors’ long-term resource planning to ensure that adequate water supplies are available to meet existing and future water needs of the service area. Puente Basin groundwater is described as a non-potable water supply in the WVWD and RWD 2020 UWMPs as follows:

- **Walnut Valley Water District 2020 Urban Water Management Plan** (Stetson Engineers, 2021). WVWD pumps groundwater in the Puente Basin to supplement the District’s non-potable water system in combination with recycled water supply.
- **Rowland Water District 2020 Urban Water Management Plan** (Stetson Engineers, 2021). RWD uses groundwater pumped in the Puente Basin to augment recycled water supplies.

2.2.5 LA Basin Plan

The responsibility for protecting water quality in California rests with the State Water Resources Control Board (State Water Board) and its nine Regional Water Quality Control Boards, who set policies and develop water quality control plans for their respective regions. The Puente Basin is within the jurisdiction of the Los Angeles Regional Water Quality Control Board (LA Regional Board), which has developed the *Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watershed of Los Angeles and Ventura Counties* (LA Basin Plan) pursuant to state and federal water quality statues and regulations to preserve and enhance water quality and protect beneficial uses of all regional waters in the Los Angeles Region (LA Regional Board, 2019). Specifically, the Basin Plan (i) designates beneficial uses for surface and groundwaters, (ii) sets objectives that must be attained or maintained to protect the designated beneficial uses and conform to the State's Antidegradation Policy, and (iii) describes implementation programs and other actions that are necessary to achieve the water quality objectives established in the Basin Plan. The Puente Basin is part of the Bulletin 118 San Gabriel Valley Basin which has the following designated beneficial uses for groundwater indicated in Chapter 2, Table 2-2 of the LA Basin Plan:

- Municipal and Domestic Supply (MUN)
- Industrial Service Supply (IND)
- Industrial Process Supply (PROC)
- Agricultural Supply (AGR)

The State's policies and plans are based on the State Water Board's Antidegradation Policy (Resolution 68-16), which restricts the degradation of surface water or groundwater quality to protect their beneficial uses. Chapter 3 of the LA Basin Plan includes narrative water-quality objectives for regional groundwaters and specific numerical objectives for sub-basins in the region. The LA Basin Plan contains numeric water-quality objectives for the Puente Basin to maintain the designated beneficial uses and conform to the State's Antidegradation Policy. The Antidegradation Policy is implemented, in part, through Waste Discharge Requirements (WDRs) issued by the Regional Boards. In the Puente Basin, this includes the reclamation requirements for dischargers to groundwater from recycled water reuse from the LACSD's Pomona Water Reclamation Plant (WRP) and South San Jose Creek WRP.

The LA Basin Plan includes salt and nutrient management plans (SNMPs) for groundwater basins in the Los Angeles Region, that were developed pursuant to the State Water Board's 2009 *Policy for Water Quality Control for Recycled Water* (Recycled Water Policy). The Recycled Water Policy requires that an SNMP be prepared by local water and wastewater agencies for all groundwater basins in the State to address: the potential for salt and nutrient degradation in groundwater from all sources, the potential impairment of beneficial uses, and to support recycled water reuse programs. Pursuant to this requirement, the Main San Gabriel Watermaster in conjunction with other primary stakeholders[1] prepared *The San Gabriel Valley Basin SNMP* (San Gabriel SNMP) to provide a framework for water management practices in the San Gabriel Valley Basin to ensure beneficial uses and sustainability of groundwater resources, consistent with the LA Regional Board's water quality objectives (Stetson Engineers Inc., 2016). The San Gabriel SNMP only incorporates the portions of the Bulletin 118 San Gabriel Valley Basin included in the Main San Gabriel Basin Judgment, and excluded the adjudicated Puente Basin, adjudicated Six Basins, and unadjudicated Spadra Basin. The San Gabriel SNMP was adopted by the LA Regional Board on December 8, 2016, the State Water Board on May 16, 2017, and the Office of Administrative Law on December 19, 2018. It was subsequently incorporated into Chapter 8 of the LA Basin Plan. No SNMPs have been prepared for the Puente, Spadra, and Six Basins areas within the eastern portions of the San Gabriel Valley Basin.

2.3 Wells in Puente Basin

Figure 2-3 shows the locations of all known existing wells in the Puente Basin. There are 25 pumping wells and 76 monitoring wells.

[1] Upper San Gabriel Valley Municipal Water District, San Gabriel Valley Municipal Water District, Three Valley's Municipal Water District, County of Los Angeles Department of Public Works, Metropolitan Water District, and Sanitation Districts of Los Angeles.

2.3.1 Pumping Wells

There are 25 known pumping wells in the Puente Basin. The wells are owned and/or operated by the Principal Parties for non-potable supply, or owned and operated by the Carrier BDP Corporation for groundwater clean-up:

- **Four wells owned and operated by WVWD**: Baker, Business Parkway, Lycoming, and Fairway. There is one additional WVWD well (Industry) along the boundary of Spadra and Puente Basins, and the pumping at this well is accounted for in the Spadra Basin. Groundwater pumped at these wells is used for non-potable supply. Groundwater pumped at the Lycoming and Fairway wells is accounted towards the WVWD production rights in the Judgment. Groundwater pumped at the Baker and Business Parkway is for the City of Industry and is accounted towards the City of Industry and Industry Successor Agency's production rights in the Judgment.
- **One well owned and operated by RWD:** Tony Poli. Groundwater pumped at this well is used for non-potable supply and is accounted towards the RWD production rights in the Judgment.
- **Two wells operated by Royal Vista Golf Course:** RV-1 and RV-2. Royal Vista Golf Course leases these wells. Groundwater pumped at these wells is used for non-potable supply (irrigation at the golf course) and is accounted towards the Royal Vista Golf Course production rights in the Judgment.
- **Eighteen wells owned and operated by Carrier BDP Corporation**. Groundwater pumped at these wells is part of a pump-and-treat system that began operating in 1986 to cleanup groundwater contamination associated with the former Carrier Corporation facility. Currently 12 of the 18 wells are active pumping wells. Groundwater extracted from these wells is treated and then delivered to the RWD for non-potable supply. If RWD is unable to use the treated groundwater, it is discharged to a sanitary sewer and exits the Puente Basin. The Carrier BDP Corporation does not have production rights in the judgment. Figure 2-3 also shows the location of five additional Carrier BDP Corporation production wells in the adjacent Main San Gabriel Basin which are currently inactive. When in operation, treated extracted groundwater from these five wells can also be delivered to the RWD for non-potable supply.

In addition to these pumping wells, there are several locations where shallow groundwater is collected in holding structures underground (wet wells), and then pumped by a groundwater pump station into the non-potable supply system. These locations are shown on Figure 2-3, termed “shallow groundwater wet wells and pump station” and include Grand Crossing, Fairway Drive Grade Separation, Fullerton Drive Grade Separation, and Nogales Grade Separation.[2] Groundwater extracted from these locations is used by the City of Industry or RWD for their non-potable supply system.

2.3.2 Monitoring Wells

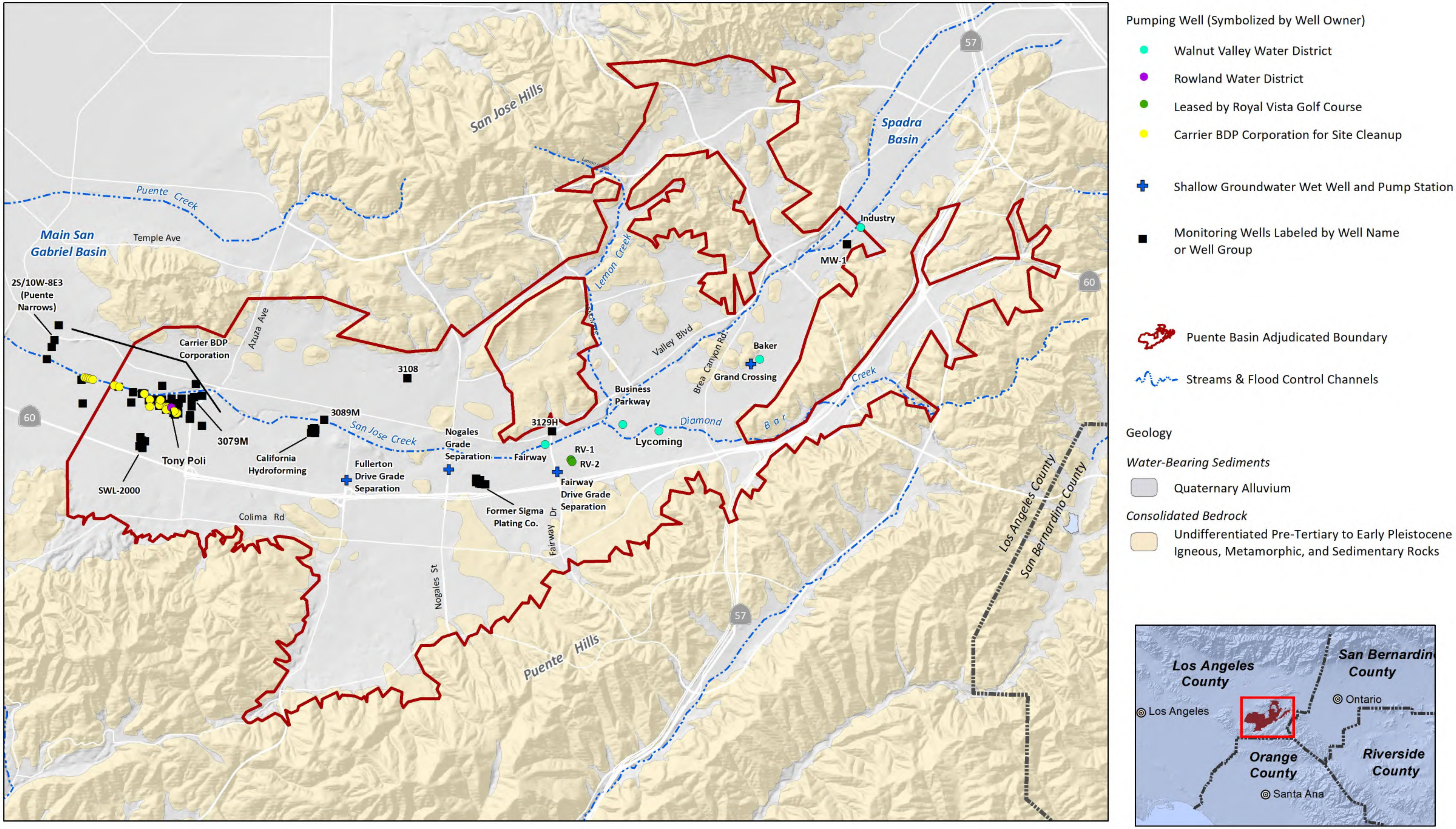
There are 76 known monitoring wells in the Puente Basin. Most of the monitoring wells are associated with point-source contaminant sites from various cleanup sites. Monitoring wells include:

- 47 wells that monitor the former Carrier BDP Corporation facility cleanup site.
- Twelve wells that monitor the former Sigma Plating Corporation cleanup site.
- Seven wells that monitor the SWL-2000 (former Unical Enterprises Inc.) cleanup site.

[2] Fairway, Fullerton and Nogales Grade Separations are used for dewatering high groundwater from construction locations.

- Five wells that monitor the California Hydroforming cleanup site.
- Five monitoring wells in the basin are monitored by the WVWD or Los Angeles County Department of Public Works (LACDPW) for groundwater levels.

Figure 2-3 also shows monitoring wells where groundwater data is collected in the adjacent Main San Gabriel in proximity to the Puente Narrows. These wells include: the Carrier BDP Corporation contaminant site monitoring wells; and the 2S/10W-8E3 (Puente Narrows) monitoring well located in the Main San Gabriel Basin that is used to calculate subsurface outflow from the Puente Basin to the Main San Gabriel Basin pursuant to the Puente Narrows Agreement described in Section 2.2.1.



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Prepared for:

Puente Basin Water Agency
Groundwater Management Plan
TM-1 Description of Plan Area and Basin Setting

PUENTE BASIN WATER AGENCY established 1971

Wells in the Puente Basin

Figure 2-3

2.4 Groundwater Monitoring

Figure 2-4 characterizes the groundwater data available at wells in the Puente Basin within the last 10 years (2013 to 2022). Currently, groundwater monitoring is performed for various purposes at municipal production wells, water purveyor monitoring wells, LACDPW monitoring wells, and contaminant site monitoring wells. Table 2-1 summarizes the type of monitoring that has occurred over the last 10 years.

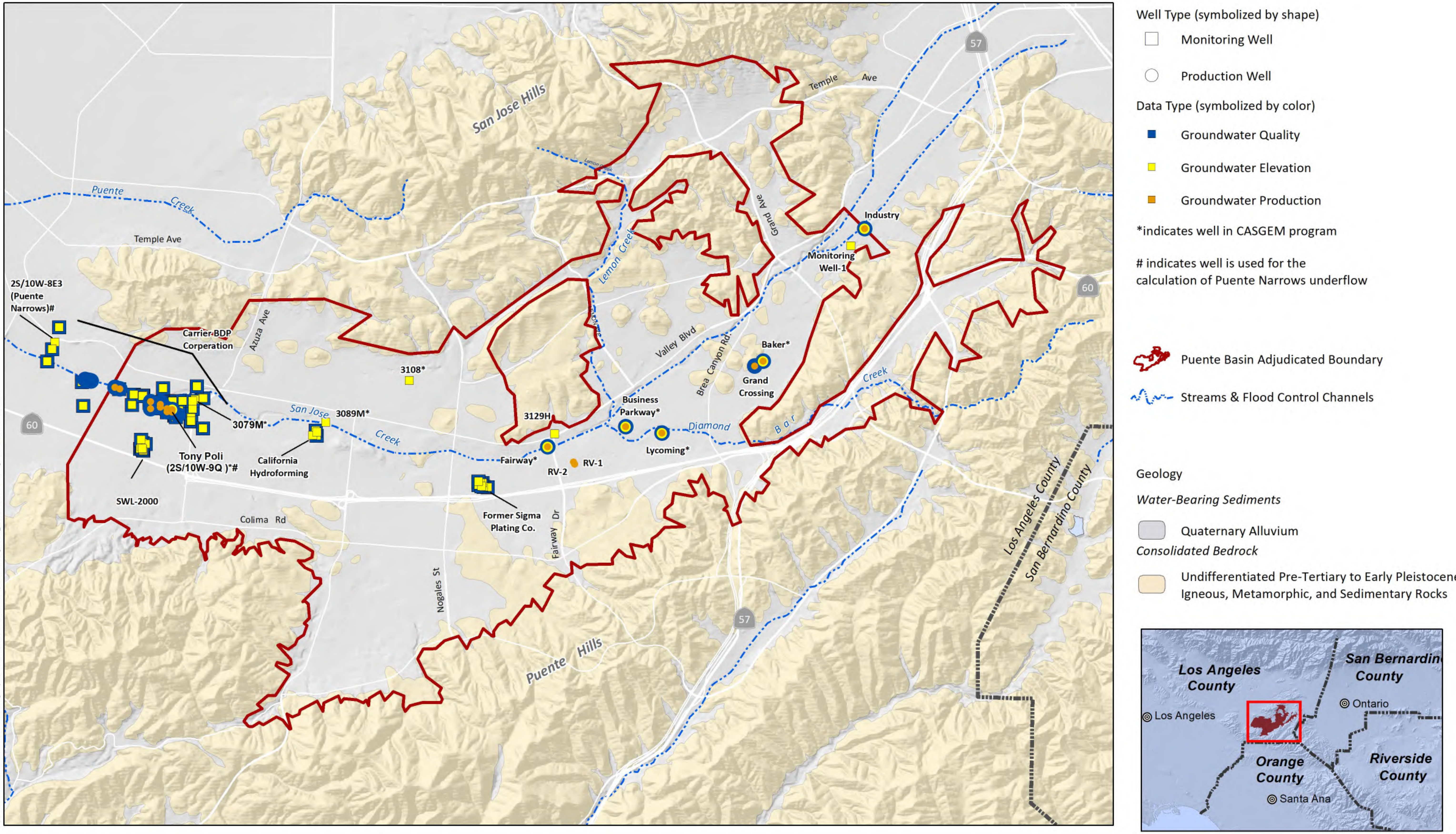
Table 2-1. Summary of Groundwater Data Available in the Last Ten Years at Puente Basin Wells, 2013-2022

Well Use and Type	Total No. of Wells in the Puente Basin	No. of Wells with Groundwater Quality Data	No. of Wells with Groundwater Level Data	No. of Wells with Groundwater Production Data
Municipal Production Well	6	6	5	6
Irrigation Well	2	0	0	2
Contaminant Site Extraction Well for Groundwater Cleanup	18	18	0	18
Contaminant Site Monitoring Well	71	67	69	n/a
Other Monitoring Well	5	0	5	n/a
Total	**112**	**91**	**79**	**26**

Groundwater quality monitoring is performed at all pumping wells by the respective well owners for informational and operational purposes. Since the wells are used for non-potable supply, monitoring at most of the wells is primarily for total dissolved solids (TDS). Groundwater quality monitoring at the point-source contamination site wells is primarily for volatile organic compounds (VOCs) which are contaminants of concern at the sites.

Eight wells in the Puente Basin are part of the DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) Program –these wells are annotated with a "*" symbol in Figure 2-4. The Puente Basin Watermaster is the designated CASGEM monitoring entity for the Puente Basin portion of the San Gabriel Valley Basin and has been reporting groundwater elevations semi-annually to the DWR for these wells since 2011. The Puente Narrows Agreement requires the Puente Basin Watermaster to measure semi-annual groundwater levels at two wells, the Tony Poli Well that's located in the Puente Basin and the 2S/10W-8E3 (Puente Narrows) well located in the Main San Gabriel Basin –these wells are annotated with a "#" symbol in Figure 2-4. Groundwater levels from these wells are used to calculate annual subsurface outflow from the Puente Basin to the Main San Gabriel Basin pursuant to the Puente Narrows Agreement as described in Section 2.2.1. The LACDPW has been conducting a long-term groundwater-level monitoring program in the Puente Basin where spring and fall measurements are collected at four monitoring wells throughout the central and western portion of the basin (3079M, 3089M, 3108, and 3129H).

Figure 2-4 also shows wells where groundwater data is collected outside of the Puente Basin in the adjacent Main San Gabriel and Spadra Basin, where such data is important to operations of the Puente Basin. These wells are not summarized in Table 2-1, and include: the WVWD Industry well along the Puente Basin and Spadra Basin boundary; the Carrier BDP Corporation contaminant site monitoring wells and extraction wells; and the 2S/10W-8E3 (Puente Narrows) monitoring well located in the Main San Gabriel Basin that is used to calculate subsurface outflow from the Puente Basin to the Main San Gabriel Basin pursuant to the Puente Narrows Agreement described in Section 2.2.1.



Prepared by:

WEST YOST

Prepared for:

Puente Basin Water Agency

Groundwater Management Plan

TM-1 Description of Plan Area and Basin Setting

PUENTE BASIN WATER AGENCY established 1971

Groundwater Monitoring in Puente Basin

Figure 2-4

2.5 Land Use, and Water Use, Flows, and Disposal in the Puente Basin

This section describes the historical and current land use, water use, and disposal of water in the Puente Basin. The overlying land use impacts water demand and supply patterns. For example, outdoor water uses can result in return flows to the groundwater basin. Indoor water uses generate wastewaters that are conveyed to a treatment plant or to a septic system. It is important to understand overlying land use, water use, and disposal practices that affect the volume of return flows to the groundwater basin. Furthermore, land use, water use, and disposal are an important influence on groundwater quality: the concentration of dissolved constituents in return flows is typically higher relative to groundwater, causing degradation of groundwater quality over time.

2.5.1 Land Use

Figure 2-5 illustrates the overlying land use in the Puente Basin in 1990, 2001, 2008 and 2019, based on data from the Southern California Association of Governments (SCAG) surveys. From 1990 to 2019, the agriculture (crops, pastures, fruit, nuts, and citrus) and vacant lands on the east and west ends of the basin have transitioned to urban (residential, commercial, and industrial) land uses. As of 2019, urban land uses accounted for about 98 percent of overlying land use, while irrigated urban and agriculture accounted for the remaining 2 percent. With the exception of vacant properties, the lands overlying the Puente Basin are completely developed, and land and water use are not projected to change significantly in the future.

2.5.2 Outdoor Water Use and Return Flows

Irrigation return flows to groundwater are a function of land imperviousness based on the land use and irrigation efficiency. As land was converted from vacant or agricultural to urban uses, the imperviousness of the land surface increased. Locally derived estimates indicate a two percent imperviousness area for orchards and vineyards whereas urbanized areas have a much higher fraction of imperviousness, typically ranging from about 20 percent for very low-density residential areas to about 90 percent or more for apartments, mobile home courts, and high-rise offices (LACDPW, 2006).

Irrigated agriculture and urban lands also have different irrigation practices, and thus, 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 will infiltrate past the root zone to the groundwater system.

The combination of higher imperviousness and higher irrigation efficiency associated with the transition to urban land uses has reduced the return flows of applied water. Additionally, irrigation return flows typically degrade groundwater quality. Agriculture, and to a lesser degree urban landscape irrigation, is associated with the application of fertilizers and pesticides that dissolve in the applied water. Plant uptake of the water concentrates the dissolved constituents within 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 groundwater quality of the Puente Basin.

2.5.3 Surface Water Outflow

Surface-water runoff over the land that does not infiltrate, flows into concrete-lined storm-drain systems and flood-control channels and exits the Puente Basin. Figure 2-6 shows the location of San Jose Creek, which is the major concrete-lined channel that drains the Puente Basin. The surface-water outflow in San Jose Creek is put to beneficial use by downstream entities (primarily for groundwater recharge), is consumptively used by riparian vegetation in unlined stream reaches, or discharges to the ocean.

The land use agencies overlying the Puente Basin are regulated by National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer Order No. R4-2012-0175 (MS4 Permit). As part of the MS4 Permit, new development and redevelopment projects are required to control pollutants, pollutant loads, and runoff volumes to the surface water system that is generated from development sites.

2.5.4 Discharge of Treated Wastewater

Figure 2-6 shows the water reclamation plants within the vicinity of the Puente Basin. The two main facilities are San Jose Creek WRP and Pomona WRP.

The San Jose Creek WRP, located in the downgradient Main San Gabriel Basin, is a regional facility that receives and treats wastewater originating from indoor residential, commercial, and industrial uses within a 190 square-mile area inclusive of the entire Puente Basin. It is owned and operated by LACSD as part of the Joint Outfall System.[3] The San Jose WRP has a tertiary treatment capacity of 100 million gallons per day (mgd). The tertiary-treated water is delivered to agencies for direct reuse for customers within the Central, Main San Gabriel, and Puente Basins. Recycled water from the San Jose Creek WRP is used for irrigation in the Puente Basin by RWD and the City of Industry. Recycled water from the San Jose Creek WRP that is not directly reused is either discharged to the unlined San Gabriel River (or the San Jose Creek tributary to San Gabriel River), where it can be incidentally recharged in the Main San Gabriel Basin, used by riparian vegetation, diverted for artificial recharge by the Water Replenishment District of Southern California (WRD) at the Rio Hondo and San Gabriel Spreading Grounds in the Montebello Forebay overlying the Central Basin[4]. In unusual circumstances, such as heavy rain, the Spreading Grounds can be bypassed and treated wastewater is discharged to the downstream concrete-lined portion of the San Gabriel River at Firestone Boulevard, which leads to the ocean. Since 2019, recycled water has been conveyed to WRD's Groundwater Reliability Improvement Project Albert Robles Center for Water Recycling and Environmental Learning (ARC) Facility where it is advance treated and then recharged at the Spreading Grounds in the Central Basin (pursuant to WRD permit Order R4-2018-0129). In FY 2022, approximately 2.5 percent of the recycled water from the San Jose Creek WRP was reused within the Puente Basin (LACSD, 2023a).

The Pomona WRP, located in the Spadra Basin, is another regional wastewater treatment plant operated by LACSD as part of the Joint Outfall System that is a source of recycled water for direct reuse for customers in the Puente Basin. The Pomona WRP receives and treats wastewater originating from indoor residential, commercial, and industrial uses within a 32 square-mile area to the east and northeast of Puente Basin (see Figure 2-6). The Pomona WRP has a treatment capacity of 15 mgd. Tertiary-treated recycled water from the Pomona WRP is used by WVWD and City of Pomona for direct reuse for customers within the Spadra and Puente Basins, as well as at the LACSD's Spadra Landfill and California State Polytechnic University of Pomona's Center for Regenerative Studies. Recycled water from the Pomona WRP that is not directly reused is discharged to the concrete-lined South San Jose Creek where it flows into the unlined San Jose Creek and then into the San Gabriel River about 15 miles downstream where it can be incidentally recharged in the Main San Gabriel Basin, used by riparian vegetation, or diverted for artificial recharge by the WRD in the Rio Hondo and San Gabriel Spreading Grounds overlying in the Central Basin. In FY 2022, approximately 30 percent of the recycled water from Pomona WRP was reused within the Puente Basin (LACSD, 2023b).

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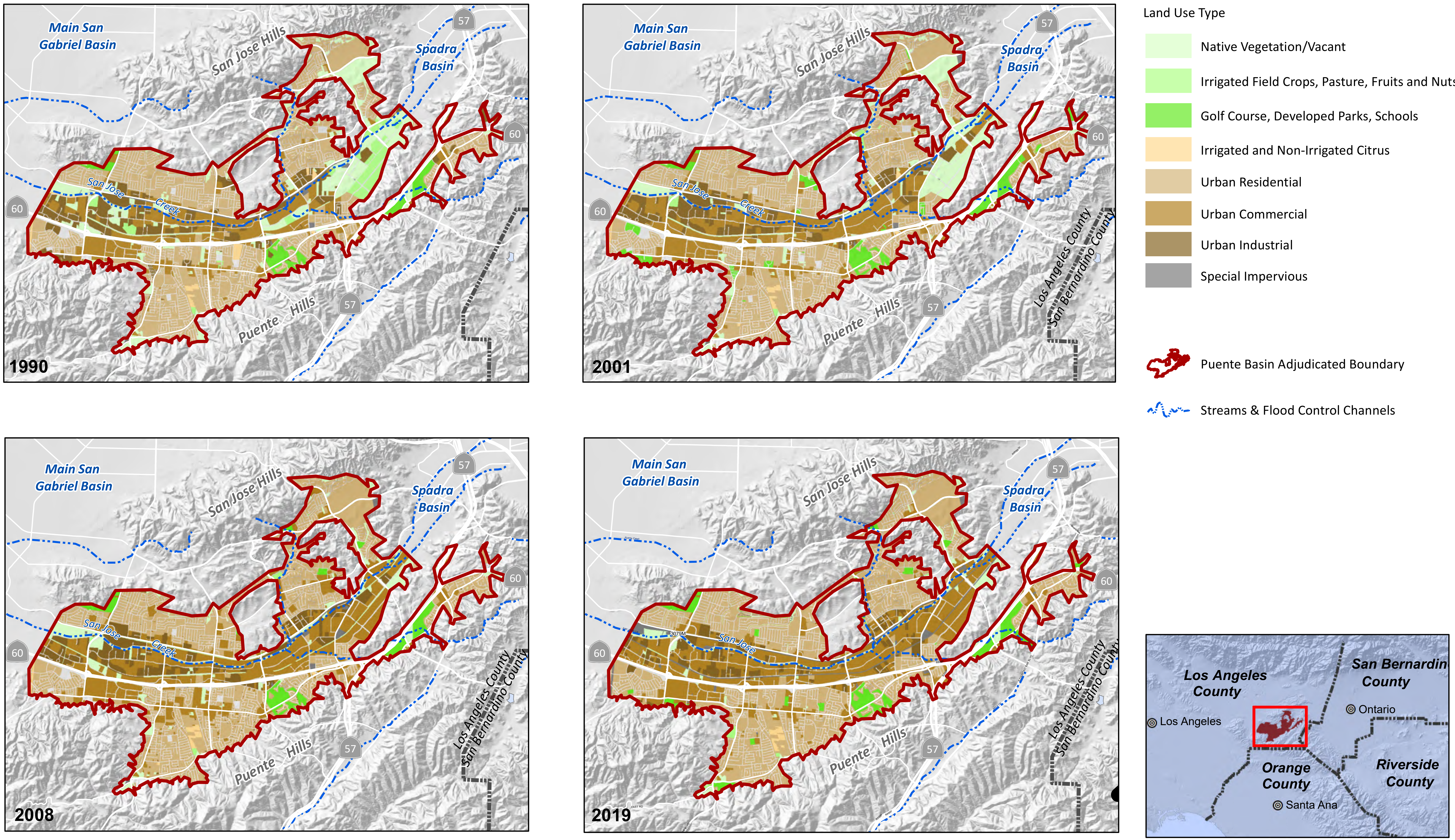
[3] The Joint Outfall System of the LACSD in the Los Angeles area consist of a Joint Water Pollution Control Plant with ocean disposal and six water reclamation Plants: La Canada, Long Beach, Los Coyotes, Pomona, San Jose Creek and Whittier Narrows.

[4] Instream incidental recharge and the recharge at the Spreading Grounds can be referred to collectively as the Montebello Forebay Groundwater Recharge Project.

The discharges, reuse, and recharge of the tertiary-treated recycled water from the LACSD San Jose Creek WRP and Pomona WRP, are subject to the following permits:

- NPDES No. CA0053911 Order No. R4-2021-0131 and WDRs for the Joint Outfall System San Jose Creek Water Reclamation Plant.
- NPDES No. CA0053619 Order No. R4-2021-0097 and WDRs for the Joint Outfall System, Pomona Water Reclamation Plant, Los Angeles County, Discharge to the South Fork San Jose Creek.
- Water Reclamation Requirements (WRRs) for County Sanitation Districts of Los Angeles County and others, 1987 Order No. 87-50 for San Jose Creek WRP, 1981 Order No. 81-24 for Pomona WRP; readopted in 1997 Order No. 97-072 combined permit for all existing water reclamation requirements for LACSD.
- WRRs for Groundwater Recharge at the Montebello Forebay Order No. 91-100.
- WDRs and WRRs for Water Replenishment District of Southern California, Groundwater Reliability Improvement Project-Advanced Water Treatment Facility, File No. 17-008, Order No. R4-2018-0219.

Section 2.6 describes the recycled water supplies from the San Jose Creek WRP and Pomona WRP used by the RWD and WVWD, respectively, as part of their water supply portfolio.



Prepared by:

WEST YOST

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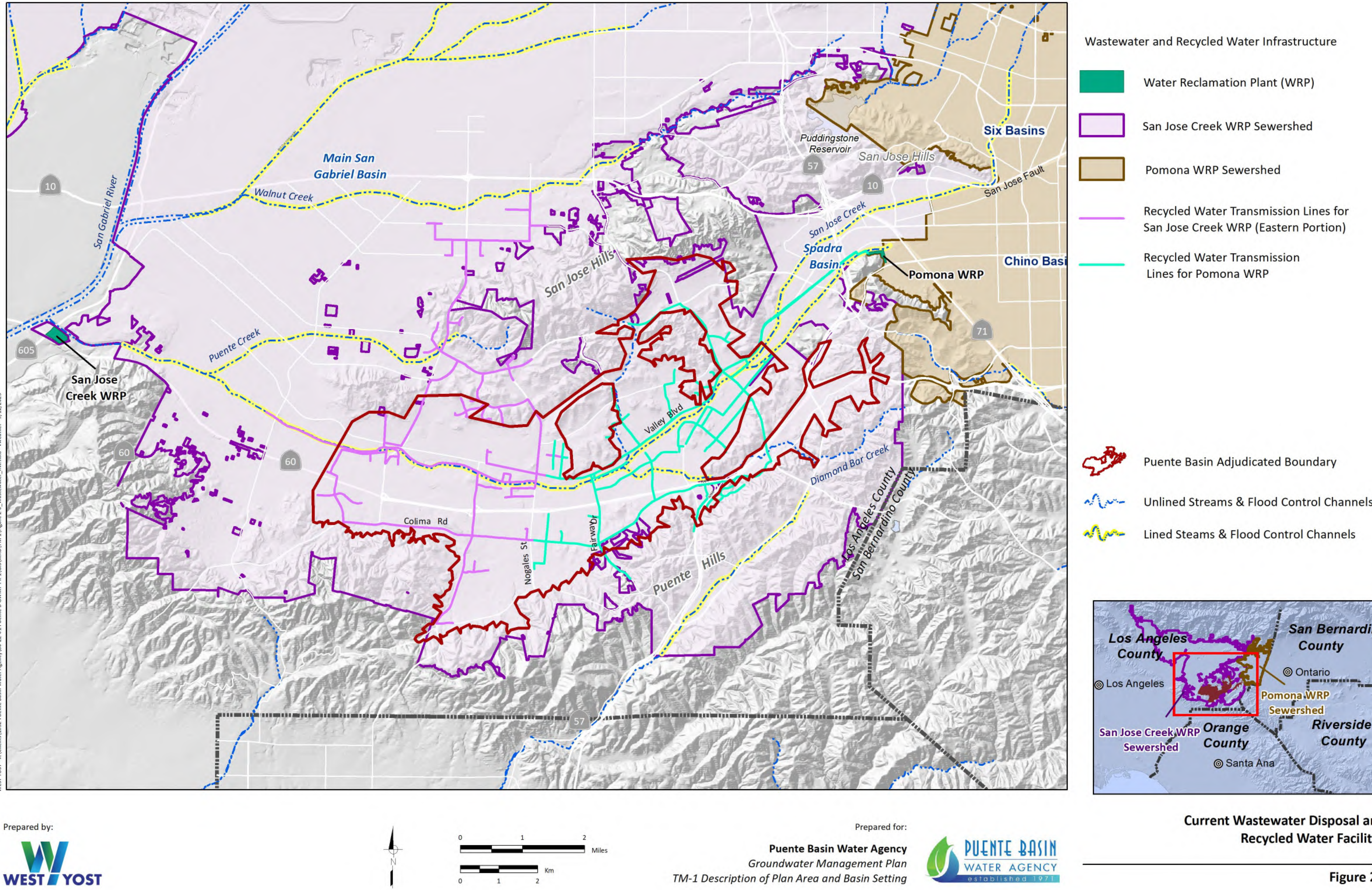
Prepared for:

Puente Basin Water Agency
Groundwater Management Plan
TM-1 Description of Plan Area and Basin Setting

PUENTE BASIN WATER AGENCY established 1971

Land Use in the Puente Basin
1990, 2001, 2008, 2019

Figure 2-5



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WEST YOST

Prepared for:

Puente Basin Water Agency
Groundwater Management Plan
TM-1 Description of Plan Area and Basin Setting

PUENTE BASIN WATER AGENCY established 1971

Current Wastewater Disposal and Recycled Water Facilities

Figure 2-6

2.6 Sources of Water Supply

Water-supply sources available to the water purveyors in the Puente Basin include: imported water purchased from the TVMWD; recycled water from the San Jose Creek WRP and Pomona WRP; and groundwater from Puente, Spadra, Main San Gabriel, and Central Basins. Each of these water supply sources is described below, followed by a description of the annual water supply volumes for the Principal Parties individually and in aggregate from FY 2010 to 2023.

2.6.1 Imported Water

Imported water is available to the Puente Basin water purveyors from the TVMWD, a member agency of Metropolitan. Metropolitan 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. Metropolitan currently delivers about 2 million afy of imported water to its service area from the State Water Project (SWP) and the Colorado River.

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 Claremont, Covina (including the areas of Charter Oak and 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 Metropolian's Weymouth Water Treatment Plant (Weymouth WTP) or from its Miramar Water Treatment Plant (Miramar WTP).

The Weymouth WTP can deliver up to 520 million gallons of potable 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 WVWD and RWD are member agencies of TVMWD and receive water from the Weymouth WTP via the Pomona-Walnut-Rowland Joint Water Line.

The TVMWD operates the Miramar WTP, which is located at its headquarters in the City of Claremont. The Miramar WTP receives 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 four percent of the total deliveries from the TVMWD's Miramar system. The City of La Verne and Golden State Water Company 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, WVWD, and Rowland Water District on an interruptible basis.

The ability of the TVMWD to meet its member agencies' water demands is dependent on Metropolitan's ability to deliver water. Although Metropolitan continues to face ongoing water-supply challenges for both the SWP and Colorado River systems, through the implementation 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.), Metropolitan predicts it will be able to meet its overall system demands through 2045 (Metropolitan, 2021).

From 2002 through 2007, Metropolitan's average rates increased by about six percent per year. From 2007-2012, Metropolitan's average water rates increased by about ten percent per year. And from 2012 through 2016, Metropolitan's average water rates increased by about two or three percent per year. In 2017 Metropolitan's average water rates increased by 11 percent and from 2018 to 2023 increased from three to five percent per year. Metropolitan's full-service untreated Tier 1 rate for 2023 is $1,209 per acre-foot. Metropolitan is projecting a rate increase of three percent by 2024 (Metropolitan, 2023).

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 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 Metropolitan service area (Metropolitan, 2016). 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. From Silverwood Lake, SWP water is conveyed to the San Bernardino area at the Devil Canyon Afterbay. Metropolitan 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 Metropolitan with a maximum of 1,911,500 af of SWP water (Table A amount) (DWR, 2020).

In September 2022, the DWR published the Final State Water Project Delivery Capability Report for 2021 (California DWR, 2022). This report updates the DWR's estimate of current and future (2040) SWP water delivery reliability. The report is produced every two years as part of a settlement agreement that was signed in 2003. The 2021 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 United States Fish and Wildlife Service (December 2008) and the National Marine Fisheries Service (June 2009); and 2) climate change, which is altering hydrologic conditions in Delta and throughout the State. In addition to concerns over climate and environmental issues, the 2021 report indicates that the continued subsidence of Delta islands, many of which that are already below sea level, are a threat to a catastrophic levee failure as water pressure increases on the fragile levee system that is used to convey water from the Sacramento River to the Harvey O. Banks pumping station. This levee system is also threatened by earthquakes and floods. Should a major levee failure occur, SWP water exports from the Delta could be interrupted for several years. 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 Metropolitan's original source of imported water when the agency was established in 1928. Metropolitan 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 1.2 million afy. Metropolitan has a legal entitlement to receive water from the Colorado River under a permanent service contract with the United States Secretary of the Interior (Metropolitan, 2021).

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 United States Bureau of Reclamation (USBR) as The Law of the River. The Colorado River Compact of 1922 apportioned 15 million afy of water between the seven states: 7.5 million afy was apportioned to the upper basin states of Colorado, New Mexico, Utah, and Wyoming, and 7.5 million afy 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 afy between the three states, of which 4.4 million afy 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 afy allocation. Of this, Metropolitan has a fourth priority right to 550,000 afy, a fifth priority right to an additional 662,000 afy and a right of up to 180,000 afy when surplus flows are available (Metropolitan, 2016). For many years, California contractors utilized more than their 4.4 million afy 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 afy 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. Metropolitan now has a firm supply of 550,000 afy of Colorado River water. To increase its allocation, Metropolitan has developed a multitude of conservation, storage, and transfer programs with various parties inside and outside of California (Metropolitan, 2021).

Metropolitan'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 Metropolitan service areas; other water quality concerns related to arsenic, uranium, perchlorate, hexavalent chromium, and 1,2,3-trichlororpropane ; and climate change (Metropolitan, 2021).

2.6.2 Recycled Water from San Jose Creek WRP

Domestic and commercial wastewater originating in portions of the Spadra Basin, Puente Basin, Main San Gabriel Basin, and Raymond Basin is treated by the LACSD at the San Jose Creek WRP (See Figure 2-6). Recycled water from the San Jose Creek WRP is an available source of recycled water for reuse in the Puente Basin by the RWD and City of Industry. The San Jose Creek WRP has a treatment capacity of 100 mgd. In FY 2022 the plant produced 63.57 mgd (71,235 afy) (LACSD, 2022). The LACSD delivers recycled water from the San Jose Creek WRP for direct reuse to the RWD, City Industry, Upper San Gabriel Valley Municipal Water District, Central Basin Municipal Water District, and a few others, for use in the Puente, Main San Gabriel Valley, and Central Basins. Recycled water from the San Jose Creek WRP not used for direct reuse, is used for groundwater recharge in the Central Basin by the WRD atRio Hondo and San Gabriel Spreading Grounds in the Montebello Forebay, or in unusual cases discharged to the concrete-lined portion of the San Gabriel River at Firestone Boulevard, bypassing recharge basins where it is lost to the ocean. In 2022, the San Jose Creek WRP produced an average of 62.86 mgd (70,500 afy) of recycled water; of this amount approximately 8.57 mgd (9,600 afy) was used for the direct reuse, which is about 13 percent of the total effluent produced from the plant (LACSD, 2023a). 86.5 percent of the recycled water produced by the San Jose Creek WRP was used for groundwater recharge in the Central Basin and 0.5 percent bypassed the recharge facilities and was discharged downstream to the concrete-lined portion of the San Gabriel River at Firestone Boulevard, which leads to the ocean.

2.6.3 Recycled Water from Pomona WRP

Domestic and commercial wastewater originating in the portions of the Spadra Basin, Six Basins, northwestern portion of Main San Gabriel Basin, and western Chino Basin, is treated by the LACSD at the Pomona WRP (See Figure 2-6). Recycled water from the Pomona WRP is an available source of recycled water for reuse in the Puente and Spadra Basins by the WVWD, and the City of Pomona and LACSD at the Spadra Landfill. The Pomona WRP has a treatment capacity of up to 15 mgd, and in FY 2022 the plant produced 6.47 mgd (7,251 afy) (LACSD, 2022). Recycled water that is not directly reused is discharged to the concrete-lined South San Jose Creek channel in the Spadra Basin, converges with the San Jose Creek and flows through and out of the Puente Basin to the San Gabriel River where about 15 miles downstream it is recharged at Rio Hondo and San Gabriel Spreading Grounds in the Montebello Forebay overlying the Central Basin. In 2022, the Pomona WRP produced an average of 6.30 mgd of recycled water (7,060 afy); of this amount approximately 3.37 mgd (3,780 afy) was used for the direct reuse, which is about 53 percent of the total effluent produced from the plant (LACSD, 2023b). The remaining 47 percent was discharged to the South San Jose Creek and used for groundwater recharge in the Central Basin.

2.6.4 Puente Basin

Section 3.2 of this TM 1 describes the physical characteristics of the Puente Basin. The Puente Basin is a subbasin in the eastern portion of the DWR Bulletin 118 San Gabriel Valley Basin. The Puente Basins is an adjudicated basin with a physical solution set in the Puente Basin Judgment (described in Section 2.2.2 of this TM), and pumping rights for five Principal Parties, WVWD, RWD, City of Industry, Industry Successor Agency, and Royal Vista Golf Course. An Operating Safe Yield is determined by the Puente Basin Watermaster annually. The Operating Safe Yield has ranged from 1,000 afy to 3,400 afy historically. The

Judgment also allows for additional production rights for the Principal Parties for Return Flow Credits for a portion of imported waters delivered and applied for use on lands overlying the Puente Basin and Carry-over Rights for underproduced rights from the succeeding year. Puente Basin groundwater is primarily used as a supplemental non-potable supply. Total pumping in the Puente Basin has ranged from 454 afy to 2,350 afy since the Judgment in 1986, and averaged 1,229 afy.

2.6.5 Spadra Basin

The Spadra Basin is a small groundwater basin, approximately seven square miles (4,200 acres) and is a subbasin in the eastern portion of the DWR Bulletin 118 San Gabriel Valley Basin. The Spadra Basin is a relatively narrow, alluvial-filled valley located between the San Jose Hills and Puente Hills. Hydrogeologic cross-sections depict a narrow aquifer system along the central axis of the basin that has a saturated thickness of about 100-200 ft and thickens to about 400 ft to the east. Groundwater inflows are primarily subsurface inflow from the saturated alluvium and fractures within the bordering bedrock of the San Jose and Puente Hills, and deep infiltration of precipitation and applied water. Groundwater discharge occurs primarily through groundwater pumping and subsurface outflow to the Puente Basin and the Chino Basin. The "developed yield" of the Spadra Basin over the historical period (1977-2018), which is the annual average pumped from the groundwater basin, corrected for the change in storage, was estimated to be 1,432 afy from the water budget (West Yost, 2022).

The Spadra Basin is not adjudicated and pumping in the basin is done by three water purveyors: WVWD, City of Pomona, and California State Polytechnic University, Pomona. Spadra Basin is primarily used as a supplemental non-potable supply by the water purveyors, in combination with their other water supplies which include imported water, recycled water, and groundwater from other basins. Some groundwater is used for potable supply but requires pumping strategies or treatment to manage water quality. Pumping in the Spadra Basin has averaged 1,230 afy over the long-term historical period of 1977 to 2022; and pumping in the last ten years (2013-2022) averaged about 840 afy. Groundwater from the Spadra Basin is about one percent of the total water supplies utilized by the WVWD and City of Pomona, and about 40 percent of the total water supplies utilized by California State Polytechnic University, Pomona (West Yost, 2023a).

In 2017, the WVWD and the City of Pomona collectively formed the Spadra Basin Groundwater Sustainability Agency (GSA) and elected to prepare and adopt a Spadra Basin groundwater Sustainability Plan (GSP), pursuant to the State's Sustainable Groundwater Management Act (SGMA) to encourage collaborative management of the Spadra Basin between all pumpers and make maximum beneficial use of the basin in a sustainable fashion. The Spadra Basin GSP was adopted by the Spadra GSA in May of 2022 (West Yost, 2023a).

2.6.6 Main San Gabriel Basin

The Main San Gabriel Basin is a large basin bound by the San Gabriel Mountains to the north, the Raymond Basin on the northwest, the Puente Basin on the southeast, and the Central Basin on the south. The Main San Gabriel Basin covers most of the DWR Bulletin 118 San Gabriel Valley Groundwater Basin. The storage capacity in the basin is estimated to be 10,438,000 af (Main San Gabriel Basin Watermaster, 2020). The major sources of natural recharge to the Basin are infiltration of rainfall on the valley floor and runoff from the nearby mountains. The Main San Gabriel Basin is the first of a series of basins to receive the benefit of mountain runoff, and the basin interacts hydrologically and institutionally with adjoining basins, including the Puente, Central, and West Coast Basins. The San Gabriel River and Rio Hondo River flow over the Main San Gabriel Basin and out through the Whitter Narrows to the Central Basin. Recharge of supplemental imported water and recycled water at spreading basins is managed by the Main San Gabriel Watermaster for intentional replenishment of the basin. Storm water is diverted to spreading basins in coordination with the County of Los Angeles Department of Public Works for groundwater replenishment in coordination with replenishment of other supplemental water.

The water demand in the Main San Gabriel Basin is satisfied 85 percent by the local groundwater and another 5 percent from other local supplies (recycled and surface water) (Main San Gabriel Watermaster 2020). Imported water from the State Water Project (SWP) used in the basin is supplied by three member agencies of Metropolitan: TVMWD, Upper San Gabriel Valley Municipal Water District, and San Gabriel Valley Municipal Water District[5].

Due to a need to guarantee a defined amount of water to downstream Central and West Coast Basin, the Main San Gabriel Basin was adjudicated in 1973 through a stipulated Judgment "*Upper San Gabriel Valley Municipal Water District vs. City of Alhambra, et al. in the Superior Court of California for the County of Los Angeles,* Case No. 924128". The Main San Gabriel Basin Judgment defined the water rights of 190 original parties, created the Main San Gabriel Basin Watermaster as the governing body, and described a physical solution for the management of water in the basin and adjudicates both groundwater and surface water rights. Since the Judgment was originally entered, there have been subsequent amendments to it that extend and clarify Watermaster's role. Two other Judgments acknowledged in the Main San Gabriel Basin adjudication include: the 1965 Long Beach Judgment which guarantees an average of 98,000 afy of flow through the Whitter Narrows from Main San Gabriel Basin to the Central and West Coast Basins; and the Puente Narrows Agreement described above that guarantees an average of 580 afy from the Puente Basin to Main San Gabriel Basin.

The Main San Gabriel Watermaster is a nine-person board comprised of six individuals elected by the pumpers and three nominated by the retail water agencies. The Main San Gabriel Watermaster manages and controls the withdrawal of groundwater and surface water, coordinates water deliveries and recharge in the basin, and raises replenishment water revenue by means of assessments and acquires and recharges replacement water.

The Main San Gabriel Basin Judgment determined the natural safe yield of the basin to be 152,700 af based on the 1967 conditions. The Judgment requires that an OSY be redefined on a yearly basis by the Main San Gabriel Basin Watermaster. The OSY is the amount of groundwater that can be pumped in a year without Replacement Water Assessments. The fiscal year 2019-2020 OSY was 150,000 af. Pumpers can pump in excess of their annual pumping right but must pay. And unproduced groundwater right can be carried over for use in the subsequent year. Any entity that wishes to spread or store supplemental water within the basin for later extraction can do so with a cyclic storage agreement with the Watermaster that has a five-year term. Over the past ten years, production in the Main San Gabriel Basin ranged from about 186,000 afy to 243,000 afy (Main San Gabriel Basin Watermaster, 2022).

In 1991 Watermaster was authorized to recharge of up to 30,000 afy of recycled water as supplemental water, and in 2012 was authorized to develop a Resources Development Assessment to purchase about 40,000 afy of untreated imported water to be stored in the Main San Gabriel Basin for an emergency reserve in the event untreated imported water was not available to satisfy a replacement water obligation and to supplement the lack of stormwater replenishment during drought conditions.

2.6.7 Central Basin

Central Basin consists of approximately 227 square miles located in Los Angeles County and is a subbasin in the northeastern half of the DWR Bulletin 118 Coastal Plain of Los Angeles Groundwater Basin in Los Angeles County. The other subbasin of the Coastal Plain of Los Angeles Groundwater Basin is the West Coast Basin which is separated from the Central Basin by the Newport Inglewood fault system. The Elysian,

[5] The San Gabriel Valley Municipal Water District is a direct State Water Project Contractor, and the TVMWD and Upper San Gabriel Valley Municipal Water District are Metropolitan Member Agencies

Repetto, Merced, and Puente Hills bound it on the northeast and east. The Orange County Basin is the southeastern boundary along Coyote Creek. The concrete-lined Los Angeles, Rio Hondo, and San Gabriel Rivers flow over the surface of the Central Basin on their way to the Pacific Ocean. Natural replenishment of groundwater in the basin occurs mainly from surface flow and underflow through Whittier Narrows from the San Gabriel Valley. Intentional replenishment is done through the capture and spreading of the Rio Hondo and San Gabriel River Spreading Grounds at the Montebello Forebay. A portion of the surface water that is captured and recharged at these spreading grounds is recycled water from the Pomona WRP discharged to San Jose Creek in the Spadra Basin.

The WRD was formed in 1959 to manage the artificial recharge in both the Central and West Coast Basins for groundwater replenishment to reduce overdraft that had occurred historically. The Central Basin was adjudicated with the adoption of its Judgment in 1965 (Central and West Basin Water Replenishment District vs. Charles E. Adams et al, Los Angeles County Superior Court Case No. 786,656), and court appointed the DWR as the Watermaster. The 1965 adjudicated pumping rights were set at 267,900 afy, and the amounts of the rights that could be pumped each year were limited to 80 percent of the total adjudicated amount, or 217,367 afy. In the years following adjudication, groundwater levels rebounded, and overdraft was halted. In 2013, a third amendment to the Central Basin Judgment was entered by the Los Angeles Superior Court transferring watermaster duties from DWR to a new Watermaster composed of three bodies: the Water Rights Panel, the Administrative Body, and the Storage Panel. The Water Rights Panel is made up of seven Central Basin water rights holders, the Administrative Body consists of WRD, and the Storage Panel consists of the Water Rights Panel and WRD.

There are about 130 Parties to the Central Basin Judgment with Allowed Pumping Allocation in the Central Basin, mostly consisting of public utilities companies, cities and other water public and private water suppliers, but also including school districts, individuals, family trusts, landowners, businesses, religious institutions, cemeteries, nurseries, country clubs, and golf courses. In addition to each Party's Allowed Pumping Allocation, the following provisions are provided for in the Judgment:

- Storage of water in the basin for Parties with water rights upon approval of the Storage Panel.
- Transfer of Allowed Pumping Allowance and stored water between Parties through sales and leases.
- One-year carryover of unused rights for use in the succeeding year up to the greater of: 1) 60 percent of their Allowed Pumping Allocation plus or minus any leases with flex or 20 af, whichever is more, less the amount of water in a Party's storage account; or 2) 20 percent of a Party's Allowed Pumping Allocation.
- Permitted over extractions up to 20 percent of a Party's Allowed Pumping Allocation.
- Option to purchase more water from an Exchange Pool if a Party estimates that their water requirements exceed their supply for the year. A request to purchase water from the Exchange Pool must be done by April 1 of each year.

Generally, the groundwater quality in Central Basin is of high quality and suitable for potable uses. RWD has purchased water rights to enable Central Basin groundwater to be delivered via a pipeline and meter station via the La Habra Heights County Water District.

2.6.8 Water Supplies for the Puente Basin Principal Parties

Table 2-2 summarizes the water supplies for the Principal Parties according to the Puente Basin Judgment, individually and in aggregate from FY 2010 to 2023. WVWD and RWD are the primary water purveyors serving the area of the Puente Basin, and utilizing Puente Basin groundwater as part of their water supply portfolios. WVWD water supplies include: imported water purchased from the TVMWD, recycled water from the Pomona WRP, and groundwater from Puente and Spadra Basins. WVWD annual water supplies averaged 18,141 afy over FY 2013 to 2023, and on average: 91 percent was from imported water from TVMWD, 6 percent from recycled water from Pomona WRP, 2 percent from Puente Basin groundwater, and 1 percent from Spadra Basin groundwater. RWD water supplies include: imported water purchased from the TVMWD, recycled water from the San Jose Creek WRP, recycled water from Pomona WRP via an emergency connection from WVWD, and groundwater from Puente, Main San Gabriel, and Central Basins. The RWD annual water supplies averaged 9,698 afy over FY 2013 to 2023, and on average: 86 percent was from imported water from TVMWD, 5 percent from recycled water from San Jose Creek WRP, 3 percent from Puente Basin groundwater, and less than 1 percent from recycled water from Pomona WRP and Central Basin groundwater.

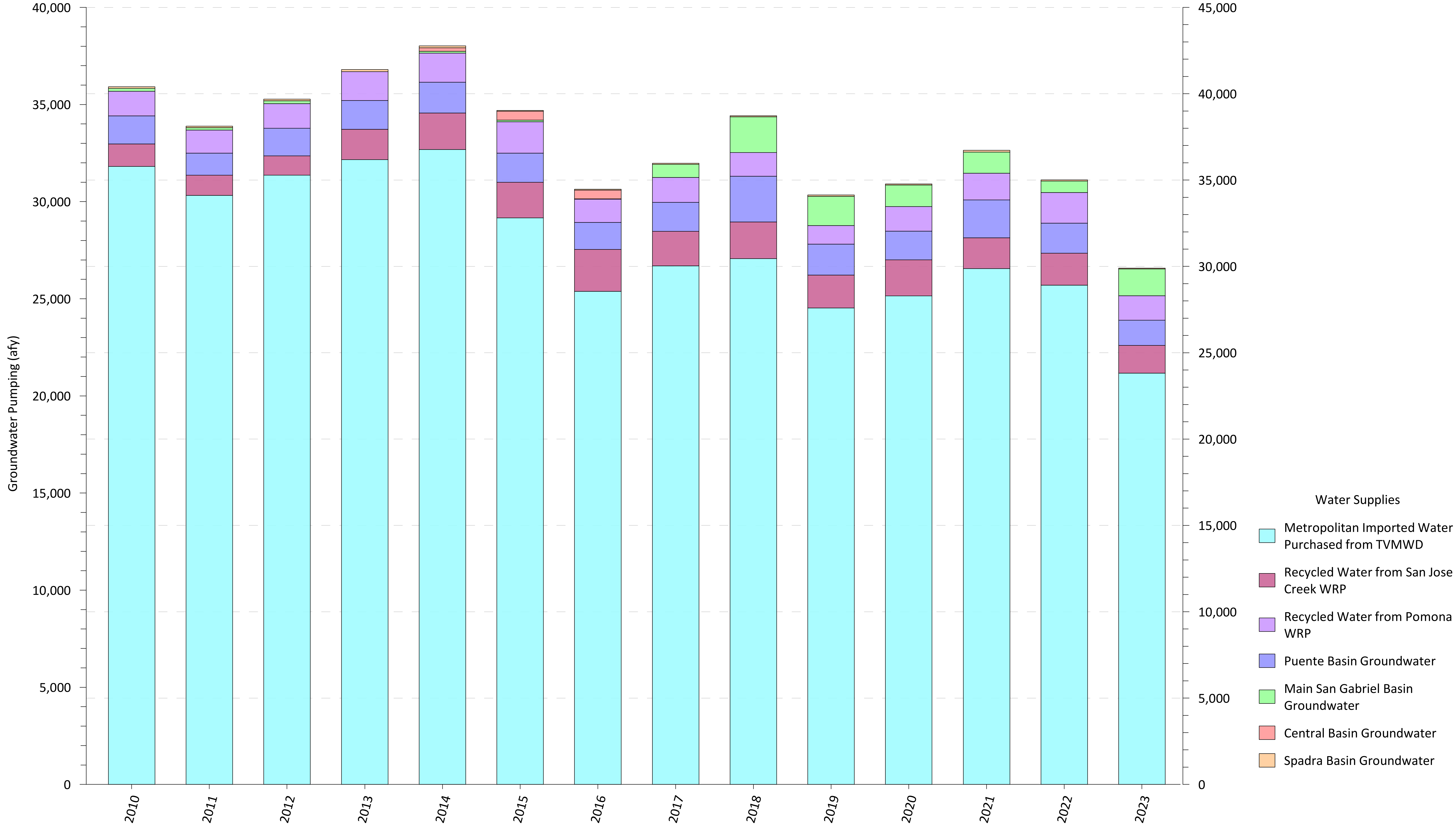
The remaining Principal Parties (City of Industry, Industry Successor Agency and Royal Vista Golf Course) are not municipal water purveyors but utilize their groundwater rights in the Puente Basin to supply water for non-potable uses in portions of the Puente Basin. The City of Industry also utilizes on average about 1,000 afy of recycled water from the San Jose Creek WRP for use at the City of Industry Recreation and Conservation Area in the San Jose Hills.

Figure 2-7 is a stacked bar chart showing the historical (2010-2023) water supplies in aggregate of the Principal Parties to the Puente Basin Judgment. In aggregate the water supplies averaged 33,080 afy, and 84 percent was from imported water from TVMWD, four percent from recycled water from Pomona WRP, five percent from recycled water from San Jose Creek WRP, five percent from Puente Basin groundwater, two percent from Main San Gabriel Basin groundwater, and less than 1 percent from Spadra Basin and Central Basin groundwater.

Table 2-2. Water Supplies for the Principal Parties of the Puente Basin Judgement (2010-2023)

Type	Fiscal Year	Water Supply Sources Available to the Puente Basin Principal Producers						
		Imported Water from TVMWD	Recycled Water from Pomona WRP [1]	Recycled Water from San Jose Creek WRP	Groundwater from Puente Basin	Groundwater from Main San Gabriel Basin [2]	Groundwater From Other Basins (Spadra or Central) [3]	Total
Walnut Valley Water District	2010	20,528	1,248	--	541	--	85	22,402
	2011	19,422	1,176	--	301	--	78	20,977
	2012	20,361	1,250	--	418	--	86	22,115
	2013	20,741	1,457	--	518	--	108	22,824
	2014	21,139	1,473	--	606	--	101	23,319
	2015	18,669	1,588	--	569	--	41	20,867
	2016	15,905	1,170	--	427	--	50	17,552
	2017	17,197	1,259	--	530	--	55	19,041
	2018	18,485	1,201	--	576	--	57	20,319
	2019	16,275	937	--	447	--	67	17,726
	2020	16,630	1,251	--	406	--	55	18,342
	2021	17,854	1,362	--	569	--	86	19,871
	2022	16,844	1,552	--	431	--	61	18,888
	2023	13,921	1,240	--	253	--	36	15,450
	Average	**18,141**	**1,297**		**471**		**69**	**19,978**
Rowland Water District	2010	11,282	18	106	272	148	0	11,826
	2011	10,901	18	82	300	117	0	11,418
	2012	11,002	18	92	447	145	0	11,704
	2013	11,423	27	553	374	3	0	12,380
	2014	11,542	27	798	116	89	184	12,756
	2015	10,495	27	754	228	86	461	12,051
	2016	9,472	22	850	225	22	448	11,039
	2017	9,495	20	759	278	679	0	11,231
	2018	8,583	18	810	276	1,845	0	11,532
	2019	8,253	21	826	239	1,508	0	10,847
	2020	8,515	15	960	319	1,112	0	10,921
	2021	8,698	16	577	447	1,088	0	10,827
	2022	8,856	19	673	382	594	0	10,524
	2023	7,249	14	443	518	1,390	0	9,614
	Average	**9,698**	**20**	**592**	**316**	**630**	**78**	**11,334**
City of Industry [4] and Industry Successor Agency	2010	--	--	1,053	245	--	--	1,298
	2011	--	--	957	227	--	--	1,184
	2012	--	--	903	212	--	--	1,115
	2013	--	--	1,006	182	--	--	1,188
	2014	--	--	1,080	429	--	--	1,509
	2015	--	--	1,076	312	--	--	1,388
	2016	--	--	1,314	387	--	--	1,701
	2017	--	--	1,018	348	--	--	1,366
	2018	--	--	1,077	1,136	--	--	2,213
	2019	--	--	866	654	--	--	1,520
	2020	--	--	900	409	--	--	1,309
	2021	--	--	1,008	531	--	--	1,539
	2022	--	--	977	359	--	--	1,336
	2023	--	--	990	184	--	--	1,174
	Average			**1,016**	**401**			**1,417**
Royal Vista Golf Course	2010	--	--	--	390	--	--	390
	2011	--	--	--	305	--	--	305
	2012	--	--	--	344	--	--	344
	2013	--	--	--	408	--	--	408
	2014	--	--	--	439	--	--	439
	2015	--	--	--	393	--	--	393
	2016	--	--	--	351	--	--	351
	2017	--	--	--	338	--	--	338
	2018	--	--	--	363	--	--	363
	2019	--	--	--	250	--	--	250
	2020	--	--	--	342	--	--	342
	2021	--	--	--	404	--	--	404
	2022	--	--	--	373	--	--	373
	2023	--	--	--	220	--	--	220
	Average				**351**			**351**
Aggregate for all Parties	2010	31,810	1,266	1,159	1,447	148	85	35,915
	2011	30,323	1,194	1,039	1,133	117	78	33,884
	2012	31,363	1,268	995	1,421	145	86	35,278
	2013	32,164	1,484	1,559	1,483	3	108	36,801
	2014	32,681	1,500	1,878	1,590	89	285	38,023
	2015	29,164	1,615	1,830	1,502	86	502	34,699
	2016	25,377	1,192	2,164	1,391	22	498	30,644
	2017	26,692	1,279	1,777	1,495	679	55	31,977
	2018	27,068	1,219	1,887	2,351	1,845	57	34,427
	2019	24,528	958	1,692	1,590	1,508	67	30,343
	2020	25,145	1,266	1,860	1,476	1,112	55	30,914
	2021	26,552	1,378	1,585	1,951	1,088	86	32,640
	2022	25,700	1,571	1,650	1,545	594	61	31,121
	2023	21,170	1,254	1,433	1,175	1,390	36	26,458
	Average	**27,838**	**1,317**	**1,608**	**1,539**	**630**	**147**	**33,080**
	Average %	**84%**	**4%**	**5%**	**5%**	**2%**	**0%**	

1- RWD recieves recycled water from the Pomona WRP via an emergency conncetion from WVWD.
2-RWD receives treated groundwater from the Carrier BDP Corporation site pumped from the Main San Gabriel Basin
3- WVWD pumps groundwater from the Spadra Basin. RWD recieves groundwater pumped from the Central Basin
4- The City of Industry recieves recycled water from the San Jose Creek WRP for use on the Industry Hills Reccreation Area in the San Jose Hills



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WEST YOST

Prepared for:

Puente Basin Water Agency
Groundwater Management Plan
TM-1 Description of Plan Area and Basin Setting

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Aggregate Water Supplies for the Principal Parties to the Puente Basin Judgement, FY 2010 to 2023

Figure 2-7

3.0 BASIN SETTING

The Basin Setting is a detailed description of the surface water and groundwater hydrology of the Puente Basin over a long-term historical period through current conditions, including the identification of data gaps and the level of uncertainty in the description.

3.1 Surface Water Hydrology and Precipitation

Figure 3-1 shows the hydrologic features of the Puente Basin. The Puente Basin lies within the San Gabriel River watershed and the San Jose Creek subwatershed.

The climate in the Puente Basin area is characteristic of a semi-arid Mediterranean climate with generally dry summers and comparatively wet winters. Precipitation is a natural source of recharge to the Puente Basin and can be characterized by looking at long term records. Precipitation falling on pervious areas within the sub watersheds in the hills can combine with any applied water in the soils, infiltrate past the root zone, and recharge the Puente Basin as underflow from the San Jose Hills and Puente Hills. Stormwater and dry weather runoff in the basin and from the sub watersheds in the hills typically enter concrete lined flood control storm drains and channels that exit the Puente Basin via the San Jose Creek and South San Jose Creek and flow about 4.5 miles downstream into the San Gabriel River. Currently, there are no artificial recharge facilities in the Puente Basin that can divert and recharge surface water runoff.

Figure 3-1 shows the locations of active precipitation stations and surface water monitoring stations that have varying historical records dating as far back as the 1930s. Table 3-1 below summarizes the active stations, their owner/operator, elevation, and period of record.

Table 3-1. Active Daily-Precipitation and Stream Gages in the Puente Basin Area					
				Period of Record	
Station ID	Owner/Operator	Surface Elevation, ft-amsl	Type and Frequency	Date Range	Length of Record, years
Spadra Landfill (1260)	Los Angeles County Flood Control District	700	Precipitation, Manual/Daily	1988 - present	32
Pomona WRP	Los Angeles County Flood Control District	786	Precipitation, Manual/Daily	1981 – Present	39
Fire Station 147	Los Angeles County Flood Control District	708	Precipitation, Automatic/Real time	1954 – Present	68
Road Maintenance Yard 417	Los Angeles County Flood Control District	582	Precipitation, Automatic/Real time	2010 – present	12
Hacienda Heights	Los Angeles County Flood Control District	875	Precipitation, Automatic/Real time	1996 – Present	26
Pomona WRP Discharge	LACSD	NA	Discharge /Daily	1966 – Present	56
Pomona WRP RSW-001D	LACSD	NA	Discharge and Water Quality/Monthly	2011-Present	13
Pomona WRP RSW-002D	LACSD	NA	Discharge and Water Quality/Monthly	2011-Present	13
Pomona WRP RSW-003D	LACSD	NA	Discharge and Water Quality/Monthly	2011-Present	13
San Jose Creek WRP RSW-001	LACSD	NA	Water Quality/Monthly	2011-Present	13
San Jose Channel Above Workman Mill Road	Los Angeles County Department of Public Works	NA	Streamflow, Automatic/Real time	1955 – Present	67

Notes:
(a) Publicly available on CIWQS is available starting in 2011; data potentially is available prior to 2011.

There is one surface water station located within the Puente Basin which is a downstream receiving water location for the Pomona WRP (RSW-002D). There are multiple surface water monitoring locations upstream and downstream of the Puente Basin:

- **Upstream - The LACSD Pomona WRP effluent discharge and the downstream receiving water station RSW-001D along South San Jose Creek.** These stations are in the Spadra Basin, upstream of Puente Basin. The Pomona WRP effluent discharge is a portion of the flow in the South San Jose Creek. The downstream receiving water station RSW-001D has monitoring data representative of the flow in the South San Jose Channel downstream of the Pomona WRP discharge prior to converging with the San Jose Creek in Puente Basin.

- **Downstream - The LACDPW San Jose Channel at above Workman Avenue station and the receiving water stations for Pomona WRP (RSW-003D) and San Jose Creek WRP (RSW-001).** These stations are downstream of the Puente Basin along San Jose Creek Channel that is at the terminus of the San Jose Creek sub watershed before it reaches the San Gabriel River.

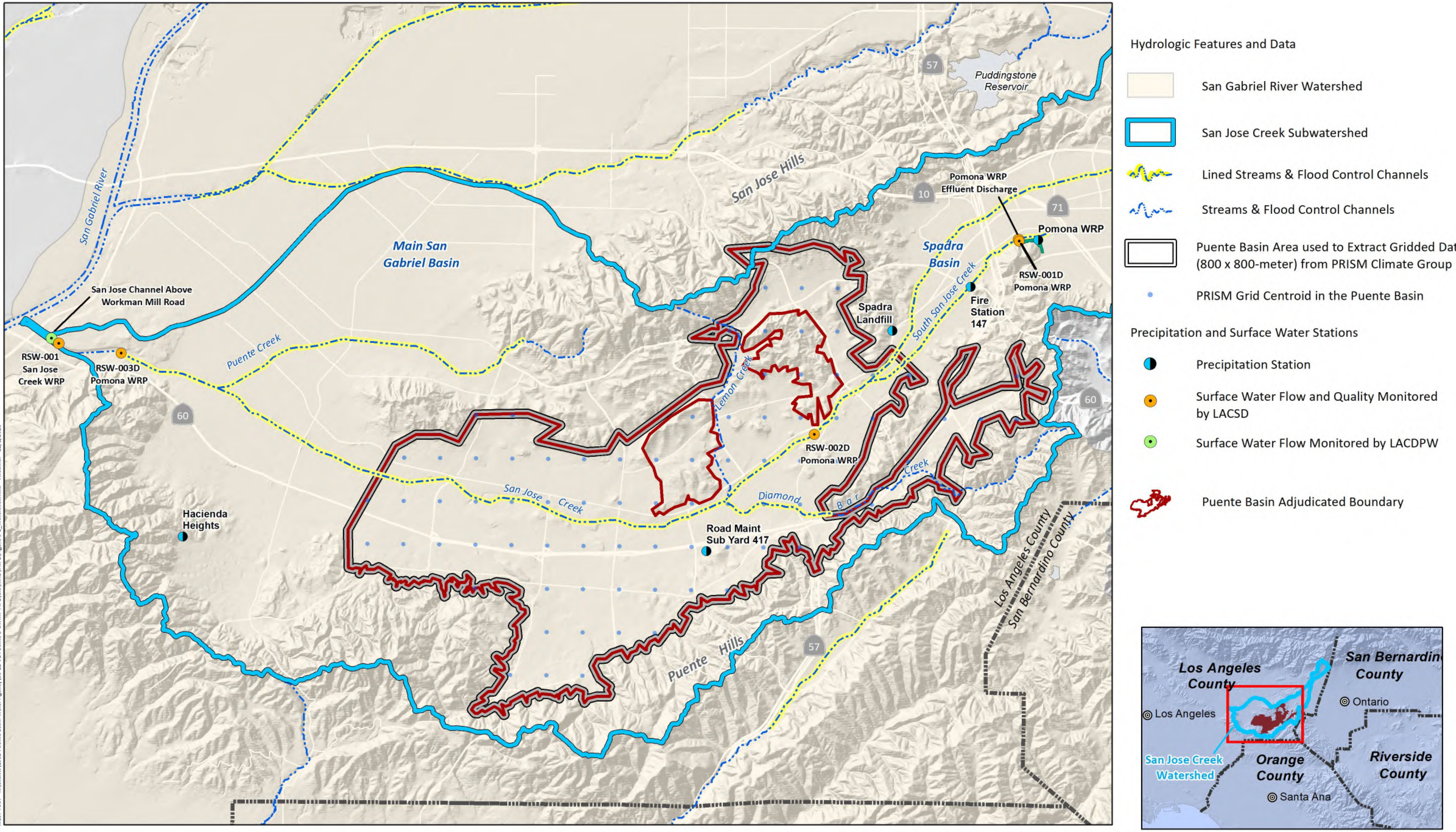
Gridded data sets of precipitation data are also available including the National Oceanic and Atmospheric Administration (NOAA) Next Generation Radar (NEXRAD), and the PRISM Climate Group (PRISM). Monthly precipitation estimates from the PRISM gridded data (an 800-meter by 800-meter grid) were computed as a spatial average across the Puente Basin boundary to characterize precipitation in the Puente Basin. Figure 3-1 shows the centroid location of the PRISM grid cells used to compute a spatial average precipitation; this data was used to characterize the long-term historical precipitation record for Puente Basin in Figure 3-2.

Figure 3-2 shows the annual precipitation time history, the long-term average annual precipitation, and the cumulative departure from mean (CDFM) precipitation for this hydrologic area of Puente Basin for the 126-year period from 1896 to 2022. The long-term average annual precipitation is 16 inches per year. The CDFM plot is a useful way to characterize the occurrence and magnitude of wet and dry periods: positive sloping segments (trending upward to the right) indicate wet periods, and negative sloping segments (trending downward to the right) indicate dry periods. Based on Figure 3-2, the trends in the wet and dry periods in the Puente Basin have been:

- 8-year dry period from 1896 through 1903
- 18-year wet period from 1904 through 1921
- 14-year dry period from 1922 through 1935
- 9-year wet period from 1936 through 1944
- 32-year dry period from 1945 through 1976
- 9-year wet period from 1977 through 1982
- 8-year dry period from 1983 through 1990
- 7-year wet period from 1991 through 1997
- 24-year dry period from 1998 through 2022

Figure 3-2 shows 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. The last 24 years constitute a long dry period.

The monthly variation in precipitation is also important to understand the availability of storm water throughout the year. Figure 3-3 is a statistical characterization of monthly precipitation in Puente Basin in the form of a Box and Whisker Plot based on the monthly precipitation estimates from PRISM Climate Group. The Box and Whisker Plot shows the minimum, lower quartile, median, upper quartile, and maximum, precipitation values. Over the period of record, the median monthly precipitation ranges from 0 to 2.7 and the minimum monthly precipitation total was zero inches in every month of the year. The plot shows that most of the annual precipitation occurs during the period of November through March (the median greater than about two inches per month in these months), with the highest 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 May through October.



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TM-1 Description of Plan Area and Basin Setting

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Hydrologic Features of the Puente Basin

Figure 3-1

Figure 3-2. Annual Precipitation and CDFM - Puente Basin - Water Year 1896 to 2022

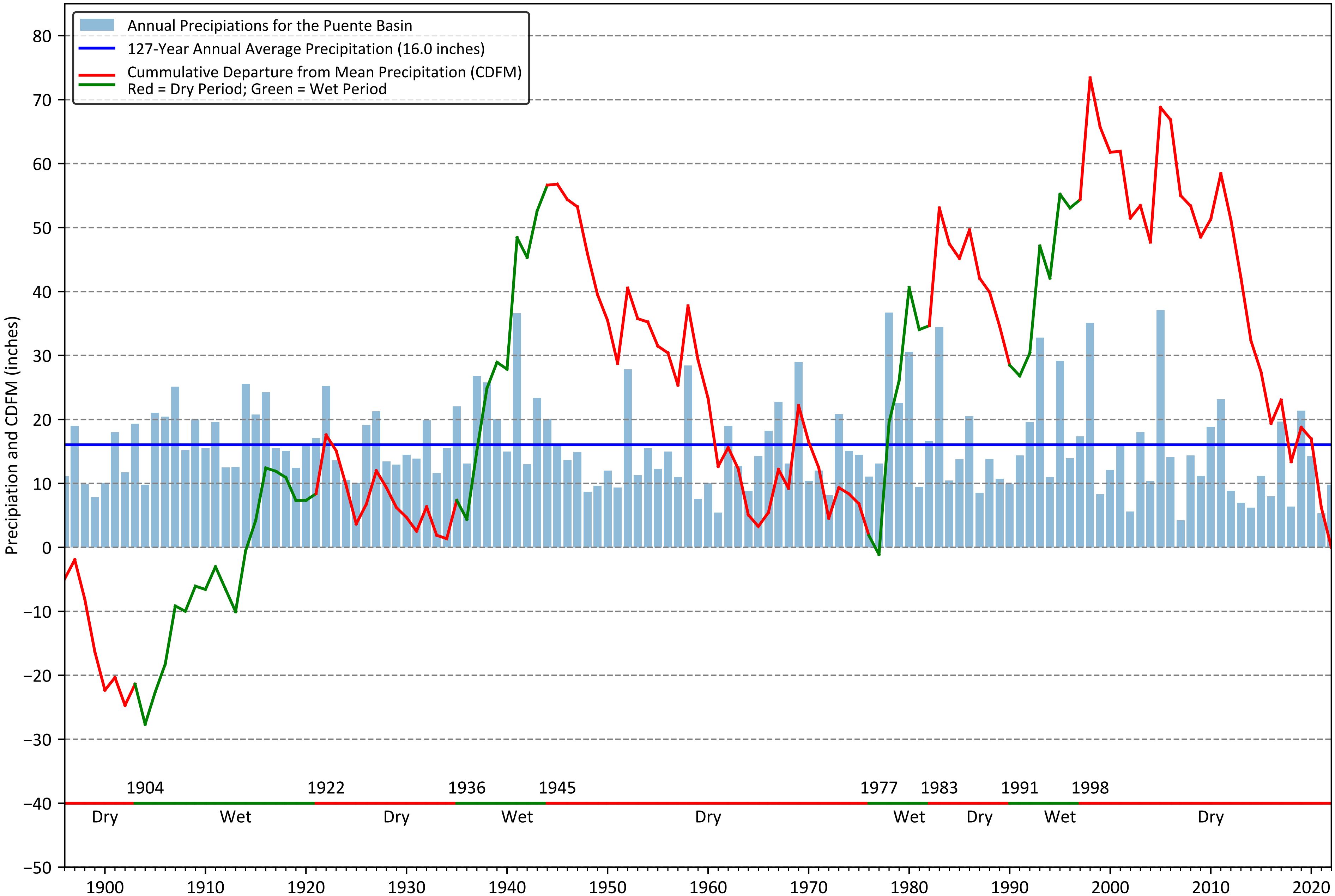

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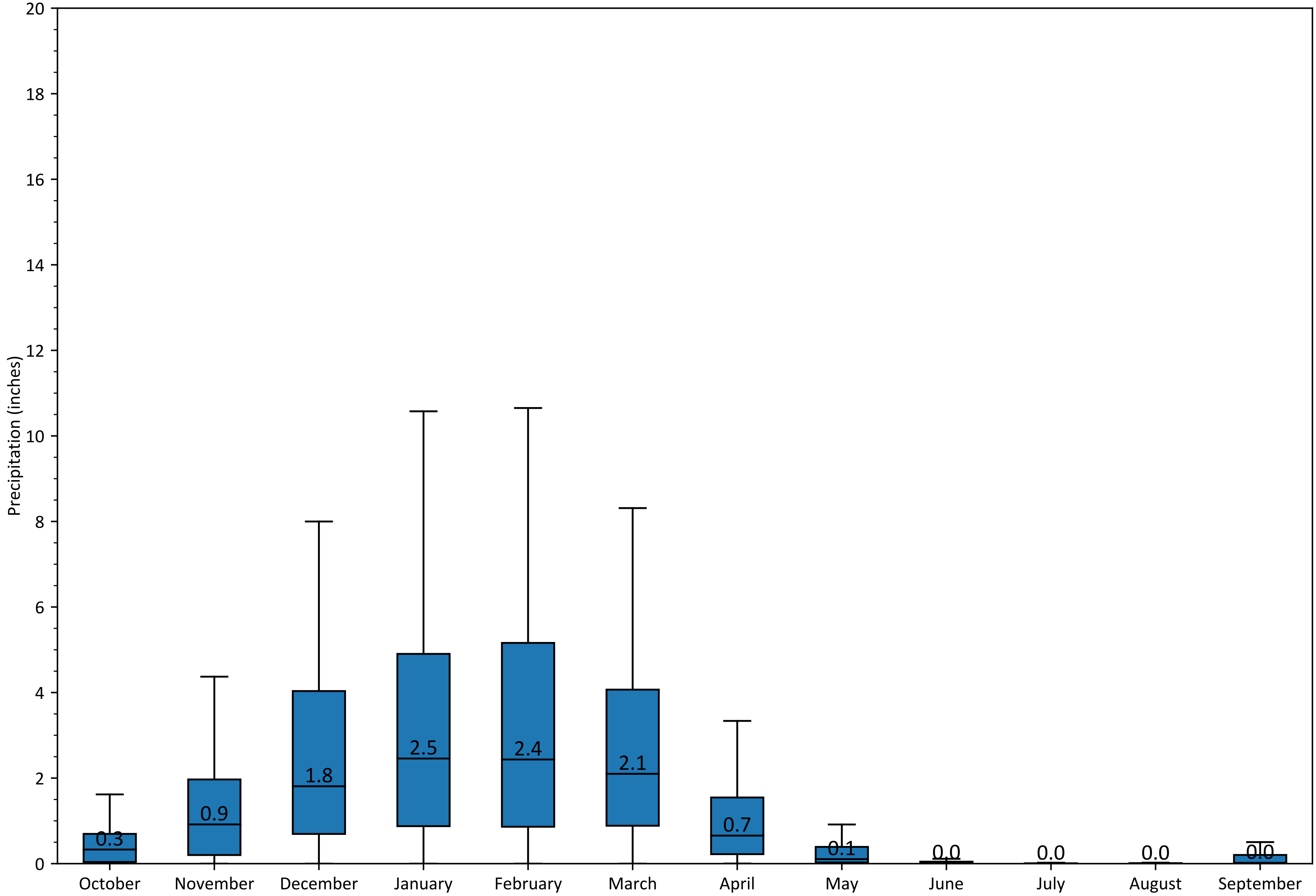
Figure 3-3. Box and Whisker Plot of Average Monthly Precipitation - Puente Basin - Water Year 1896 to 2022



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3.2 Hydrogeologic Conceptual Model

This section describes the evolution, structure, and composition of the Puente Basin aquifer system and the occurrence and movement of groundwater. The section concludes with an initial estimate of the long-term groundwater yield that has been developed from the Puente Basin and a discussion of data gaps.

The hydrogeology of the Puente Basin area has been studied by various entities and authors in the past, including: Mendenhall (1908); Eckis (1934); California DWR (1947, 1966, 1970); John Jones and Associates (1969); Ecological Systems Corporation (1975); Donald R. Howard Consulting Engineers (1999); Fox and Roberts (2002); and Worley Parsons Resources and Energy (2009). The hydrogeologic description below was prepared from a review of these prior studies and from original work performed for this effort.

3.2.1 Geologic Setting

Figure 3-4 is a geologic map of the Puente Basin and the surrounding area (Morton and Miller, 2006). The Puente Basin is a relatively narrow, alluvial-filled valley located between the San Jose Hills and Puente Hills at the northern end of the Peninsular Ranges. The Puente Basin was formed as tectonic compression and faulting uplifted the Tertiary and pre-Tertiary consolidated bedrock formations of the San Jose Hills and Puente Hills. A westward flowing ancestral stream carved a narrow canyon into the bedrock formations that deepens to the west. In Quaternary time, as the San Gabriel Mountains to the north were elevated, sediments were eroded and washed out of the mountains by San Antonio Creek, depositing a broad alluvial fan that emanates from the mouth of San Antonio Canyon. The progradation of the alluvial fan began to fill the valley between the San Jose Hills and Puente Hills with unconsolidated sediments, as San Antonio Creek may have flowed through this valley towards the west. Sediments were also eroded and deposited in the valley from local tributaries flowing out of the San Jose Hills and Puente Hills. The interconnected pore spaces within the Quaternary sediments are today's groundwater reservoirs of the Puente Basin. At present, the main creek that drains the Puente Basin is San Jose Creek, which flows to the west and ultimately merges with the San Gabriel River in the Main San Gabriel Basin.

3.2.2 Basin Boundaries

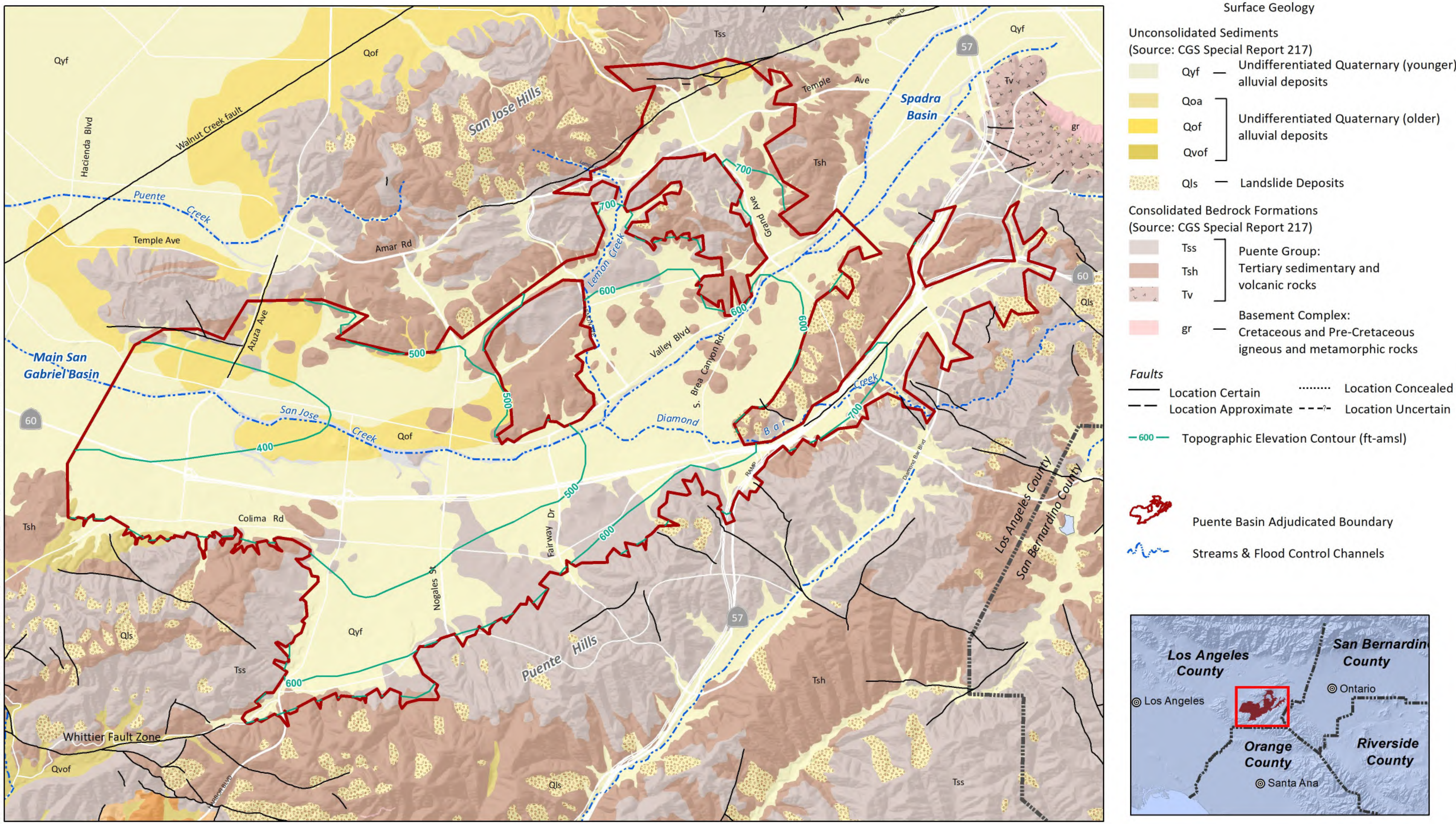
The physical boundaries of the Puente Basin are described below and are shown in Figure 3-4. The physical boundaries do not coincide exactly with the adjudicated boundary of the Puente Basin, which are also shown in Figure 3-4.

San Jose Hills. The northern boundary of the Puente Basin is the contact with impermeable Basement Complex and the Puente Group that outcrops within the San Jose Hills.

Puente Hills. The southern boundary of the Puente Basin is the contact with impermeable Basement Complex and the Puente Group that outcrops within the Puente Hills.

Spadra Basin. The eastern boundary of the Puente Basin is a bedrock narrows that separates the Puente Basin from the Spadra Basin. Groundwater flows through the bedrock narrows as underflow from the Spadra Basin into the Puente Basin.

Main San Gabriel Basin. The western boundary of the Puente Basin is shared with the Main San Gabriel Basin which is part of the larger Los Angeles Plain alluvial basin. Groundwater flows across this boundary as underflow from the Puente Basin into the much larger Main San Gabriel Basin.



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WEST YOST

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Puente Basin Water Agency

Groundwater Management Plan

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Geologic Map of Puente Basin

Figure 3-4

3.2.3 Stratigraphy

In this report, the stratigraphy of the Puente Basin is divided into two generalized geologic formations: (i) the pervious formations which form the groundwater reservoir of the Puente Basin are termed the "water bearing sediments" and (ii) the impermeable formations which enclose the groundwater reservoir are termed the "consolidated bedrock." The water bearing sediments overlie the consolidated bedrock, with the bedrock formations coming to the surface in the surrounding hills and highlands.[6] These geologic formations are described below in stratigraphic order, with the oldest formations first.

3.2.3.1 Consolidated Bedrock

The consolidated bedrock formations that flank and underlie the Puente Basin consist of very old crystalline rocks of the Basement Complex and younger sedimentary and volcanic rocks of the Puente Group.

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 3-4, the Basement Complex outcrops in the eastern margins of the San Jose Hills and Puente Hills outside of the Puente Basin boundary. 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 Puente Basin.

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). As shown in Figure 3-4, the Puente Group outcrops along the margins of the San Jose Hills and Puente Hills.

3.2.3.2 Water-Bearing Sediments

During the Quaternary Period, sediments that eroded from the surrounding and distant mountains and hills were transported to the Puente Basin 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 200 ft 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 in the Puente Basin can pump over 700 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 and Younger Alluvium of Holocene age. 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. 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 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. The Older Alluvium is the main source of groundwater from today's wells.

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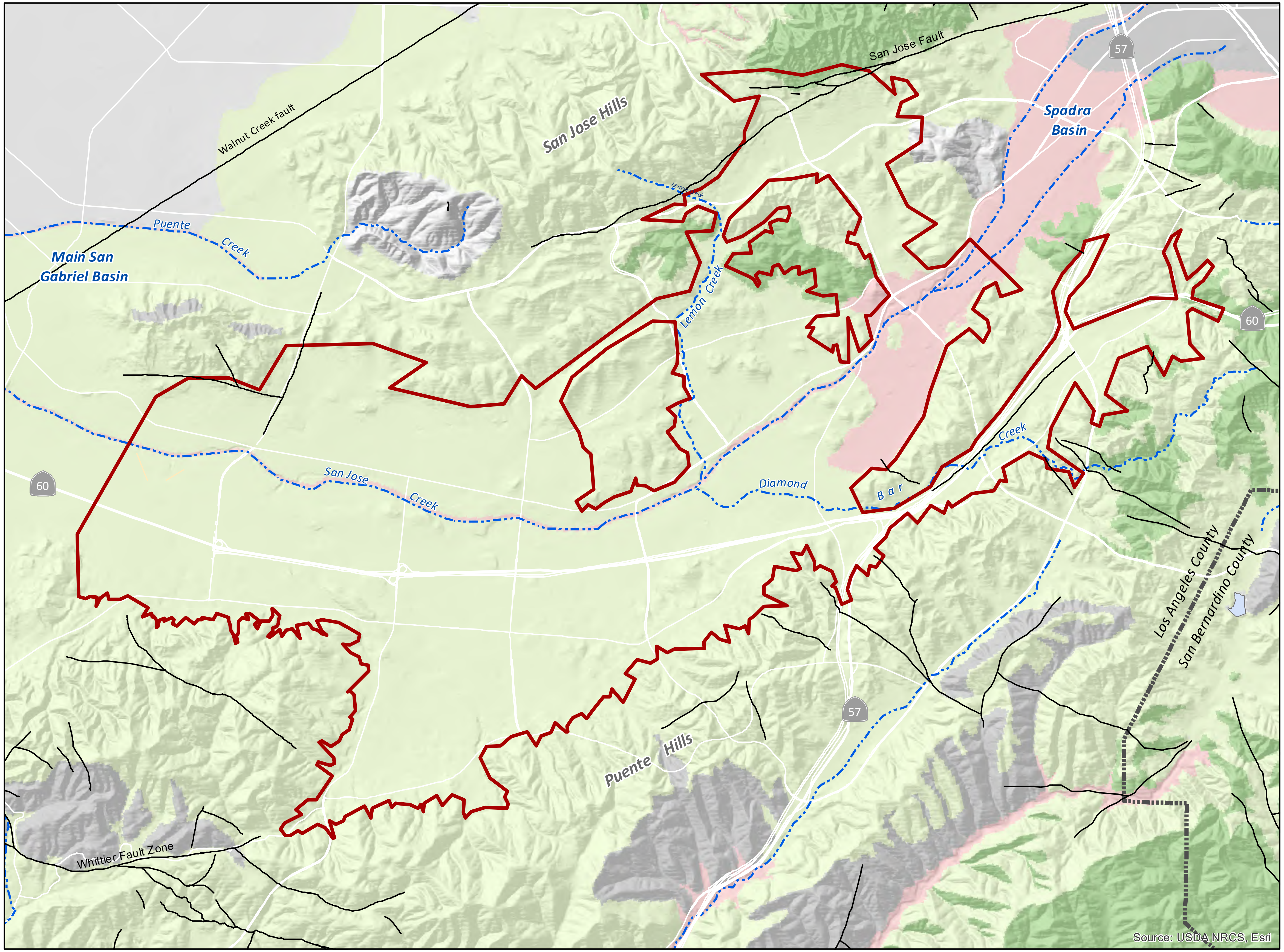
[6] The terms used in this report to describe bedrock, such as "consolidated," "non water bearing," and "impermeable," are used in a relative sense. The water content and permeability of the bedrock formations is not zero but is much less than the aquifer sediments within the basin.

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, unweathered, grey or brown color, and exists in outcrop only along the recent streambed channels of San Jose Creek. The Younger Alluvium is absent in most places and is typically thin compared to the Older Alluvium. 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.

Figure 3-5 is a map of the hydrologic soil types across the Puente Basin area, as mapped by the Soil Conservation Service:

- **Type A soils** - have high infiltration rates, even when thoroughly wetted. Typically composed of sands and gravels.
- **Type B soils** - have moderate infiltration rates when thoroughly wetted. Typically composed of moderately fine to moderately coarse texture.
- **Type C soils** - have slow infiltration rates when thoroughly wetted. Typically include a layer that impedes downward movement of water and/or moderately fine to fine texture.
- ***Type D soils*** - have very slow infiltration rates when thoroughly wetted and a high runoff potential. Typically, are of fine texture and/or a thin soil over a nearly impervious material.

Note the absence of Type A soils across the Puente Basin, which is consistent with the near absence of Younger Alluvium. Type B soils cover part of the western Puente Basin and the stream channels of San Jose Creek. Type C soils occur across most of the basin and along the basin fringes, likely representing the deposition of sediments eroded from the flanking San Jose Hills and Puente Hills. Type D soils occur infrequently in the San Jose Hills, which are composed of the consolidated bedrock formations.



Hydrologic Soil Types

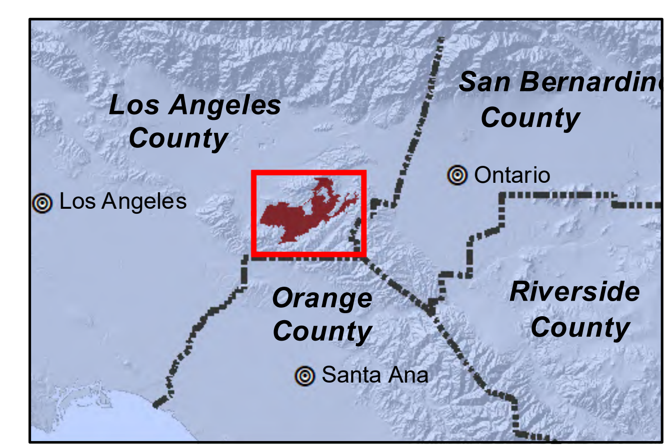
A	Low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.
B	Soils having moderate infiltration rates when thoroughly wtted and consisting chiefly 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 cheifly 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 infiltraiton 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 near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

Faults

Location Certain
Location Approximate
Location Concealed
Location Uncertain

Puente Basin Adjudicated Boundary

Streams & Flood Control Channels



Prepared by:

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Miles 0 1 2

Km 0 1 2

Prepared for:

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Hydrologic Soil Types of the Puente Basin

Figure 3-5

3.2.4 Bottom of Aquifer

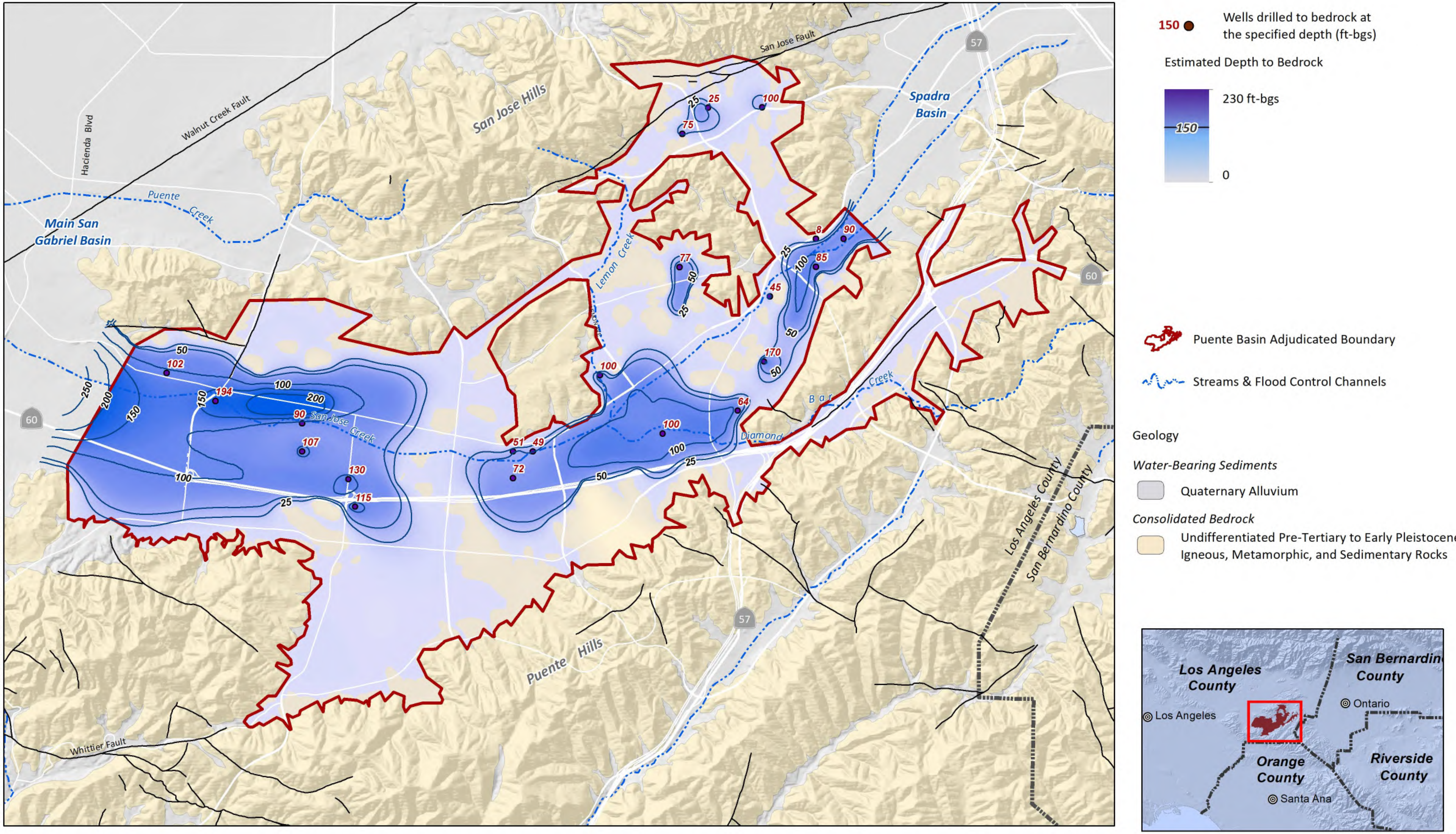
The consolidated bedrock formations underlying the water-bearing sediments of the Puente Basin act as the effective base of the freshwater aquifer. Herein, the effective base of the freshwater aquifer is referred to as the "bottom of the aquifer" which is the buried contact between the water-bearing sediments and consolidated bedrock.

Figure 3-6 is a contour map of equal depth to the bottom of the aquifer. The units of depth are in feet below ground surface (ft-bgs). These contours were estimated from lithologic descriptions of borehole cuttings that were recorded on well driller's reports and review of past efforts to estimate the configuration of the bottom of the aquifer (Fox and Roberts, 2002). In reviewing the borehole lithology data, best efforts were made to interpret the borehole depth where consolidated bedrock was penetrated. The typical terminology used to describe bedrock on the reports were: "Puente Formation", "hill formation," "rock," or "decomposed granite," among others. However, the lithologic descriptions by the well drillers are often subjective and poorly described on the well driller's reports.

To draw the contours of equal depth to bedrock, driller's logs from wells and borings within the Puente Basin were reviewed. The depth to bedrock was mapped at each well and borehole location that penetrated bedrock. Zero depth to bedrock was defined by the surface contact between the water bearing sediments and the consolidated bedrock. The bottom of aquifer contours generated by Fox and Roberts (2002) were replicated in GIS. Using both well and borehole data and the Fox and Roberts (2002) bottom of aquifer contours, contours and rasterized surface of the bottom of the aquifer, shown on Figure 3-6, were prepared in ArcGIS. Figure 3-6 shows that the bottom of the aquifer is a narrow trough aligned along the axis of the Puente Basin. A bedrock "narrows" is located at the northeastern end of Puente Basin where the bottom of the aquifer appears to be less than 100 ft bgs—this represents the boundary with the Spadra Basin. The bedrock trough generally deepens and widens to the west in an undulating fashion. There appears to be two main bedrock highs that interrupt the deepening and widening trend to the west. At the western margin of the Puente Basin the bottom of the aquifer is greatest at over 200 ft bgs—this represents the boundary with the Main San Gabriel Basin.

The westward sloping bedrock trough likely formed by erosion by ancestral streams that flowed from east to west as the San Jose Hills and Puente Hills were uplifted. 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 Puente Basin area was undergoing erosion prior to deposition of the water bearing sediments. Eckis (1934) reported that the weathered zone is about 50 ft thick, and that beneath the weathered zone the bedrock is hard. Fractured and weathered zones in the bedrock formations may yield water to wells locally, but the storage capacity is typically inadequate for sustained production.

Figure 3-7 is a contour map of equal elevation of the bottom of the aquifer. The units of depth are in feet above mean sea level (ft-amsl). The following steps were executed in ArcGIS to complete this conversion: (i) create a raster of the depth to the bottom of the aquifer from the contours and data as shown on Figure 3-6; (ii) subtract the depth raster from the United States Geological Survey (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.



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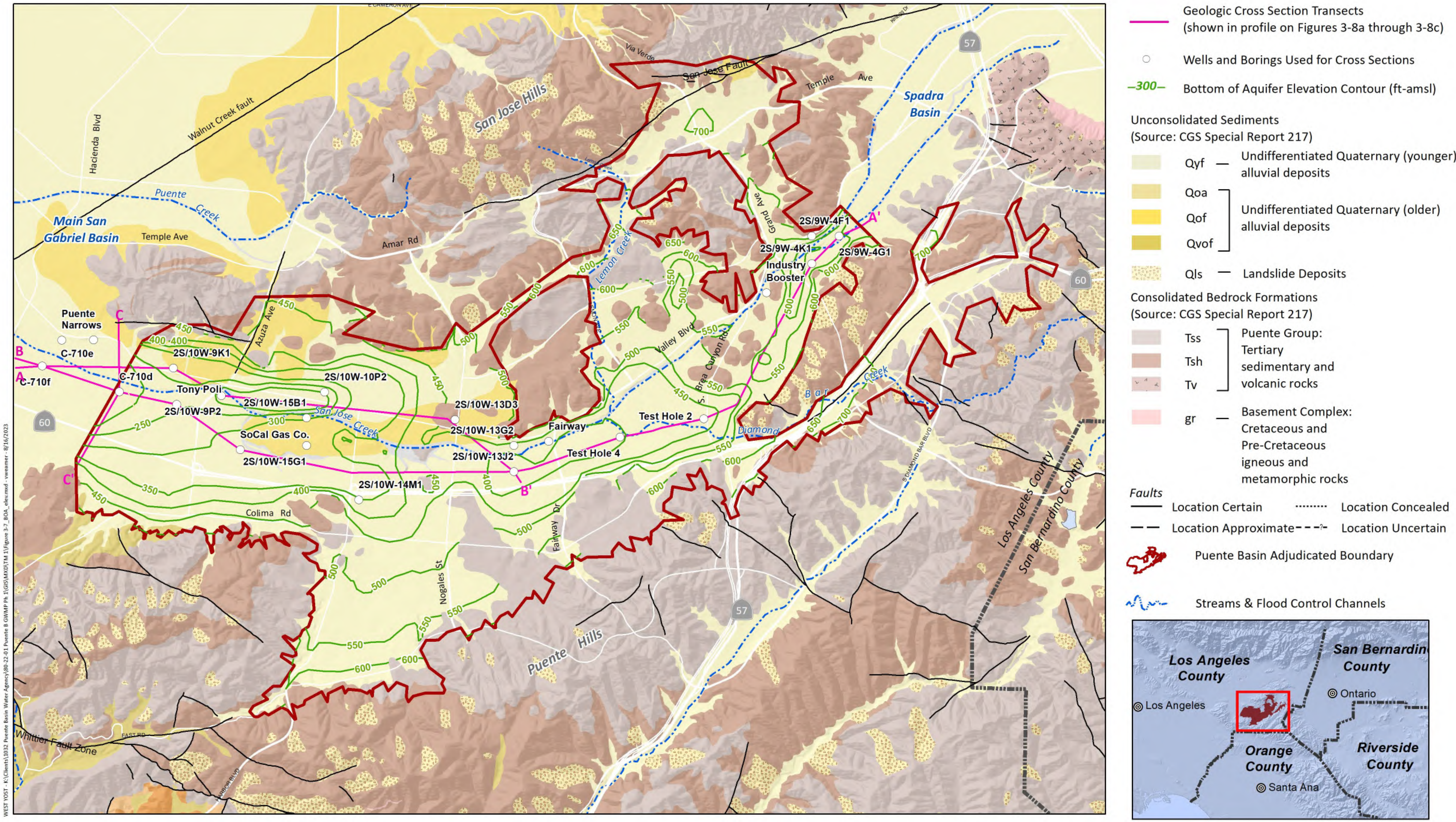
Depth to Bottom of Aquifer

Figure 3-6



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Elevation of the Bottom of Aquifer and Location of Hydrogeologic Cross Sections

Figure 3-7

3.2.5 Hydrostratigraphy

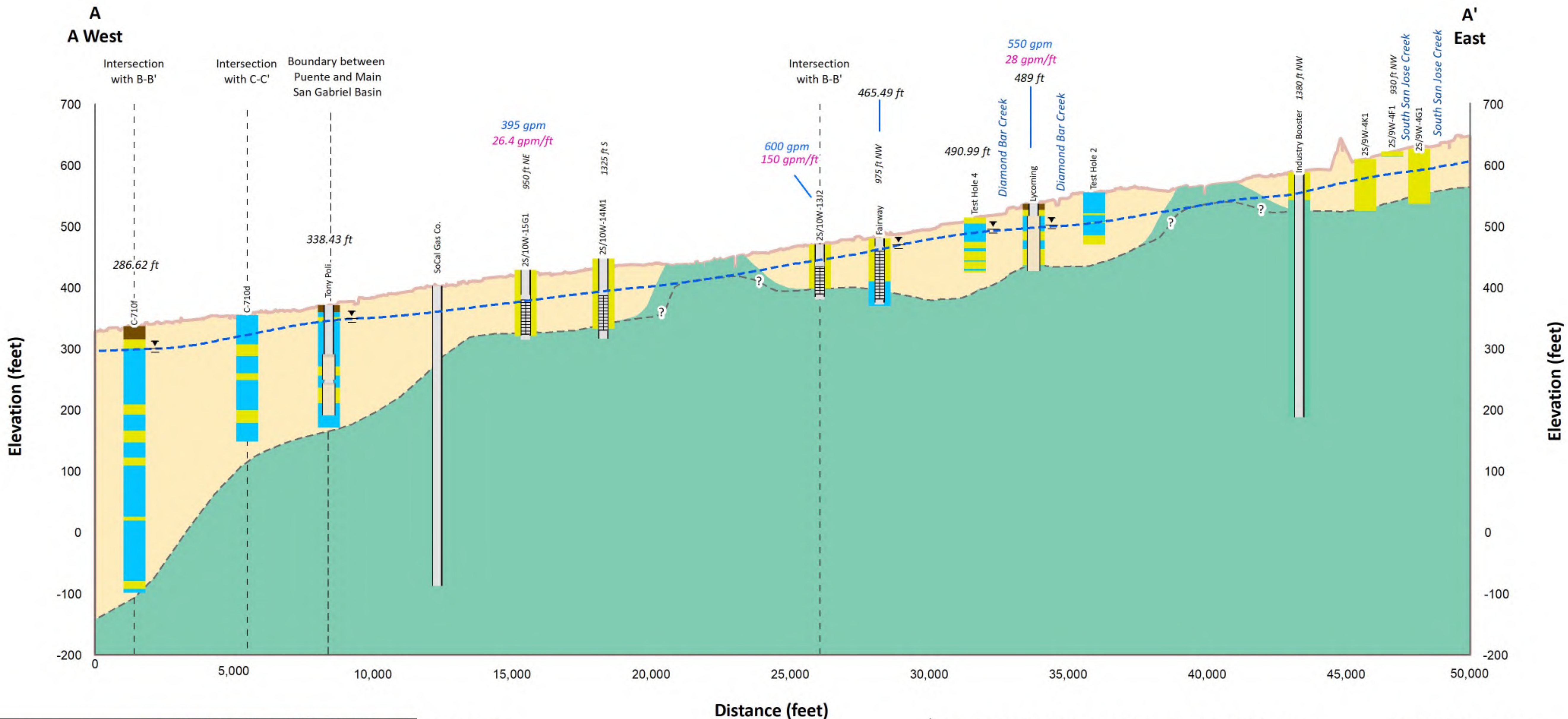
The water-bearing sediments are composed of interbedded layers of gravel, sand, silt and clay, or layers that are a combination of one or more of these sediment types. The layers composed mainly of gravel and sand are permeable and groundwater flows through the interconnected pore space within these layers towards pumping wells. These layers of gravel and sand are referred to as “aquifers.” The sediment layers 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. Together, the aquifers and aquitards are herein referred to as the “aquifer system.”

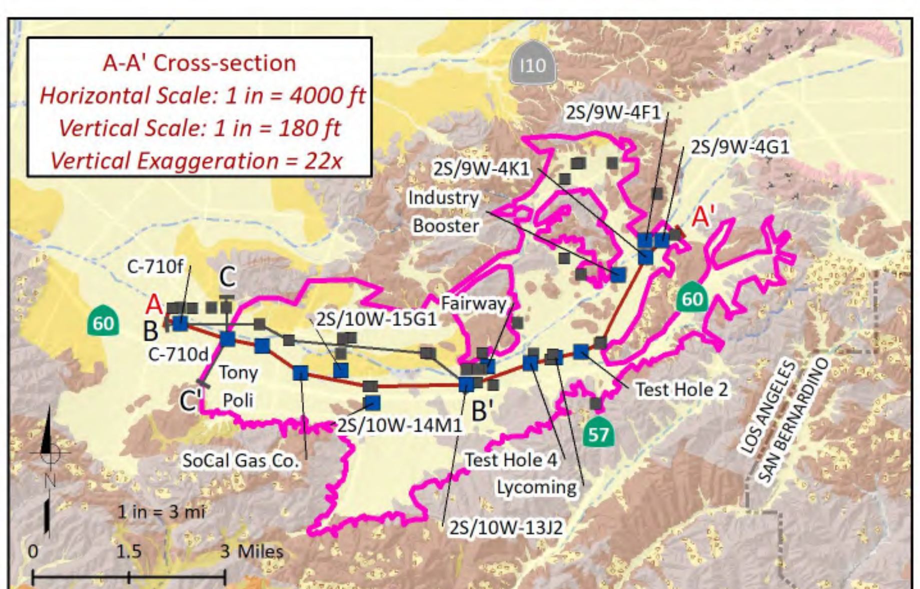
Groundwater can exist within an aquifer system under two different hydraulic conditions: unconfined and confined. Where the groundwater table is exposed to the atmosphere through the overlying unsaturated zone, the aquifer system is unconfined, and the groundwater table can rise and fall freely under 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.

The aquifer and aquitard layers and their geometries are numerous and complex in the Puente Basin and must be simplified into a hydrogeologic conceptual model that represents the three-dimensional distribution of the water bearing sediments and their hydrogeologic properties. To depict the hydrogeologic conceptual model, three hydrogeologic cross sections were constructed across the Puente Basin. The plan view locations of these cross sections are shown on Figure 3-7 and the profile view cross sections are shown in Figure 3-8a through Figure 3-8c. Plotted on these cross sections are well and borehole data, including: borehole lithology, well casing perforations, Spring 2022 groundwater elevations, estimated extent of the weathered zone in bedrock (Eckis, 1934), and the pumping rates and specific capacities of the wells.

The hydrogeologic cross sections depict a narrow, undulating, channel-like aquifer system that consists of about 50 to 230 ft of saturated sediments along the axis of the basin. Along the northern and southern edges of the basin and near the bedrock highs within the basin, the depth to bedrock becomes shallow and the saturated sediments pinch out against the buried contact with bedrock. The saturated sediments thicken to about 200 ft near the western boundary with the Main San Gabriel Basin.

The available data do not indicate a multiple-layer aquifer system within Puente Basin. The saturated sediments are a relatively thin unit (typically less than about 200 ft thick) of interbedded, discontinuous layers of gravel, sand, silt, and clay mixtures. There are no thick, regionally extensive, aquitards that could create conditions for deeper confined aquifers. Flowing artesian wells—an indication of confined aquifer conditions—have never been observed or mapped in the basin. The Puente Basin is best characterized as a relatively thin, narrow, unconfined, alluvial aquifer system.





WEST YOST - K:\Clients\1032 Puente Basin Water Agency\80-22-01 Puente B GWMP Ph 1\GIS\MXD\TM 1\Figure 3-8a_XsectionA-A'.mxd - vweamer - 9/5/2023

Inset Map

- Wells not in Cross-Section
- Wells in Cross-Section
- Other Detailed Cross Section Shown on This Figure
- Detailed Cross Section Shown on this Figure
- Puente Basin Boundary
- County Line

Notes:
1. Well construction and location data was compiled from the Department of Water Resources and Fox/Roberts Consulting Geology report, *Hydrogeologic Study of the Puente Groundwater Basin*, 2002.
2. Depth to the top of Puente Formation was approximated based on Fox/Roberts Consulting Geology's *Hydrogeologic Study of the Puente Groundwater Basin*, 2002.

Hydrogeologic Formation

- Water-Bearing Sediments
- Consolidated Bedrock

Boreline Lithology

- Unclassified Soil
- Clay/Silt
- Sand/Gravel
- Consolidated Bedrock

Well Construction

- Blank Casing
- Screen
- Transition Sand
- Filter Pack

Symbology

- Groundwater Elevation
- 360 gpm — Well Pumping Rate
- 465.5 ft — Groundwater Elevation
- 20.5 gpm/ft — Well Specific Capacity
- 1,380 N — Offset Distance and Direction from Cross-Section Line
- --?-- Approximate extent of weathered bedrock

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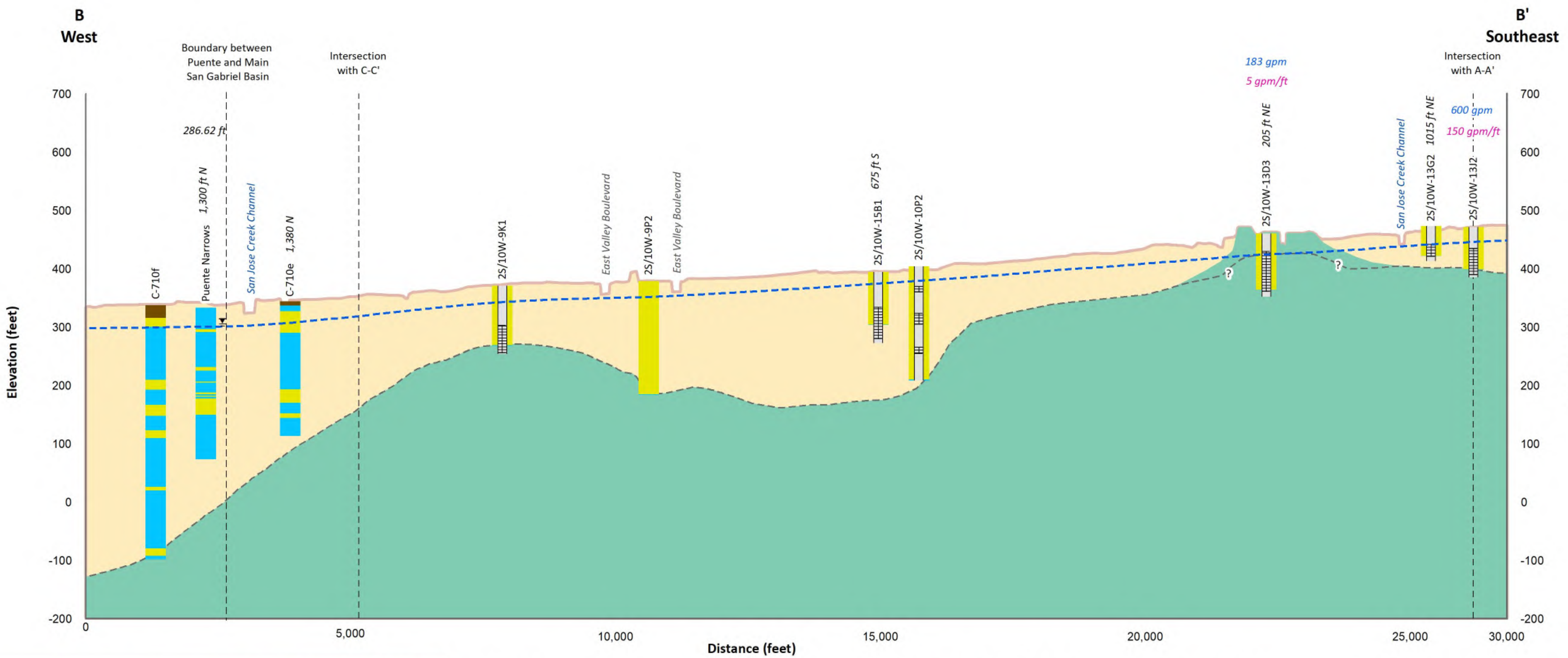
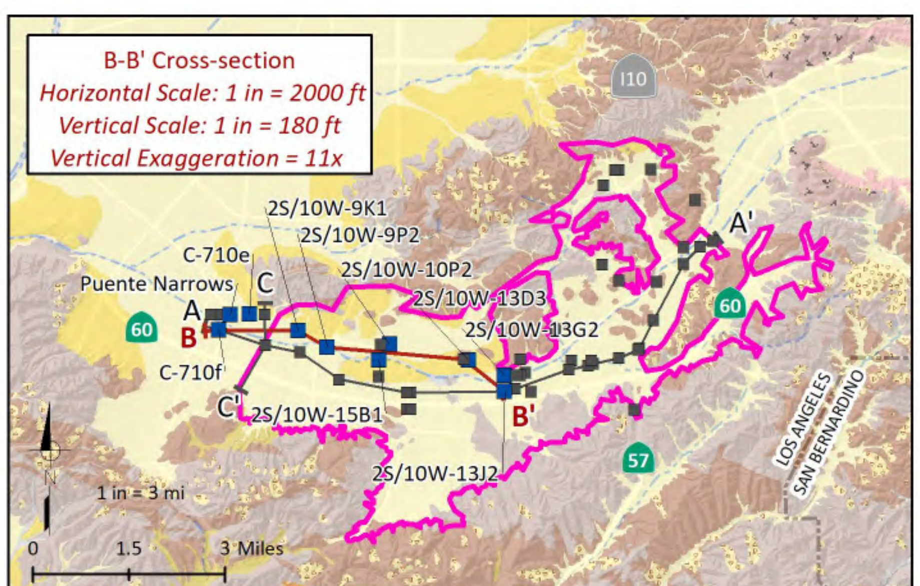
Hydrogeologic Cross-Section

A-A'

Figure 3-8a





WEST YOST - K:\Clients\1032 Puente Basin Water Agency\80-22-01 Puente B GWMP Ph 1\GIS\MXD\TM 1\Figure 3-8b_XsectionB-B'.mxd - vweamer - 9/5/2023

Inset Map

- Wells not in Cross-Section
- Wells in Cross-Section
- Detailed Cross Section Shown on This Figure
- Other Detailed Cross Section Shown on This Figure
- Puente Basin Boundary
- County Line

Notes:
1. Well construction and location data was compiled from the Department of Water Resources and Fox/Roberts Consulting Geology report, *Hydrogeologic Study of the Puente Groundwater Basin*, 2002.
2. Depth to the top of Puente Formation was approximated based on Fox/Roberts Consulting Geology's *Hydrogeologic Study of the Puente Groundwater Basin*, 2002.

Hydrogeologic Formation

- Water-bearing Sediments
- Consolidated Bedrock

Symbology

- Groundwater Elevation
- *360 gpm* Well Pumping Rate
- *465.5 ft* Groundwater Elevation from Spring 2022
- *20.5 gpm/ft* Well Specific Capacity
- *1,380 N* Offset Distance and Direction from Cross-Section Line
- --?-- Approximate extent of weathered bedrock

Borehole Lithology

- Unclassified Soil
- Clay/Silt
- Sand/Gravel
- Consolidated Bedrock

Well Construction

- Screen
- blank casing

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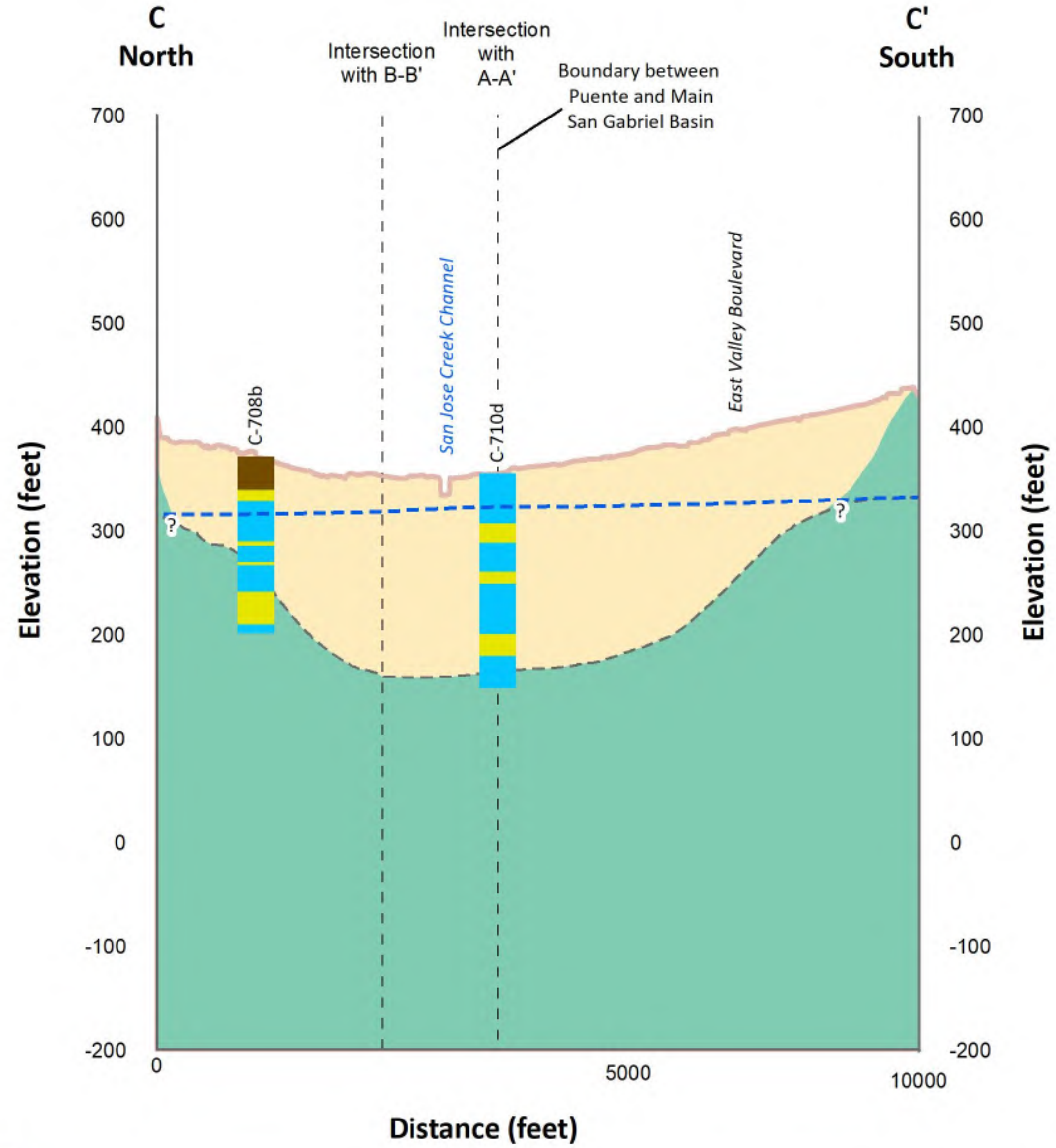
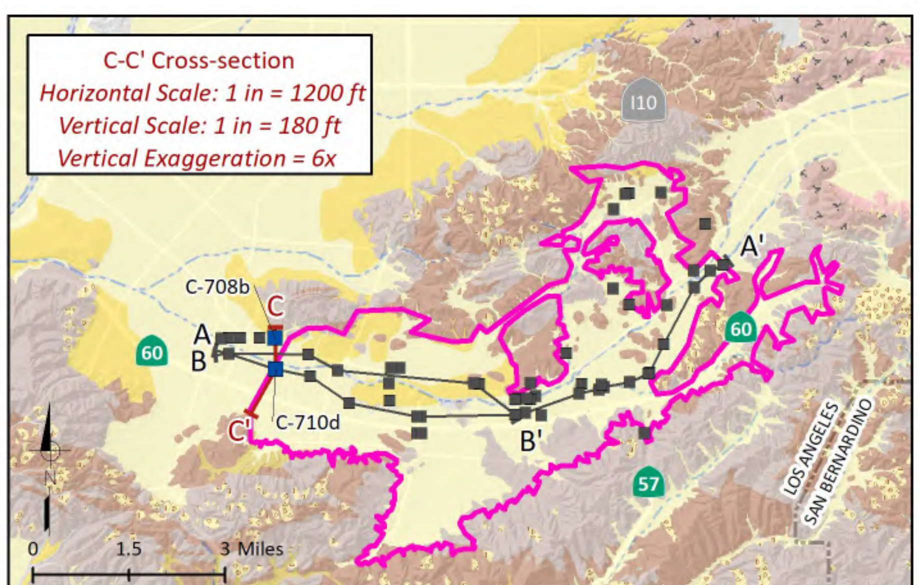
Hydrogeologic Cross-Section

B-B'

Figure 3-8b





WEST YOST - K:\Clients\1032 Puente Basin Water Agency\80-22-01 Puente B GWMP Ph 1\GIS\MXD\TM 1\Figure 3-8c_XsectionC-C'.mxd - vweamer - 9/5/2023

Inset Map

- Wells not in Cross-Section
- Wells in Cross-Section
- Other Cross- Section Not Shown on Figure
- Detailed Cross Section Shown on this Figure
- Puente Basin Boundary
- County Line

Notes:
1. Well construction and location data was compiled from the Department of Water Resources and Fox/Roberts Consulting Geology report, *Hydrogeologic Study of the Puente Groundwater Basin*, 2002.
2. Depth to the top of Puente Formation was approximated based on Fox/Roberts Consulting Geology's *Hydrogeologic Study of the Puente Groundwater Basin*, 2002.

Hydrogeologic Formation

- Water-Bearing Sediments
- Consolidated Bedrock

Borehole Lithology

- Unclassified Soil
- Clay/Silt
- Sand/Gravel

Symbology

- Groundwater Elevation
- *360 gpm* Well Pumping Rate
- *465.5 ft* Groundwater Elevation from Spring 2022
- *20.5 gpm/ft* Well Specific Capacity
- *1,380 N* Offset Distance and Direction from Cross-Section Line
- --?-- Approximate extent of weathered bedrock

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Hydrogeologic Cross-Section

C-C'

Figure 3-8c

3.2.6 Aquifer Properties

The properties that characterize the ability of the water bearing sediments of the Puente Basin 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/d).

This section describes initial estimates of specific yield and hydraulic conductivity for the saturated water bearing sediments within the Puente Basin which were calculated at select wells for this TM and derived in prior studies (Fox and Roberts, 2002; John Jones and Associates, 1969).

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; and Johnson, 1967). These estimates were used to assign hydraulic conductivity and specific yield to each sediment description on every available well driller’s report for boreholes drilled in the Puente Basin. Using the following formulas, thickness weighted estimates of horizontal hydraulic conductivity and specific yield were computed for each borehole across the saturated thickness based on 2022 water level conditions:

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

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

Where:

K_h is the average horizontal hydraulic conductivity of the saturated sediments

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 of the saturated sediments

S_y is average specific yield of the saturated sediments

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

Figure 3-9 shows the thickness weighted, initial estimates for specific yield at 17 boreholes that penetrated the entire thickness of the water bearing sediments. The figure also shows interpolated estimates of specific yield between boreholes to depict its spatial distribution. The interpolated surface is clipped to the area of the saturated sediments (i.e., the water bearing sediments are thin and unsaturated along the margins of the basin, hence, estimates of aquifer properties are not needed). Specific yield of the saturated sediments is relatively low across the basin and ranges from about 4 percent to 18 percent, with an average of 10 percent for the basin. Generally, specific yield is higher along the basin axis and lower along the edges of the basin. There is a localized area of higher specific yield in the central portion of the basin where the aquifer thickness is greater.

Figure 3-10 shows the thickness weighted, initial estimates for horizontal hydraulic conductivity at boreholes that penetrate the entire thickness of the water bearing sediments. The figure also shows interpolated estimates of horizontal hydraulic conductivity between boreholes to depict its spatial distribution. Horizontal hydraulic conductivity of the saturated sediments ranges from about 2 to 191 ft/d. As with specific yield, hydraulic conductivities are higher along the basin axis and lower along the edges of the basin. There is a localized area of higher hydraulic conductivity in the central portion of the basin where the aquifer thickness is greater.

The initial estimates of vertical hydraulic conductivity are assumed to be 10 percent of the horizontal hydraulic conductivity.

John Jones and Associates (1969) noted estimates of specific yield calculated by DWR Bulletin No. 45 (Eckis, 1934) and 104-2 ranged between 3 to 9 percent in the Puente Basin. The variation in specific yield is noted to be primarily due to the increased abundance of clayey material near the margins of the basin boundary where the specific yield ranges from 3 to 5 percent. Within the central part of the basin along the basin axis of the basin, specific yield ranges from 6 to 8 percent. Thickness weighted estimates of specific yield of saturated sediments calculated from drillers logs were on average greater than what was reported by John Jones and Associates (1969). Although spatially what is represented in Figure 3-9 generally agrees with the findings by John Jones and Associates (1969), more data and analysis is needed to better understand the spatial variability of specific yield within the basin.

Fox and Roberts (2002) measured production rate, specific capacity, and estimated transmissivity at numerous wells within the Puente Basin. Transmissivity may be defined as the rate of flow of water in gallons per day through a vertical section of the aquifer system. Determination of formation constants can be accomplished from pumping tests of a well and measuring the rate of decline or recovery of water levels in nearby observation wells. When test data is unavailable, an empirical method for determining transmissivity can be utilized. The theoretical value of transmissivity can be related to the specific capacity of the well and represented by the following empirical equation as noted by Fox and Roberts (2002):

$$T = 1500\frac{Q}{S}$$

Where:

Q/S is the specific capacity of the well

1500 is an empirical constant for an unconfined aquifer (Driscoll, 1986)

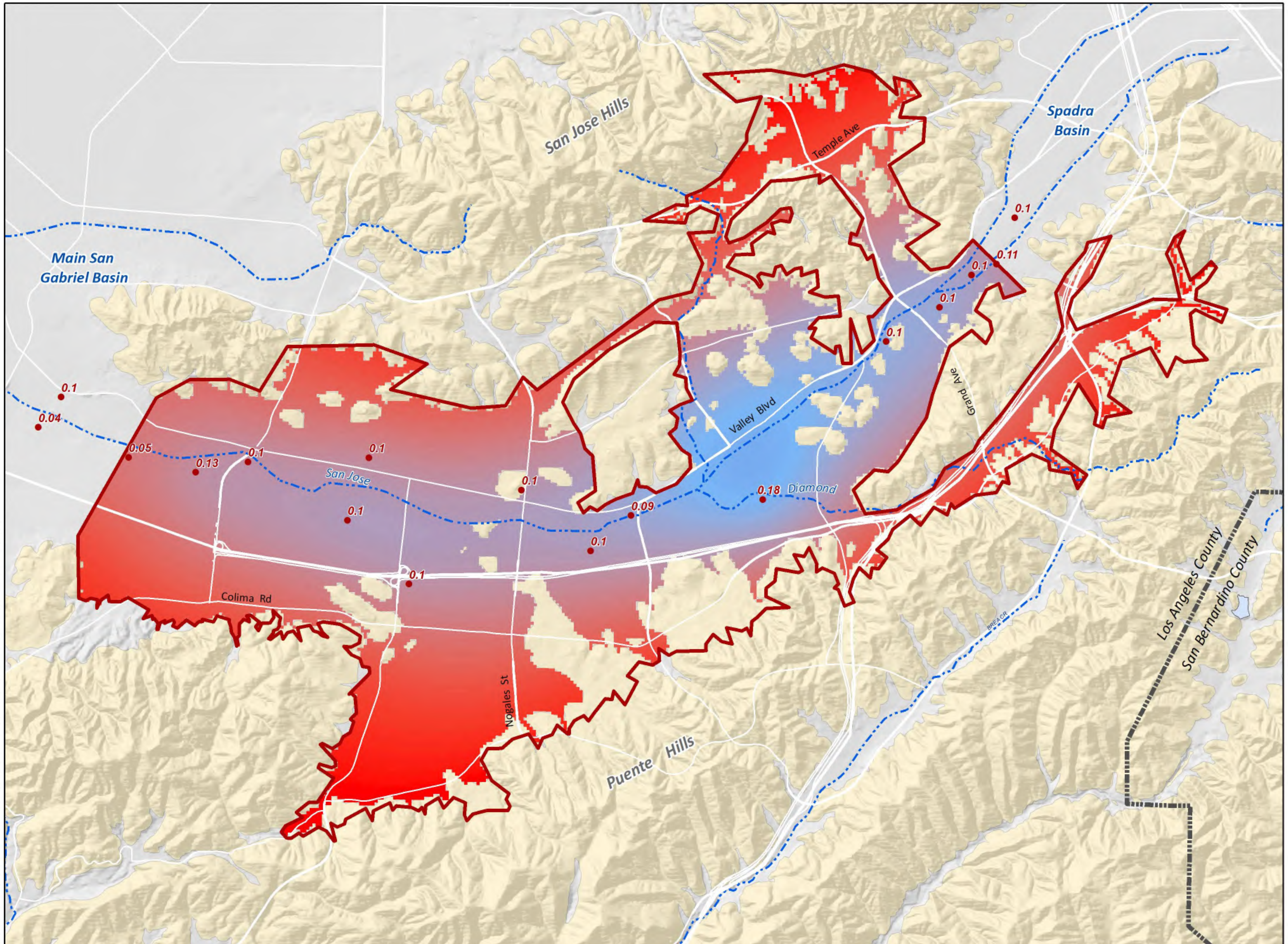
Transmissivity was estimated by Fox and Roberts by multiplying the specific capacity of the well by the empirical constant.

Table 3-2 shows pumping rates, specific capacity, and estimated transmissivity of wells shown on Figures 3-8a and 3-8c.

Table 3-2. Pumping Rates and Aquifer Property Estimates from Wells within the Puente Basin.

Well ID	Well Depth, ft	Saturated Thickness, ft	Pumping Rate, gpm	Specific Capacity, gpm/ft	Transmissivity, gal/ft/day
Fairway	110	95	375	NC	NC
Lycoming	104	52	550	28.0	42,000
Puente Narrows	260	214	490	7.2	10,800
2S/10W-13D3	108	67	183	5.00	7,500
2S/10W-15G1	122	57	395	26.4	30,600
2S/10W-13J2	96	51	600	150	225,000
AC No 2	104	59	600	NC	NC
2S/10W-10P4	300	274	750	12.5	18,750

(a) Groundwater elevations from spring 2022 were used to calculate saturated thickness.
NC – Not calculated.



Estimates of Specific Yield

0.20 %

0 %

0.1 Wells used to estimate specific yield labeled by specific yield of the saturated sediments

Puente Basin Adjudicated Boundary

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

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WEST YOST

0 1 2 Miles

0 1 2 Km

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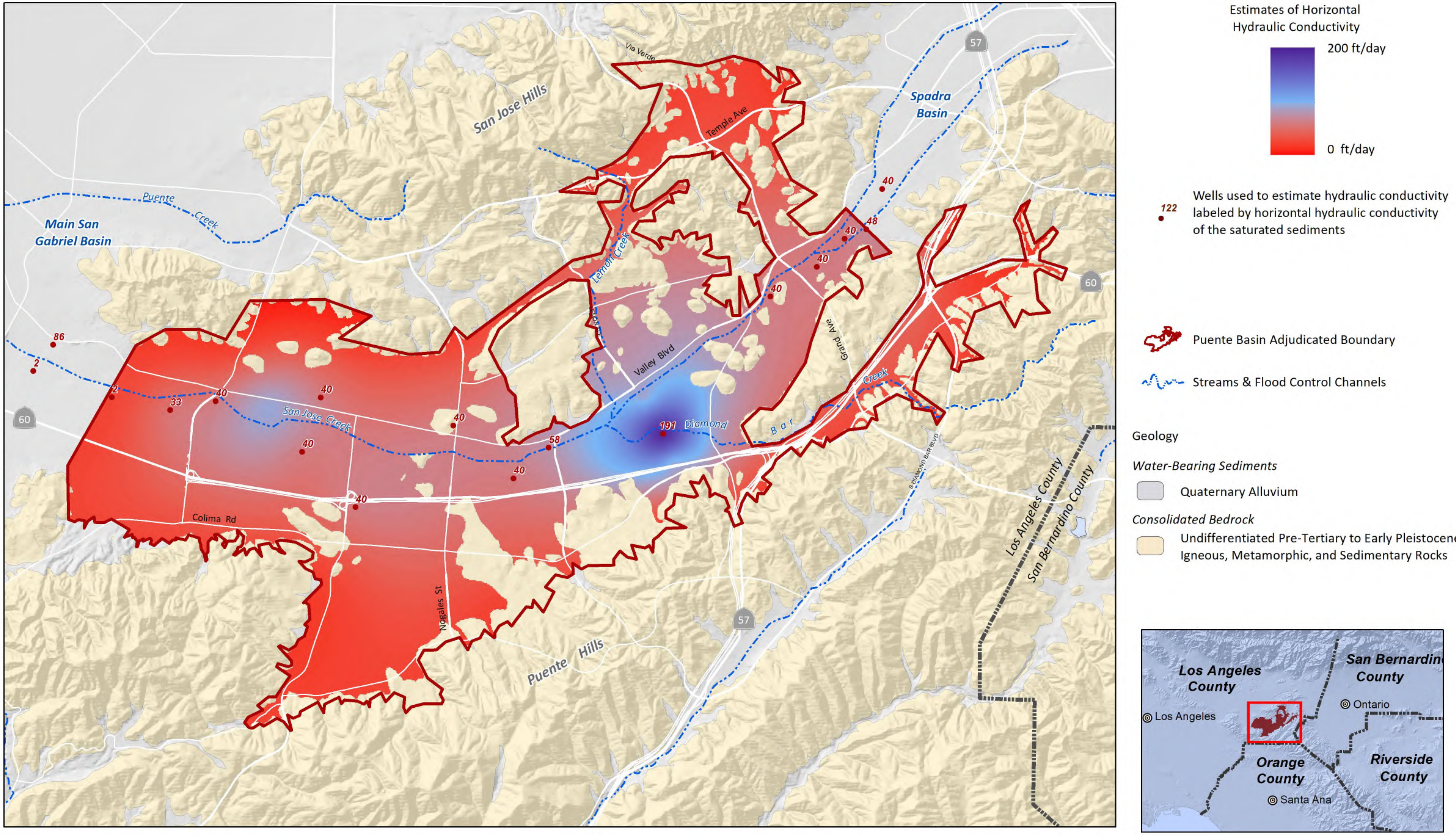
Initial Estimates of Specific Yield of the Water Bearing Sediments

Figure 3-9



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Initial Estimates of Horizontal Hydraulic Conductivity

Figure 3-10

3.2.7 Groundwater Recharge

Groundwater recharge to the Puente Basin primarily occurs by the following general mechanisms:

- **Subsurface inflow from the Spadra Basin**. The Spadra Basin Groundwater Model developed by the Spadra Basin GSA during the preparation of the Spadra Basin GSP estimated subsurface outflow to the Puente Basin from the Spadra Basin ranged from about 1,100 afy to 2,000 afy and averaged about 1,500 afy for the calibration period (1978-2018) (West Yost, 2023a).
- **Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose Hills and Puente Hills).**
- **Deep infiltration of precipitation and applied water (DIPAW).** DIPAW includes the combination of precipitation that falls directly on a pervious land surface, precipitation that falls on impermeable land surface that subsequently flows onto pervious surfaces, and irrigation water applied to the land surface; all of which when combined is surplus to the evapotranspiration (ET) demand and soil water storage capacity. DIPAW migrates through the root zone and subsequently reaches the underlying groundwater reservoir. DIPAW is an important source of recharge from a water quality standpoint because it is typically high in total dissolved solids (TDS) and nitrogen from land application of fertilizers and from consumptive use by vegetation.

3.2.8 Groundwater Discharge

Groundwater discharge from the Puente Basin occurs primarily as:

- **Groundwater production from wells.**
- **Sub-surface outflow to the Main San Gabriel Basin.** This component of discharge occurs as underflow through the saturated sediments when the groundwater divide is located west of the boundary with the Main San Gabriel Basin. The rate of underflow is dependent on the hydraulic gradient and the hydraulic conductivity of the saturated sediments. This was estimated to be 550 afy according to the Puente Narrows Agreement (1972).

3.2.9 Groundwater Flow

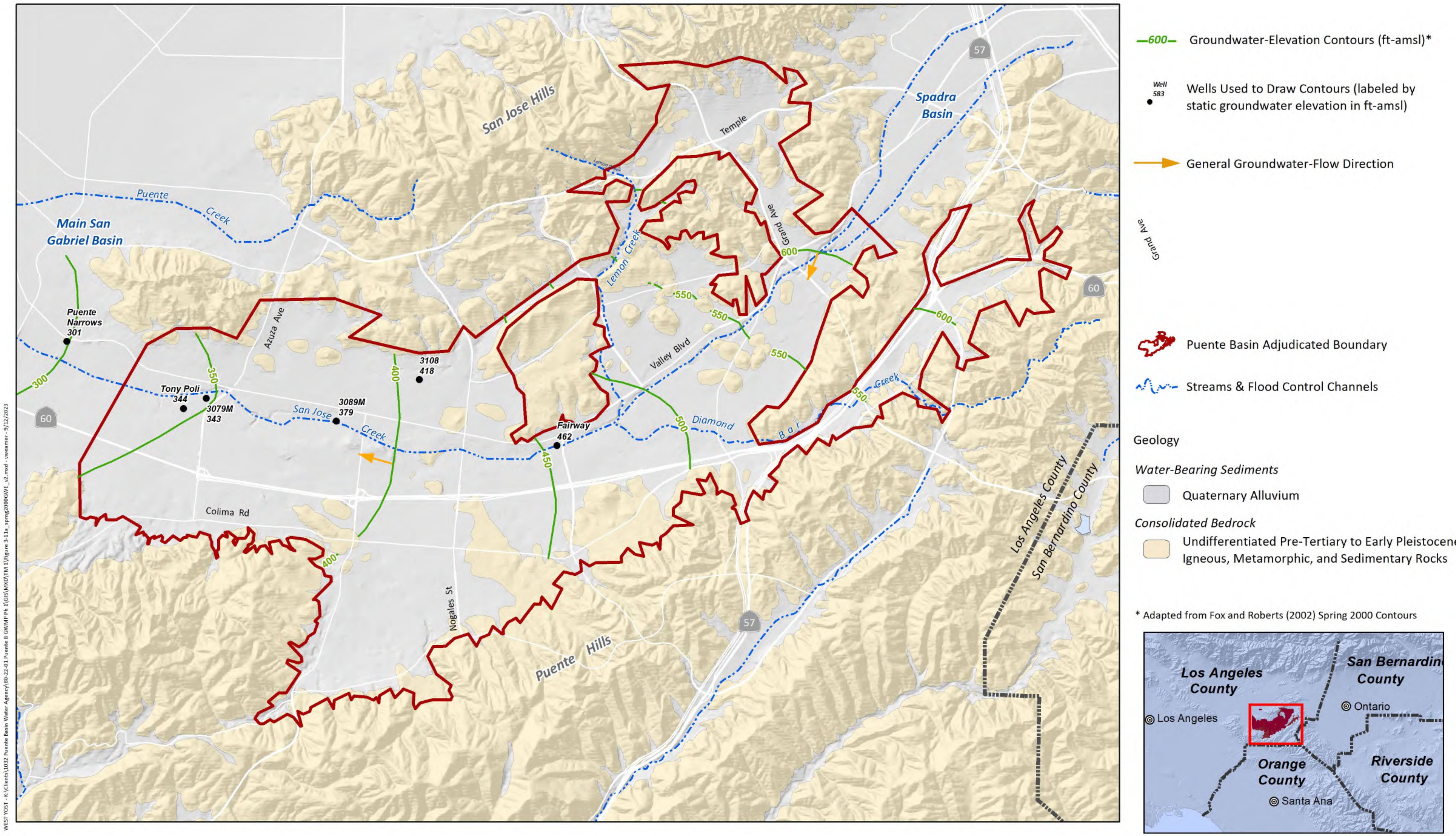
Figure 3-11a and 11b shows an equal groundwater-elevation contour map for Spring 2000 and Spring 2022, respectively. Groundwater elevation contours for Spring 2000 were adapted from groundwater contours generated from Fox and Roberts (2002) using water level measurements (or estimates) from wells where data existed. The procedure for constructing the groundwater elevation contour map was as follows:

Collect historical groundwater-elevation data for wells within the basin*.* The main data sources used in this exercise were files from the WVWD, RWD, City of Industry, BDP Carrier Corporation, Sigma Plating Corporation, SWL-200 (Former Unical Enterprises Inc.), California Hydroforming, Puente Basin Watermaster, and LACDPW.

- **Prepare and analyze time-series charts of groundwater elevations for all wells.** The time-series charts were used to distinguish between static and pumping groundwater levels. Groundwater-elevation data that were collected while the well was under the influence of pumping were not used in the preparation of the groundwater-elevation contour maps.
- **Extract groundwater-elevation data for specific time periods**. For example, for the Fall 2022 groundwater-elevation contour map, we extracted groundwater elevation data for wells with data between March 1 and May 31, 2022. After "pumping" data were discarded, we chose one groundwater-elevation data point for each well in the following order of priority: April, March, May.

- **Prepare maps of the groundwater-elevation data***.* The maps included the data points for groundwater elevation and background hydrogeologic layers, such as surface geology, faults, and stream channels.
- **Prepare contours of equal groundwater elevation***.* Groundwater elevation contours were hand drawn based on the groundwater elevation point (well) data. The groundwater elevation contours were digitized and imported into ArcGIS. The contours are dashed where groundwater-elevation data are sparse or absent, and hence, groundwater-elevation contours are uncertain.

The groundwater elevation contour map on Figure 3-11a and 3-11b were used to analyze and interpret groundwater-flow direction, which is perpendicular to the contours from higher elevation to lower elevation. Groundwater-flow patterns within the Puente Basin have been generally consistent over time due to the consistent groundwater levels along the eastern and central part of the basin and slightly declining water levels in the western part of the basin. The maps and interpretations from the analysis of groundwater elevations and flow directions are consistent with maps and interpretations published in prior studies.



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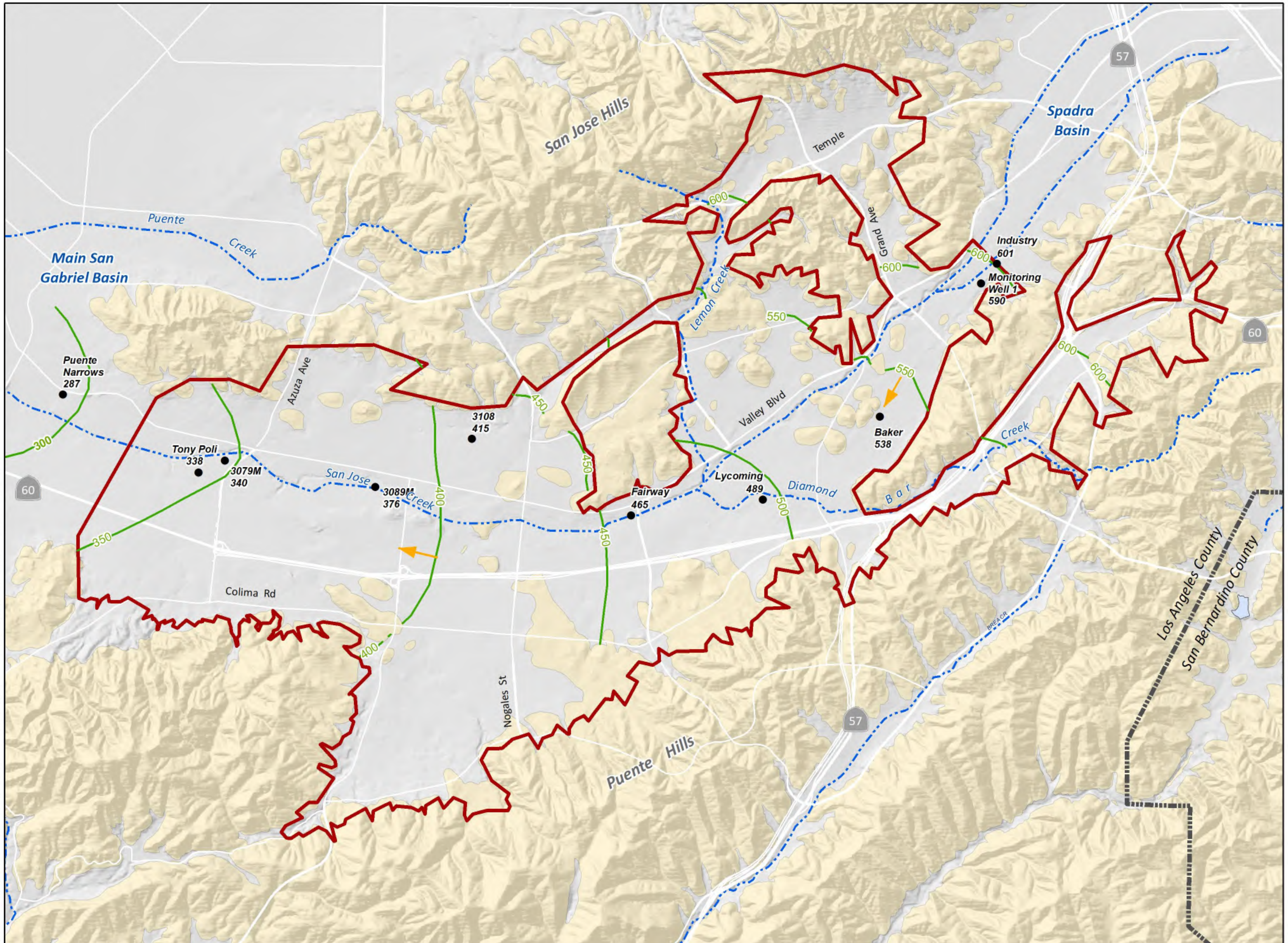
Groundwater Elevation and Flow Directions
Spring 2000
Figure 3-11a



- Groundwater-Elevation Contours (ft-amsl)
- Wells Used to Draw Contours (labeled by static groundwater elevation in ft-amsl)
- General Groundwater-Flow Direction
- Puente Basin Adjudicated Boundary
- Streams & Flood Control Channels

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

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

WEST YOST - K:\Clients\1032 Puente Basin Water Agency\80-22-01 Puente B GWMP Ph 1\GIS\MXD\TM 1\Figure 3-11b_spring2022GWE_v2.mxd - wesamer - 9/12/2023

Prepared by: WEST YOST

0 1 2 Miles
0 1 2 Km

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Groundwater Elevation and Flow Directions
Spring 2022
Figure 3-11b

3.2.10 Groundwater Pumping

Groundwater pumping is the extraction of groundwater from the aquifer system. Figure 2-3 shows the active production wells in the Puente Basin. Currently, there are approximately 25 pumping wells. Pumping capacities at the pumping wells are low to moderate ranging between 42 to 750 gpm. Specific capacities at the pumping wells are also typically low to moderate (<30 gpm/ft drawdown). Wells with lower pumping rates and low specific capacities are generally located in areas with bedrock highs and thin alluvium, or along the margins of the basin near the surrounding highlands. Wells will higher pumping rates and specific capacities are generally located along the central axis of the basin where alluvium is thicker. There are also four locations where high shallow groundwater is collected in holding tanks or structures underground, and then pumped for non-potable water supply.

Annual groundwater pumping from FY 1970 to FY 2022 is listed by pumper in Table 3-3 and shown graphically in Figure 3-12. The pumpers in the Puente Basin include Primary Parties to the Judgment (WVWD, RWD, City of Industry, Industry Successor Agency and Royal Vista Golf Course), and pumping for groundwater contamination clean-up (Carrier BDP Corporation, Malibu Grand Prix 3, and Hamilton Standard Controls). From FY 1986/87 to FY 2021/22, the percentage of the total pumping in the Puente Basin between five Principal Parties was 27 percent WVWD, nine percent RWD, eleven percent City of Industry, eight percent Industry Successor Agency, and 29 percent Royal Vista Golf Course; and seventeen percent of the total pumping was for groundwater contamination clean-up projects, primarily by the Carrier BDP Corporation.

The long-term average groundwater pumping in the Puente Basin from FY 1970 to FY 2022 is 933 afy, but annual pumping over this period has increased. The history of groundwater pumping from 1970 to 2022 is described below.

Before the Puente Judgment (FY 1970 to FY 1986)

- There were no established pumping rights and groundwater pumping was not reported to the Puente Basin Watermaster .
- Royal Vista Golf Course was the only non-minimal producer pumping groundwater from the basin and pumped an estimated average of 306 afy. Therefore, the estimated average annual pumping in the Puente Basin was 306 afy.

After the Puente Judgment (FY 1987 – FY 2022)

- Groundwater pumping was required to be reported by Primary Parties to the Judgement and other non-minimal producers (> 3 afy) to the Puente Basin Watermaster.
  - 1987
    - Carrier BDP Corporation and Industry Successor Agency began pumping from the basin.
  - 1988
    - Walnut Valley Water District started pumping from the basin.
  - 1994
    - Between 1987 to 1994, pumping tripled relative to pre-Judgment pumping.
    - Industry Successor Agency ceased pumping from the basin, and City of Industry started pumping from the basin.
    - Pumping at the Malibu Grand Prix site for groundwater contamination clean-up occurred and continued until 1995.

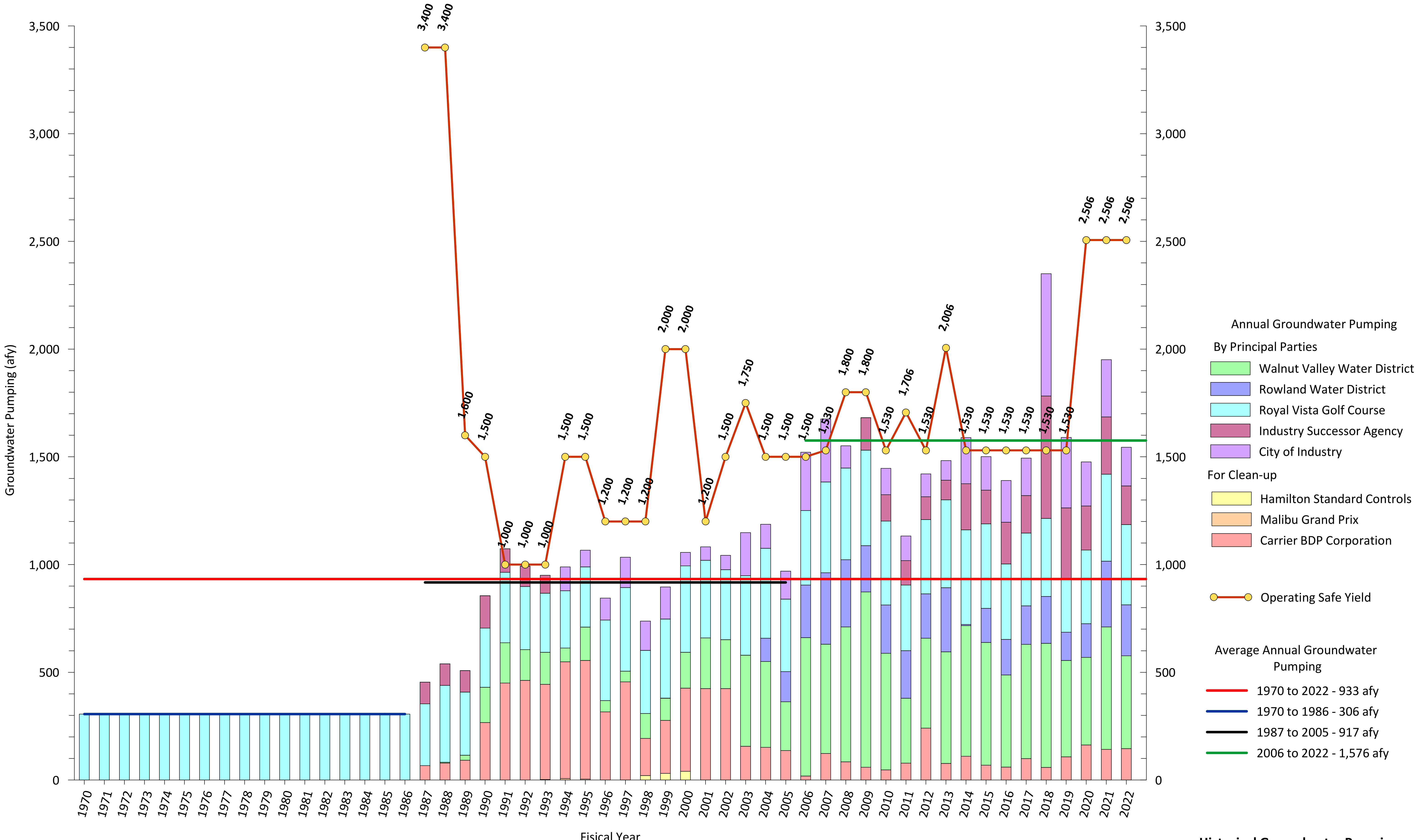
- 1998
  - Pumping at the Hamilton Standard Control site for groundwater contamination clean-up occurred and continued until 2000.
- 2004
  - RWD started pumping from the basin.
- 2005
  - Between 1987 to 2005, average annual pumping was 917 afy, a three-time increase from the pre-Judgment period of 306 afy.
  - Industry Successor Agency started pumping groundwater again from the basin.
- 2018
  - Pumping in 2018 reached an all-time-high of 2,350 afy, nearly seven times the pre-Judgment pumping. This occurred following an extreme drought period in the region and the state which significantly impacted imported surface water supply availability.
- 2022
  - Between 2006 to 2022, average annual pumping was 1,576 afy, a five-time increase from the pre-Judgment period of 306 afy.
  - In 2022, the annual pumping was 1,544 afy, and the percentage of the pumping was: twelve percent by City of Industry, twelve percent by Industry Successor Agency, and 24 percent by Royal Vista Golf Course, fifteen percent by RWD, 28 percent by WVWD, and nine percent by Carrier BDP Corporation.

Also shown in Figure 3-12 is the annual Operating Safe Yield determined annually by the Puente Basin Watermaster pursuant to the Judgment, and used to determine the Principal Parties' pumping rights based on their share of the safe yield. The Operating Safe Yield set by the Puente Basin Watermaster has ranged from 1,000 afy to 3,400 afy. For the period since the Judgment in FY 1987, the annual groundwater pumping was mostly at or below the annual Operating Safe Yield, and six out of the 35 years the annual pumping was above the Operating Safe Yield, but typically just by a small amount (except in 2018).

Table 3-3. Groundwater Pumping in the Puente Basin from 1970 - 2022.

	Principal Party					Clean-up Pumping			
Fiscal Year	**City of Industry**	**Industry Successor Agency**	**Royal Vista Golf Coarse**	**Rowland Water District**	**Walnut Valley Water District**	**Carrier BDP Corp.**	**Malibu Grand Prix 3**	**Hamilton Standard Controls**	**Total**
1970	-	-	*306*	-	-	-	-	-	306
1971	-	-	*306*	-	-	-	-	-	306
1972	-	-	*306*	-	-	-	-	-	306
1973	-	-	*306*	-	-	-	-	-	306
1974	-	-	*306*	-	-	-	-	-	306
1975	-	-	*306*	-	-	-	-	-	306
1976	-	-	*306*	-	-	-	-	-	306
1977	-	-	*306*	-	-	-	-	-	306
1978	-	-	*306*	-	-	-	-	-	306
1979	-	-	*306*	-	-	-	-	-	306
1980	-	-	*306*	-	-	-	-	-	306
1981	-	-	*306*	-	-	-	-	-	306
1982	-	-	*306*	-	-	-	-	-	306
1983	-	-	*306*	-	-	-	-	-	306
1984	-	-	*306*	-	-	-	-	-	306
1985	-	-	*306*	-	-	-	-	-	306
1986	-	-	*306*	-	-	-	-	-	306
1987	-	100	287	-	-	67	-	-	454
1988	-	100	357	-	4	79	-	-	539
1989	-	100	293	-	24	92	-	-	508
1990	-	150	275	-	164	267	-	-	855
1991	-	110	327	-	187	450	-	-	1,074
1992	-	95	292	-	143	463	-	-	992
1993	-	84	274	-	149	441	2	-	951
1994	111	-	266	-	64	542	7	-	989
1995	78	-	279	-	155	551	4	-	1,067
1996	102	-	374	-	52	316	-	-	844
1997	141	-	388	-	50	455	-	-	1,034
1998	136	-	293	-	116	172	-	21	738
1999	149	-	367	-	103	246	-	31	896
2000	62	-	401	-	166	386	-	40	1,056
2001	62	-	360	-	235	424	-	-	1,082
2002	67	-	325	-	227	424	-	-	1,043
2003	200	-	369	-	423	157	-	-	1,148
2004	111	-	417	109	398	152	-	-	1,187
2005	130	-	336	140	226	137	-	-	969
2006	270	-	347	244	643	18	-	-	1,521
2007	292	-	422	332	507	123	-	-	1,676
2008	103	-	426	312	626	84	-	-	1,551
2009	-	151	444	214	814	59	-	-	1,682
2010	123	123	390	224	541	47	-	-	1,447
2011	114	114	305	221	301	78	-	-	1,132
2012	106	106	344	206	418	241	-	-	1,421
2013	91	91	408	297	518	77	-	-	1,483
2014	214	214	439	6	606	110	-	-	1,590
2015	156	156	393	159	569	69	-	-	1,501
2016	194	194	351	165	427	60	-	-	1,390
2017	174	174	338	179	530	99	-	-	1,494
2018	568	568	363	217	576	59	-	-	2,350
2019	327	327	250	131	447	108	-	-	1,590
2020	204	204	342	157	406	162	-	-	1,476
2021	266	266	404	305	569	142	-	-	1,951
2022	179	179	373	237	431	146	-	-	1,544
Minimum	**-**	**-**	**250**	**-**	**-**	**18**	**-**	**-**	**306**
Average	**131**	**100**	**336**	**107**	**328**	**208**	**0**	**3**	**933**
Maximum	**568**	**568**	**444**	**332**	**814**	**551**	**7**	**40**	**2,350**
Total	**4,729**	**3,604**	**17,818**	**3,855**	**11,813**	**7,503**	**14**	**92**	**49,429**
% of Total	**10%**	**7%**	**36%**	**8%**	**24%**	**15%**	**0.0%**	**0.2%**	**100%**

* Numbers in *italics* are estimated volumes of pumping. These estimates were prepared based on confirmation that the well was active and were determined using the average of the measured and recorded annual pumping volumes.



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Historical Groundwater Pumping Relative to Puente Basin Operating Safe Yield and Estimated Developed Yield

Figure 3-12

3.2.11 Groundwater Levels and Storage

This section describes how groundwater levels and storage have changed over time across the Puente Basin, and why those changes occurred.

Figure 3-13 shows time-series charts of groundwater elevation at seven wells located across the Puente Basin. The time-series charts indicate:

- At some wells, the short-term groundwater-level fluctuations are caused by including pumping and non-pumping measurements on the time series charts.
- Seasonal changes in groundwater levels at all wells are minimal, and generally do not exceed a few feet of seasonal change.
- Groundwater levels have been relatively stable in the eastern and central portions of the Basin, but have shown a small decline in the western part of the Basin since 2006. This decline is most likely due to declining groundwater levels in the Main San Gabriel Basin due to drought conditions and lack of local recharge. The slightly declining trends evident at the Tony Poli and 3079M wells in the western portion of the Basin generally correlate to water level trends in SWS 155W-2 since 2006 located on the west side of the Puente Basin boundary (Stetson Engineers Inc., 2023).

On Figure 3-13, the behavior of groundwater levels is compared to precipitation patterns and groundwater pumping from FY 1970 to FY 2022, to help describe why the changes in groundwater levels may have occurred. Precipitation patterns are illustrated by the CDFM curve. Despite variations in precipitation during dry periods and wet periods, and a gradual increase in pumping over this period, groundwater levels (and therefore storage) have remained relatively stable across most of the Puente Basin with the exception of the western part of the Basin that shares a boundary with the Main San Gabriel Basin. The Tony Poli well in this western boundary area shows a six-foot decline.

Estimates of groundwater in storage were prepared for spring 2000 and spring 2022 using the groundwater-elevation contours shown in Figures 3-11a and 3-11b. To estimate groundwater in storage, the groundwater elevations for each year (2000 and 2022), the bedrock elevation (shown on Figure 3-7), and the specific yield of the saturated sediments (shown on Figure 3-9), were assigned to each cell of a 60 x 60-meter grid (196 x 196 ft) superimposed over the Puente Basin in ArcGIS. The volume of groundwater in storage within each grid cell was calculated and summed to estimate the total groundwater in storage in af. Groundwater in storage in 2000 and 2022 is estimated to be 18,071 af and 17,551 af, respectively. Thus, the change in groundwater storage from 2000 to 2022 is estimated as -520 af. Figures 3-14a and 3-14b show the bottom of aquifer elevation contours and estimates of groundwater in storage in each grid cell for Spring 2000 and Spring 2022, respectively. Note that there are areas in the throughout the Puente Basin where groundwater is estimated to not be present along the basin margins and near bedrock highs on the western and eastern flanks of the central part of the basin where groundwater is present.

Total storage of the aquifer if the basin sediments were fully saturated was not estimated because of the relatively shallow groundwater levels across the basin which implies that the basin is for the most part at nearly full capacity.

There have been previous studies that have estimated groundwater in storage for the Puente Basin:

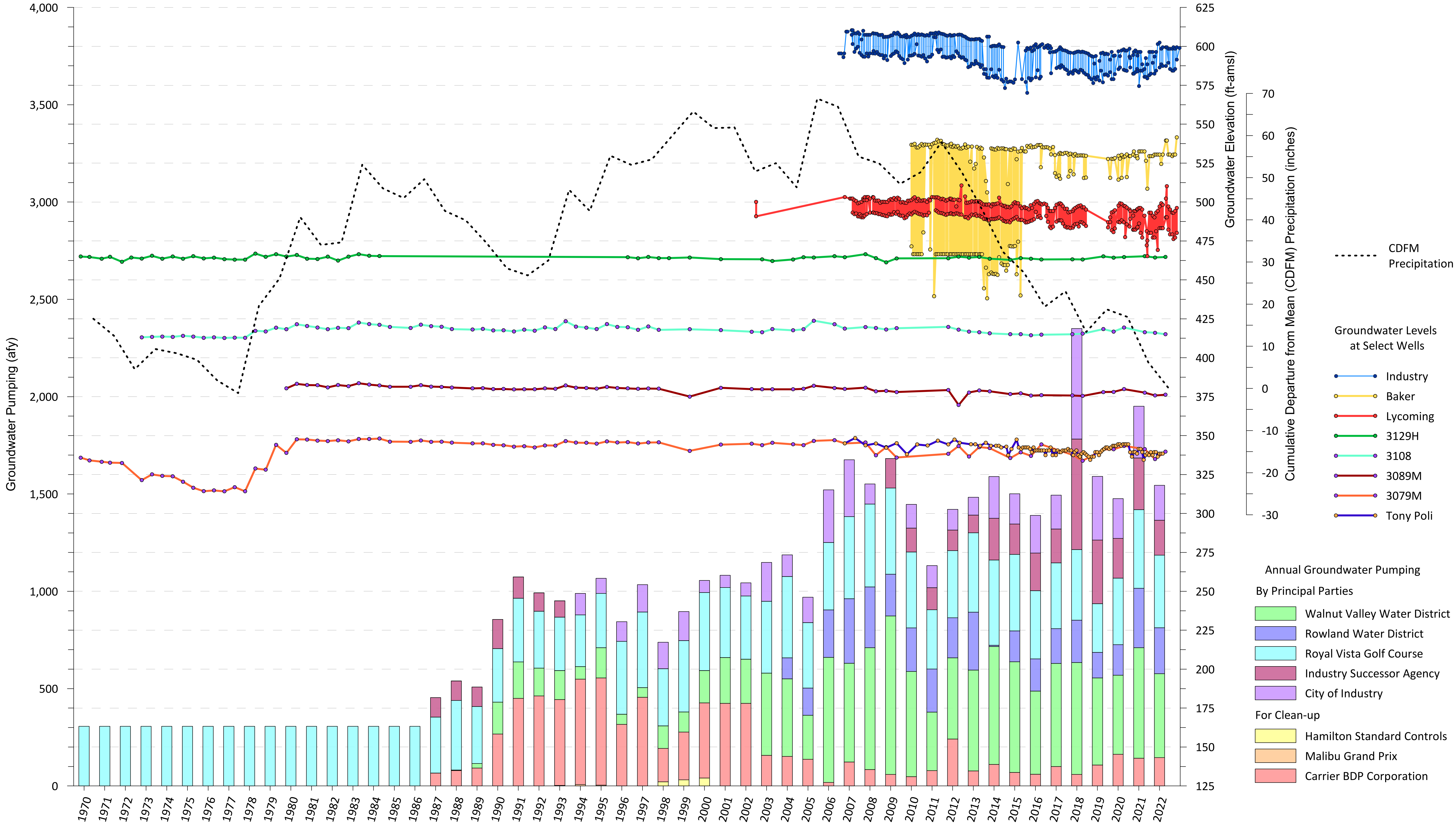
- Eckis (1934) estimated the basin contained 57,000 af in storage.
- John Jones & Associates (1969) used average specific yield values of the basin sediments as described in DWR's *Bulletin No 104-2* (DWR, 1966) to estimate 550 af per foot of saturated sediments in the basin. The study assumes an average thickness of 100 ft of saturated sediments, thus groundwater in storage was calculated to be 55,000 af.
- Geotechnical Consultants (1979) made a preliminary evaluation of groundwater in storage based on Spring 1978 water levels. Their calculations estimated 49,300 af of groundwater in storage in the basin and an additional 14,600 af of available storage assuming the entire unsaturated zone between spring 1978 water levels and ground surface could become saturated.

Table 3-4 summarizes the estimated water in storage from each study over the years and in 2022 as part of the development of this TM (West Yost, 2023b).

Table 3-4. Groundwater in Storage in the Puente Basin (1933-2022)

Year	Groundwater in Storage, af	Total Storage Capacity, af	Source
1933	-	57,000	Eckis, 1934
1969	55,000	-	John Jones & Associates, 1969
1979	49,300	63,900	Geotechnical Consultants, 1979
2000	18,071	-	Fox and Roberts, 2002 and West Yost, 2023b
2022	17,551	-	West Yost, 2023b

As shown in Table 3-4, estimates of groundwater in storage for 2000 and 2022 are roughly estimated for this study, are roughly a third to half of what was estimated by previous studies. This may be due to: different data, estimation tools, and applied methods used in those studies that were available at the time, compared to what is available now; a difference in basin boundary; and possible unaccounted bedrock highs in the aquifer geometry and specific yield estimates. Areas identified in Figure 3-14a and Figure 3-14b that are not saturated near bedrock highs may suggest a separation of the aquifer system into various discontinuous saturated subbasins is a significant data gap that deserves additional investigation. See a more detailed description of this data gap in *Section 3.6 Data Gaps.*



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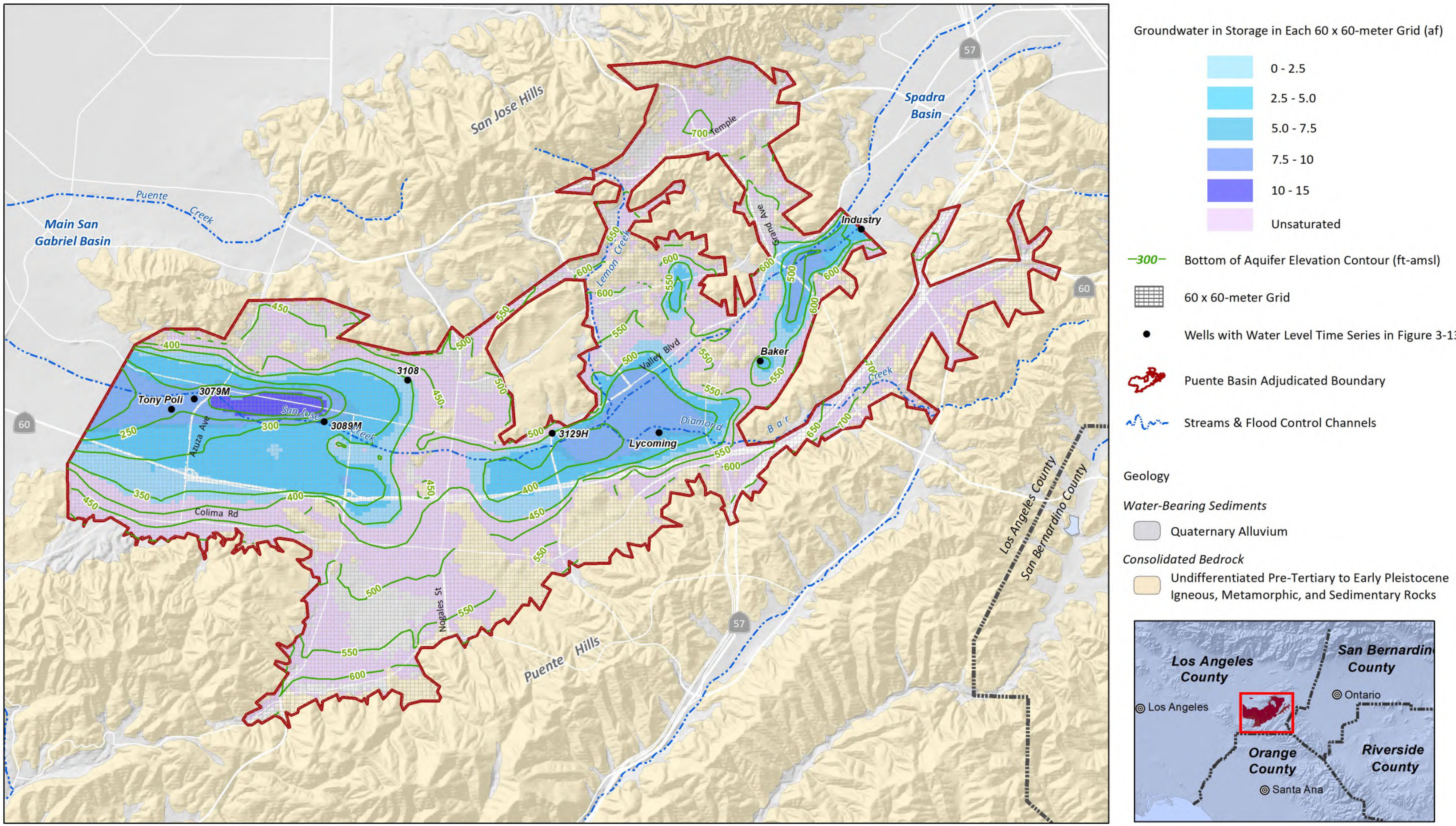
Precipitation, Groundwater Pumping, and Groundwater Levels in the Puente Basin

Figure 3-13



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0 1 2 Miles

0 1 2 Km

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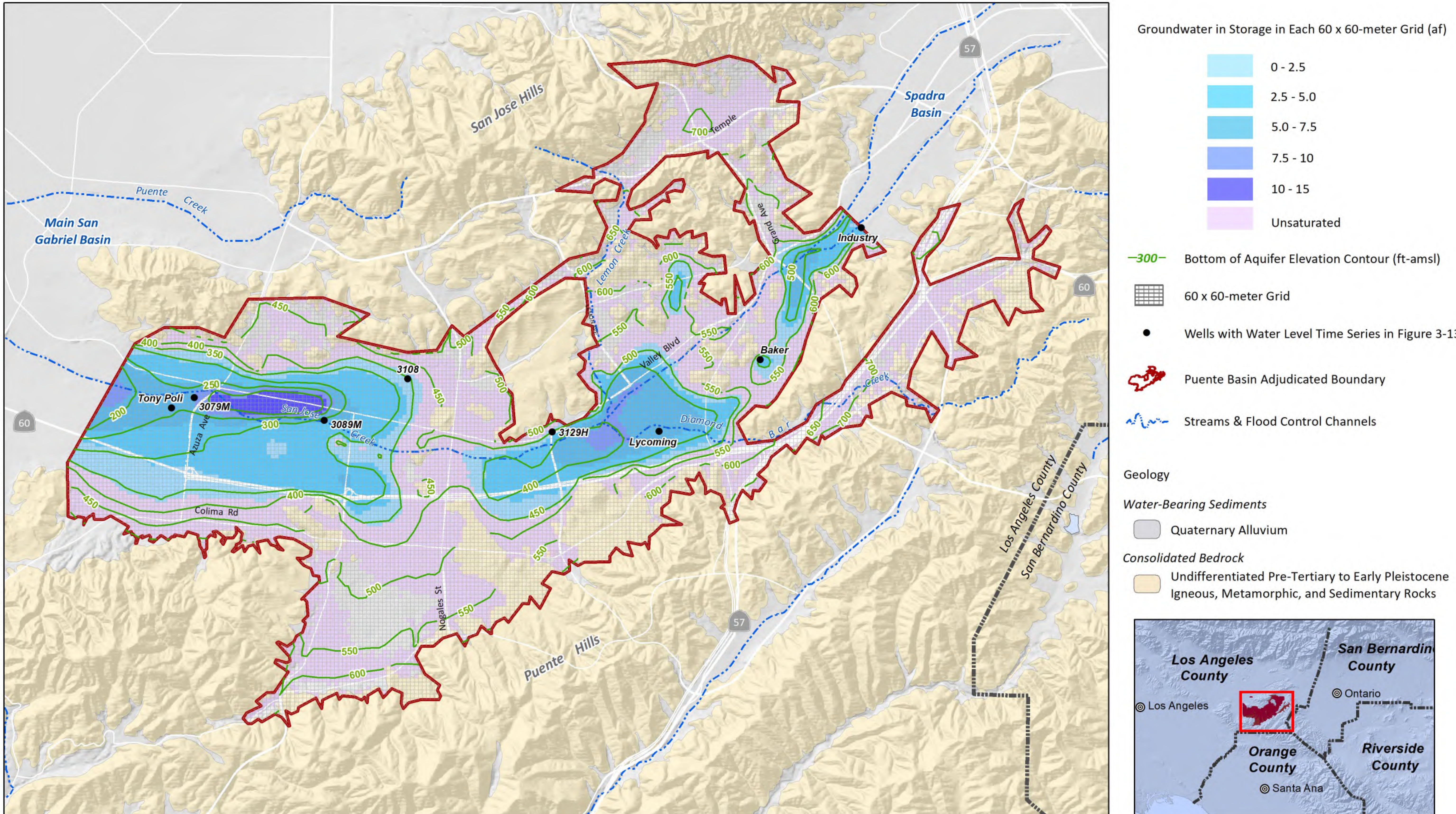
Groundwater in Storage

Spring 2000

Figure 3-14a



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Groundwater in Storage
Spring 2022
Figure 3-14b

3.2.12 Developed Yield

The developed yield is the annual average yield that was pumped from the groundwater basin over a finite period but is corrected for the change in groundwater storage and the volume of supplemental-water recharge that occurred during the period of interest. The developed yield is reflective of the hydrology and water management practices of that period. It can be considered an estimate of the sustainable yield of a basin if: (i) it is computed over a long enough period to include both wet and dry hydrologic periods and (ii) there were no obvious undesirable results that occurred, such as chronic lowering of groundwater levels and reduction of storage.

The period used herein for computing an estimate of developed yield is 2000 to 2022. This period is representative of a time when Puente Basin production included all Principal Parties and cleanup pumping by Carrier BDP Corporation, and there is a good time history of groundwater levels in the basin. This period includes a long dry period that started in 1999 and has persisted through 2022, and groundwater levels slightly decline in the western part of the basin. No supplemental water recharge occurred in the Puente Basin during 2000 to 2022.

The developed yield can be estimated using the following formula:

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

Where:

Δt is the period over which the developed yield is being estimated

O_p is the total groundwater pumped from the basin during Δt

I_{ar} is the total supplemental water recharged to the basin during Δt

ΔS is the change in groundwater storage within the basin during Δt

From 2000 to 2022, the total groundwater pumped from the Puente Basin is 33,286 af, and no supplemental water recharge occurred. In, *Section 3.2.11 Groundwater Levels and Storage*, it was noted that groundwater levels do not exhibit a significant long-term downward trend uniformly throughout the Basin except a slight downward trend in the western part of the basin, near the Main San Gabriel Basin boundary; groundwater elevations were used to estimate a total change in storage of -520 af from FY 2000 to FY 2022. The developed yield was calculated and shown below:

$$\textbf{Developed Yield} = (33{,}286 \text{ af} - 0 \text{ af} - 520 \text{ af})/23 \text{ yr} = 1{,}425 \text{ afy}$$

The estimated developed yield from FY 2000 to FY 2022 is 1,425 afy.

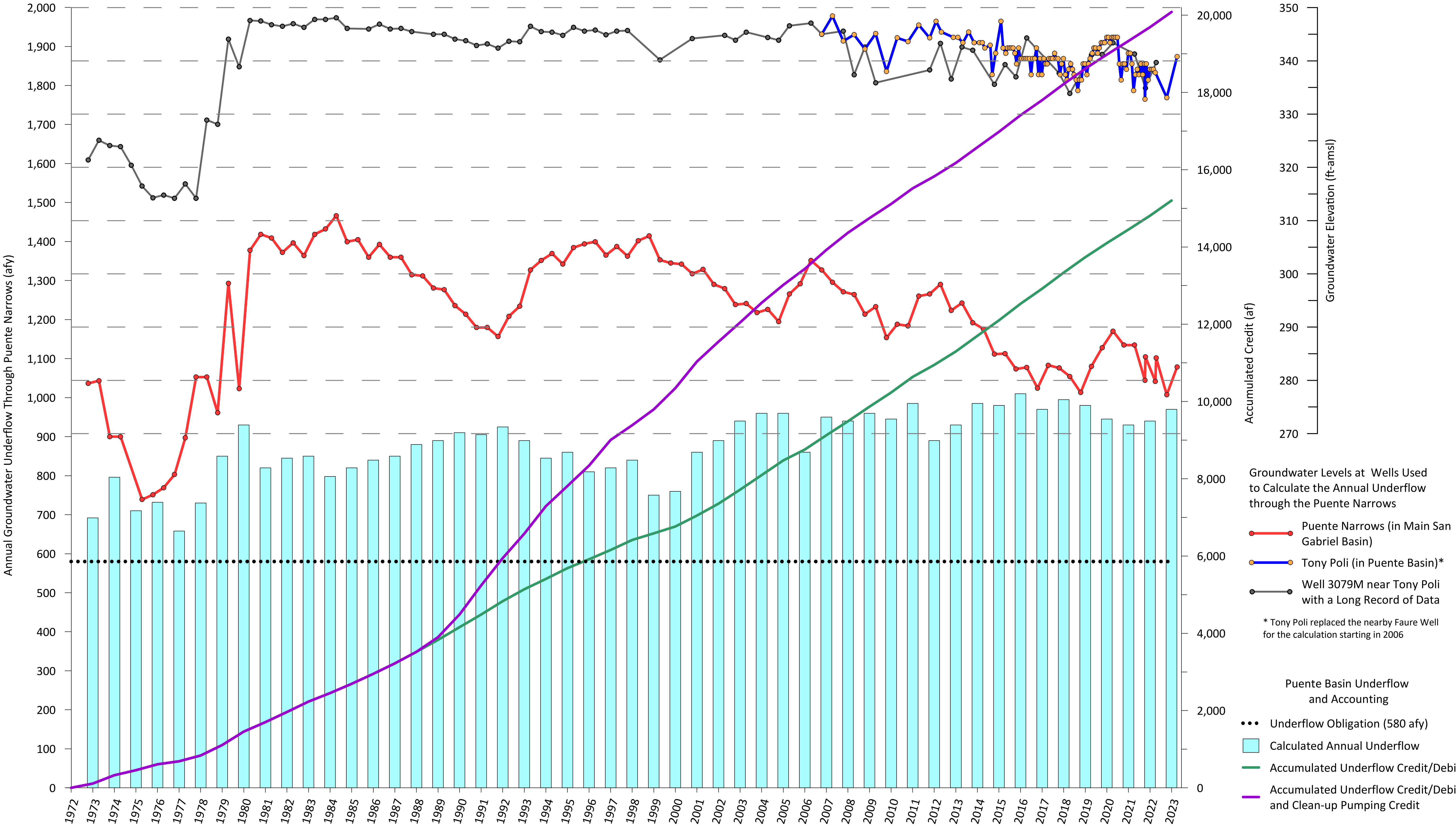
3.2.13 History of the Puente Narrows Underflow and Accounting

This section summarizes the cumulative accounting and reporting of the Puente Narrows Watermaster per the terms of the Puente Narrows Agreement for the obligation of the PBWA to Upper San Gabriel Valley Water District for a groundwater underflow of 580 afy through the Puente Narrows. As described in *Section 2.2.1 Puente Narrows Agreement,* the Puente Narrows Watermaster performs the calculation of subsurface flow through the Puente Narrows from Puente Basin to Main San Gabriel Basin based on water levels at two wells, one in the Puente Basin (Tony Poli) and one in the Main San Gabriel Basin (Puente Narrows). The Puente Narrows Agreement defines engineering criteria to measure and to calculate underflow through the Puente Narrows using the measured water levels at these two wells. Static groundwater-level measurements are collected at these two wells semi-annually in April and October and used to compute two components: 1) groundwater elevation along a Puente Narrows cross section midway between the two wells, which is computed as the average of the measured groundwater elevations at the two wells; and 2) the hydraulic gradient which is computed as the difference in the groundwater elevations between these two wells (in ft), divided by the distance between the wells (9,000 ft). An average of the spring and fall is used annually for both of these components. Underflow is then determined using a chart on file with the Puente Basin Watermaster, and applying the average annual (spring and fall) hydraulic gradient to the average annual (spring and fall) groundwater elevation at the Puente Narrows cross section, and reading on a vertical scale the annual underflow volume in af. The Puente Basin Watermaster performs perpetual accounting and reporting of this underflow including credits or debits of the PBWA based on if they have met their 580 afy obligation for underflow.

Figure 3-15 shows the time history of measured groundwater levels in the Puente Narrows well and Tony Poli well[7] used to calculate underflow, a bar chart of the annual calculated underflow, and the accumulated credit/debit for underflow obligation and credit for clean-up pumping since the start of the Puente Narrows Agreement in FY 1972. The groundwater levels at the two wells used to calculate underflow show similar long-term increasing and decreasing trends over the period of record and a similar gradient between them. The calculated underflow has ranged between about 650 afy to 1,000 afy, and for the last 20 years has fluctuated around 900 afy. For every year since FY 1972, the calculated underflow from the Puente Basin to the Main San Gabriel Basin has been greater than the 580 afy underflow obligation as required by the Puente Narrows Agreement. Since FY 1972, the PBWA has accumulated 15,201 af of credit for excess underflow through the Puente Narrows (green line shown in Figure 3-15). Starting in FY 1989, the PBWA began receiving credit for the clean-up pumping by Carrier BDP Corporation in the Puente Basin that is then discharged to the San Jose Creek per the November 1989 Clean-up Production Agreement. Since 1989, the PBWA received annual clean-up pumping credits that were added to the underflow debit/credit accounting. The PBWA has not received a clean-up credit since FY 2008 because all of the treated groundwater by the Carrier BDP Corporation was delivered to RWD and not discharged to San Jose Creek. Since FY 1972, the PBWA has accumulated 20,081 af of credit for excess underflow through the Puente Narrows and the clean-up pumping credit combined (purple line shown in Figure 3-15).

The PBWA has managed the Puente Basin in a manner that's consistent with the Judgment and requirements of the Puente Narrows Agreement and resulted in an accumulated credit of almost 20,000 af inclusive of the both the underflow and clean-up credits. This accumulation of credits occurred while the average pumping in the basin was ranged from about 300 to 2,400 afy, and averaged 1,000 afy, and a developed yield of 1,425 afy for last 23 years (FY 2000 – FY 2022).

[7] The Tony Poli well replaced the destroyed Faure Well for the underflow calculation beginning in 2006. Data is unavailable for the Faure well at this time and the time-series chart show data for well 3079M nearby to represent the longer historical period.



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History of Calculated Underflow through Puente Narrows, and Accounting of Accumulated Credits

Figure 3-15

3.3 Groundwater Quality

Puente Basin groundwater is used primarily for non-potable supply by the overlying water purveyors (RWD and WVWD) because of the poor quality of groundwater.

In the Puente Basin, groundwater quality data are available for production wells and monitoring wells. Groundwater quality samples from production wells are sampled by well owners for informational and operational purposes, however sampling is infrequent at most of the pumping wells and most are sampled only for TDS. Groundwater quality samples from monitoring wells in the Puente Basin are collected by private companies and their consultants to characterize point-source contamination for which they are potentially responsible as determined by the LA Regional Board. The constituents and sampling frequency vary by contamination site but are primarily for VOCs which are the constituents of concern at the sites.

All available groundwater quality data from wells in the Puente Basin over the past 35 years since the Judgment (1987 - 2022) was analyzed for exceedances of regulatory standards including: primary or secondary California maximum contaminant levels (MCLs) for drinking water; and state notification levels (NLs) set by the State Water Resources Control Board Division of Drinking Water (DDW) as advisory levels for potential negative health effects. There were 98 wells within and adjacent to the Puente Basin with groundwater quality data for this period that were analyzed for exceedances; 87 wells with the basin boundary, ten wells just outside of the western basin boundary in the Main San Gabriel Basin (BDP Carrier Corporation extraction and monitoring wells); and one well at the Spadra/Puente boundary (WVWD pumping well). Most of the groundwater quality data available is for the past twelve years since 2010; data prior to this year is very limited. Table 3-5 summarizes the number of wells in the Puente Basin with constituent concentrations that exceed an MCL or NL.

Understanding the spatial distribution of wells with concentrations greater than regulatory standards is important because it indicates areas in the basin where groundwater may be impaired from a beneficial use standpoint, and hence, poses current and future challenges that the pumpers may face in using the groundwater for certain end uses. A series of maps were prepared to depict the areal distribution of contaminants of concern in the Puente Basin which are defined as follows:

- Constituents that are associated with salt and nutrient management: TDS and nitrate.
- Constituents associated with known point-source contamination sites and exceed a primary MCL in 25 or more wells. These constituents are trichlorethylene (TCE), tetrachlorethylene (PCE), and cis-1,2-dichloroethylene (cis-1,2-DCE). Figures 3-16 through 3-20 show the areal distribution of groundwater quality for the contaminants of concern listed above. The maximum concentration measured at each well in the last 12 years from 2010 to 2022 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

Table 3-5. Exceedances of Groundwater Quality Standards in the Puente Basin 1987 - 2022

Analyte	Standard	Number of Wells Sampled	Number of Wells with Exceedances	Number of Samples with Exceedances	Percent of Wells Sampled with Exceedances
Contaminant with Primary MCL [(a)]					
1,1-Dichloroethane	6 µg/L	90	1	3	1%
1,1-Dichloroethene (1,1-DCE)	6 µg/L	90	3	191	3%
Benzene	1 µg/L	88	15	32	17%
Chromium	50 µg/L	11	2	8	18%
Chromium (VI)	10 µg/L	10	7	40	70%
cis-1,2-Dichloroethene (cis-1,2-DCE)	6 µg/L	88	29	762	33%
Ethylbenzene	0.3 µg/L	88	9	43	10%
Methyl Tert-Butyl Ether (MTBE)	13 µg/L	81	1	26	1%
Nickel	0.1 µg/L	11	7	30	64%
Nitrate-Nitrogen	10 µg/L	11	3	19	27%
Nitrite-Nitrogen	1 µg/L	11	1	1	9%
Tetrachloroethylene (PCE)	5 µg/L	90	88	1632	98%
Toluene	0.15 µg/L	88	9	65	10%
trans-1,2-Dichloroethene (trans-1,2-DCE)	10 µg/L	87	2	2	2%
Trichloroethylene (TCE)	5 µg/L	90	47	1072	52%
Vinyl Chloride	0.5 µg/L	88	16	119	18%
Xylene	10 mg/L	20	9	65	45%
Contaminant with Secondary MCL					
Chloride	500 mg/L	11	3	21	27%
Methyl Tert-Butyl Ether (MTBE)	5 µg/L	81	1	26	1%
Sulfate	250 mg/L	11	10	21	91%
TDS	500 mg/L	16	16	441	100%
Contaminant with California NL					
1,4-Dioxane	1 µg/L	1	1	2	100%
Boron	1 µg/L	11	1	1	9%
PFOA (Perfluorooctanoic acid)	4 µg/L [(b)]	3	3	1	100%
PFOS (Perfluorooctanesulfonic acid)	4 µg/L [(b)]	3	3	1	100%
PFHxS (Perfluorohexanesulfonic acid)	3 µg/L	3	3	1	100%
Naphthalene	17 µg/L	87	10	12	11%
Tert-Butyl Alcohol	120 µg/L	77	2	8	3%

(a) All MCL standards used for this analysis are California Primary MCL standards; the Federal EPA MCL standards are typically higher than, equivalent to, or non-existent for all the contaminants in Puente Basin wells with a MCL exceedance.
(b) For the per- and polyfluoroalkyl substances (PFAS) PFOA and PFOS, the standards are shown are the Proposed Federal EPA MCLs. The California NLs are slightly higher than the Proposed Federal EPA MCLs (PFOA - 5.1 µgl, and PFOS - 6.5 µgl).

3.3.1 Total Dissolved Solids

TDS has a secondary MCL of 500 milligrams per liter (mgl). Figure 3-16 displays the areal distribution of the maximum TDS concentration at wells in the Puente Basin from 2010 to 2022. During this period, 16 of the 98 wells with water quality data were sampled for TDS. The wells sampled for TDS include all the municipal pumping wells and one group of monitoring wells for the Former Sigma Plating Co. clean-up site in the center of the basin. The maximum TDS concentrations at all 16 wells sampled exceed the secondary MCL. The maximum TDS concentrations ranged from 840 – 1,270 mgl and averaged 1,001 mgl.

Fox and Roberts (2002) analyzed TDS data from 1960 – 1993. It was noted that during the wet period between 1978 and 1980 where there was over 90 inches of precipitation over a three-year period, TDS concentrations dropped by more than 50 percent in the Puente Narrows well in the Main San Gabriel Basin on the west side of the Puente and Main San Gabriel Basin boundary. During this extreme wet cycle, there may have been a short-lived dilution and mixing of water on the west end of the Puente Basin. The only well in the western part of the Puente Basin that has been sampled for TDS in the last 20 years is the Tony Poli well. TDS data from the Tony Poli well in the western part of the basin has not shown the same degree of change in TDS in response to a wet period since monitoring consistently began in 2005; however, this is inclusive of the prolonged 23-year dry period and there have been no wet years of the same magnitude as 1978 - 1980. Additional water quality monitoring in the western part of the basin and potentially other parts of the basin is needed to understand concentrations for TDS and constituents of concern concentrations may decrease during extreme wet periods.

3.3.2 Nitrate

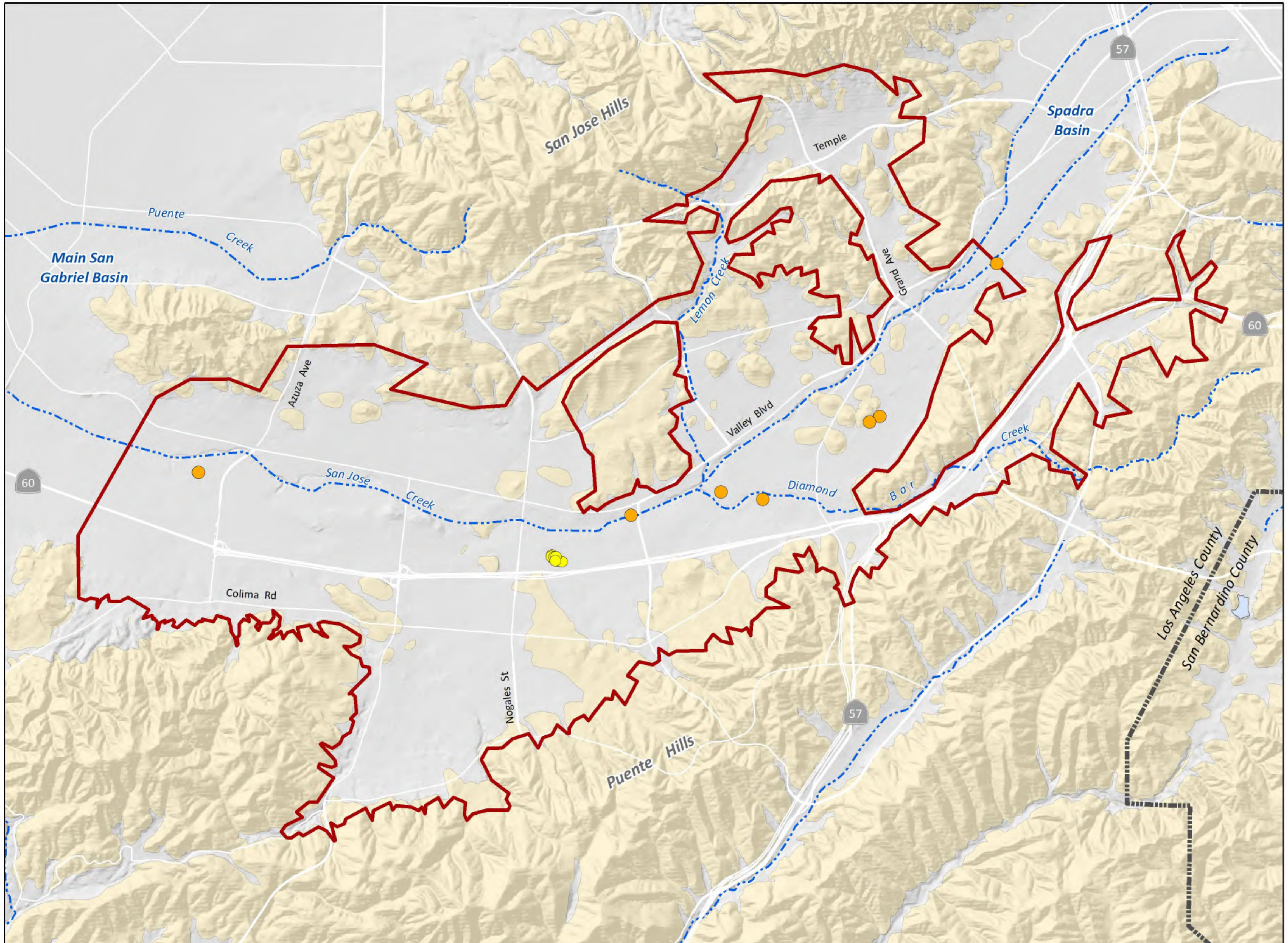
The California primary MCL for nitrate (as nitrogen) in drinking water is 10 mgl. By convention all nitrate values are expressed in this TM as nitrate as nitrogen. Figure 3-17 displays the areal distribution of the maximum nitrate concentration at wells in the Puente Basin from 2017 to 2022. During this period, eleven of the 98 wells with water quality data were sampled for nitrate. The wells sampled for nitrate include one municipal pumping well (Tony Poli) and one of the monitoring wells for the Former Sigma Plating Co. clean-up site in the center of the basin. The maximum nitrate concentrations at three of the eleven wells sampled (30 percent) exceed the primary MCL. The maximum nitrate concentration ranged from 2.1 to 94 mgl and averaged 21 mgl. The highest nitrate concentrations are located in the monitoring wells associated with the Former Sigma Plating Co. site. Additional monitoring of nitrate a wells throughout basin is needed to understand the distribution of nitrate in the basin.

3.3.3 PCE and TCE

PCE and TCE are regulated drinking water contaminants in California each with a primary MCL of 5 micrograms per liter (µgl). Figures 3-18 and 3-19 display the areal distribution of the maximum concentration of PCE and TCE at wells in the Puente Basin from 2010 to 2022, respectively. During this period, 90 out of 98 wells with water quality data were sampled for PCE and TCE; these wells include one municipal production well (Tony Poli) and the monitoring wells associated with the SWL-2000, Carrier BDP Corporation, California Hydroforming, and Former Sigma Plating Co. clean-up sites. The maximum PCE concentrations at 88 of 91 wells sampled (98 percent) exceeded the primary MCL. The detectable maximum PCE concentration ranged from 0.8 to 1,930 µgl and averaged 116 µgl. The maximum TCE concentrations at 47 of the 90 wells sampled (53 percent) exceeded the primary MCL. The detectable maximum TCE concentration ranged from 1.0 to 1,500 µgl and averaged 45 µgl. PCE and TCE are common industrial solvents used as degreasers in metal-working industries. Wells with detectable levels of PCE and TCE occur predominantly in monitoring well clusters associated with known actively sampled point-source contaminations sites within the Puente Basin and the eastern portion of the Main San Gabriel Basin, and the one municipal production well sampled in the western portion of the basin. The point-source contamination sites in the Puente Basin are discussed further in *Section 3.3.5 Point Source Contamination in the Puente Basin.* Additional monitoring of PCE and TCE at all pumping and monitoring wells in the central and eastern part of the basin is needed to understand the distribution of these contaminants in the basin.

3.3.4 cis-1,2-DCE

Cis-1,2-DCE is a regulated drinking water contaminant in California with a primary MCL of 6 µgl. Figure 3-20 displays the areal distribution of the maximum cis-1,2-DCE concentration at wells in the Puente Basin from 2010 to 2022. During this period, 88 of the 98 wells with water quality data were sampled for cis-1,2-DCE. The wells sampled for cis-1,2-DCE include the monitoring wells associated with the SWL-2000, Carrier BDP Corporation, California Hydroforming, and Former Sigma Plating Co. The maximum cis-1,2-DCE exceeded the primary MCL at 29 of the 88 wells sampled (33 percent). The detectable maximum cis-1,2-DCE concentration ranged from 1.0 to 820 µgl and averaged 26 µgl. Cis-1,2-DCE is a degradation byproduct of PCE and TCE that is formed by reductive dehalogenation. Wells with detectable levels of cis-1,2-DCE occur predominantly in in monitoring well clusters associated with known actively sampled point-source contaminations sites within the Puente Basin and the eastern portion of the Main San Gabriel Basin. The point-source contamination sites in the Puente Basin will be discussed further in *Section 3.3.5 Point Source Contamination in the Puente Basin.* Additional monitoring of cis-1,2-DCE at all pumping and monitoring wells in the central and eastern part of the basin is needed to better understand the distribution of cis-1,2-DCE in the basin.



TDS (mgl)

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

California Secondary MCL = 500 mgl

Puente Basin Adjudicated Boundary

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Prepared by:

WEST YOST

0 1 2 Miles

0 1 2 Km

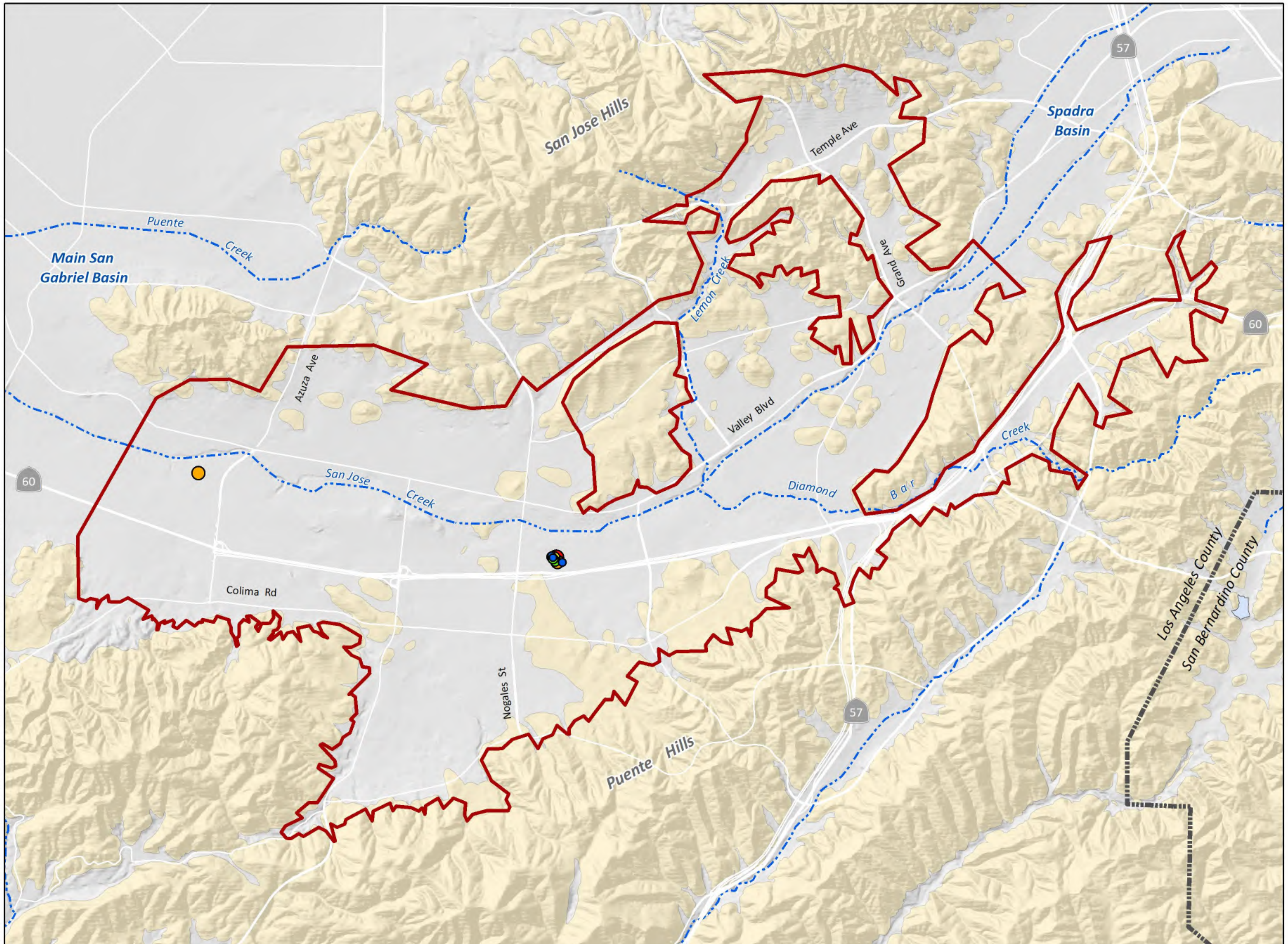
Prepared for:

Puente Basin Water Agency
Groundwater Management Plan
TM-1 Description of Plan Area and Basin Setting

PUENTE BASIN WATER AGENCY established 1971

Total Dissolves Solids in Groundwater
Maximum Concentration (2017 - 2022)

Figure 3-16



Nitrate-Nitrogen (mgl)

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

California Primary MCL = 10 mgl

Puente Basin Adjudicated Boundary

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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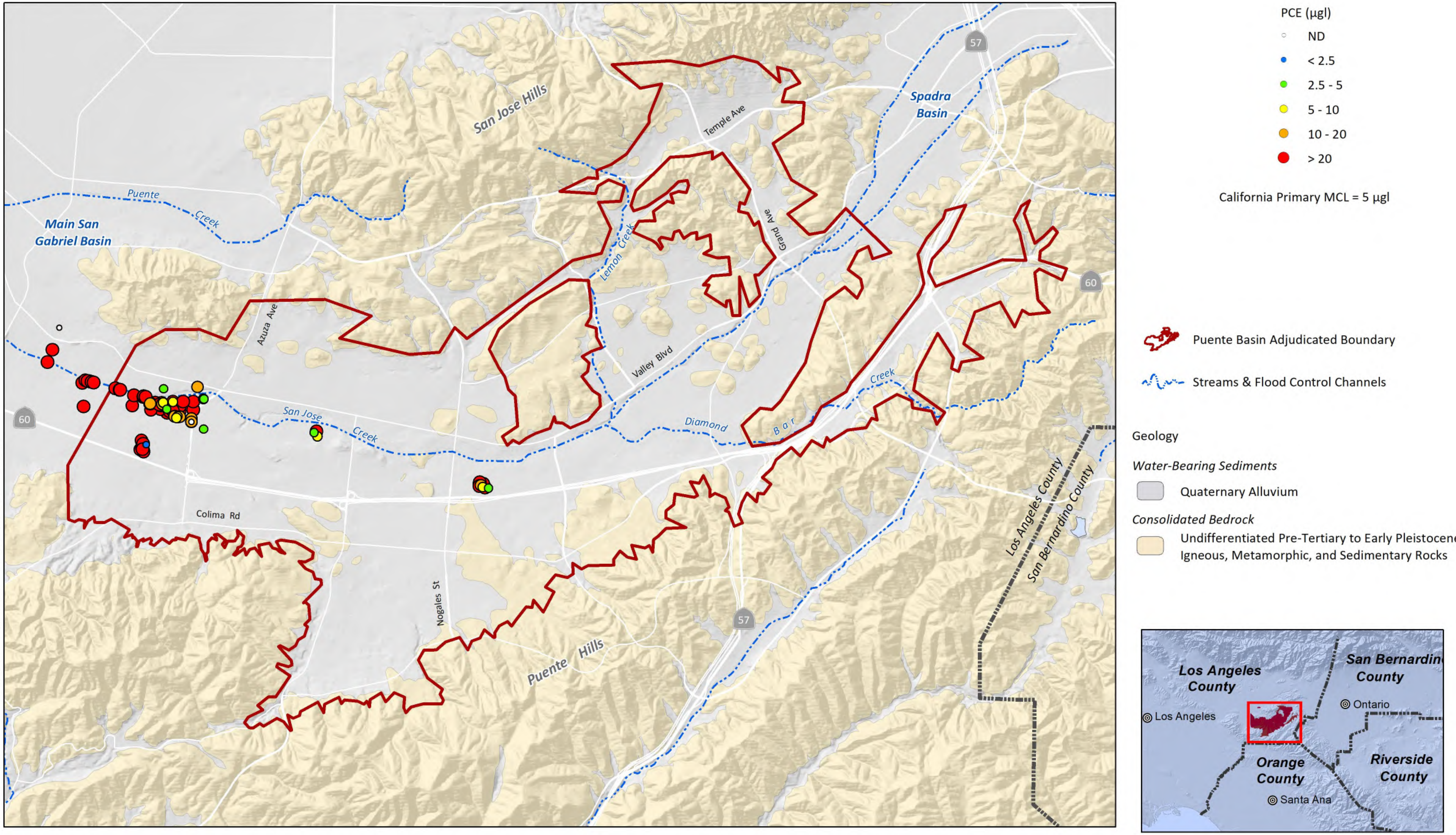
Nitrate-Nitrogen in Groundwater
Maximum Concentration (2010 - 2022)

Figure 3-17



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0 1 2 Miles

0 1 2 Km

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TM-1 Description of Plan Area and Basin Setting

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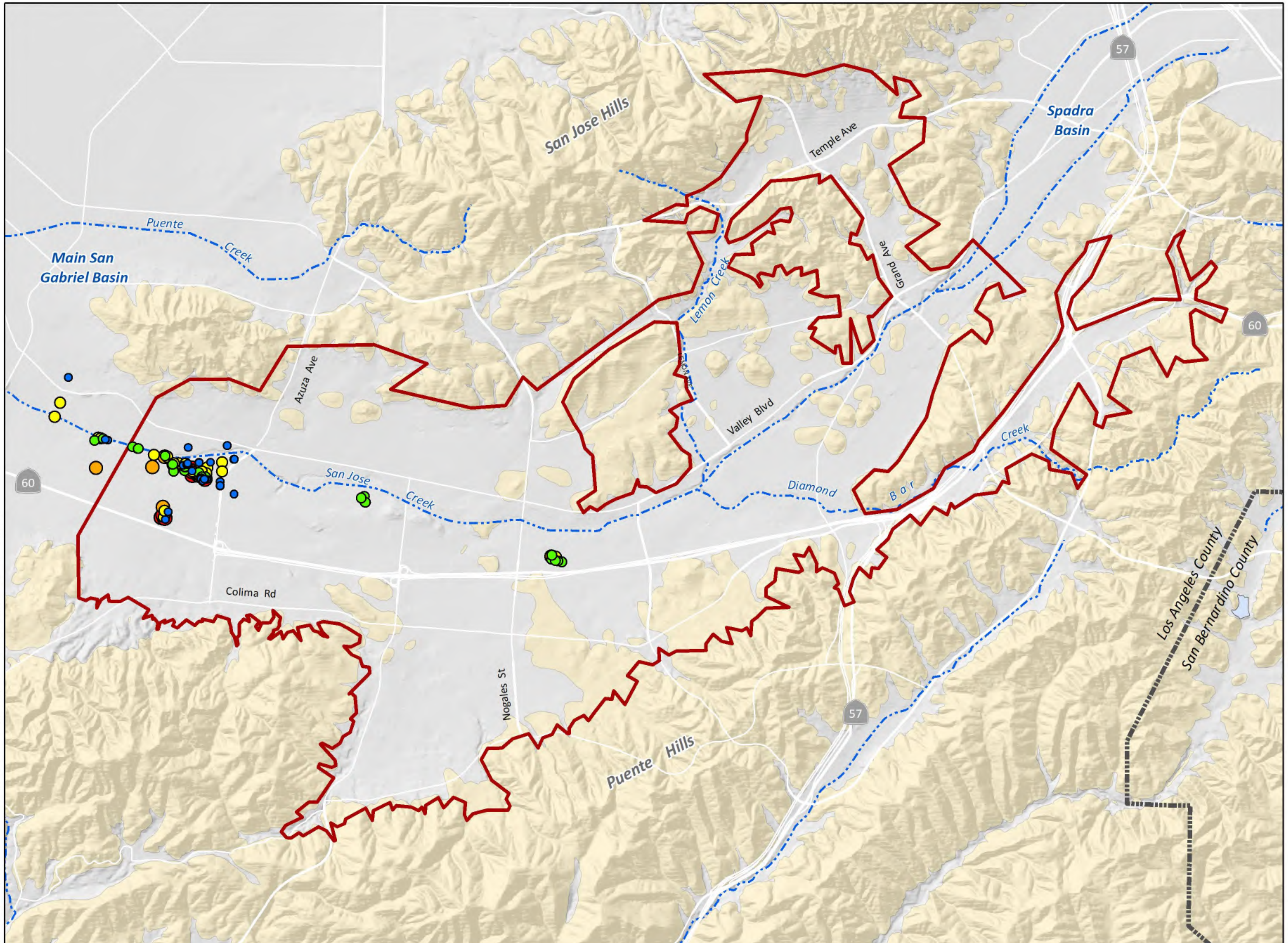
Tetrachloroethylene (PCE) in Groundwater
Maximum Concentration (2010 - 2022)

Figure 3-18



TCE (µgl)

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

California Primary MCL = 5 µgl

Puente Basin Adjudicated Boundary

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

WEST YOST - K:\Clients\1032 Puente Basin Water Agency\80-22-01 Puente B GWMP Ph 1\GIS\MXD\TM 1\Figure 3-19_TCE.mxd - vweamer - 9/12/2023

Prepared by:

WEST YOST

0 1 2 Miles

0 1 2 Km

Prepared for:

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Groundwater Management Plan

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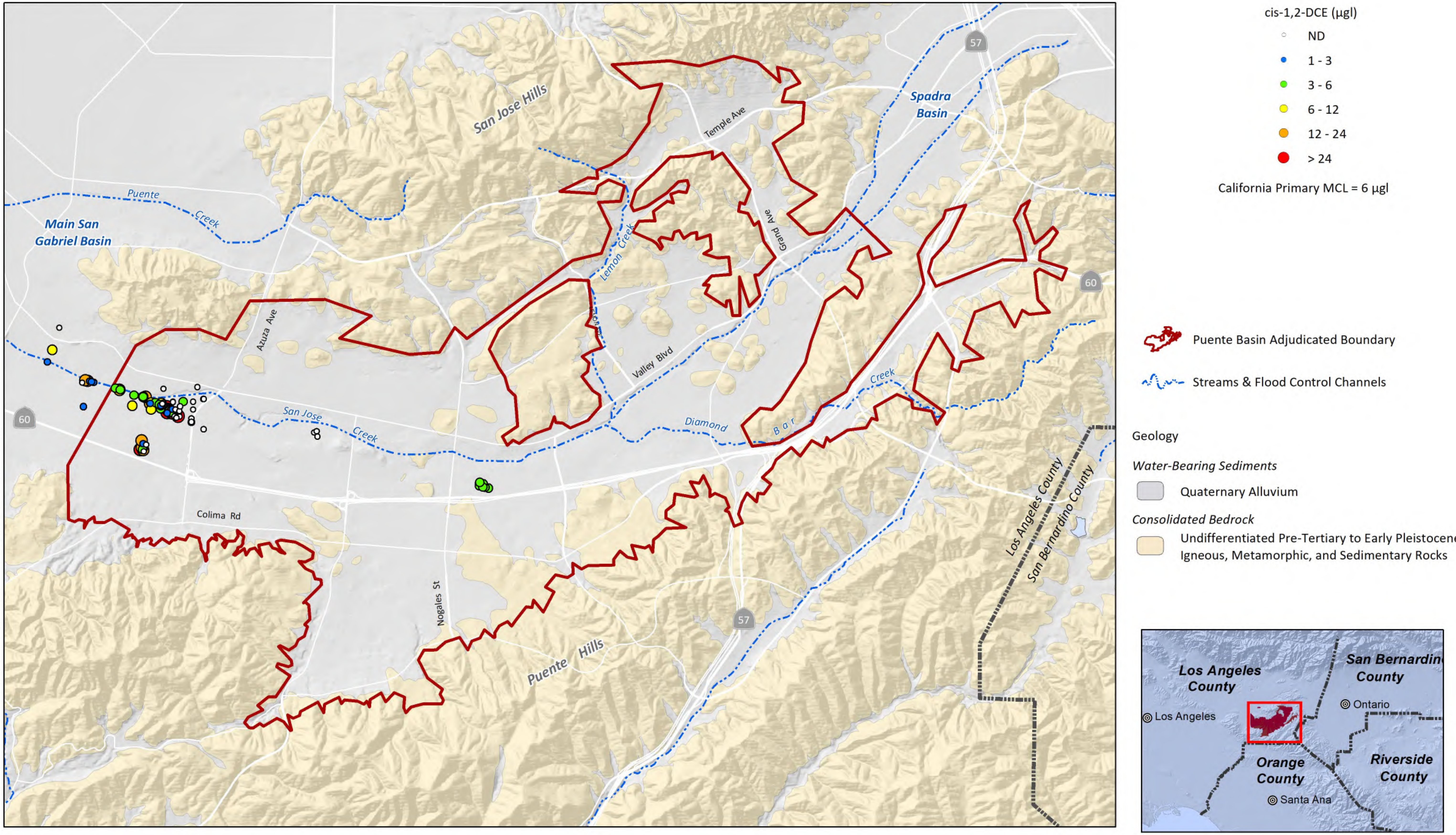
Trichloroethylene (TCE) in Groundwater

Maximum Concentration (2010 - 2022)

Figure 3-19



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TM-1 Description of Plan Area and Basin Setting

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cis-1,2-Dichlorothene (cis-1,2-DCE) in Groundwater

Maximum Concentration (2010 - 2022)

Figure 3-20

3.3.5 Point Source Contamination in the Puente Basin

The State Water Board's GeoTracker database and California Department of Toxic Substances Control (DTSC) EnviroStor database were reviewed to determine if there are any point-source contamination sites with open cases with monitoring data and information indicating a potential impact on groundwater quality. GeoTracker is the State Water Board's online data-management system for the compliance data collected from point-source discharge sites with confirmed or potential impacts to groundwater. EnviroStor is the DTSC's online data-management system for permitted hazardous waste facilities. Sites listed on the Geotracker and EnviroStor that contained no information about the contamination source, contaminants of concern, contaminated media, or monitoring data were not further investigated, as well as sites where the contaminated media is only soil. Figure 3-21 shows the general location of the four point-source contaminant sites identified within the Puente Basin which include: SWL-2000 (Former Unical Enterprises), Former Sigma Plating Co., Carrier BDP Corporation, and California Hydroforming Company Inc. (California Hydroforming). These sites are described below using the resources available on GeoTracker.

3.3.5.1 SWL-2000 (Former Unical Enterprises)

The current SWL-2000 (former Unical Enterprises Inc. [Unical]) site (GeoTracker Case ID: SL603798660) is located in the City of Industry at 16960 E. Gale Avenue in the western portion of the Puente Basin. The site consists of two large single-story warehouse buildings constructed in 1968 and 1996 encompassing approximately four acres in an industrial and commercial area. Between 1968 and 1994, several manufacturers and supplies occupied the site, including Bixby Ranch Company, Royal Industries, Missile Craft, American Tele Corporation, and ASC Company. In 1994, Unical purchased the property from in Bixby Ranch Company, and constructed the second warehouse building in 1996. In September 2000, Uncial transferred the property to a related company, SWL-2000, who presently owns the property.

The preliminary Phase I and Phase II environmental work at the site was initiated in 1991. The Phase I assessment identified four areas of concerns that needed additional investigations. Between 1994 and 1999, Unical conducted a subsurface investigation on-site, including collecting soil matrix, soil vapor, and groundwater samples. Investigation results indicated that the soil vapor and groundwater beneath the site were impacted by VOCs, in particular, PCE and TCE.

A workplan for site investigation was prepared by Unical (Murex Environmental [Murex], 2015) to further assess the extent of VOC impacts in the southwest corner of the site and determine if contaminants from onsite sources or offsite sources have impacted groundwater. The workplan was approved by the LA Regional Board on November 17, 2015. Pursuant to the 2015 workplan, and a subsequent investigation, six monitoring wells were constructed and monitoring began. The maximum PCE concentrations at the six wells range from 160 µgl to 2.2 µgl, and maximum TCE concentrations range from 33 µgl to non-detect. In April 2022, a soil vapor extraction and air sparge system began operating as part of the remediation strategy. Since the implementation of this remediation, SWL-2000 is reporting there have been significant decreases in PCE concentrations observed in the extraction well samples, soil vapor extraction influent vapor samples, and monitoring wells (Murex, 2022) and requested to reduce monitoring from quarterly to semiannual. The site currently has a status of *Open-Remediation as of July 15, 2022* on GeoTracker.

3.3.5.2 Former Sigma Plating Co.

The former Sigma Plating Co. facility (GeoTracker Case ID: SL603798678) is located in the City of La Puente at 1040 South Otterbein Avenue in the center of Puente Basin. The facility previously operated as an industrial plating facility from the 1960s to 2013. Currently the project site consists of 2.4 acres of land where one main structure that was used for the plating operations exists along with several smaller warehouse structures just east of the main plating facility.

In March 1990, heavy metals and chlorinated hydrocarbons were detected in the soil as part of the removal of the clarifier, and the LA Regional Board began oversight of investigation and clean-up at the site. Between 1990 and 2001, several soil and groundwater investigations occurred. The groundwater monitoring included construction of twelve monitoring wells and a series of hydropunch samples. The results of the investigations show elevated concentrations of chromium, hexavalent chromium, and nickel in the soil, and high concentrations of PCE, TCE, chromium and hexavalent chromium in groundwater. In 2020, there was groundwater sampling for per- and polyfluoroalkyl substances (PFAS) at three of the twelve monitoring wells and the results indicated that there are high concentration for several PFAS compounds, above State NLs if applicable, at all three monitoring wells sampled.

Between 2001 and 2006, a soil vapor extraction program was implemented at the site. Annual or semi- annual groundwater monitoring data at twelve wells is available on GeoTracker for data collected since 2017. The maximum PCE, TCE, and hexavalent chromium concentrations at the wells for this period are 1930 µgl, 19 µgl, and 7,770 µgl, respectively. In November 2021, a revised Interim Remedial Action Plan for hexavalent chromium was approved by the Regional Board. The interim remedial action includes utilizing several different type of injectable reagents to remediate chromium and hexavalent chromium in soil and groundwater beneath the site. As of 2023, the Interim Remedial Action Plan with the injectables has been implemented as a pilot study. The site currently has a status of Open-Remediation as of March 15, 2018 on GeoTracker.

3.3.5.3 Carrier BDP Corporation

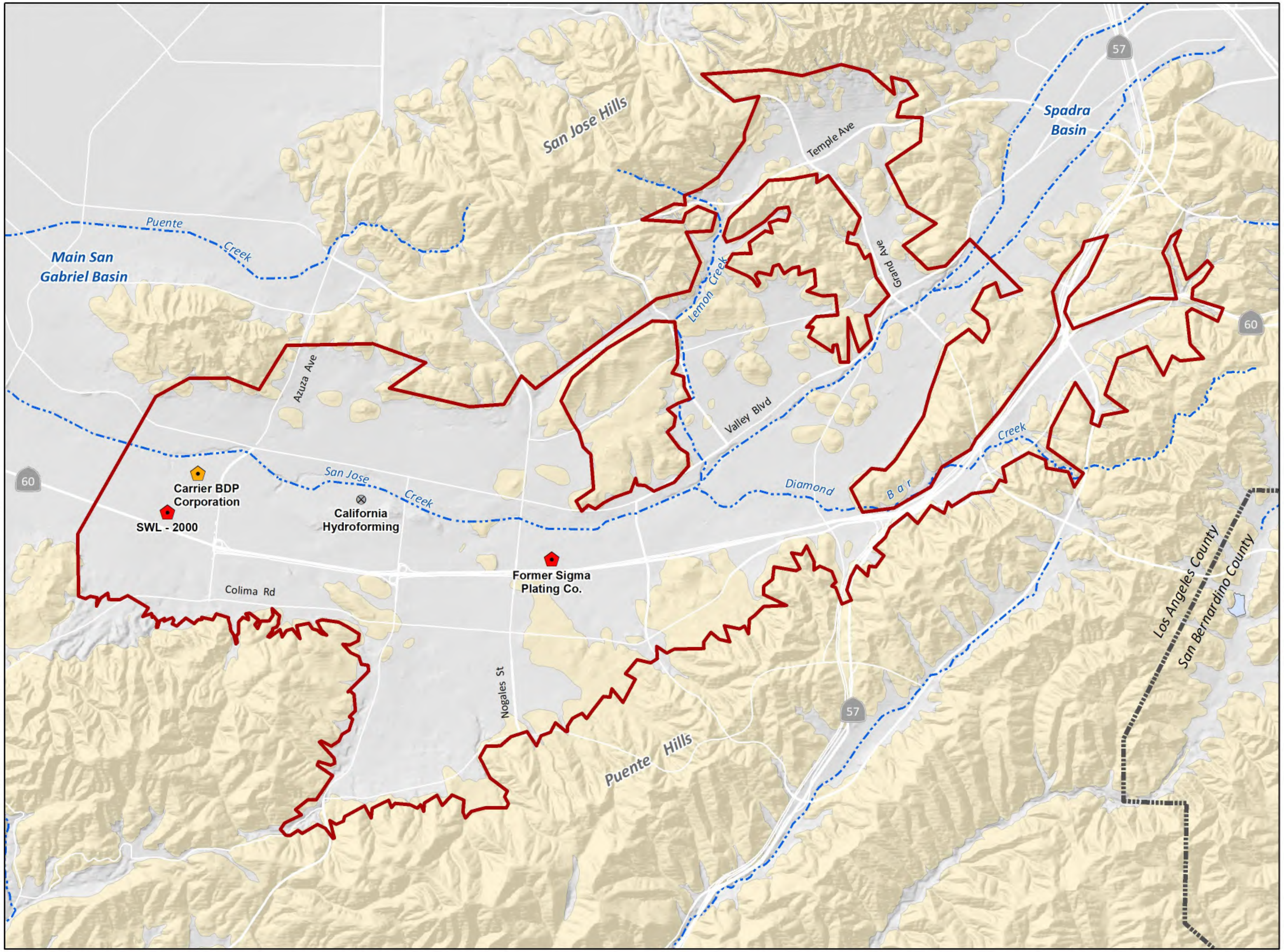
The former Carrier BDP facility (GeoTracker Case ID: T0603700149 and Envirostor ID. 71002533) is located in the City of Industry at 855 Anaheim-Puente Road, in the western portion of the Puente Basin. The facility was used to manufacture air conditioners from approximately 1959 to 1992. The property was sold in 1999. Following the sale of the property, the existing approximately 570,000 square foot manufacturing building was subdivided into 17 individual warehouse spaces. In late April 1985, Carrier personnel discovered free-phase PCE in the facility's main industrial wastewater clarifier during a routine inspection. Following this discovery, BDP personnel assessed the inventory and usage of PCE at its facility and determined that 8,000 to 15,000 gallons of PCE may have been unaccounted for during the period of November 1984 through April 1985. Carrier BDP notified the Regional Board and began site investigation activities and interim remediation to control and clean up the released chemical.

The site assessments conducted at the site indicated that the soil and groundwater were impacted with VOCs, mainly PCE and TCE. The PCE and TCE groundwater plume extends offsite towards the west into the Main San Gabriel Basin. Groundwater remediation began in 1986 by installing and operating a groundwater extraction and treatment system involving air stripping to remove the VOCs from groundwater. In 1997 and 1988 the treatment system was augmented with additional extraction wells downgradient ("nose wells") in the Main San Gabriel Basin. In 2018, two new extraction wells were installed upgradient of the existing "nose wells" to optimize groundwater containment recovery. A total of 23 extraction wells have been constructed for the groundwater treatment system and 13 are currently in operation.

Fifty-two groundwater monitoring wells have been installed onsite and offsite. Annual or semi-annual groundwater monitoring data at all the extraction and monitoring wells is available on GeoTracker for data collected since 2007. The maximum PCE and TCE concentrations at the wells for this period are 1,200 µgl, and 1,500 µgl, respectively. A SVE system was installed and began operation in 1989 for soil remediation. The SVE system was expanded in 1994 by installing eleven additional extraction wells. Soil and groundwater remediation is still ongoing; and pumping for groundwater clean-up is reported to the Puente Basin Watermaster. The primary discharge point for the treated water is to RWD for their non-potable reclaimed water system. At times when RWD cannot accept this water, it is discharged to the lined San Jose Creek. The site currently has a status of *Open-Remediation as of May 22, 2009* on GeoTracker.

3.3.5.4 California Hydroforming

The California Hydroforming site (GeoTracker Case ID: SL603798656) is a metal forming facility still in operation in the City of Industry at 850 Lawson Street in the western portion of the Puente Basin. The California Hydroforming facility is located in an industrial area on the southeast intersection of Lawson Street and Courtney Court within proximity of the San Jose Creek approximately 500 ft to the north. Soil at the site has been remediated, but PCE and TCE still exist within the groundwater underlying the site. Groundwater monitoring at this site began in 1993 and the Regional Board requested a groundwater monitoring program in 2004. Five monitoring wells have been installed and monitored. The monitoring data is available on GeoTracker in annual reports since 2012. Groundwater monitoring shows concentrations of PCE and TCE above the MCLs detected in groundwater. The maximum PCE concentrations at the five wells range from 2,940 µgl to 6 µgl, and maximum TCE concentrations range from 18 µgl to 0.7 µgl. However, these maximum concentrations are from early sampling in the late 1990s and concentrations are currently much lower. The site currently has a status of *Open-Inactive as of January 29, 2015* on GeoTracker.



Open Clean-up Sites Potentially Impacting Groundwater Supplies

Status on GeoTracker*

- Active Case-Remediation
- Active Case-Site Assessment
- Active Case-No Specified Action
- Active Case-Verification Monitoring
- Inactive Case**

*Based on State Board's GeoTracker and EnviroStor website as of July 26, 2023

**Inactive Cases: Cases where there is no funding or resources available to work on the case

Puente Basin Adjudicated Boundary

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

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0 1 2 Miles
0 1 2 Km

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Groundwater Management Plan
TM-1 Description of Plan Area and Basin Setting

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Point Source Groundwater Contamination Sites
Open Cleanup Sites in the Spadra Basin

Figure 3-21

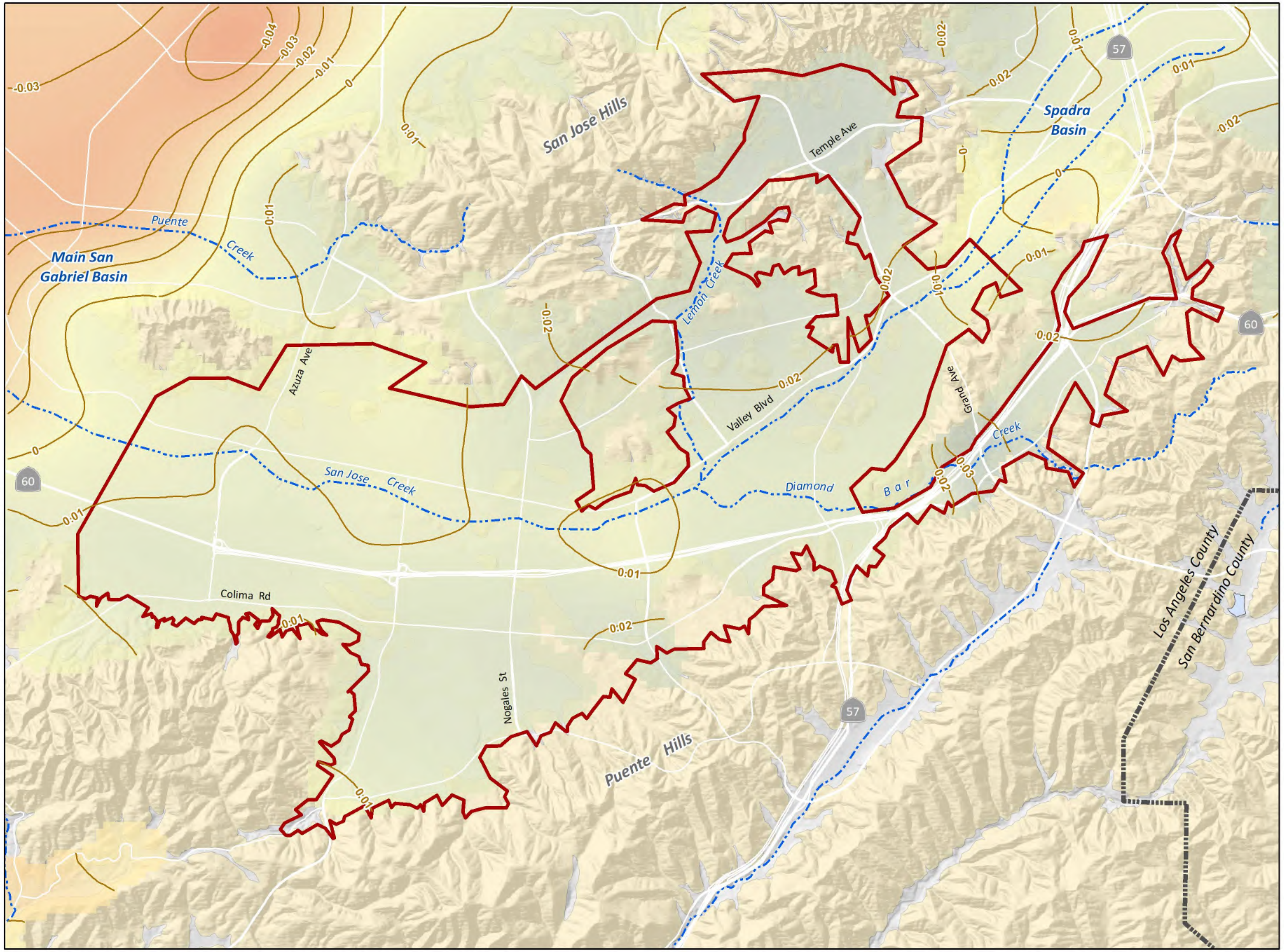
3.4 Ground Levels

Vertical ground motion, in the form of subsidence and rebound of the land surface, occurs in most groundwater basins as groundwater levels change within the underlying aquifer system. This process has occurred in the Puente Basin, as well as in the adjacent groundwater basins, such as well-documented occurrences in the nearby Chino Basin (WEI, 2019). It is important to understand and monitor vertical ground motion because land subsidence can cause damage to vulnerable infrastructure at the surface.

Although drawdown of groundwater levels is the driving force that causes land subsidence due to groundwater pumping, the geology of the 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.

The process that describes pumping-induced land subsidence is termed the “aquitard-drainage model”. This means 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 groundwater-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 pore pressures 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, the groundwater 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 groundwater level fluctuations, this process can occur in a purely elastic fashion. That is, a recovery of groundwater 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” level, referred to as the “pre-consolidation 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.

The hydrogeologic cross sections in Figures 3-8a through 3-8c show that the aquifer system in the Puente Basin contains multiple aquitard lenses of varying thickness that could be susceptible to compaction via the aquitard-drainage model. However, the Puente Basin is a relatively thin aquifer system which limits the potential magnitude of aquitard compaction and land subsidence that could occur. Figure 3-22 shows the InSAR estimates of vertical ground motion across the Puente Basin between 2015- 2022 based on DWR’s TRE ALTAMIRA dataset. The map indicates no discernable subsidence across the entire basin, and groundwater levels have slightly declined in the western portion of the basin. These observations suggest that land subsidence is not a likely future adverse impact, but should be monitored, especially if groundwater levels are projected to decline in the future due to implementation of groundwater management strategies.



Relative Change in Land Surface Elevation as Measured by InSAR

+ 0.1 ft

0

- 0.1 ft

Vertical Ground Motion Contour (ft)

Puente Basin Adjudicated Boundary

Streams & Flood Control Channels

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Prepared by:

WEST YOST

Prepared for:

Puente Basin Water Agency

Groundwater Management Plan

TM-1 Description of Plan Area and Basin Setting

PUENTE BASIN WATER AGENCY established 1971

Vertical Ground Motion

2015 - 2022

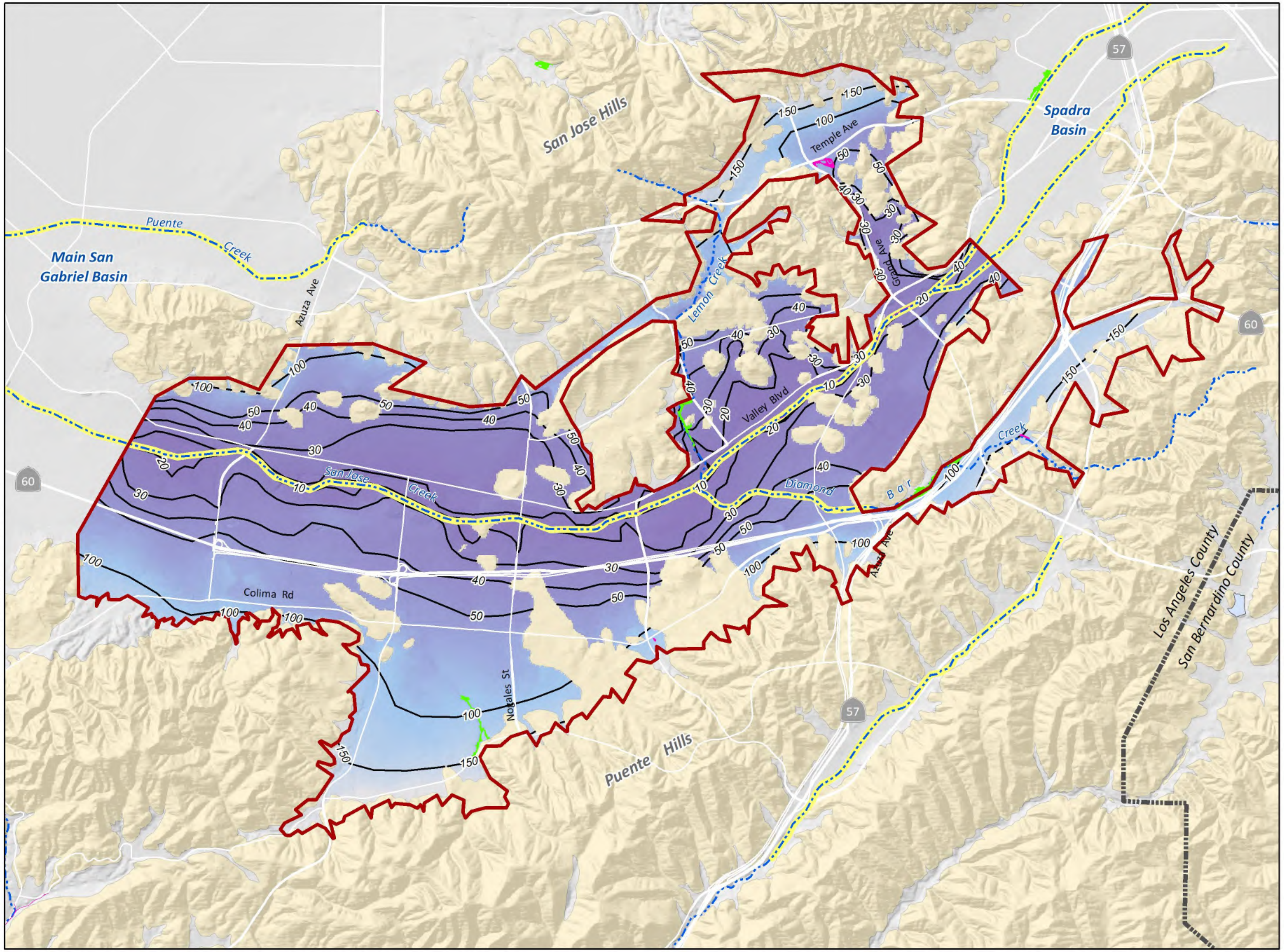
Figure 3-22

3.5 Groundwater Dependent Ecosystems

GMPs typically consider ecological resources that may be dependent on shallow groundwater. These areas are identified as Groundwater Dependent Ecosystems (GDEs). GDE data is available from DWR's Natural Communities Commonly Associated with Groundwater (NCCAG) dataset. This dataset classifies GDE vegetation and wetland types. The NCCAG data set is to be used as a starting point to identify GDEs within a basin.

Figure 3-23 is a map of estimated depth-to-groundwater in the Puente Basin in 2022 with the location of the GDEs defined on the DWR's NCCAG dataset in the Puente Basin boundary. The estimated depth-to-groundwater in the Puente Basin ranges from a maximum of 200 ft-bgs in the basin margins to a minimum of about 10 ft-bgs along the center of the basin. The majority of the Puente Basin has a depth-to-groundwater ranging from 20 to 50 ft-bgs. Maximum rooting depths for vegetation in GDEs is typically less than 30 ft-bgs.

There are five potential GDE areas in the Puente Basin boundary in the DWR's NCCAG dataset, with the vegetation types of riparian mixed hardwood and riverine semipermanently flooded. At four of the GDE areas the estimated depth-to-groundwater is much greater than 30 feet, hence there appears to be no areas of interconnected groundwater and surface water, or shallow groundwater, in the areas that are supporting GDEs. These areas are also in the fringe areas of the basin where there is no groundwater pumping and likely no pumping in the future, hence there is no concern of groundwater level declines from pumping. For one GDE, the estimated depth-to-groundwater is about 30 ft-bgs and it is near the unlined Lemon Creek tributary of the San Jose Creek in the northern portion of the basin. At this GDE area, there is potential for interconnected groundwater and surface water and shallow groundwater supporting the GDE which is defined as riparian mixed hardwood vegetation. This GDE area will need to be further researched and verified if groundwater management activities (i.e. pumping) have a potential to cause groundwater level declines in this area.



Estimated Depth to Groundwater

0 ft-bgs

50

200 ft-bgs

Area Identified in the NCAAG Data Set as a Potential GDE (Vegetation Type Commonly Associated with Shallow Groundwater)

- Riparian Mixed Hardwood
- Riverine, Semipermanantly Flooded

- Puente Basin Adjudicated Boundary
- Streams & Flood Control Channels
- Lined Steams & Flood Control Channels

Geology

Water-Bearing Sediments

- Quaternary Alluvium

Consolidated Bedrock

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

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Prepared by:

WEST YOST

0 1 2 Miles

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Depth to Groundwater in 2022 and Potential Groundwater Dependent Ecosystems (GDEs)

Figure 3-23

3.6 Data Gaps

A preliminary list of data gaps of the Basin Setting of the Puente Basin is described below:

Aquifer Properties in the Bedrock High Areas in the Puente Basin: Figures 3-14a and 3-14b indicate that the Puente Basin is separated by "bedrock highs" into what appears to be three independent subbasins. If this is true, it has significant implications regarding groundwater flow within the basin and for identifying appropriate groundwater management strategies.

A workplan is recommended to be developed to better understand the aquifer in these bedrock high areas, and answer these questions for these areas:

- What are groundwater levels?
- What is the thickness and hydraulic continuity of the weathered zone of bedrock?
- What is the specific yield and horizontal conductivity of sediments and the weathered zone of bedrock?
- What is the estimated travel time between the independent subbasins if there is evidence of connectivity in the bedrock high areas connecting the subbasins?

The workplan would be developed to answer these questions, and identify the available methods that can be used, select the most appropriate methods to achieve the data gap objectives, and prepare a scope, budget, and schedule to implement the workplan.

Collecting this additional data in these areas will refine the hydrogeologic conceptual model, estimations in groundwater storage, aquifer properties, and the impact of pumping if in fact the aquifer system is discontinuous as the data in this TM suggests.

Groundwater Quality: Historically, groundwater quality sampling is limited throughout the Puente Basin that provides a clear understanding of the water quality conditions important to the management of the basin. The groundwater quality analysis in *Section 3.3. Groundwater Quality* was not based on a robust data set regarding the number of monitoring locations, distribution of monitoring locations, the frequency of sample collection, and the constituents analyzed. The regulated contaminants of concern identified in Section 3.3 are TDS, nitrate, PCE, TCE, and cis-1,2-DCE. However, the spatial distribution for the monitoring of the contaminants is limited. Examples of the limited water quality monitoring include:

- the pumping wells in the central and eastern portion of the Puente Basin are only sampled for TDS;
- there is no water quality data collected at the monitoring wells measured by the WVWD and LACDPW throughout the basin;
- the monitoring wells for contaminant clean-up sites in the western portion of the basin only sample for VOCs; and not TDS, nitrate, and other potential contaminants.

A more robust groundwater-quality monitoring program is necessary to characterize TDS, nitrate, regulated contaminants of concern and emerging contaminants. It is recommended that the existing pumping wells and monitoring wells (measured by WVWD/ LACDPW) throughout the basin are sampled semi-annually to annually and analyzed for a more robust list of parameters inclusive of contaminants of concern and emerging contaminants. Annual sampling should include at a minimum: TDS, nitrate, general minerals, perchlorate, hexavalent chromium, 1,2,3-thrichlropropane, VOCs, and PFAS. It is also recommended to communicate with the Carrier BDP Corporation to coordinate sampling and analysis at some of their monitoring wells in the western portion to develop a similar parameter list.

It is prudent to perform more robust groundwater quality monitoring, to better characterize water quality conditions in the Puente Basin, to understand how water quality changes over time, to determine how contaminant plumes may migrate with pumping and wet and dry climatic cycles, and to understand what treatment is necessary if there is a desire to use groundwater for potable supply or other beneficial uses.

Surface Water Discharge: There are no surface water discharge monitoring sites along the tributaries of the San Jose Creek channel within the Puente Basin; this includes Lemon Creek and partially lined Diamond Bar Creek. And the discharge measurements of flow in the San Jose Creek within the Puente Basin are for only a monthly frequency. Surface water discharge and quality monitoring along the Lemon and Diamond Bar Creeks, and more frequent discharge monitoring along San Jose Creek, would help provide an understanding of the volume of storm water flows, dry-weather runoff, and recycled water discharge that can be potential sources for groundwater recharge projects.

GDEs: There is one GDE identified by the DWR's NCCAG within the Puente Basin, where the estimated depth-to-groundwater is about 30 ft-bgs and it is near the unlined Lemon Creek in the northern portion of the basin. At this GDE area, there is potential for interconnected groundwater and surface water along the unlined Lemon Creek, and potential for shallow groundwater supporting the GDE. If the PBWA is considering a groundwater management plan that will increase pumping near this GDE, and there is potential for declining ground water levels in this area, this potential GDE should be further investigated and considered. Data and information will need to be collected at the GDE site to confirm the presence; and if confirmed, document the extent and health vegetation, and determine the necessary monitoring and management for the GDE.

4.0 BASIN MANAGEMENT IMPLICATIONS

The following is a summary of basin management challenges that are evident from the description of the Puente Basin GMP Area and hydrogeology of the basin in this TM-1:

- The size of the Puente Basin and the yield of groundwater that can be reliably pumped on an annual basis (about 1,400 afy) is relatively small. Because of the relatively small size of the basin, attempts to increase annual groundwater pumping, without simultaneously increasing recharge, could cause significant declines in groundwater levels, which in turn, could cause: significant changes in the directions of groundwater flow; pumping sustainability challenges at existing pumping wells; impacts to GDEs if and where they exist in the basin; and reductions in groundwater outflow to the Main San Gabriel Basin.
- Recharge to the Puente Basin is limited, primarily because of the small tributary watersheds, the concrete-lining of the creeks that cross the basin, small volumes of subsurface inflows from upgradient groundwater basins, and the absence of artificial recharge of supplemental water supplies. Recharge will likely decline in the future as water conservation measures are implemented for outdoor irrigation, which will result in reduced return flows to the basin. This is the primary reason why the annual groundwater yield of the basin (about 1,400 afy) is relatively small.
- Depth to groundwater is relatively shallow across the Puente Basin (20-50 ft-bgs), hence, the basin has limited volumes of unused storage. If the intent is to increase recharge in the basin, then you pumping must increase because there is limited room for storage.
- Currently groundwater from Puente Basin is used as a non-potable water supply. Analysis of available groundwater-quality data indicates that concentrations of TDS, nitrate, TCE, PCE, and other VOCs in the basin are generally higher than primary and secondary MCLs. Hence, treatment would be required to produce a potable groundwater supply that complies with the drinking water standards.
- There are several gaps in the data and understanding of the Puente Basin that may need to be filled to support the design and implementation of certain basin management strategies. These gaps include:
  - **Water quality.** The basin needs more robust characterization of contaminants. There is no sampling for potential contaminants like hexavalent chromium, perchlorate, 1,2,3-1,2,3-trichlororpropane throughout the basin, and at the pumping wells there is no monitoring for the known contaminants like TCE, PCE, and nitrate. Additional monitoring is needed to fully characterize groundwater quality conditions of the basin and understand what type of treatment is necessary if groundwater is to be used for potable supply or other beneficial uses, and how to optimize treatment if there are multiple contaminants.
  - **GDEs.** There is a potential GDE in the northern portion of the Puente Basin along the unlined reach of Lemon Creek where groundwater levels are less than 30 ft-bgs, and there are four other potential GDE areas according to the DWR's NCCAG dataset that are likely not GDEs because the depth to groundwater is much deeper than 30 ft-bgs. These areas will need to be evaluated if groundwater management activities in the basin could cause declines of groundwater levels that could impact the potential GDE in the respective areas. If these GDEs are confirmed, the potential impact will need to be considered and monitoring will be performed as needed.

- **Water supplies for recharge.** The quantities, availability, and reliability of water supplies that could be used for artificial recharge is not understood, including surface water runoff, recycled water, and imported water. These different types of potential recharge water sources need to be monitored and/or better characterized if artificial recharge projects are considered for basin management.
- **Land Subsidence.** It is unknown what the potential is for pumping-induced land subsidence, because historically no permanent land subsidence has occurred and groundwater levels have remained relatively stable during slight increases in pumping.
- **Underflow Obligation.** How and if the PBWA's underflow obligation through the Puente Narrows for the Upper San Gabriel Valley Municipal Water District will be met with certain basin management strategies. It is essential to understand this when selecting basin management strategies and developing a GMP and determining whether the nearly 20,000 af of PBWA underflow credits could be utilized.
- **Aquifer in Bedrock-High Areas.** There is a data gap in the characterization of the aquifer properties in these bedrock-high areas. A better understanding of the aquifer in these bedrock high areas is crucial to understand if there are separate subbasins and to ascertain how groundwater flows between these bedrock-high areas, and what implications may arise in connection with developing various groundwater management strategies in the basin.

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Appendix A

Comments and Responses on September 2023 Draft

Appendix A – Comments and Responses on the September 2023 Puente Basin Groundwater Management Plan - Draft Technical Memorandum 1 (TM 1): Description of the Puente Basin Groundwater Management Plan Area and Basin Setting

Comments by Suzanne Brown, Senior Engineer, Los Angeles County Sanitation Districts (LACSD)

Thank you for the opportunity to comment on the Draft Technical Memorandum 1 (TM-1) Puente Basin Groundwater Management Plan (GMP) Area and Basin. Below are comments on behalf of the Los Angeles County Sanitation Districts (LACSD):

Comment No. 1. Page 17 (25 of the PDF)

- We recommend changing the heading for section 2.5.4 to "Discharge of Treated Wastewater" instead of "Disposal of Wastewater".
- We recommend revising the first sentence under section 2.5.4 as follows: "Figure 2-6 shows the ~~wastewater disposal and recycled facilities~~ water reclamation plants within the vicinity of the Puente Basin"
- Please revise the following sentences in the second paragraph under section 2.5.4 as follows: "Recycled water from the San Jose Creek WRP that is not ~~used~~ directly reused is either discharged to the unlined San Gabriel River (or the San Jose Creek tributary to San Gabriel River), where it can be incidentally recharged in the Man San Gabriel Basin, used by riparian vegetation, diverted for artificial recharge by the Water Replenishment District of Southern California (WRD) at the Rio Hondo and San Gabriel Spreading Grounds overlying the Central Basin~~, or lost to the ocean~~. In unusual circumstances, such as heavy rain, the Spreading Grounds can be bypassed and treated wastewater is discharged to the downstream concrete-lined portion of the San Gabriel River at Firestone Boulevard, which leads to the ocean. Since 2019~~2018~~, recycled water has been conveyed to WRD's Groundwater Reliability Improvement Project ~~Water Treatment Facility~~ Albert Robles Center for Water Recycling and Environmental Learning (ARC) facility where it is advance treated…"
    - Note: Alternatively, instream incidental recharge and the Spreading Grounds can be referred to collectively as the Montebello Forebay Groundwater Recharge Project.
- Please revise the following sentences in the third paragraph under section 2.5.4 as follows: "Tertiary-treated recycled water from the Pomona WRP is used by WVWD and City of Pomona for direct reuse for customers within the Spadra and Puente Basins, as well as at LACSD's Spadra Landfill, and California State Polytechnic University Pomona's Center for

Regenerative Studies. Recycled water from the Pomona WRP that is not ~~used~~ directly reused is discharged to the concrete-lined South Fork San Jose Creek where it flows into the unlined San Jose Creek and then into the San Gabriel River about 15 miles downstream where it can be incidentally recharged in the Main San Gabriel Basin, used by riparian vegetation, or diverted for artificial recharge by WRD in the Rio Hondo and San Gabriel Spreading Grounds overlying the Central Basin."

- Note: Alternatively, instream incidental recharge and the Spreading Grounds can be referred to collectively as the Montebello Forebay Groundwater Recharge Project.

Response to Comment #1. Revisions made to text. And a footnote was added to the text in this section: "Instream incidental recharge and the recharge at the Spreading Grounds can be referred to collectively as the Montebello Forebay Groundwater Recharge Project." And one slight change is instead of using "…recharged at the Montebello Forebay Groundwater Recharge Project" used "… recharged at Rio Hondo and San Gabriel Spreading Grounds in the Montebello Forebay…"

Comment No. 2 Page 23 (31 of the PDF)

- In both section 2.6.2 and 2.6.3, the memo references a LACSD 2022 report for 2022 fiscal year recycled water production by the San Jose Creek WRP and Pomona WRP, respectively. However, there is no 2022 LACSD report included in the references. Please add the citation for this report. Please revise the following sentence under section 2.6.2 as follows: "Recycled water from the San Jose Creek WRP not used for direct reuse, is used for groundwater recharge at the Montebello Forebay Groundwater Recharge Project ~~in the Central Basin by the WRD at Rio Hondo and San Gabriel Spreading Grounds~~, or (in unusual cases) discharged to the concrete-lined portion of the San Gabriel River at Firestone Boulevard, bypassing recharge basins where it is lost to the ocean."
    - Note: Incidental recharge upstream of the Whittier Narrows Dam was not mentioned, however combined with the Spreading Grounds, it can be referred to collectively as the Montebello Forebay Groundwater Recharge Project.

- Please revise the last sentence under section 2.6.2 as follows: "~~The remaining 87~~ 86.5 percent of the recycled water produced by the San Jose Creek WRP was used for groundwater recharge in the Central Basin and 0.5 percent bypassed the recharge facilities and was discharged downstream to the concrete-lined portion of the San Gabriel River at Firestone Boulevard, which leads to the ocean. "

- Section 2.6.3 contains the following statements regarding LACSD recycled water contracts "LACSD has agreements to deliver up to one-third of its recycled water available from the Pomona WRP to the WVWD and the remaining two-thirds to the City of Pomona (Carollo Engineers, 2009). Based on this agreement and the average plant production the amount of recycled water available to the WVWD is about 2,300 afy and the amount available to City of Pomona is 4,700 afy." As this information doesn't appear to be used later in the report, we recommend removing these references to the contracts and recycled water allotments. The allotments are more complicated than represented in the document, and there are other entities that have contracts for the recycled water produced by Pomona WRP. For example, technically, WVWD is entitled to 1/3 of recycled water produced on a daily basis minus what is used by Spadra Landfill and Cal Poly Center for Regenerative Studies, but this may be more detail than desired for this memo. Furthermore, LACSD also has an agreement with WRD that covers the recycled water discharged from the Pomona WRP to the South Fork San Jose Creek for groundwater recharge.

- Please revise the following sentence in section 2.6.3 as follows: "Recycled water that is not <u>directly reused</u> ~~utilized by the WVWD and City of Pomona~~ is discharged to the concrete-lined South <u>Fork</u> San Jose Creek channel in the Spadra Basin, converges with the San Jose Creek and flows through and out of the Puente Basin to the San Gabriel River where about 15 miles downstream it is <u>recharged at the Montebello Forebay Groundwater Recharge Project</u> ~~diverted for groundwater recharge at Rio Hondo and San Gabriel Spreading Grounds overlying the Central Basin~~."
    - Note: For the Pomona WRP, the majority of the recycled water discharged is recharged instream upstream of the Whittier Narrows Dam. Alternatively, instream incidental recharge and the Spreading Grounds can be referred to collectively as the Montebello Forebay Groundwater Recharge Project.

Response to Comment #2: Revisions made to text. One slight change is instead of "…recharged at the Montebello Forebay Groundwater Recharge Project" used "…recharged at Rio Hondo and San Gabriel Spreading Grounds in the Montebello Forebay…"

Comment No. 3 Page 89 (97 of the PDF)

- The second to last paragraph indicates there are no surface water discharge monitoring sites along the creeks in the Puente Basin, but mentions the Pomona WRP effluent discharge monitoring location upstream. Please note that San Jose Creek WRP also has an upstream receiving water monitoring location for NPDES permit required monitoring (RSW-001) downstream of Puente Basin that may provide useful surface water quality information. Data are publicly available through CIWQS.
- The last sentence of the second to last paragraph mentions a need to assess quantity of recycled water discharge that can be potential sources for groundwater recharge projects. Please consult with LACSD regarding recycled water availability for any future proposed projects.

Response to Comment #3. There are three receiving water monitoring locations for the Pomona WRP (RSW-001D, RSW-002D, and RSW-003D) that are within the San Jose Creek channel upstream, within, and downstream of the Puente Basin. And there is a receiving water monitoring location within the San Jose

Creek channel downstream of the Puente Basin (RSW-001). These sites were added to Figure 3-1 and the text was modified to include them in *Section 3.1 Surface Water Hydrology and Precipitation* and *Section 3.6 Data Gaps*.

Comments by Sam Hernandez, Civil Engineering Assistant, Walnut Valley Water District (WVWD)

Comments. Mr. Hernandez suggested some grammatical fixes and adjustment to the export of all map figure to resolve a printing error.

Response. All suggested changes and fixes have been incorporated into the final TM 1.