Project Agreement 16

Riverside/Colton Water Resources Management Task Force

Reconnaissance-Level Investigations
Riverside/Colton Basins
Water Resources Management Program

FINAL REPORT

Prepared by
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ACRONYM AND ABBREVIATIONS LIST

AL	action level
DWR	California Department of Water Resources
ft-msl	feet above mean sea level
MCL	maximum contaminant level
mg/L	milligrams per liter
ND	not detected
TDS	total dissolved solids
TIN	total inorganic nitrogen
WE, Inc.	Wildermuth Environmental, Inc.
μg/L	micrograms per liter

SECTION 1 INTRODUCTION

BACKGROUND AND PAST STUDIES

In March of 1992, the City of San Bernardino (City), Orange County Water District (OCWD), San Bernardino Valley Municipal Water District (SBVMWD), and Western Municipal Water District (WMWD) agreed to conduct a study to develop conjunctive-use alternatives for integrating the management of imported water, recycled water, and storm water for water users that have access to groundwater in the Riverside and Colton groundwater basins. The objective of conjunctive use developed by the above entities is *to maximize the use of local water resources for water users in the OCWD, SBVMWD, and WMWD service areas, with equitable cost sharing between all parties including water purveyors, regional water management agencies, and recycled water dischargers.*

The issue that brought this group together was a proposal by the City of San Bernardino and Eastern Municipal Water District (EMWD) to discharge 30 mgd of the City's secondary effluent to EMWD, where it would receive additional treatment and be reused in the EMWD service area. In this proposal, the City would avoid future cost of nitrogen removal, tertiary treatment, and other future costs associated with discharge of recycled water to the Santa Ana River. EMWD would gain a supply of low TDS recycled water. OCWD and WMWD, however, wanted to keep the City's effluent in the Santa Ana River for reuse in their service areas.

On April 25, 1992 the City, OCWD, SBVMWD, and WMWD met to discuss their individual goals and conjunctive-use alternatives. These goals were primarily focused on improving the reliability and usability of local resources and in minimizing the cost of obtaining these goals. The agencies completed an investigation that developed a conjunctive-use management plan that would achieve these goals. The agencies then approached SAWPA to form a project committee to implement the conjunctive-use plan. SAWPA responded and formed Project Agreement 16.

Based on these goals a work plan was developed to refine the conjunctive-use plans developed by the agencies. This work plan was executed and a final report was produced in September 1993. Subsequently, engineering reports and environmental assessments were done to implement parts of the conjunctive plans that were deemed "pilot" projects. The pilot projects were seen as an important first step to test the physical and institutional viability of the larger conjunctive-use plans. Draft reports for pilot or *Initial Projects B and C* were completed in June 1994 (Wildermuth, 1994). In addition to these reports, a draft report was prepared that described *Principles of Agreement* (1994) that would be necessary to implement the conjunctive-use plans.

Water rights issues that arose during the development of the *Principles of Agreement* were deemed not solvable without extensive negotiations. Implementation of the conjunctive-use plan was put on hold indefinitely pending the resolution of the "issues." These issues were subsequently resolved.

GOALS OF THE RIVERSIDE/COLTON CONJUNCTIVE USE PROGRAM

The contract under which this investigation was carried out listed the following goals for the Riverside/Colton Conjunctive-Use Program:

- Improve water quality of Riverside and Colton Basins groundwater
- Create drought storage
- Reduce dependence on imported water
- Maximize local groundwater production
- Maximize capture and use of local surface water
- Provide seasonal storage

ORGANIZATION OF THIS REPORT

This report consists of three additional sections that include:

- *Section 2 Review of Riverside/Colton Conjunctive-Use Projects in 1994 Plan*
- *Section 3 Current Conditions in the Study Area.* This section describes the physical state of the Colton and Riverside Basins and known limitation on the use of groundwater.
- *Section 4 New Basin Management Alternatives.* This section describes new management alternatives, consistency with conjunctive-use goals, and an implementation strategy.

SECTION 2 REVIEW OF RIVERSIDE/COLTON CONJUNCTIVE-USE PROJECTS IN 1994 PLAN

THE PROJECT COMMITTEE 16 CONJUNCTIVE-USE PLAN

The conjunctive-use plan was originally developed and described in *Develop Conjunctive-use Plans to Manage Local and Imported Water and Wastewater above Riverside Narrows* (Wildermuth, 1992). These plans were revised in the Project Committee 16 process during 1993 and 1994. The Project 16 conjunctive-use plan consists of four distinct projects (A through D), each having different goals and beneficiaries. When implemented, the projects would meet most of the goals of the stakeholders. Each project had an ultimate and initial level of implementation. The ultimate project would achieve the greatest benefits and was the long-term goal. The initial project was a pilot project to test the institutional viability of the project prior to investing the resources required to implement the ultimate project. The original project descriptions are summarized below. These descriptions are somewhat obsolete and have been included for historical perspective.

Project A – Wastewater Quality Enhancement and Relocation of Wastewater Discharge.

Ultimate Project Description. This project involves the improvement of wastewater quality discharged to the Santa Ana River through improvements at the Colton, Rialto and San Bernardino wastewater treatment plants, and the construction of a pipeline to relocate wastewater discharge points for these dischargers downstream of the Mission Boulevard bridge. The facilities described herein are shown in Figure 2-1. The City of Rialto would implement wastewater treatment improvements itself while Colton and San Bernardino would individually improve their existing facilities and join together to construct a regional tertiary treatment plant (RTTP). A pipeline would be constructed from the City of San Bernardino wastewater plant to convey secondary treated effluent to the RTTP located in Colton. The City of Colton would construct a pipeline to the same facility. A pipeline would be constructed from the RTTP along the Santa Ana River to convey the RTTP effluent to the River just downstream of the Mission Boulevard Bridge. Rialto could put its effluent in this pipeline or construct it own pipeline to the same location. A pipeline would be constructed from San Bernardino wastewater plant to EMWD to convey up to 30 mgd of secondary treated effluent to EMWD for treatment and use in EMWD.

Initial Project A Description. The initial project consists of the construction of the secondary effluent pipeline from San Bernardino to the RTTP, connection by Colton to the same pipeline, construction of the RTTP, and improvements to existing wastewater facilities.

Current Status of Project A. Initial Project A was implemented in the period 1995 to 1996. The RTTP is known as the *Rapid Infiltration Extraction Tertiary Treatment Facility* (RIX). There are currently no efforts being made to move the points of discharge for RIX or Rialto to the Mission Boulevard Bridge. In fact, the recent listing of the Santa Ana Sucker could prohibit the construction the recycled water effluent pipeline from the RIX and Rialto facilities to Mission Boulevard Bridge.

Project B – Riverside Basin Salt Export and Seasonal Storage

Ultimate Project Description. This project involves the removal of high-TDS groundwater from the Riverside South Basin, with goal of creating capacity for recharge of higher quality water including storm water, state project water, Bunker Hill Basin groundwater and seasonal storage capacity for recycled water produced in Project A.

Wells would be constructed along the River as shown in Figure 2-1. Groundwater would be produced from these wells in late spring, summer, and early fall, and discharged to the River downstream of the well field. The timing of groundwater production in Project B would ensure capture in OCWD spreading basins. Capacity of this project ranges from 10 to 30 mgd. The expected range in TDS and nitrate-nitrogen concentrations in water produced from these wells would be 600 to 800 mg/L and 13 to 17 mg/L, respectively. The combination of improved recycled water quality discharged in Project A and the OCWD constructed wetlands in behind Prado dam would ensure that the nitrogen concentration in the Santa Ana River will meet nitrogen objectives at Prado Dam. Eventually, the groundwater produced from Project B would have a TDS concentration around 500 mg/L and a nitrate-nitrogen concentration less than 10 mg/L.

Seasonal storage of recycled water would be accomplished by recharging recycled water in the river in the reach upstream of and adjacent to the Project B well field during the late fall, winter and early spring (*put* period); and by recovering this water with the Project B well field during the remainder of the year (*take* period). "T" levees or other run-of-river recharge facilities would be constructed in the River to ensure maximum recharge during the *put* period. Project A recycled water would be diverted downstream of Mission Boulevard bridge when Project B well field is producing groundwater thus creating groundwater storage space for the subsequent *put* period.

Initial Project B Description. The initial project is similar to the ultimate project with the following exceptions. Available existing wells would be used to produce groundwater. Temporary and/or existing pipelines would be used to convey groundwater to the River during the *take* period. Some of these same wells and pipelines could be used in the ultimate project. Recycled water recharge would be incidental, that is, no "T" levees or comparable run-of-river recharge facilities will be constructed. The groundwater production rate would be limited to the capacity of wells that can be used for the initial project, existing pipelines, and the desire for ease of implementation.

Current Status of Project B. Initial Project B was not implemented due to the then unresolved issues regarding the 1969 Judgment. OCWD produced a finding that the seasonal shifting of effluent discharged to the River was not necessary for them to increase conservation of Santa Ana River discharge. Finally, the recent listing of the Santa Ana Sucker will most likely prohibit the construction of run-of-river recharge facilities and the recycled water effluent pipeline from the RTTP to Mission Boulevard Bridge. Run-of-river recharge facilities would involve continuous clearing of vegetation and maintenance of "T" levees with heavy earth-moving equipment operating in "the wet." The diversion of all RIX effluent through a pipeline from RIX to Riverside Drive would impact Sucker habitat at the RIX outfall. U. S. Fish and Wildlife service has indicated that they are concerned about short-term interruptions (one to three hours in length) of discharge that occur routinely at RIX. Project B as described above is not implementable.

Project C – Colton Basin Restoration and Water Supply Project

Ultimate Project Description. This is a water supply project that will develop groundwater from an area that contains a portion of the Colton and Riverside North Basins that is located along the Santa Ana River, between the San Jacinto Fault and the northern edge of La Loma Hills. This would be accomplished by removing groundwater whose water quality is too poor for potable use in the WMWD service area and refilling the basin with good quality water. Future groundwater quality would be maintained by managing recharge. Only recharge with good quality water would be permitted. Well field(s) would be constructed to recover groundwater near the recharge area. Groundwater in this area has a TDS in the range of 400 to 650 mg/L, which makes it unusable for municipal supply in the WMWD and SBVMWD service areas. In this project, about 15,000 to 20,000 acre-ft of high TDS water would be pumped and conveyed from the Project C area during the first three years of the project. Production would run year round as long as OCWD has recharge capacity. Existing wells owned by the City of Riverside and the successors to the 350 Miners-inch Company could be used for the initial pump-out of the project area. Groundwater produced in the initial pump-out would be conveyed in local facilities through Riverside and discharged to the Santa Ana River at Hole Lake, just downstream of Riverside Narrows.

The project area would be recharged during the *put* period with low TDS local runoff, state project water, surplus Bunker Hill water, and recycled water from the City of San Bernardino. Recharge would occur in run-of-river recharge facilities constructed between Interstate 10 and the La Cadena Bridge or as incidental recharge in the River bottom. A combination of new and existing wells would be used to recover the water during a *take* period. Production capacity could range from 15 to 20 mgd. Product water could be delivered to the cities of Colton and Riverside, Riverside Highland and West San Bernardino County Water District (WSCWD).

Initial Project C Description. In the initial project, poor quality groundwater would be removed as in the ultimate project but at a lower rate. The rate at which the project area would be pumped down depends on available production capacity and on simplicity of implementation. New groundwater production facilities for recovery of good quality groundwater would not be constructed. No run-of-river recharge facilities would be constructed. Recharge of recycled water would not occur

Current Status of Project C. Initial Project C was not implemented due to then unresolved issues regarding the 1969 Judgment.

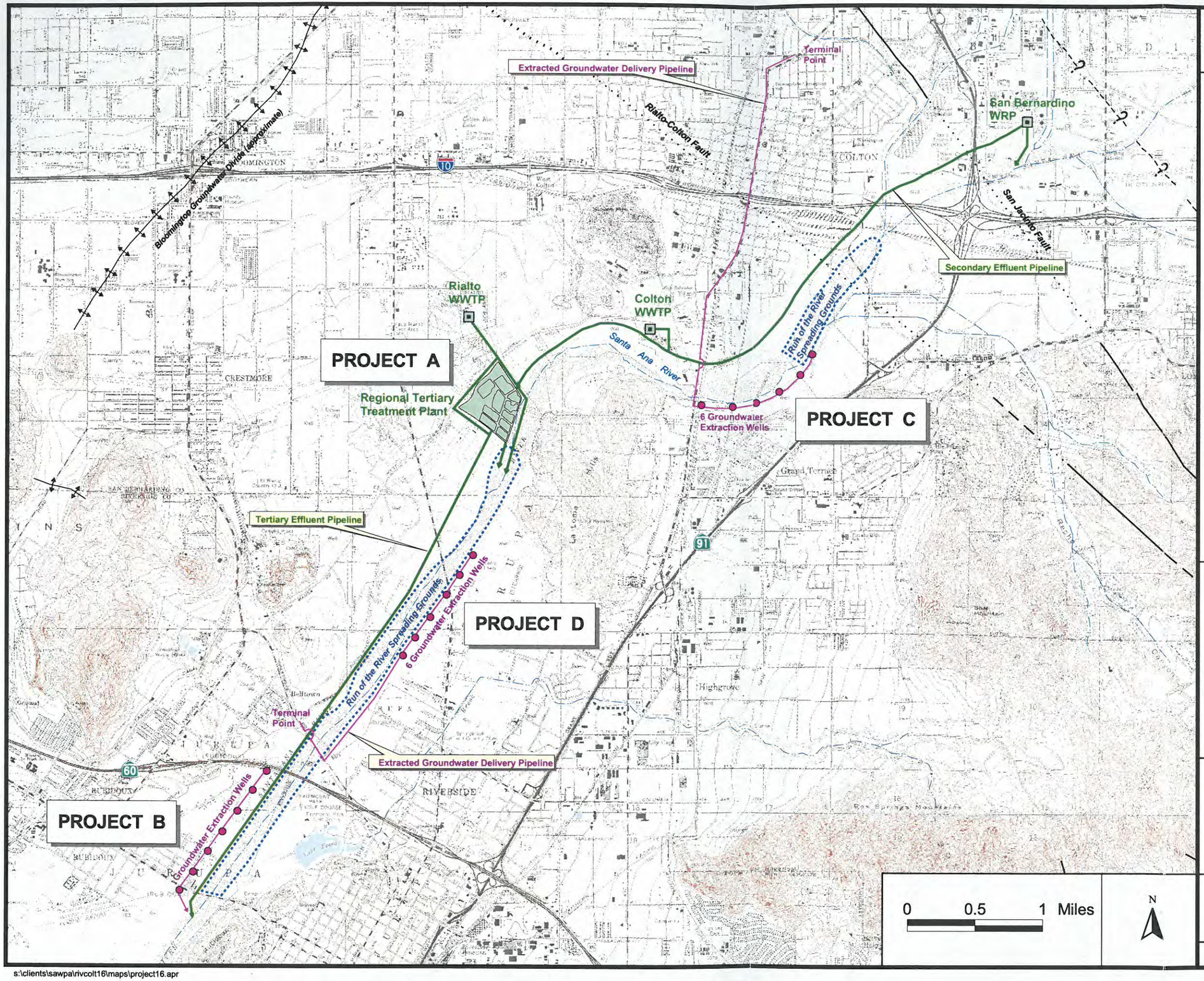
Project D – Riverside Basin Restoration and Water Supply Project

Ultimate Project Description. Project D is a water supply project that would develop groundwater from a portion of the Riverside Basin located along the Santa Ana River between La Loma Hills and Crestmore Drive. This project is similar to Project C except that an initial pump out period is not required. Groundwater quality in this area will be improved by reducing recycled water recharge and increasing the recharge of high quality water. Good quality local runoff, SPW, Bunker Hill groundwater, and recycled water from the RTTP would be recharged in the Riverside Basin in run-of-river recharge facilities. The recharge facilities would be located in the River from the RTTP site to Crestmore Drive Bridge. Well fields would be constructed near the river to produce groundwater for Jurupa Community Services District, Rubidoux Community Services District, and the City of Riverside. Production capacity of this well field would be about 15 to 20 mgd.

Initial Project D Description. The is no initial Project D.

Current Status of Project D. As with the other projects, Project D was not implemented due to then unresolved issues regarding the 1969 Judgment. The pipeline to convey recycled water from the RTTP and Rialto facilities to Mission Boulevard Bridge was not constructed. Finally, the recent listing of the Santa Ana Sucker will most likely prohibit the construction of run-of-river recharge facilities and the pipeline to convey recycled water from the RTTP and Rialto facilities to Mission Boulevard Bridge. Project D as described above is not implementable.

Riverside-Colton Conjunctive Use Project



Legend

- Existing Wastewater Treatment Facility
- Proposed Extraction Well
- Outline of Proposed Spreading Grounds
- Extracted Groundwater Delivery Pipeline
- Wastewater Pipeline

Other Map Features

- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Groundwater Divide
- Waterways

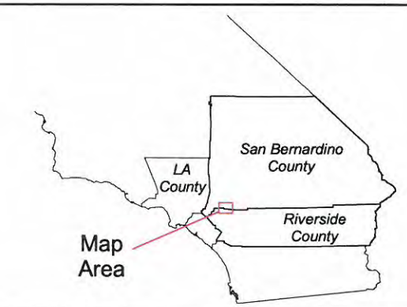


Figure 2-1
Facilities Layout for Project 16
June, 1994

WE WILDERMUTH ENVIRONMENTAL, INC.

Prepared by: AEM | *Date: January 2001*

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SECTION 3 CURRENT CONDITIONS IN THE STUDY AREA

HYDROGEOLOGIC DESCRIPTION

Geology

The groundwater basins in the Riverside-Colton area are part of a large, broad, alluvial-filled basin located between the San Gabriel/San Bernardino Mountains to the north and the elevated Perris Block/San Jacinto Mountains to the south. The Santa Ana River is the main tributary draining this basin. Sediments eroded from igneous and metamorphic rocks within the surrounding mountains have filled the basin to provide reservoirs for groundwater. The San Jacinto Fault cuts through this alluvial-filled basin from the northwest to the southeast to form a major barrier to groundwater flow and, hence, separates the groundwater basins of the San Bernardino Valley in the east from the groundwater basins of the Chino, Rialto, and Riverside-Colton areas in the west.

Figure 3-1 is an equal elevation contour map of the effective base of the freshwater aquifers in the Riverside-Colton area. Note that numerous faults and bedrock protrusions sub-divide the larger area into a number of groundwater subbasins with unique bedrock configurations. The major faults within this area – the San Jacinto and Rialto-Colton faults – are known barriers to groundwater flow. These faults, their effects on groundwater movement, and groundwater movement in general have been studied in detail by various entities and authors (Eckis, 1934; Gleason, 1947; Burnham, 1953; MacRostie and Dolcini, 1959; Dutcher & Garrett, 1963; DWR, 1965a; Gosling, 1966; DWR, 1970; Woofenden and Kadhim, 1997) and will be discussed below.

Occurrence of Ground Water

Groundwater within the Riverside-Colton area primarily exists under unconfined to semi-confined conditions. Predominant recharge to the groundwater reservoirs in the area is from:

- Underflow as seepage across the San Jacinto Fault from the Bunker Hill Basin.
- Underflow from the Rialto area between the San Jacinto and Rialto-Colton faults.
- Underflow from the saturated alluvium and fractures within the surrounding bedrock hills.
- Infiltration of stream flow within tributaries exiting the surrounding hills and within the Santa Ana River.
- Deep percolation of precipitation and returns from use.

In general, groundwater flow mimics surface drainage patterns. Figure 3-2 and 3-3 are groundwater elevation contour maps for Fall 1973 and Fall 1997, respectively, that show this general groundwater flow pattern. Note that groundwater flow paths (perpendicular to the contours) are generally from areas of recharge (the San Jacinto Fault and along the flanks of the surrounding hills) to converge beneath the Santa Ana River until discharging as rising water at the Riverside Narrows. Groundwater elevation contour maps from other periods show similar contour patterns, indicating consistent flow systems over time within this area.

A more detailed description of the occurrence and flow of groundwater follows – from up-gradient areas of recharge to down-gradient areas of discharge at Riverside Narrows:

The San Jacinto Fault separates the Colton Basin from the Bunker Hill groundwater basin. The San Jacinto Fault is competent barrier to groundwater flow in this area within the deep, older alluvium, but not within the shallow, recent alluvium underlying the channels of the Santa Ana River and Warm Creek (Dutcher and Garrett, 1963). Groundwater flows across the San Jacinto Fault within the shallow alluvium from the upgradient Bunker Hill (San Bernardino) Basin into the Colton Basin. In addition, groundwater flowing northwest within the alluvium and semi-consolidated rocks of Reche Canyon and groundwater flowing southeast from the Rialto area commingle with groundwater in the aquifer underlying the Santa Ana River and, thence, flows southwest toward the Rialto-Colton Fault.

The Rialto-Colton Fault separates the Colton Basin from the Chino and Riverside North basins. The fault is a known barrier to groundwater flow along much of its length – especially in its northern reaches where groundwater elevations can be hundreds of feet higher within the Colton Basin (Dutcher and Garrett, 1963; DWR, 1970; Woolfenden and Kadhim, 1997). However, the disparity in groundwater elevations across the fault decreases to the south, indicating the barrier effect of the fault also decreases to the south. Many studies have postulated that groundwater flows freely across the Rialto-Colton Fault within aquifers underlying the Santa Ana River (Eckis, 1934; Gosling, 1966; DWR, 1970). However, in this same area, recent geophysical investigations (Ryland Associates, 1995) and hydrologic studies (Gosling, 1966) indicate the existence and the barrier effect of the Rialto-Colton Fault within the deep, older alluvium.

A flattened mound of groundwater exists beneath the Bloomington area as a likely result of groundwater flow from the Colton Basin through a gap in the Rialto-Colton Fault north of Slover Mountain (Dutcher and Moyle, 1963; Gosling, 1966; DWR, 1970). This mound of groundwater extends from the gap in the Rialto-Colton Fault to the northeast tip of the Jurupa Mountains, and effectively separates the Chino Basin from the Riverside North Basin. Groundwater to the northwest of this divide recharges the Chino Basin and flows westward staying north of the Jurupa Mountains. Groundwater southeast of the divide recharges the Riverside North Basin and flows southwest towards the Santa Ana River.

The elevated bedrock hills that separate the Riverside-Colton basins from the San Jacinto basins are composed of impermeable metamorphic and/or igneous bedrock. Water that recharges along the northern flanks of these hills – either as channel percolation of surface water draining the hills or as deep percolation of return flows and precipitation – flows toward the Santa Ana River to commingle with aquifers underlying the river.

Throughout the Riverside-Colton area, groundwater that recharges within the Santa Ana River channel generally flows in the same direction as surface water within the river. One possible exception to the above observation is in the Grand Terrace area (east of La Loma Hills). Eckis (1934) speculated that groundwater beneath the Santa Ana River northeast of La Loma Hills can flow into the Grand Terrace area based on groundwater elevation contour maps. However, Basin Planning Model simulations indicate that this flow is minor compared to flow around the north side of La Loma Hills (Wildermuth, pers. comm., 1999).

Groundwater discharge within the Riverside-Colton area primarily occurs as:

- Groundwater production.
- Rising water within the channel of the Santa Ana River upstream of the Riverside Narrows.

- Evapotranspiration along the Santa Ana River where groundwater is near or at the ground surface.

Available Groundwater

Total groundwater storage in the Riverside-Colton area has not changed greatly from 1973 to 1997. Groundwater storage within the Colton, Riverside North, and Riverside South basins totaled about 1,100,000 acre-feet during both years. {Note that storage in the Colton Basin is measured only in the saturated areas south of San Bernardino Avenue}.

Table 3-1 displays groundwater storage values for the individual Colton, Riverside North, and Riverside South basins. Note that groundwater storage has increased from 1973 to 1997 in the Riverside South Basin by about 10,000 acre-feet. During this same period, groundwater storage has decreased in the Colton and Riverside North basins by about 1,400 and 8,000 acre-feet, respectively. These changes in storage are relatively small and represent changes of less than 3% of total storage for each basin.

The years 1973 and 1997 were chosen to compare groundwater storage in the Riverside-Colton area because detailed water level maps were constructed for these years as part of Phase 2A of the TIN/TDS Study (Wildermuth Environmental, 2000). Analysis of water level time histories at selected wells located throughout the Riverside-Colton area reveals water level and storage conditions in years prior to, between, and after 1973 and 1997. These water level time histories are shown in Figures 3-4 through 3-7. The locations of the selected wells are shown in Figure 3-3.

Figure 3-4 is a water level time history of a well in the Colton Basin adjacent to the Santa Ana River (Johnson 1 Well). Note that water levels in this well during 1973 and 1997 were about the same at 890 feet above mean sea level (ft-msl). Also apparent is that water levels have fluctuated over time, and that these fluctuations closely follow climatic conditions (i.e. trends in water levels coincide with trends in the accumulative departure from mean precipitation curve). Historically, static water levels at this well have been as high as about 935 ft-msl during wet periods (mid-1940s and again in the early-1980s), and as low as about 850 ft-msl during dry periods (mid-1960s).

Figure 3-5 is a water level time history of a well in the Riverside North Basin adjacent to the Santa Ana River (Flume 3 Well). The water level time history for this well is similar to the well in the Colton Basin (Johnson 1 Well). Water levels in this well during 1973 and 1997 were about the same at 875 ft-msl, but have fluctuated over time in a manner that closely follows climatic conditions. Historically, static water levels at this well have been as high as about 915 ft-msl during wet periods (mid-1940s), and as low as about 790 ft-msl during dry periods (mid-1960s).

Figure 3-6 is a water level time history of a well in the Riverside South Basin adjacent to the Santa Ana River and near the Riverside Narrows (RCSD Well 9). This water level time history is markedly different in comparison to wells in the Colton and Riverside North basins. Water levels in this well have been relatively constant over time at about 760 ft-msl. This constancy of water levels is expected at areas of groundwater discharge as rising water.

Figure 3-7 is a water level time history of a well in the Grand Terrace area of the Riverside North Basin (DeBerry Well). The water level time history for this well is similar to the wells in the Colton Basin (Johnson 1 Well) and the Riverside North Basin (Flume 3 Well) adjacent to the Santa Ana River. Water levels in this well during 1973 and 1997 were about the same at 845 ft-msl, but have fluctuated over time in a manner that closely follows climatic conditions.

Historically, static water levels at this well have been as high as about 885 ft-msl during wet periods (mid-1940s), and as low as about 800 ft-msl during dry periods (mid-1960s).

Water Quality

Groundwater within the Rialto-Colton and Riverside basins primarily exists under unconfined to semi-confined conditions. Predominant recharge to the groundwater reservoirs in the area is from percolation of direct precipitation and infiltration of stream flow within tributaries exiting the surrounding mountains and hills and within the Santa Ana River.

Riverside North and Riverside South groundwater basins have experienced relatively high concentrations of nitrate in groundwater since the 1940s. Figures 3-8a through 3-8c show the distribution of nitrate in groundwater in the study area for the following periods:

- 1930s
- 1940s
- 1950s
- 1960 – 1964
- 1965 – 1969
- 1970 – 1974
- 1975 – 1979
- 1980 – 1984
- 1985 – 1989
- 1990 – 1994
- 1995 – 1997
- 1930s – present (average)

By the 1940s, nitrate (as NO_3) concentrations greater than 90 mg/L (twice the maximum contaminant level [MCL]) were detected in wells in Riverside South basin. Concentrations in Riverside South appear to remain high until the present. The difference in spatial distribution on the maps is a function of data availability. The nitrate concentrations in Riverside South are probably a result of historical land use, including citrus overlying this basin.

Nitrate in concentrations greater than the MCL began to appear in Riverside North in the 1950s. Most of the wells in the 1950s had concentrations greater than half the MCL (22.5 mg/L). Again, these relatively high concentrations are likely the result of overlying land used. Nitrate in wells along the Santa Ana River near the San Jacinto Fault in the 1960s to early 1990s probably result from effluent from the City of San Bernardino's Wastewater Reclamation Plant former discharge location. Beginning in the early 1980s, wells along this reach of the Santa River appear to have lower concentrations of nitrate (< 22.5 mg/L), although there are fewer wells sampled during this period.

Beginning in the 1950s, most wells in Riverside North and Colton basins had total dissolved solids (TDS) concentrations between 250 and the secondary MCL of 500 mg/L (Figures 3-9a through 3-9c). All the wells in Riverside South exceeded the MCL n the 1950s with several wells exceeding 1000 mg/L. TDS in Riverside North along the Santa Ana River increased from the 1960s to early 1970s. Although there are relatively fewer data, it appears that TDS concentrations in Riverside North have decreased since the mid-1970s and most of the wells sampled in the 1995 to 1997 period again had concentrations between 250 and 500 mg/L.

A summary of other water quality constituents is provided in Table 3-2 and in Figures 3-10 through 3-87 (see compact disk). General mineral data were extracted from the TIN/TDS database for the period 1990 to 1997. Trace inorganic chemical, organic chemical, and radiological parameters were extracted from the State of California database acquired from Department of Health Services. The data in this table and in the figures are the maximum values over the entire period for each well.

The first column lists the constituent, sorted by the following groups: inorganics, organics, and radiological parameters. The second column provides the units for the standards. The next four columns are the Federal and State standards (MCLs or Action Levels). The standard type is provided next to the standard and is listed below:

a	Current Primary MCL
b	California Action Level
c	Secondary MCL
d	California fluoride standard is temperature dependent
e	Treatment technique triggered at action level of 15 mg/L

Primary maximum contaminant levels are established for 78 chemicals and 6 radioactive contaminants based on potential health effects. Secondary MCLs are established for 17 chemicals or characteristics based on taste, odor, or appearance of drinking water. Action Levels (ALs) are health-based advisory levels established for 36 chemicals for which primary MCLs have not been adopted.

Columns 7 and 8 are the 1994 Santa Ana Basin Plan surface water discharge objectives. The next three columns give the number of wells in the study area that exceed one-half the MCL, the MCL, and twice the MCL, respectively. Column 12 groups the constituents into the following categories in order to discuss their potential impact on Project 16 alternatives:

I	Constituent not detected in any well. No limitation on any Project 16 Alternative.
II	Constituent is an unregulated chemical. Based on concentrations and distribution or on health effects (sodium) this constituent will probably not impact Project 16 Alternatives.
III	Constituent was detected, but not in concentrations greater than one-half its MCL. The constituent will probably not impact Project 16 Alternatives.
IV	The constituent was detected in wells in concentrations greater than half its MCL. The constituent will either not limit or may limit Project 16 Alternatives where groundwater is proposed for direct use, based on distribution and health effects.
V	The constituent was detected in wells in concentrations greater than its MCL. The constituent may or will limit Project 16 Alternatives.

The final column discusses the constituent and its potential impact on Project 16 alternatives. Based on this review, the following constituents are most likely to limit Project 16 Alternatives:

- Chromium (total or hexavalent)
- Hardness
- Iron
- Lead
- Manganese
- Mercury (inorganic)

- Nitrate
- TDS
- 1,1-Dichloroethene
- DBCP
- EDB
- PCE
- TCE
- Gross alpha
- Radon
- Uranium

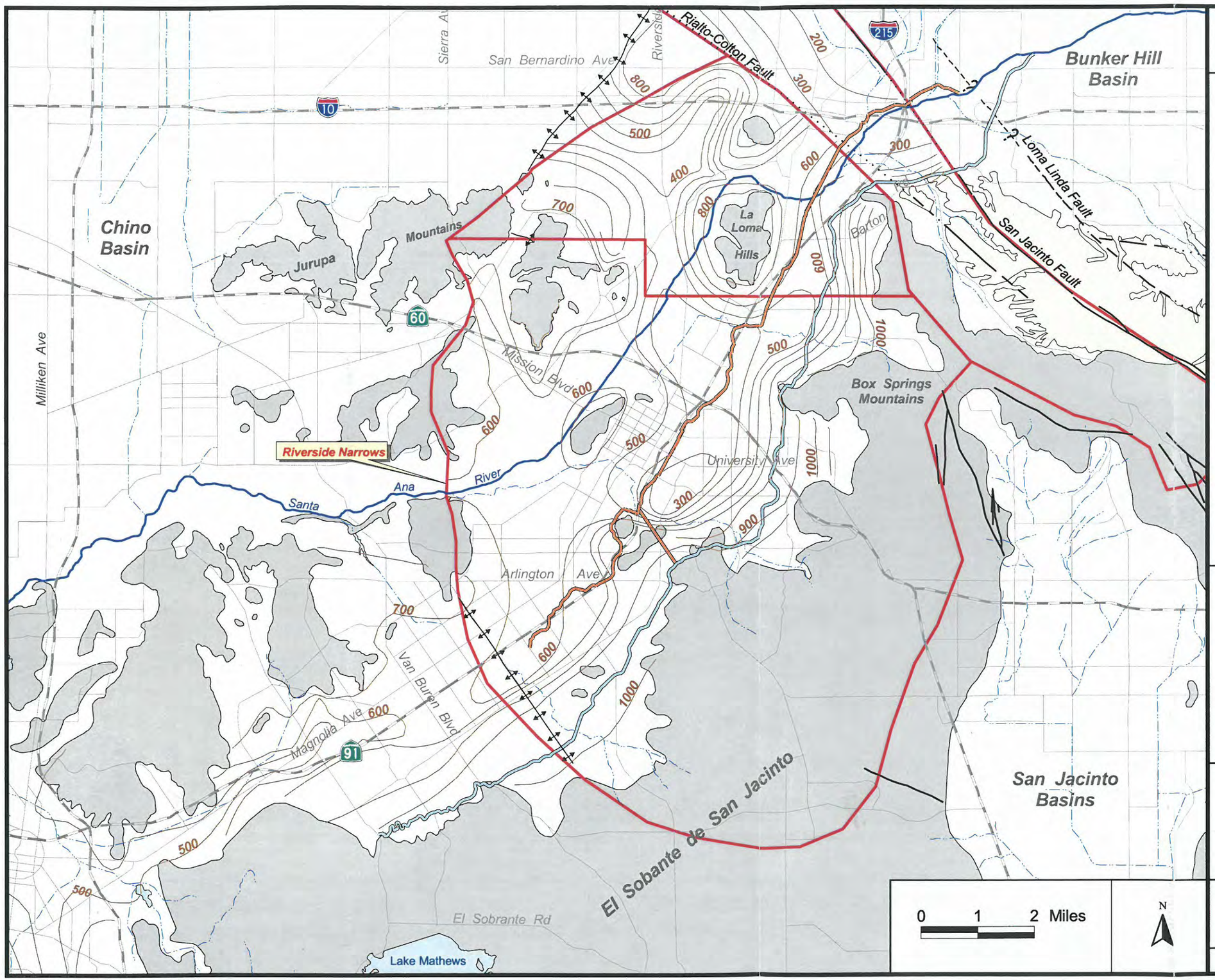
Alternatives that include pumping and discharging groundwater to the Santa Ana River will also be impacted by TDS and nitrogen concentrations.

Table 3-1
Groundwater Storage in the Riverside Colton Area

Basin	----- Groundwater Storage -----		------- Change in Storage -------	
	1973	1997	Volume	Percent of Total
	(acre-ft)	*(acre-ft)*	*(acre-ft)*	*%*
Colton	214,870	213,513	-1,357	0.63%
Riverside North	302,760	294,724	-8,036	2.65%
Riverside South	580,689	590,309	9,620	1.66%
Total	1,098,320	1,098,546	227	0.02%

Table 3-2
Summary of Water Quality in the Riverside/Colton Area

Constituent	Units	Standards: Federal MCL Standard	Federal MCL Type	California MCL or AL Standard	California MCL or AL Type	1994 Basin Plan Standard	1994 Basin Plan Note	No of Wells Exceeding Most Stringent Limit: 0.5 x	1 x	2 x	Cate-gory	Remarks
Inorganics												
Antimony	µg/L	6	a	6	a			0	0	0	I	Antimony was not detected in any samples collected from wells in the study area. Based on these data, antimony will not limit any of the Project 16 Alternatives.
Arsenic	µg/L	50	a	50	a			0	0	0	III	Arsenic was not detected in concentrations greater than one-half the MCL in any samples collected from wells in the study area. Based on these data, arsenic will not limit any of the Project 16 Alternatives.
Barium	µg/L	2000	a	2000	a			0	0	0	III	Barium was not detected in concentrations greater than one-half the MCL in any samples collected from wells in the study area. Based on these data, barium will not limit any of the Project 16 Alternatives.
Beryllium	µg/L	4	a	4	a			0	0	0	I	Beryllium was not detected In any samples collected from wells in the study area. Based on these data, beryllium will not limit any of the Project 16 Alternatives.
Boron	µg/L			1000	b			2	0	0	IV	Boron was not detected in concentrations greater than the MCL in any samples collected from wells in the study area, but was found in 2 wells in concentrations that were greater than one-half the MCL. Based on these data, boron will not limit any of the Project 16 Alternatives.
Cadmium	µg/L	5	a	5	a			2	0	0	IV	Cadmium was not detected in concentrations greater than the MCL in any samples collected from wells in the study area, but was found in 2 wells in concentrations that were greater than one-half the MCL. Based on these data, cadmium will not limit any of the Project 16 Alternatives.
Chloride	mg/L	250	c	250	c			75	15	0	IV	Fifteen wells in the study area had chloride concentrations greater than the secondary MCL. Seventy-five wells had concentrations greater than half the MCL. No wells had concentrations greater than twice the MCL. Chloride will not generally be limiting for any of the Project 16 Alternatives.
Chromium (total)	**µg/L**	**100**	**a**	**50**	**a**			**1**	**0**	**0**	**V**	**One well in the study area had total chromium concentrations greater than one-half the MCL. If the MCL is lowered to 2.5 ug/L (as proposed by the State), 5 wells would exceed this concentration. No information is currently available for hexavalent chromium (check with Aladdin.) Chromium (or hexavalent chromium) may be limiting for Project 16 Alternatives, depending on potential changes in MCLs Also depending on promulgated limits, the hexavalent chromium in groundwater in the study area may need to be characterized.**
Color	units	15	c	15	c			8	4	2	IV	Color values greater than the MCL were found in four wells, with two of those wells having values greater than twice the MCL. The maximum color value was 70 color units. Color will not generally be limiting for any of the Project 16 Alternatives.
Copper	µg/L	1000	c	1000	c			0	0	0	III	Copper was not detected in concentrations greater than one-half the MCL in any samples collected from wells in the study area. Based on these data, copper will not limit any of the Project 16 Alternatives.
Cyanide	µg/L	200	a	200	a			0	0	0	I	Cyanide was not detected in any samples collected from wells in the study area. Based on these data, cyanide will not limit any of the Project 16 Alternatives.
Fluoride	mg/L	4	a	1.4 - 2.4	d			4	2	0	IV	Fluoride was detected in two wells in concentrations greater than the MCL and in four wells at concentrations greater than half the MCL. Fluoride will not generally be limiting for any of the Project 16 Alternatives.
Hardness	**µg/L**										**V**	**Slightly hard = 17.1 to 60 mg/L ⇨ 3 wells** **Moderately hard = 60 to 120 mg/L ⇨ 10 wells** **Hard = 120 to 180 mg/L ⇨ 7 wells** **Very hard > 180 mg/L ⇨ 295 wells** **Groundwater in the study area is typically very hard. Based on these data, hardness may limit Project 16 Alternatives where groundwater is proposed for direct use.**



Riverside-Colton Conjunctive Use Project

Legend

- 300 — Equal Elevation Contour of the Effective Base of Freshwater Aquifers *(feet - mean sea level)*
- Approximate Location of Groundwater Divide
- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Unconsolidated Sediments
- Semi-consolidated Sediments
- Consolidated Bedrock

Other Map Features

- Riverside Canal
- Gage Canal
- Legal Basin Boundaries

Figure 3-1

Elevation Contours of the Effective Base of Freshwater Aquifers

Riverside-Colton Area

WE WILDERMUTH ENVIRONMENTAL, INC.

Prepared by: AEM | *Date: February 2001*

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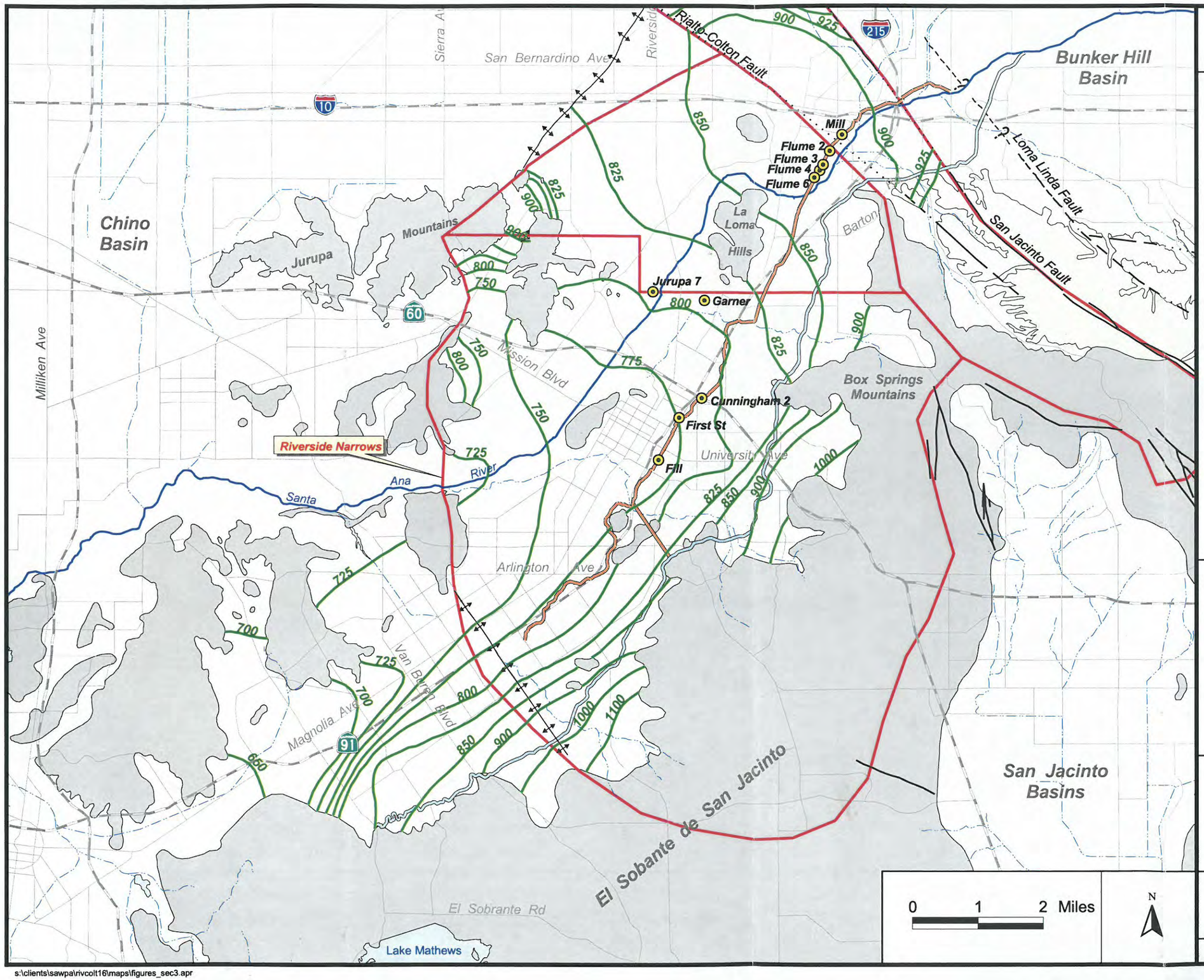

Riverside-Colton Conjunctive Use Project

Legend

- Equal Elevation Contour of the Effective Base of Freshwater Aquifers *(feet - mean sea level)*
- Riverside Irrigation Wells
- Approximate Location of Groundwater Divide
- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Unconsolidated Sediments
- Semi-consolidated Sediments
- Consolidated Bedrock

Other Map Features

- Riverside Canal
- Gage Canal
- Legal Basin Boundaries

Figure 3-2
Fall 1973
Groundwater Elevation Contours
Riverside-Colton Area

WE WILDERMUTH ENVIRONMENTAL, INC.

Prepared by: AEM | *Date: February 2001*

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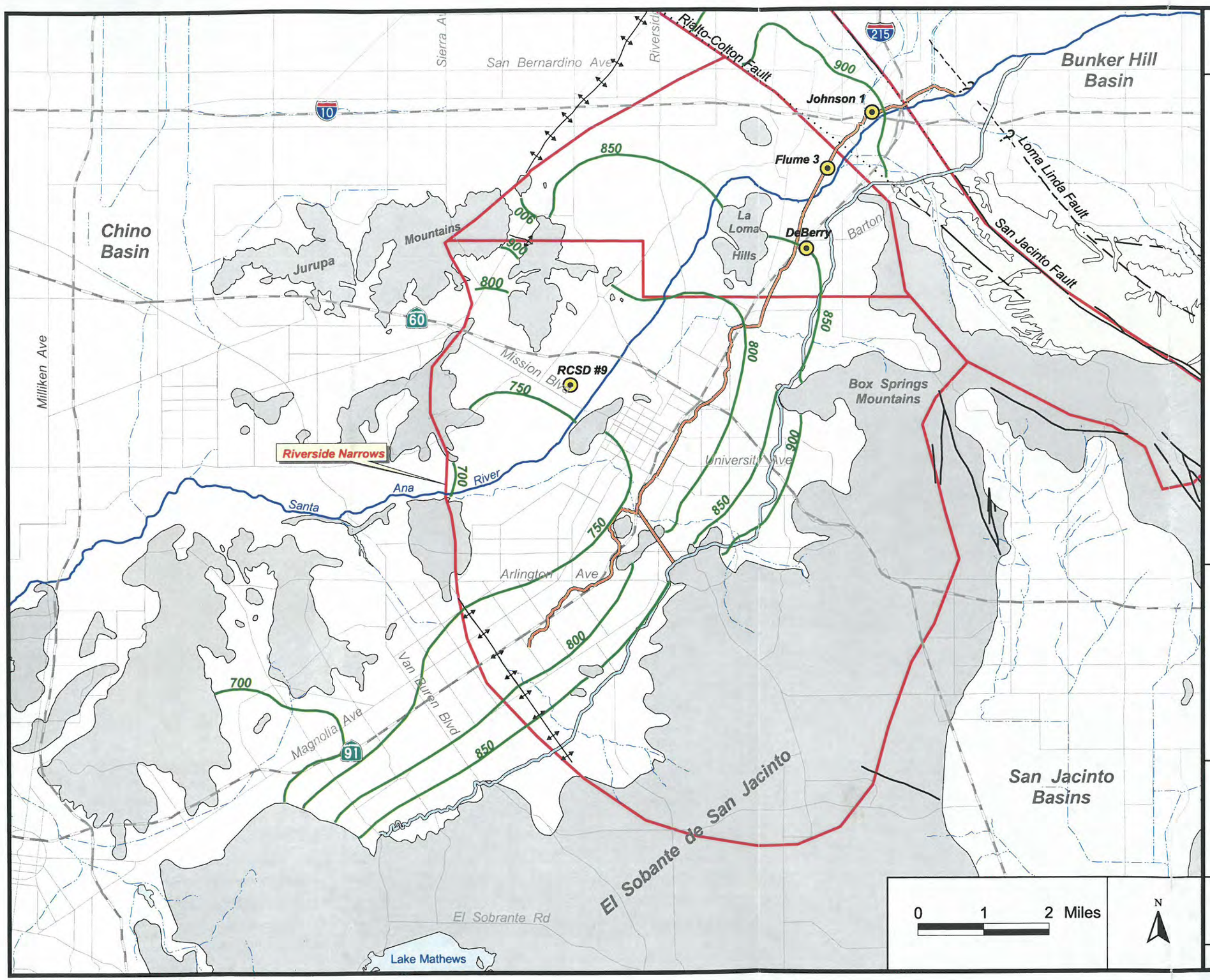

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Figure 3-4
Groundwater Elevation Time History -- Colton Basin Well

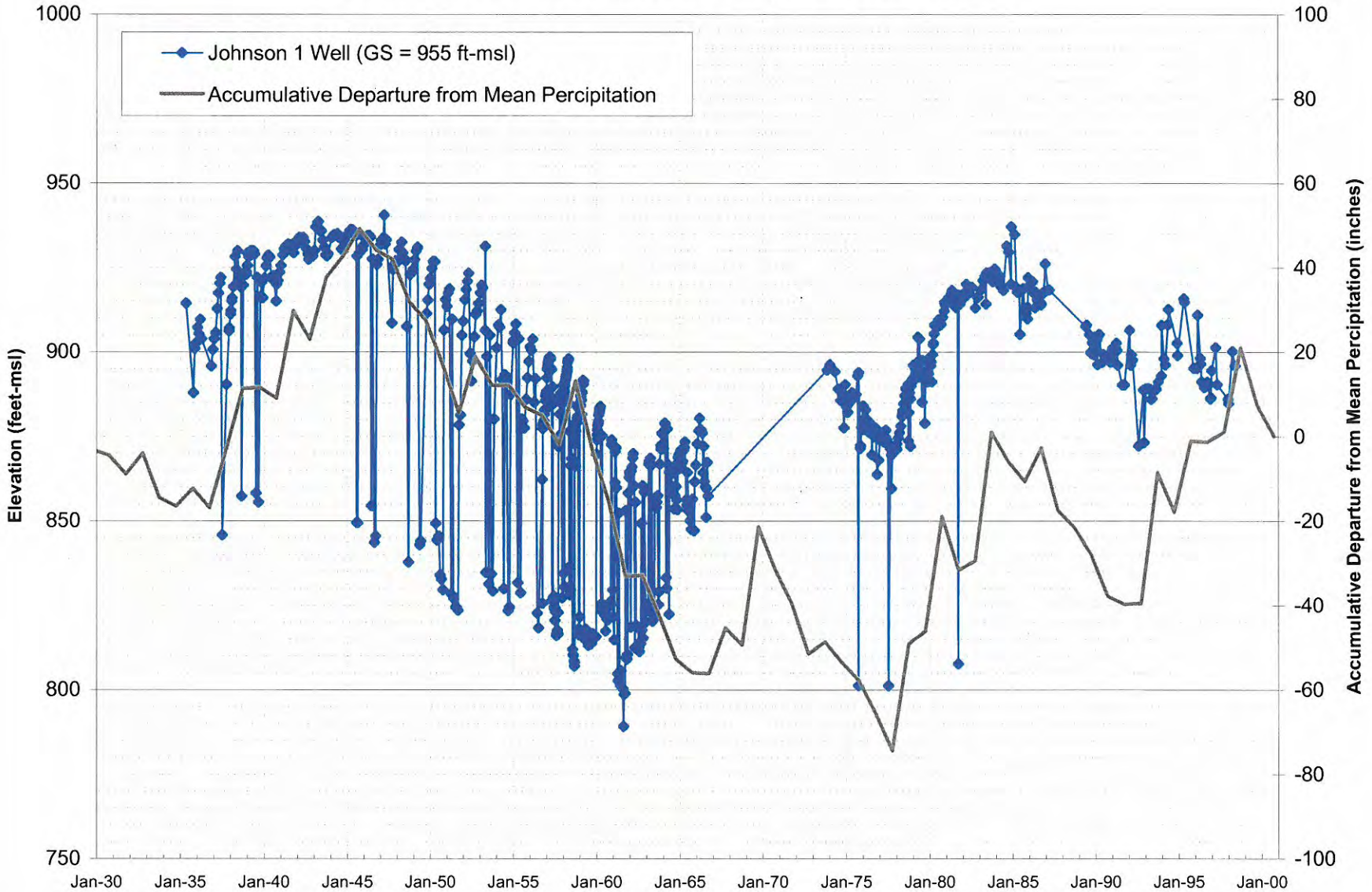


Figure 3-5
Groundwater Elevation Time History -- Riverside North Basin Well

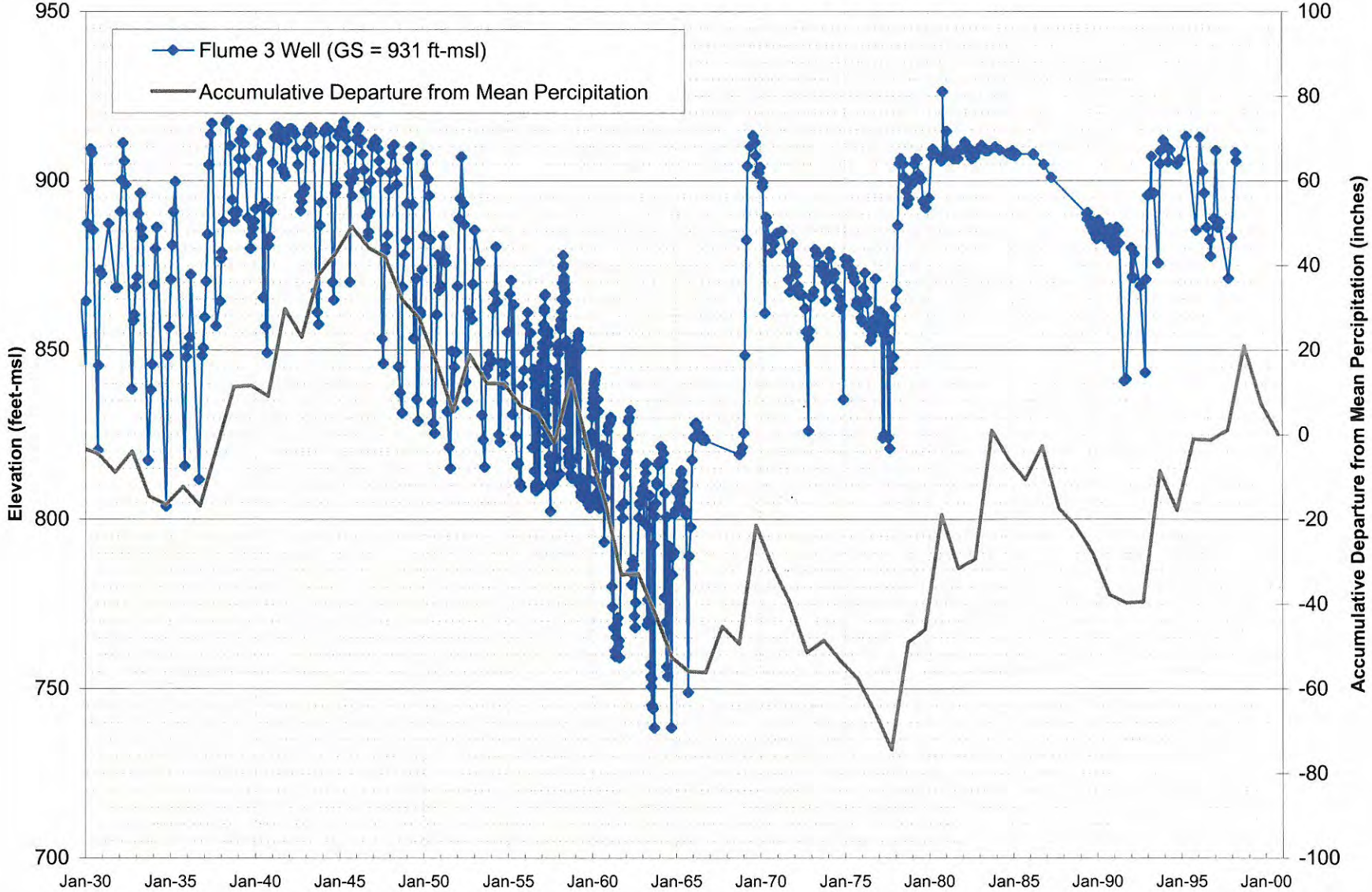
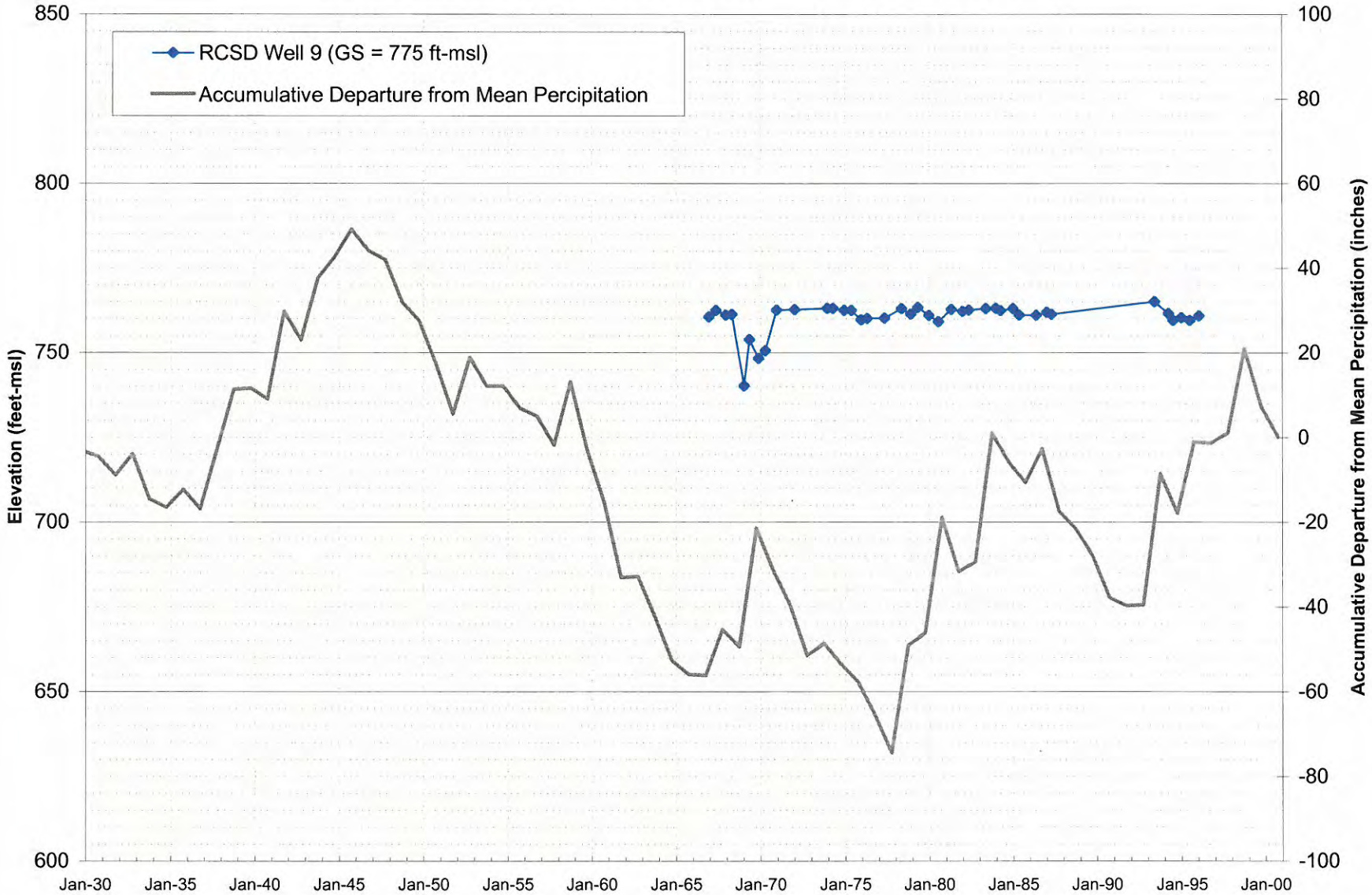
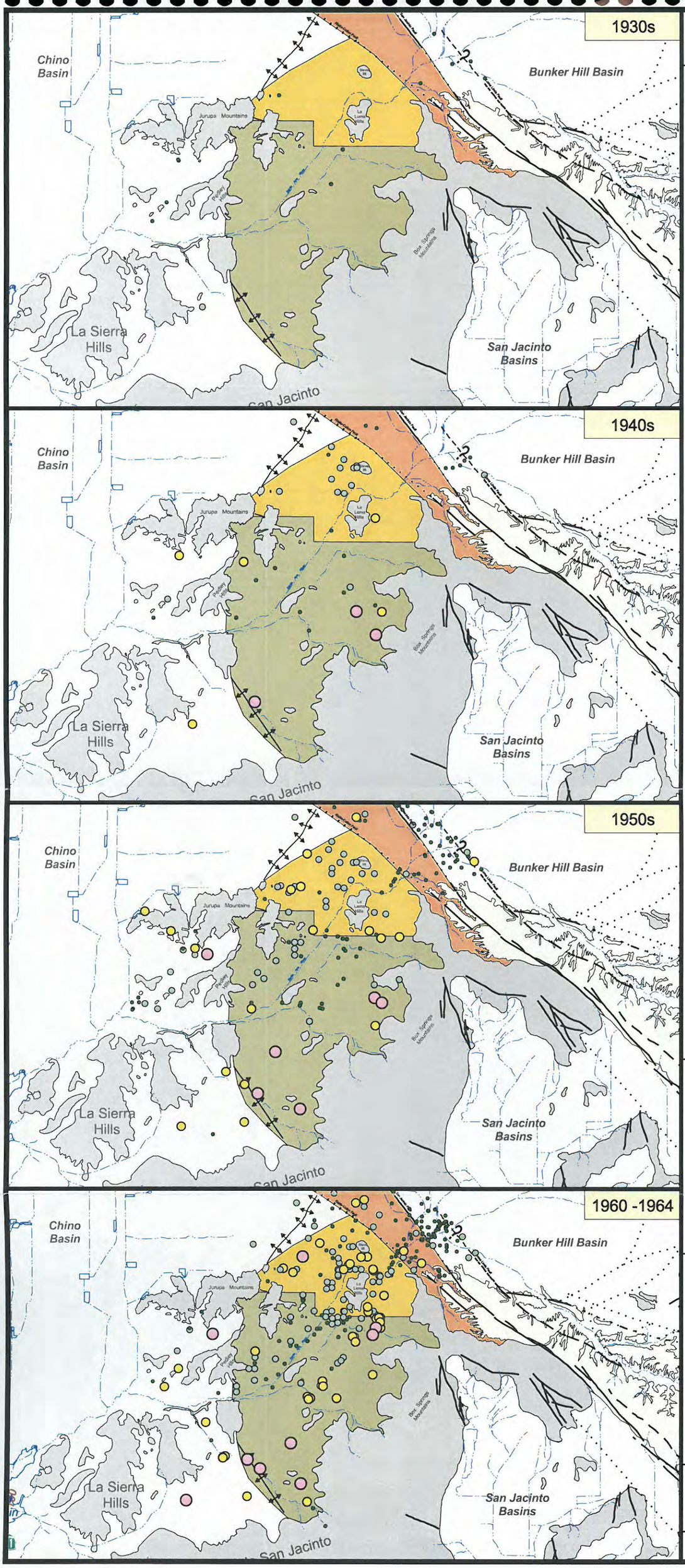


Figure 3-6
Groundwater Elevation Time History -- Riverside South Well





Riverside-Colton Conjunctive Use Plan

Legend

Nitrate, as NO3 (mg/L)

- >180
- 90 - 180
- 45 - 90
- 22.5 - 45
- <22.5

Legal Basin Boundaries

- Colton Basin
- Riverside North Basin
- Riverside South Basin

Other Map Features

- Unconsolidated Sediments
- Semi-consolidated Sediments
- Consolidated Bedrock
- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Groundwater Barrier (suspected fault)
- Groundwater Divide
- Major Roads & Highways
- Waterways, Reservoirs & Spreading Grounds

Figure 3-8a

Nitrate (as NO3) Concentrations for Different Periods

(1930s, 1940s, 1950s, 1960-1964)

Colton and Riverside Basins

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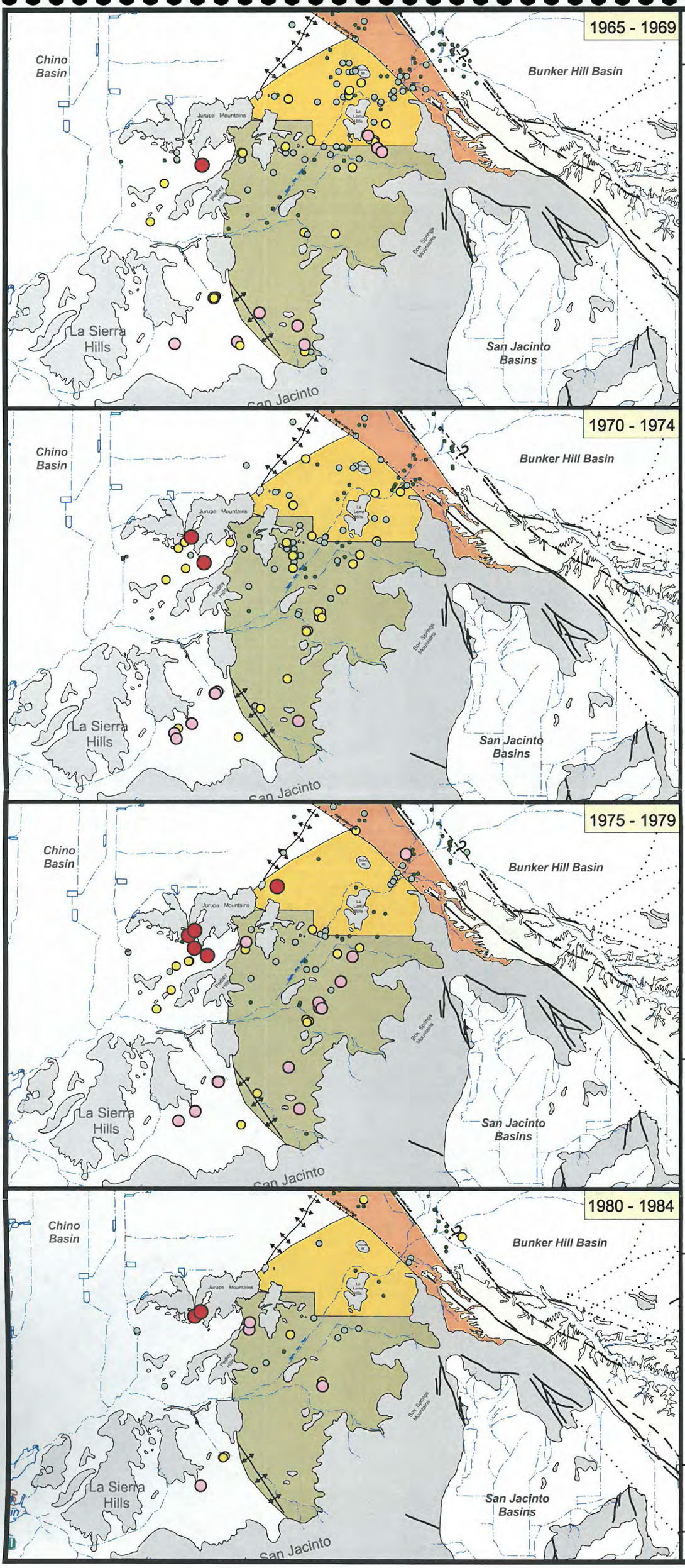

Riverside-Colton Conjunctive Use Plan

Legend

Nitrate, as NO3 (mg/L)

- >180
- 90 - 180
- 45 - 90
- 22.5 - 45
- <22.5

Legal Basin Boundaries

- Colton Basin
- Riverside North Basin
- Riverside South Basin

Other Map Features

- Unconsolidated Sediments
- Semi-consolidated Sediments
- Consolidated Bedrock
- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Groundwater Barrier (suspected fault)
- Groundwater Divide
- Major Roads & Highways
- Waterways, Reservoirs & Spreading Grounds

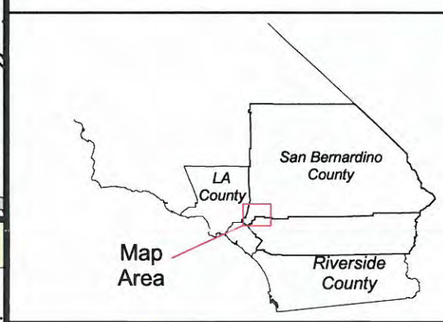

Figure 3-8b

Nitrate (as NO3) Concentrations for Different Periods

(1965-1969, 1970-1974, 1975-1979, 1980-1984)

Colton and Riverside Basins

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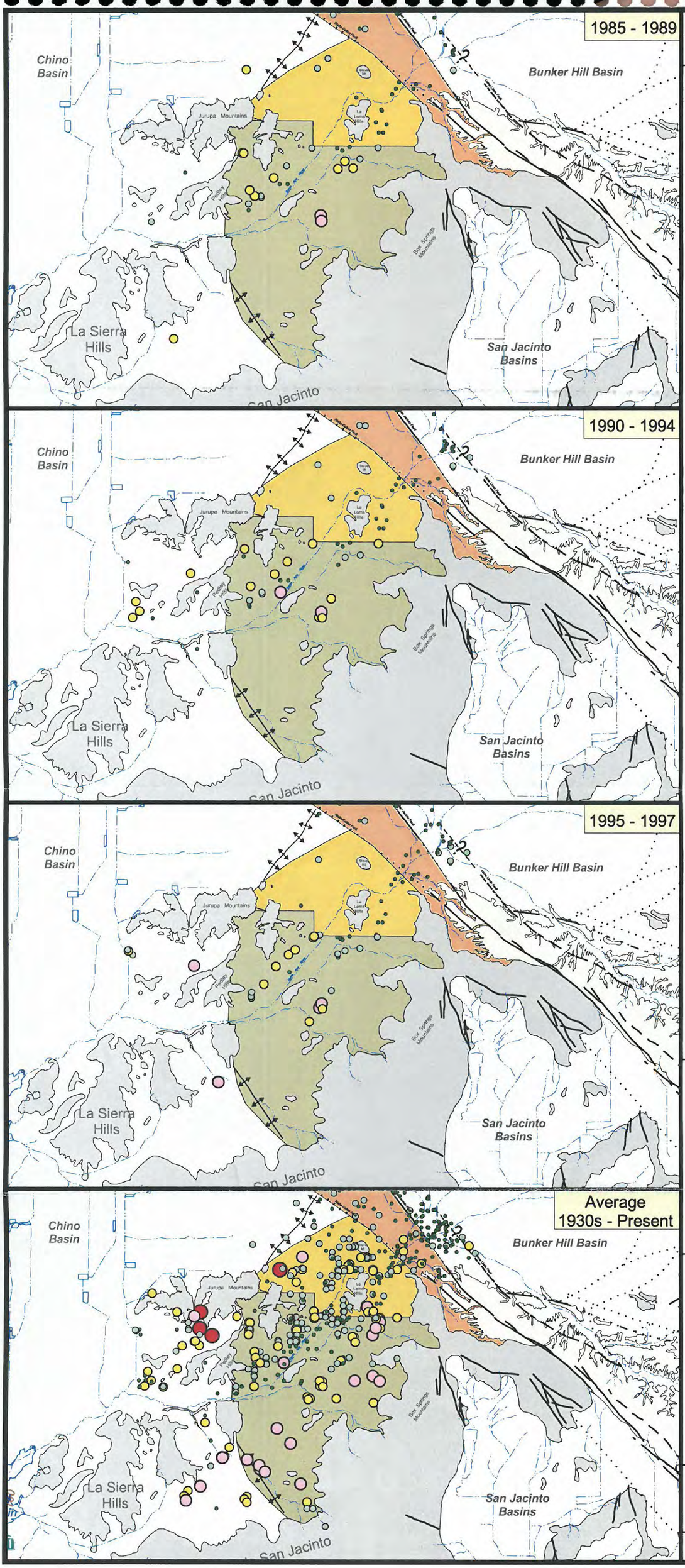

Riverside-Colton Conjunctive Use Plan

Legend

Nitrate, as NO3 (mg/L)

- >180
- 90 - 180
- 45 - 90
- 22.5 - 45
- <22.5

Legal Basin Boundaries

- Colton Basin
- Riverside North Basin
- Riverside South Basin

Other Map Features

- Unconsolidated Sediments
- Semi-consolidated Sediments
- Consolidated Bedrock
- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Groundwater Barrier (suspected fault)
- Groundwater Divide
- Major Roads & Highways
- Waterways, Reservoirs & Spreading Grounds

Figure 3-8c

Nitrate (as NO3) Concentrations for Different Periods

(1985-1989, 1990-1994, 1995-1997, Average)

Colton and Riverside Basins

WE WILDERMUTH ENVIRONMENTAL, INC.

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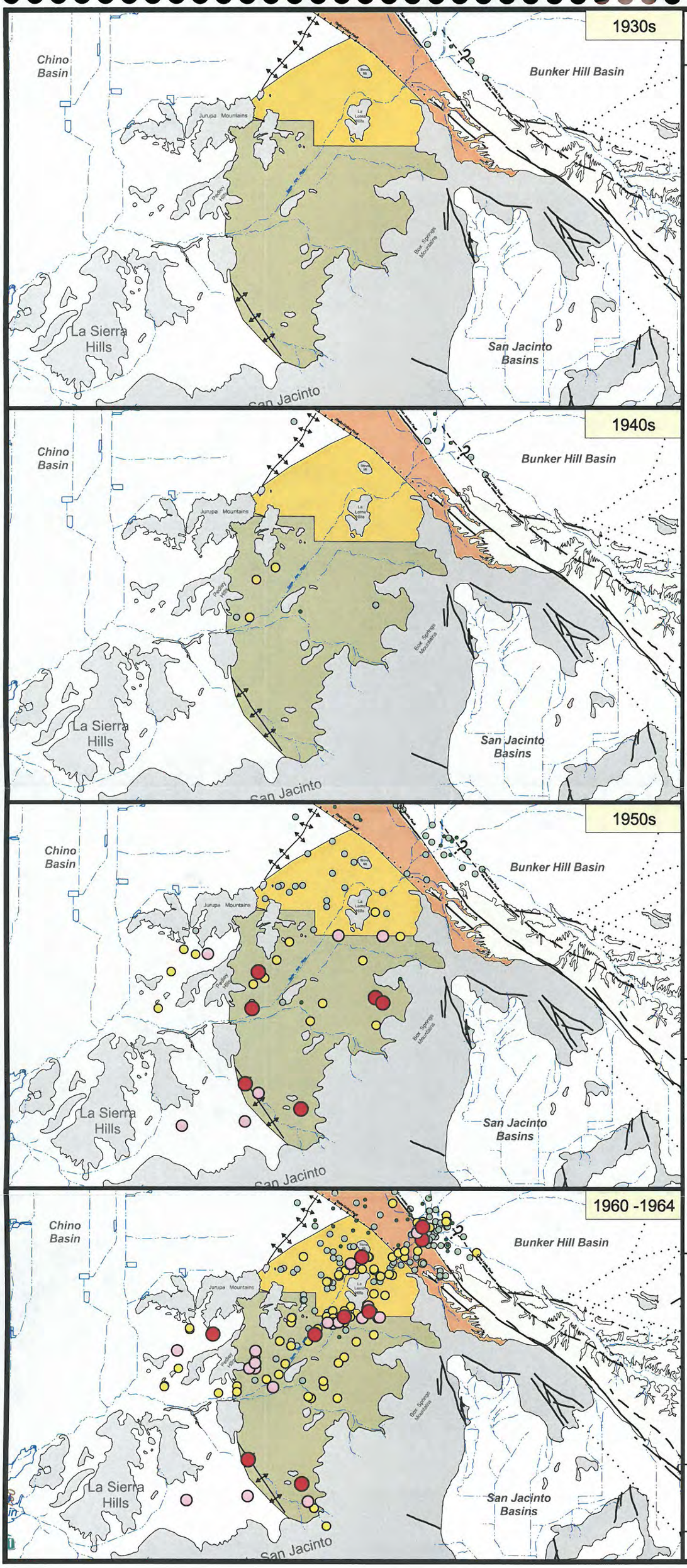


Riverside-Colton Conjunctive Use Plan

Legend

Total Dissolved Solids (mg/L)

- >1000
- 750 - 1000
- 500 - 750
- 250 - 500
- <250

Legal Basin Boundaries

- Colton Basin
- Riverside North Basin
- Riverside South Basin

Other Map Features

- Unconsolidated Sediments
- Semi-consolidated Sediments
- Consolidated Bedrock
- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Groundwater Barrier (suspected fault)
- Groundwater Divide
- Major Roads & Highways
- Waterways, Reservoirs & Spreading Grounds

Figure 3-9a

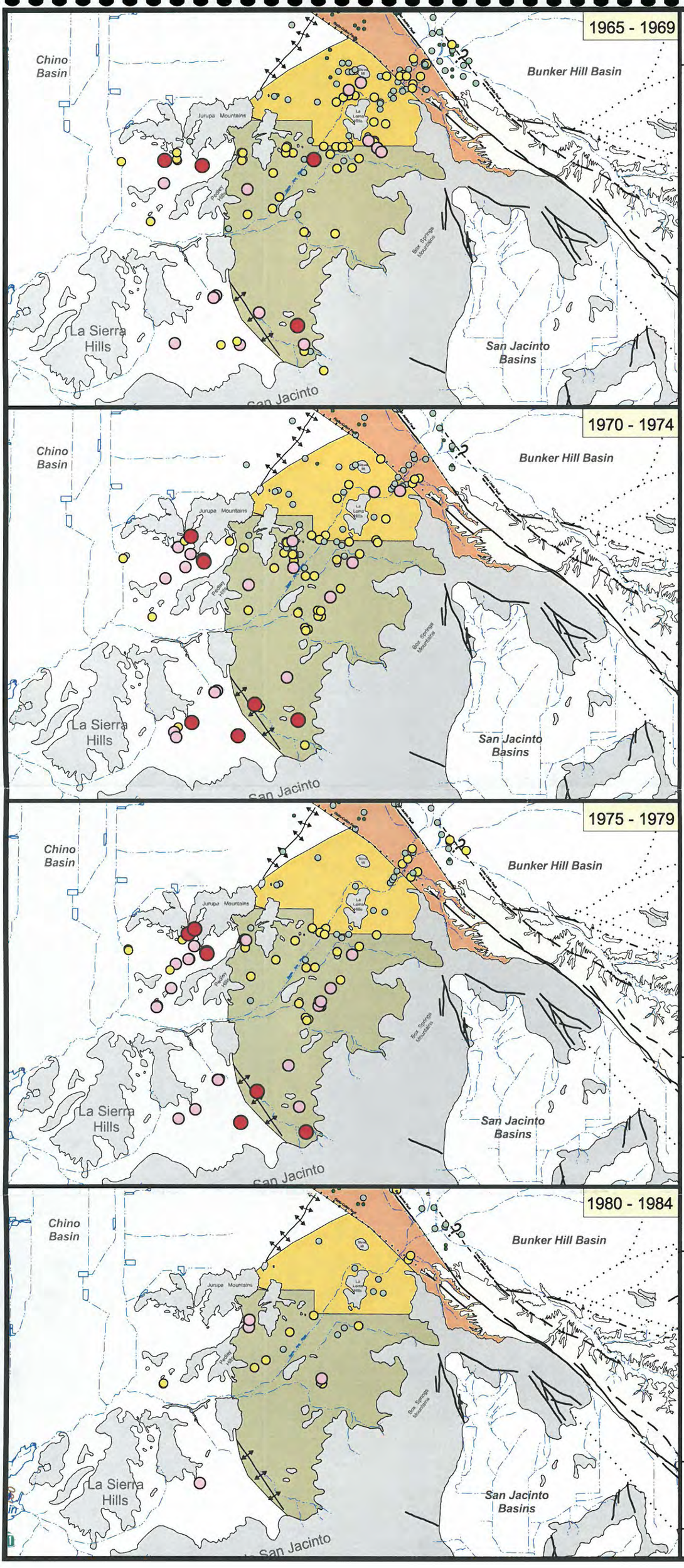
TDS Concentrations for Different Periods

(1930s, 1940s, 1950s, 1960-1964)

Colton and Riverside Basins

WE WILDERMUTH ENVIRONMENTAL, INC.

Prepared by: AEM/JPL | *Date: December 2000*



Riverside-Colton Conjunctive Use Plan

Legend

Total Dissolved Solids (mg/L)

- >1000
- 750 - 1000
- 500 - 750
- 250 - 500
- <250

Legal Basin Boundaries

- Colton Basin
- Riverside North Basin
- Riverside South Basin

Other Map Features

- Unconsolidated Sediments
- Semi-consolidated Sediments
- Consolidated Bedrock
- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Groundwater Barrier (suspected fault)
- Groundwater Divide
- Major Roads & Highways
- Waterways, Reservoirs & Spreading Grounds

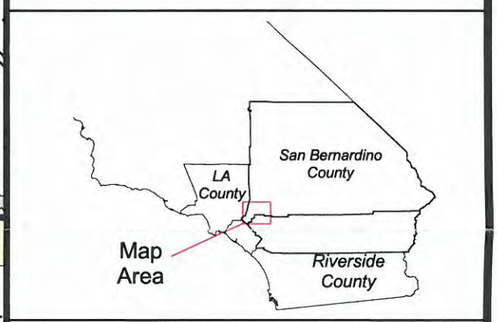


Figure 3-9b

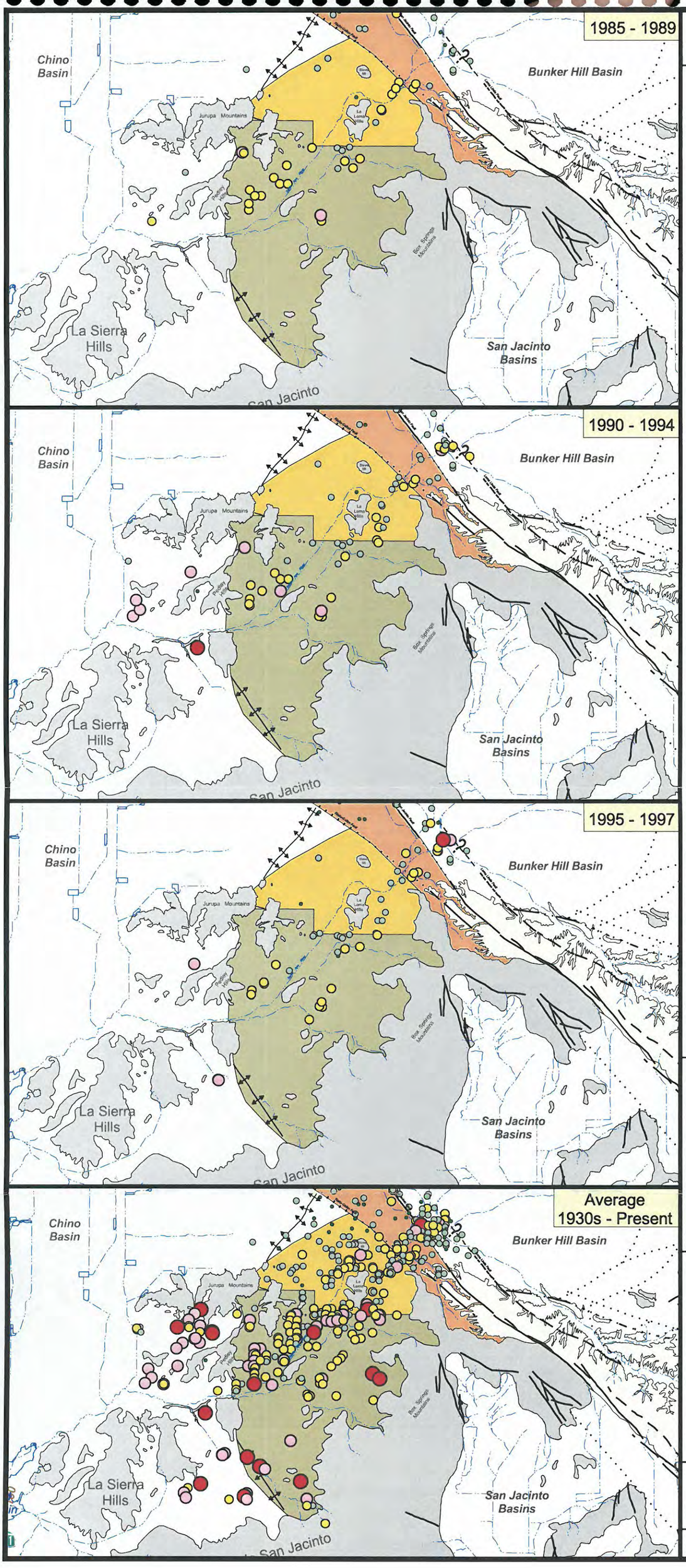
TDS Concentrations for Different Periods

(1965-1969, 1970-1974, 1975-1979, 1980-1984)

Colton and Riverside Basins

WE WILDERMUTH ENVIRONMENTAL, INC.

Prepared by: AEM/JPL | *Date: December 2000*



Riverside-Colton Conjunctive Use Plan

Legend

Total Dissolved Solids (mg/L)

- >1000
- 750 - 1000
- 500 - 750
- 250 - 500
- <250

Legal Basin Boundaries

- Colton Basin
- Riverside North Basin
- Riverside South Basin

Other Map Features

- Unconsolidated Sediments
- Semi-consolidated Sediments
- Consolidated Bedrock
- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Groundwater Barrier (suspected fault)
- Groundwater Divide
- Major Roads & Highways
- Waterways, Reservoirs & Spreading Grounds

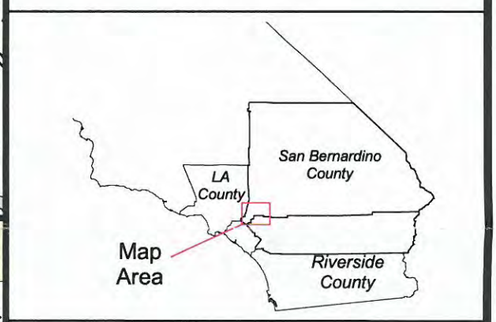


Figure 3-9c

TDS Concentrations for Different Periods

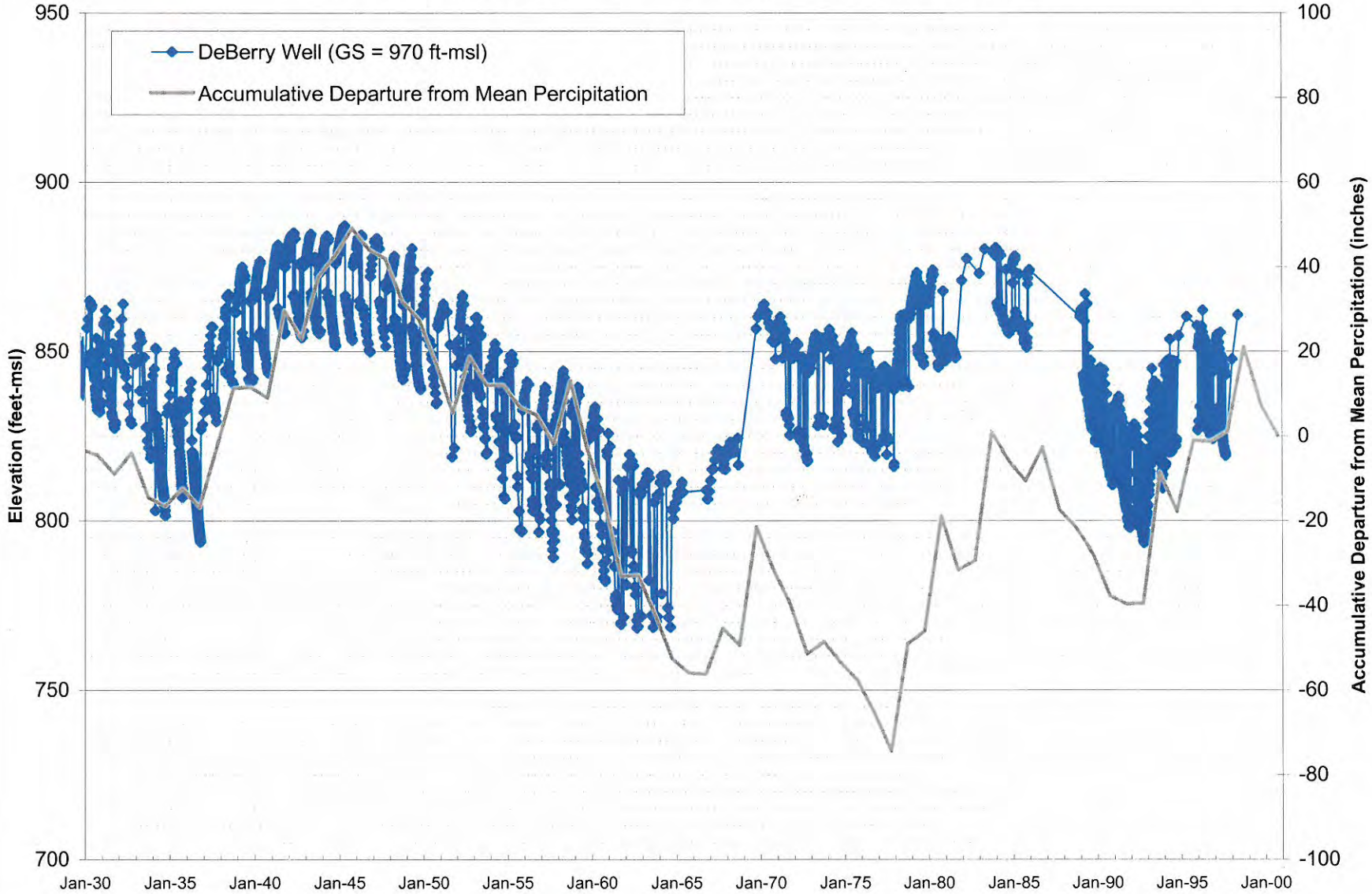
(1985-1989, 1990-1994, 1995-1997, Average)

Colton and Riverside Basins

WE WILDERMUTH ENVIRONMENTAL, INC.

Prepared by: AEM/JPL | *Date: December 2000*

Figure 3-7
Groundwater Elevation Time History -- Grand Terrace Well



SECTION 4 NEW BASIN MANAGEMENT ALTERNATIVES

NEW PROJECT ALTERNATIVES

Project B1 New Non-Potable Supply from the Riverside South Basin

Operating Concept. This project is similar to the original Project B except that it no longer includes any dedicated recharge facilities in the River. The main limitation to potable use of groundwater in the lower end of the Riverside South Basin is elevated TDS concentrations, which would make the resulting wastewater unable to meet discharge requirements to the River, and elevated concentration of nitrate, DBCP, and other contaminants, as described in Section 3. In Project B1, groundwater would be produced from the hydrologically lowest point in the Riverside South basin during the times of the year that OCWD has capacity in their recharge basins to divert and recharge Project B1 water. The groundwater produced in this project would be discharged directly to the river downstream from the Project B1 well field. The main goal of this project is to create room in the lower end the Riverside South basin for low-TDS, high-quality recharge water by removing existing poorer quality groundwater. Eventually, the groundwater quality in the lower end of the basin will improve to such a point that Riverside and other water supply agencies could produce potable groundwater from the lower end of the Riverside South basin. A secondary goal is to shift the natural supply of rising groundwater at the Riverside Narrows such that Orange County can capture more Santa Ana River.

Presently, the River nearly dries up during dry-weather flow in the reach between RIX and the Riverside Narrows when RIX goes offline. This creates additional stress on the Santa Ana Sucker. An additional benefit of the project will be the maintenance of consistent Santa Ana River discharge between the Project B discharge point to the point where the City of Riverside discharges its recycled water to the Santa Ana River.

Facility Requirements. New groundwater wells and pipelines would be required to pump groundwater and discharge this water to the Santa Ana River. For purposes of testing the feasibility of this project, it was assumed that a new well field consisting of eight wells and pipelines would be constructed. These wells and pipelines are shown in Figure 4-1. The facility and cost assumptions are listed in Table 4-1. It was assumed that these wells would run a minimum of six months (May through October) producing about 9,700 acre-ft/yr, but could run as much as nine months per year (April through December) producing about 14,500 acre-ft/yr.

Costs. Table 4-2 contains a cost opinion for Project B1 assuming six months of operation and other assumptions listed in Table 4-1. The unit cost of wells is based on recent well drilling and equipping costs in the Chino Basin. The capital cost for an eight-well project, excluding land cost is about $9.1 million. Assuming a 20-year amortization period at six percent interest, and a six-month operating period, the annual cost of the project would be about $1.16 million with a unit cost of $120/acre-ft. For a nine-month operating period the annual cost would be $1.27 million with a unit cost of about $87/acre-ft.

Legal and Institutional Issues. The primary obstacle is the development of an agreement in which OCWD would agree to purchase the water produced by this project at a rate that would recover the cost of the project.

Environmental Challenges. As mentioned above this project would most likely improve the Santa Ana Sucker habitat between its point of discharge and the point where the City of Riverside discharges to the Santa Ana River. The environmental challenge of this project will be to demonstrate that the project water quality does not impair beneficial uses of the river and that the TDS and total inorganic nitrogen (TIN) of the project water does not adversely impact the recycled water producers that discharge to the River. This demonstration will need to be made in a subsequent feasibility investigation and periodically after the project is implemented

Project C1 Cycling Groundwater through Riverside North and Colton Basins

Operating Concept. The objective of Project C1 is to improve the water quality in the Riverside North and Colton Basins by pumping groundwater and exporting it to water users downstream of Riverside Narrows. The continuous cycling of groundwater from the Project C1 combined with the existing groundwater production by the other producers (City of Riverside, Riverside Highland Water Company and West San Bernardino County Water District) from the Project C1 area will create room for the recharge of low TDS and low nitrate storm water and thereby improve water quality in the area. In this investigation, it was assumed that OCWD would be the primary market for Project C1 water.

Facility Requirements. Two concepts were developed. The first concept, Project C1A, consists of using existing irrigation wells owned by the City of Riverside to extract groundwater from the Project C1 area, and then using the Riverside Canal to convey this water to an existing storm drain for discharge to the Santa Ana River just upstream of the Riverside Narrows. From that point the Project C1 water would commingle with Santa Ana River discharge and would flow to Orange County for recharge in OCWD's recharge facilities. Figure 4-1 shows the location of the City of Riverside's irrigation wells, the Riverside Canal, the proposed WMWD non-potable supply project, and the Santa Ana River.

The proposed WMWD non-potable supply project involves producing about 6,000 acre-ft/yr of groundwater from the Colton and Riverside North Basins and conveying this water to non-potable water users in the Rancho El Sobrante, Lake Mathews and Woodcrest areas. This project would use existing wells in the City of Riverside's non-potable system and convey this water to the area of use through the Riverside Canal and through 40,000 feet of new pipeline. Three pumping stations would be required to boost the water from the Riverside Canal to area of use.

Table 4-3 illustrates a water supply plan that, in order of priority, satisfies the City of Riversides agricultural demands on the Riverside Canal, agricultural demands from the proposed WMWD non-potable supply project, and Project C1 demands. Table 4-4 shows the same water supply on a per well basis. The water supply plan illustrated in Table 4-4 encourages the production of poorer quality groundwater for agricultural use and uses wells with better water quality to dilute the water produced by poor quality wells when project C1 is delivering water to the Santa Ana River. The agricultural demands are patterned on the consumptive use requirements of citrus (DWR, 1973). Project C1A uses existing City of Riverside wells and could produce about 5,500 acre-ft/yr.

Project C1B is similar to Project C1A except that it includes three new non-potable wells to expand production from the Riverside North Basin. These new wells would be located adjacent to the Riverside Canal to minimize cost. Riverside Highland Water Company has two non-potable agricultural supply wells that could be made available for Project C1B. About 2,100 feet of new pipeline would need to be constructed to use these Riverside Highland wells. To be

conservative at this level of analysis, we assumed that new wells would be constructed. Table 4-4 shows the water supply plan for C1B. Project C1B could produce about 11,000 acre-ft/year.

Costs. There are no new capital costs involved in Project C1A. The cost to deliver water in Project C1A is based on power only and will be about $140,000 per year or about $28/acre-ft.

The facility and cost assumptions are listed in Table 4-5. Table 4-6 contains a cost opinion for Project C1B based on the assumptions listed in Table 4-5 and the water supply plan in Table 4-4. The unit cost of wells is based on recent well drilling and equipping costs in the Chino Basin. The capital cost for a three-well project, excluding land cost, is about $3.0 million. Assuming a 20-year amortization period at six percent interest, the annual cost of the project would be about $572,000 with a unit cost of $53/acre-ft.

Legal and Institutional Issues. The parties to the 1969 Judgment have entered into an agreement that would permit implementation of Project C1. The primary obstacle is the development of an agreement in which OCWD would agree to purchase the water produced by this project at a rate that would recover the cost of the project. WMWD would also need to develop an agreement with the City of Riverside to allow WMWD to use the canal for this Project.

Environmental Challenges. This project would most likely improve the Santa Ana Sucker habitat between its point of discharge and the point where the City of Riverside discharges to the Santa Ana River. The environmental challenge of this project will be to demonstrate that the project water quality does not impair beneficial uses of the river and that the TDS and TIN of the project water does not adversely impact the recycled water producers that discharge to the River. Table 4-7 lists the average concentration of various water quality constituents for wells listed in Table 4-4 for which data is available. These data were provided by the City of Riverside and correspond to the five-year period 1996 through 2000. Review of the table shows two things: the potential exists to discharge certain contaminants to the River that exceed Basin Plan and Title 22 drinking water limits; and that the water quality of Project C1 water is not adequately characterized.

The City of Riverside has indicated a concern that groundwater production in Project C1 will cause deterioration of water quality at their wells. Their concern is based on changing groundwater flow patterns near their North Orange well field and in anticipated reduction in groundwater levels north of La Loma Hills.

Riverside Highland Water Company has indicated that they will oppose this project unless it can be shown that the lowering of groundwater levels south of the San Jacinto fault will not induce groundwater to flow across the fault and degrade their wells. These demonstrations will need to be made in a subsequent feasibility investigation and periodically thereafter if Project C1 is implemented

Project C2 New Potable Supply from the Riverside North and Colton Basins

Operating Concept. This project is similar to the original Project C except that the initial pump out of the basin is not included or necessary. Groundwater quality in the Project C area north of La Loma Hills is generally very good but may require some limited wellhead treatment. Project C2 will take advantage of the existing good quality water in the project area and will enhance the cycling done by Project C1. In Project C2, new wells would be constructed on the west side of the river. Production from these wells will be conveyed to either Riverside Highland Water

Company (Project C2A) or to the City of Colton and West San Bernardino County Water District (Project C2B).

Facilities Requirements. For either Project C2A or C2B, a new well field would be built on the west side of the Santa Ana River as shown in Figure 4-2. Riverside Highland Water Company indicated that it could use about 4 mgd of new supply to meet new potable demands in their service area. The City of Colton and WSCWD have not indicated a need for a new supply. It was assumed herein that Project C2B capacity would be the same as Project C2A. Both projects will require a pump station to boost the groundwater produced in the new well field to system pressure. It was assumed that the project would run a minimum of six months producing about 4,400 acre-ft/yr. If it ran all year, the project would produce about 8,700 acre-ft/yr.

Costs. Table 4-9 and 4-10 contain cost opinions for Projects C2A and C2b, respectively assuming six months of operation and the assumptions listed in Table 4-8. The capital cost for Project C2A, excluding land cost, is about $5.7 million. Assuming a 20-year amortization period at six percent interest, and a six-month operating period, the annual cost of Project C2A would be about $770,000 with a unit cost of $159/acre-ft. For a twelve-month operating period the annual cost would be $1.0 million with a unit cost of about $114/acre-ft.

The capital cost for Project C2B, excluding land cost, is about $9.1 million. Assuming a 20-year amortization period at six percent interest, and a six-month operating period, the annual cost of Project C2B would be about $1.1 million with a unit cost of $233/acre-ft. For a twelve-month operating period the annual cost would be $1.4 million with a unit cost of about $160/acre-ft.

Legal and Institutional Issues. The primary legal and institutional issue will be the development of agreements for the purchase of product water from the project. There are no issues related to the 1969 Judgments in OCWD *vs*. City of Chino *et al.*, and in WMWD *vs*. ESBCWD, *et al.*

Environmental Challenges. The environmental issues raised by the City of Riverside and Riverside Highland Water Company for Project C1 are applicable here as an individual project and as cumulative impact with Project C1. Based on a review of City of Riverside water quality data for their flume wells located near the proposed Project C2B well field, the water produced by the project may require treatment to remove TCE and PCE.

Project C3 Colton Lakes Recharge Project

Operating Concept. This project consists of construction of a series of lakes in the Santa Ana River between the La Cadena Bridge and Interstate 10. This project would be an extension of the *Lakes and Stream* concept currently under investigation in the San Bernardino area. This concept is illustrated in Figures 4-3 and 4-4. The lakes would be used to recharge the Colton and Riverside Basins. Secondary benefits include creation of visual amenity and potential wildlife uses. The lakes would be created between inflatable rubber dams. The sources water for this project include rising groundwater when it occurs in the Bunker Hill Basin, high groundwater pumped from the Bunker Hill Basin for dewatering purposes, stormwater flows that can be safely stored, and imported water discharged from a the Santa Ana Valley Pipeline.

Generally the rubber dams would be deflated for the period November through April to allow flood flows to pass through unimpeded, and would be inflated May through October for recharge purposes. Water from any of the sources listed above would be discharged to the River and flow downstream to the upstream lake. From the upstream lake water would cascade downstream to

other lakes in the project. Assuming a long-term average percolation rate of 0.5 ft/day, the volume of water recharged during the period May through October would be about 17,000 acre-ft/yr.

Facilities Requirements. Five inflatable rubber dams would be constructed as shown in Figure 4-3. Each dam would consist of two 400-foot long inflatable bladders anchored to a concrete structure. Each dam structure would include an energy dissipater. The rubber dam prototype used in this investigation was the OCWD rubber dam on the Santa Ana River in Orange County.

The channel bottom would need to be excavated an average of 4 feet to preserve channel conveyance for storm flows and to create the lakes required for recharge. The minimum lake depth at the upstream end of each lake (with the exception of the upper lake) was assumed to be 6 feet. The excavated channel material was assumed to be used to create channel levees near the downstream end of the project and any remaining material would either be disposed on adjacent land or stockpiled on adjacent land for subsequent unknown uses. The channel bank down stream of each dam was assumed to be protected with new grouted riprap for a length of 1,000 feet below each dam.

Costs. Table 4-11 contains the assumptions used in preparing a cost opinion for Project C3 and Table 4-12 contains the cost opinion. The capital cost for Project C3, excluding land cost, is about $54 million. Assuming a 20-year amortization period at six percent interest, the annual cost of Project C3 would be about $6 million. The facility-related cost of recharge would be about $360 per acre-ft.

Legal and Institutional Issues. There are no issues related to the 1969 Judgments in OCWD *vs.* City of Chino *et al.*, and in WMWD *vs.* ESBCWD, *et al.* The primary legal and institutional issues are finding parties that will be responsible to fund, construct, and maintain this project, and obtaining agreements from the State and Federal resource agencies, and San Bernardino County to permit the construction of this project.

Environmental Challenges. The environmental challenges in this project include potential high groundwater hazard adjacent to the River, localized groundwater quality degradation, and the potential change in habitat caused by inundation of the project reach from May through October. Mitigation of high groundwater problems could be done through increasing groundwater production as in Projects C1 and C2, and by reducing recharge during the May through October period if groundwater levels are too high. Localized groundwater quality degradation could occur through the acceleration and redirection of existing water quality anomalies near the River, and by raising the groundwater level beneath the Cooley Ranch landfill.

Off-stream lakes may be a feasible alternative to the on-stream lakes described in Project C3. The Task Force may want to investigate off-stream lakes to supplement Santa Ana River channel recharge if any one of Projects C1a, C1b, C2a, or C2b is implemented.

Project E Maximize City of Riverside Production from Riverside North and South

Operating Concept. The City is currently producing about 10,000 ac-ft/yr of water from the North Orange area, and is planning to increase production by up to 20,000 ac-ft/yr in the near future. Riverside's production could reach 30,000 ac-ft/yr of production in Riverside North and Riverside South basins and would be in addition to the proposed WMWD non-potable supply project and Projects C1 and C2 described herein. New recharge facilities and/or pumping schemes may be required to maintain production.

Facility Requirements. No new facilities will be needed initially. New recharge facilities may be required to maintain projected production goals of 30,000. These facilities may include surface spreading facilities located along the south side of the Santa Ana River near north side of La Loma Hills, and groundwater injection wells. Induced recharge could be done with a combination of existing and new extraction wells located to draw more groundwater from near the Santa Ana River.

Costs. New recharge facilities have not been identified and thus their costs are unknown.

Legal and Institutional Issues. There are no legal or institutional issues with regard to the City increasing their production in the Riverside North and South Basins. There will be legal and institutional issues if new recharge facilities are required. These issues will be described when and if recharge proposals are developed.

Environmental Challenges. The environmental challenges from increased production will be ensuring potable water quality in the supply produced by the City. The City is committed to construction of groundwater treatment facilities to ensure potable water quality. Environmental challenges from new future recharge will surface when and if recharge proposals are developed.

COMPARISON OF PROJECTS TO PROJECT GOALS

A matrix comparing the goals of the Riverside/Colton conjunctive-use program to the individual projects discussed above is shown in Table 4-13. *Project B1 New Non-Potable Supply from the Riverside South Basin* is consistent with four out of the six goals. Project B1 does not create drought storage nor does it reduce the dependency on imported water. *Projects C1A and C1B Cycling Groundwater through Riverside North and Colton Basins* are consistent with all but one goal – they do not create drought storage.

Projects C2A and C2B New Potable Supply from the Colton and Riverside North Basins are consistent with all but one goal – they do not create drought storage. Consistency with reducing dependency on imported water is somewhat arguable in that the development of more supplies in the Colton and Riverside areas will reduce the Santa Ana River discharge and may increase the need for imported water in Orange County.

Project C3 Colton Lakes Recharge Project is consistent with all but two goals – it does not create drought storage nor does it reduce the dependency on imported water. Projects C2 and C3 can be combined and operated in such a way to increase drought storage for Colton and WSBCWD.

Project E Maximize City of Riverside Production from Riverside North and South is consistent with all but two goals – it does not create drought storage nor does it reduce the dependency on imported water.

RECOMMENDED IMPLEMENTATION STRATEGY

One of the action items described in the scope of work was to develop a recommended list of projects and an implementation strategy for those projects. It became clear during this investigation that several other Tasks outside of this investigation are necessary prior to recommending specific projects and an implementing strategy. Based on this reconnaissance-level investigation the Task Force should do the following additional work should it desire to proceed with Projects C1, C2, C3 and/or Project E.

Task 1 Estimate the Water Quality Impacts in the Colton and Riverside North from Project C

As mentioned above, Riverside Highland Water Company has stated that it will oppose Projects C1A, C1B, C2A, C2B, and C3 unless it can be shown that groundwater quality in the Project C area is not adversely impacted. Riverside Highland's main concern is migration of contaminants from the Bunker Hill Basin across the San Jacinto fault and from landfills in the Project area. Riverside Highland is also concerned about water quality impacts from elevated groundwater levels near the River caused by Project C3. The work involved in this Task includes:

- *Characterizing groundwater levels, existing contamination and background groundwater quality in the Project C area.*
- *Estimating the groundwater level and flow system changes caused by the projects.*
- *Estimating the groundwater quality changes caused by the project.*

Characterization of existing groundwater quality will include the collection of new groundwater quality data and may include drilling of monitoring wells. The cost of this effort is estimated to range from $125,000 to $650,000 (excluding cost of new monitor wells). The duration of the effort could range from 6 to 24 months.

Task 2 Estimate the Water Quantity and Quality Impacts on the City of Riverside's Potable Wells East of La Loma Hills

As mentioned above, the City of Riverside has stated that it will oppose Projects C1A, C1B, C2A, and C2B unless it can be shown that groundwater quality at their wells located east of La Loma Hills is not adversely impacted. Riverside's main concern is that good quality water from the Colton and Riverside North Basins that currently flows south from the River and east of La Loma Hills and feeds their wells will be intercepted by the proposed projects. This will result is a decrease in production and deterioration in water quality at their wells. The work involved in this Task includes:

- *Characterizing groundwater levels and quality in the Project C area.*
- *Geophysical studies to define aquifer geometry in the Grand Terrace area*
- *Estimating the groundwater level and flow system changes caused by the projects.*
- *Estimating the groundwater quantity and quality changes caused by the project.*

Characterization of existing groundwater quality will include the collection of new groundwater quality data and specialized geochemistry work. The cost of this effort is estimated to range from $125,000 to $250,000. The duration of the effort could range from 6 to 12 months.

Task 3 Feasibility-Level Engineering and Marketing Analysis

Using the results of this investigation, the Task Force needs to determine if there are willing buyers to purchase the water produced by Projects B1A, C1A, C1B, C2A, and C2B. The need for additional recharge in Project 3 and the integration of Projects C2A, C2B and C3 needs to be evaluated to optimize the scale of the projects. The Marketing analysis should be done prior to starting Tasks 1 and 2. The initial marketing analysis can be done by the Task Force in about three to six months. The marketing analysis should be revisited after completion of Tasks 1 and 2

if the results of Tasks 1 and 2 suggest significant changes in the proposed projects operation and location. Engineering studies need to be done to refine the location of new well, pipeline alignments and point of connection to the receiving water systems. The cost of the feasibility–level engineering and marketing effort is estimated at around $200,000 to $300,000. The duration of the effort could range from 6 to 12 months.

Task 4 California Environmental Quality Act (CEQA) Process

A CEQA process needs to be done in a parallel with the feasibility and marketing work described in Task 3. Given that Tasks 1 and 2 are done prior to Tasks 3 and 4, the CEQA process is estimated to cost between $150,000 and $200,000. The duration of the effort could range from 9 to 12 months.

Table 4 - 1
Project B1 -- Design and Financial Analysis Assumptions for New Non-Potable Water Supply from Riverside South Basin

Wells		
Number	8	
Capacity, each	1,500	gpm
Availability	50%	
Pump efficiency	70%	
Well depth to water level	50	feet
Well discharge pressure	60	psi
	139	feet
Well construction cost	$350,000	Drilling
	$350,000	Equipping
Energy cost	$0.08	/kWh
Well rehabilitation	$35,000	ea
Pipelines		
Max. velocity	6	ft/sec
Max. headloss	6	ft/1,000 ft
Chezy coefficient	120	
Unit pipe cost	$7.00	/in dia./L.F., installed
Fixed O&M	2%	of Construction Cost
Project Financing		
Contingency	20%	
Engineering	15%	
Legal/Administration	5%	
Amortization period	20	years
Interest rate	6%	
Project Yield	9,678	acre-ft/yr

Table 4 - 2
Opinion of Probable Cost
Project B1 -- New Non-Potable Supply for for New Non-Potable Water Supply from Riverside South Basin

Cost Component	Unit Cost	Unit	Quantity	Total Cost
	Capital Cost			
Wells				
Well Drilling	$350,000	EA	8	$2,800,000
Well Equipping	$350,000	EA	8	2,800,000
Subtotal				$5,600,000
Pipelines				
12" Pipeline	$84	FT	600	$50,400
16" Pipeline	$112	FT	600	67,200
20" Pipeline	$140	FT	600	84,000
24" Pipeline	$168	FT	1,200	201,600
28" Pipeline	$196	FT	1,200	235,200
32" Pipeline	$224	FT	500	112,000
Subtotal			4,700	$750,400
Estimated Construction Cost				$6,350,400
Contingency				1,270,000
Total Construction Cost				$7,620,400
Engineering				1,143,000
Legal/Administration				381,000
Total Capital Cost				$9,144,400
	Annual Cost			
Power (Wells)				$213,419
Total Annual O&M Cost				$213,419
Total Annualized Capital Cost				797,000
Fixed O&M				$152,408
Total Annual Cost				$1,162,827
Project Yield (acre-ft/yr)				9,678
Unit Cost of Production				$120

Table 4-3
General Water Supply Plan for the City of Riverside and Proposed WMWD Ag Services from the Riverside and Colton Basins

Month	Days	New WMWD Ag Service: Delivery Capacity		Citrus	Volume Served[1]	Riverside Agricultural Service: Availability of Riverside's Ag Wells[2]	Capacity of Agricultural Wells		Volume Served[1]	Unused Capacity	Combined Riverside and WMWD Ag Service			Project C1A Capacity (Unused Production with Projected Riverside and WMWD Ag Service)			Project C1B Capacity: C1A Capacity	New Wells for C1B	Total C1B Capacity	
		(gpm)	(acre-ft)	(in)	(acre-ft)		(gpm)	(acre-ft)	(acre-ft)	(acre-ft)	(gpm)	(acre-ft)	(cfs)	(gpm)	(acre-ft)	(cfs)	(gpm)	(gpm)	(gpm)	(acre-ft)
January	31	7,800	1,069	0.0	0	0%	12,945	0	0	0	0	0	0	0	0	0	0	0	0	0
February	28	7,800	965	1.8	238	50%	12,945	801	204	597	3,569	442	8	2,904	359	6	2,904	4,500	7404	458
March	31	7,800	1,069	2.0	264	50%	12,945	887	227	660	3,581	491	8	2,891	396	6	2,891	4,500	7391	506
April	30	7,800	1,034	2.2	552	95%	12,945	1,630	474	1,157	7,734	1,025	17	4,563	605	10	4,563	4,500	9063	1,142
May	31	7,800	1,069	2.4	602	95%	12,945	1,685	517	1,168	8,165	1,119	18	4,132	566	9	4,132	4,500	8632	1,123
June	30	7,800	1,034	2.8	702	95%	12,945	1,630	603	1,027	9,844	1,305	22	2,454	325	5	2,454	4,500	6954	876
July	31	7,800	1,069	3.0	768	97%	12,945	1,720	660	1,061	10,422	1,428	23	2,135	292	5	2,135	4,500	6635	882
August	31	7,800	1,069	3.0	768	97%	12,945	1,720	660	1,061	10,422	1,428	23	2,135	292	5	2,135	4,500	6635	882
September	30	7,800	1,034	2.4	602	95%	12,945	1,630	517	1,114	8,438	1,119	19	3,860	512	9	3,860	4,500	8360	1,053
October	31	7,800	1,069	2.2	552	95%	12,945	1,685	474	1,211	7,485	1,025	17	4,813	659	11	4,813	4,500	9313	1,212
November	30	7,800	1,034	2.0	502	95%	12,945	1,630	431	1,200	7,031	932	16	5,266	698	12	5,266	4,500	9766	1,230
December	31	7,800	1,069	1.8	451	95%	12,945	1,685	388	1,297	6,124	839	14	6,174	846	14	6,174	4,500	10674	1,389
Totals			12,581	25.6	6,000			16,704	5,152	11,552		11,152			5,552					10,753
Average		7,800	1,048	2	500	80%	12,945	1,392	429	963	6,901	929	15	3,444	463	8	3,444	4,125	7,569	896
Max		7,800	1,069	3	768	97%	12,945	1,720	660	1,297	10,422	1,428	23	6,174	846	14	6,174	4,500	10,674	1,389
Min		7,800	965	0	0	0%	12,945	0	0	0	0	0	0	0	0	0	0	0	0	0

Note -- 1 Annual project deliveries of 6000 acre-ft/yr are assumed distributed monthly on a pro rata basis based on monthly consumptive use of citrus
Note -- 2 Assumes Ag wells are down for maintenance in January each year, and that Riverside Canal is available half the time during February and March

Table 4-4
Allocation of Capacity to Riverside Agricultural Service, WMWD Agricultural Service and Project C1

Well Name	1993-1997 Average Well Capacity (ac-ft)	(gpm)	(ac-ft)[1]	2005 Riverside Ag Service: Baseline Riverside Ag Service (ac-ft)	Unused Capacity (ac-ft)	Increase in Production for WMWD Ag Service (ac-ft)	Combined Riverside and WMWD Ag Services (ac-ft)	Capacity Available for Discharge to Santa Ana River in Project C1 (ac-ft)	Total New Production From Riverside North and South Basins (ac-ft)
					Project C1A				
Mill	357	580	748	357	391	0	357	391	391
Flume 2	511	1,140	1,471	511	960	0	511	960	960
Flume 3	329	2,400	3,097	329	2,768	0	329	2,768	2,768
Flume 4	0	2,460	3,174	0	3,174	1,742	1,742	1,432	3,174
Flume 6	891	1,765	2,277	891	1,386	1,386	2,277	0	1,386
Cunningham	0	1,000	1,290	0	1,290	1,290	1,290	0	1,290
Fill	1,547	2,100	2,710	1,547	1,163	1,163	2,710	0	1,163
First Street	1,517	1,500	1,936	1,517	419	419	1,936	0	419
Total	5,152	12,945	16,704	5,152	11,552	6,000	11,152	5,552	11,552
					Project C1B				
New C1-1	na	1,500	1,936	0	1,936	0	0	1,936	1,936
New C1-1	na	1,500	1,936	0	1,936	0	0	1,936	1,936
New C1-1	na	1,500	1,936	0	1,936	0	0	1,936	1,936
Subtotal New Wells		4,500	5,807	0	5,807	0	0	5,807	5,807
Subtotal C1A Wells								5,552	11,552
Total C1B								11,358	17,358

Note -- 1 Average well utilization is about 76 percent as per Table 4-1

Table 4-5
Project C1 -- Design and Financial Analysis Assumptions for Cycling Groundwater from the Colton and Riverside North Basins

Wells		
Pump efficiency	70%	
Well depth to water level	100	feet
Well discharge pressure	60	psi
	139	feet
Well construction cost	$350,000	Drilling
	$350,000	Equipping
Energy cost	$0.08	/kWh
Well reahibilation	$35,000	
Pipelines		
Max. velocity	6	ft/sec
Max. headloss	6	ft/1,000 ft
Chezy coefficient	120	
Unit pipe cost	$7.00	/in dia./L.F., installed
Project Financing		
Contingency	20%	
Engineering	15%	
Legal/Administration	5%	
Amortization period	20	years
Interest rate	6%	

Table 4-6
Opinion of Probable Cost
Project C1B -- Design and Financial Analysis Assumptions for Cycling Groundwater from the Colton and Riverside North Basins

Cost Component	Unit Cost	Unit	Quantity	Total Cost
	Capital Cost			
Wells				
Well Drilling	$350,000	EA	3	$1,050,000
Well Equipping	$350,000	EA	3	1,050,000
Subtotal				$2,100,000
Pipelines				
12" Pipeline	$84	FT	600	$50,400
Subtotal				$50,400
Estimated Construction Cost				$2,150,400
Contingency				430,000
Total Construction Cost				$2,580,400
Engineering				387,000
Legal/Administration				129,000
Total Capital Cost				$3,096,400
	Annual Cost			
Power (Wells)				$316,815
Total Annual O&M Cost				$316,815
Total Annualized Capital Cost				270,000
Total Annual Cost				$586,815
Unit Cost of Production ($/acre-ft)				$52

Table 4-7
Estimated Concentrations of Selected Water Quality Constituents in Riverside Canal Discharges to Santa Ana River
Between Mission Blvd Bridge and Riverside Narrows

Well Name	Projected Production (ac-ft)	TDS (mg/L)	1,1-DCE (ug/L)	Alkalinity (mg/L)	Al (mg/L)	As (mg/L)	Ba (mg/L)	B (mg/L)	Ca (mg/L)	Cl (mg/L)	Cr (mg/L)	Cu (mg/L)	DBCP (ug/L)	T (mg/L)	Gross Alpha (pC/L)	Fe (mg/L)	Pb (mg/L)	Mg (mg/L)	Mn (mg/L)	Hg (mg/L)	NO3 (mg/L)	Odor	pH	K (mg/L)	Na (mg/L)	EC	SO4 (mg/L)	PCE (ug/L)	Hardness (mg/L)	THMs (ug/L)	TCE (ug/L)	U (pC/L)	Zn (mg/L)
Mill	391	314		193		0.004		0.15	41	30	0.003			0.3				6.17		0.00035	4.7	1.0	7.8	3.5	60.8		54		132				0.01
Flume 2	960	342	0.6	189		0.005		0.24	59	48			0.12	0.5	2.1			8.88	0.07		5.0	0.7	7.4	5.5	51.7	617	64		186				0.00
Flume 3	2,768	353		220		0.010			55	56				0.4	5.9			11.67	0.13		2.1	1.0	7.3	5.0	57.0	647	61	1.8	179	14.7	11.1		0.03
Flume 4	3,174																																
Flume 6	1,386	331		191	0.008	0.006		0.22	56	46				0.6	2.3	0.013	0.002	9.33	0.17		2.3	1.0	7.4	5.3	52.9	614	61		178				0.09
Jurupa 7	0	371		190				0.00	71	25	0.008			0.1				9.00			34.5		7.7	1.5	36.0		45		210				
Fill	1,163	611	2.55	304			0.061	0.00	122	92			2.31	0.2	9.6			24.40			84.3	11.0	7.3	2.9	67.3	1104	72	4.7	395	0.8	38.1	14.0	
First Street	419	557		279				41.87	113	65		0.030		0.3	11.9			15.53			35.2	1.0	7.6	3.3	63.5	965	110		323			14.8	
Cunningham 2	1,290																																
Brunton	0	420		222				0.16	78	54			1.72	0.3	7.0			15.10			27.0		7.6	2.9	47.5	750	76		278			13.0	
Average		400	1.7	226	0.008	0.008	0.061	5.74	69	58	0.003	0.030	1.32	0.4	5.6	0.013	0.002	12.85	0.13	0.00035	18.1	2.6	7.4	4.6	57.8	735	66	2.7	221	10.6	19.1	14.2	0.05
Basin Plan Objective		700						0.75		140		*			15.0		*				45.0	3.0	6.5<pH<8.5		110.0		150		350			20.0	
Total	11,551																																

Note -- * Objective is based on hardness of River water

Table 4-8
Project C2 -- Design and Financial Analysis Assumptions for New Regional Potable Water Supply from Colton and Riverside North Basins

Wells		
Number	4	
Capacity, each	1,500	gpm
Availability	50%	
Pump efficiency	70%	
Well depth to water level	100	feet
Well discharge pressure	60	psi
	139	feet
Well construction cost	$350,000	Drilling
	$350,000	Equipping
Energy cost	$0.08	/kWh
Pipelines		
Max. velocity	6	ft/sec
Max. headloss	6	ft/1,000 ft
Chezy coefficient	120	
Unit pipe cost	$7.00	/in dia./L.F., installed
Booster Stations		
Project C-1 discharge pressure	120	psi
	277	feet
Project C-1 static head	0	feet
Project C-1 booster station	300	HP
Project C-2 discharge pressure	100	psi
	231	feet
Project C-2 static head	100	feet
Project C-2 booster station	416	HP
Pump efficiency	70%	
Availability	90%	
Booster station unit cost	$1,500	/HP
Project Financing		
Contingency	20%	
Engineering	15%	
Legal/Administration	5%	
Amortization period	20	years
Interest rate	6%	
Project Yield		
6 Months Production	4,839	acre-ft/yr
12 months Production	8,710	acre-ft/yr

Table 4-9
Opinion of Probable Cost
Project C2A -- New Potable Supply for Riverside Highland Water Company

Cost Component	Unit Cost	Unit	Quantity	Total Cost
		Capital Cost		
Wells				
Well Drilling	$350,000	EA	4	$1,400,000
Well Equipping	$350,000	EA	4	1,400,000
Subtotal				$2,800,000
Pipelines				
12" Pipeline	$84	FT	600	$50,400
16" Pipeline	$112	FT	800	89,600
20" Pipeline	$140	FT	800	112,000
24" Pipeline	$168	FT	2,600	436,800
Subtotal				$688,800
Booster Station				
Booster Station	$1,500	HP	300	$450,000
Estimated Construction Cost				$3,938,800
Contingency				788,000
Total Construction Cost				$4,726,800
Engineering				709,000
Legal/Administration				236,000
Total Capital Cost				$5,671,800
		Annual Cost		
Power (Wells)				$134,999
Power (Booster Station)				141,155
Total Annual O&M Cost				$276,154
Total Annualized Capital Cost				494,000
Total Annual Cost				$770,154
		Unit Cost of Production ($/acre-ft)		
12 Months of Production				$114
6 Months of Production				$159

Table 4-10
Opinion of Probable Cost
Project C2B -- New Potable Supply for City of Colton and WSBCWD

Cost Component	Unit Cost	Unit	Quantity	Total Cost
	Capital Cost			
Wells				
Well Drilling	$350,000	EA	4	$1,400,000
Well Equipping	$350,000	EA	4	1,400,000
Subtotal				$2,800,000
Pipelines				
12" Pipeline	$84	FT	600	$50,400
16" Pipeline	$112	FT	800	89,600
20" Pipeline	$140	FT	800	112,000
24" Pipeline	$168	FT	15,800	2,654,400
Subtotal				$2,906,400
Booster Station				
Booster Station	$1,500	HP	416	$624,675
Estimated Construction Cost				$6,331,075
Contingency				1,266,000
Total Construction Cost				$7,597,075
Engineering				1,140,000
Legal/Administration				380,000
Total Capital Cost				$9,117,075
	Annual O&M Cost			
Power (Wells)				$134,999
Power (Booster Station)				195,947
Total Annual O&M Cost				$330,946
Total Annualized Capital Cost				795,000
Total Annual Cost				$1,125,946
	Unit Cost of Production ($/acre-ft)			
12 Months of Production				$160
6 Months of Production				$233

Table 4-11
Project C3 -- Design and Financial Analysis Assumptions for Colton Lakes Recharge Project

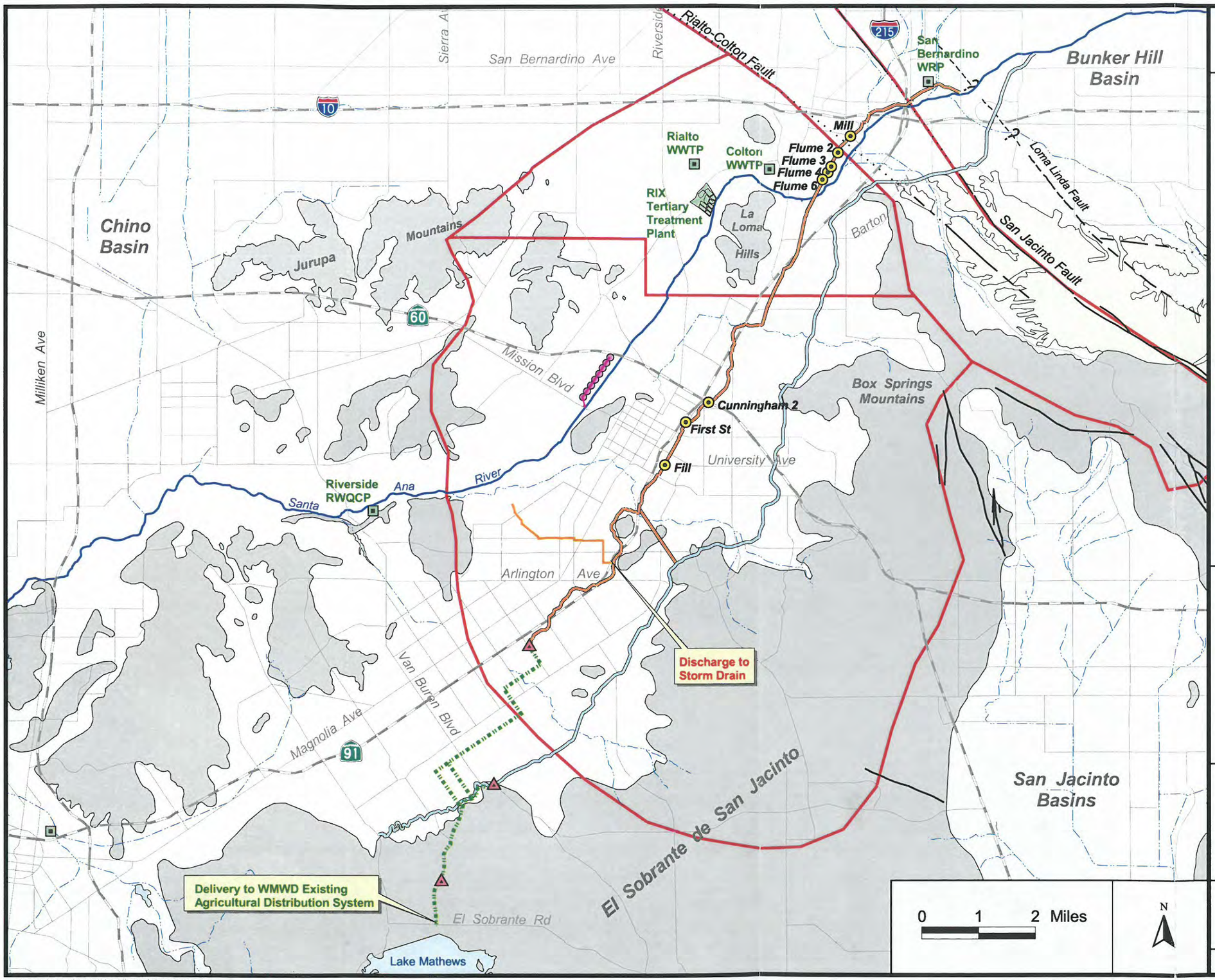
Rubber Dam	
Number	5
Width	800 feet
Height	8 feet
Spans per dam	2 400-foot spans
Bladder cost and equipment	$2,021,000 each
Reinforced concrete support and energy dissipater	$3,678,000 each
Complete cost per dam	$5,699,000 each
Earth Work	
Excavation, hauling and compacted backfill	$5 cuyd
Bank stabilization	
Length	1,000 feet ds each side of dam
Height	20 feet
Grouted rip rap	$142 sqyd
Channel Percolation	
After storm flow	3.0 ft/day
Equilibrium rate	0.5 ft/day
Operations and Maintenance Cost	2% of capital cost
Project Financing	
Contingency	20%
Engineering	15%
Legal/Administration	5%
Amortization period	20 years
Interest rate	6%

Table 4-12
Opinion of Probable Cost
Project C3 -- Colton Lakes
Recharge Project

Cost Component	Unit Cost	Unit	Quantity	Total Cost
	Capital Cost			
Earth Work				
Excavation, hauling and compacted backfill	$5	cuyd	1,185,000	$5,925,000
Bank stabilization	$142	sqyd	23000	$3,266,000
Subtotal				$9,191,000
Rubber Dams	$5,699,000	EA	5	$28,495,000
Estimated Construction Cost				$37,686,000
Contingency				$7,537,000
Total Construction Cost				$45,223,000
Engineering				$6,783,000
Legal/Administration				$2,261,000
Total Capital Cost				$54,267,000
	Annual Cost			
Total Annual O&M Cost				$1,249,000
Total Annualized Capital Cost				$4,731,000
Total Annual Cost				$5,980,000
Annual Recharge of Supplemental Water (acre-ft/yr)				
May through October				17,000
Unit facilities cost of recharge				$360

Table 4-13
Consistency of Proposed Projects with Project Agreement 16 Goals

Project	Goals					
	Improve groundwater quality of Riverside and Colton Basin	Create drought storage	Reduce dependency on imported water	Maximize local groundwater production	Maximize capture and use of local surface water	Provide seasonal storage
Project B1 New Non-Potable Supply Supply from the Riverside South Basin	Yes	No	No	Yes	Yes	Yes
Project C1A Cycling Groundwater from Riverside North and Colton Basins	Yes	No	Yes	Yes	Yes	Yes
Project C1B Cycling Groundwater from Riverside North and Colton Basins	Yes	No	Yes	Yes	Yes	Yes
Project C2A New Potable Supply from the Colton and Riverside North Basins	Yes	No	Yes	Yes	Yes	Yes
Project C2B New Potable Supply from the Colton and Riverside North Basins	Yes	No	Yes	Yes	Yes	Yes
Project C3 Colton Lakes Recharge Project	Yes	No	No	Yes	Yes	Yes
Projects C2 and C3 Combined	Yes	Yes	No	Yes	Yes	Yes
Project E Maximize City of Riverside Production from Riverside North and South	Yes	No	Yes	Yes	Yes	No



Riverside-Colton Conjunctive Use Project

Legend

- Existing Wastewater Treatment Facility
- Riverside Irrigation Well Used in Project C1
- Project B1 Wells
- Riverside Canal
- Gage Canal
- Proposed WMWD Non-potable Water Conveyance Pipeline
- Storm Drain
- Proposed Booster Pump Station
- Legal Basin Boundaries

Other Map Features

- Faults (solid where known, dashed where approximate, dotted where concealed, queried where uncertain)
- Unconsolidated Sediments
- Semi-consolidated Sediments
- Consolidated Bedrock

Index of Legal Basin Boundaries

Figure 4-1
Facilities Layout for Alternative B1 and C1

WE WILDERMUTH ENVIRONMENTAL, INC.

Prepared by: AEM | Date: June 2001

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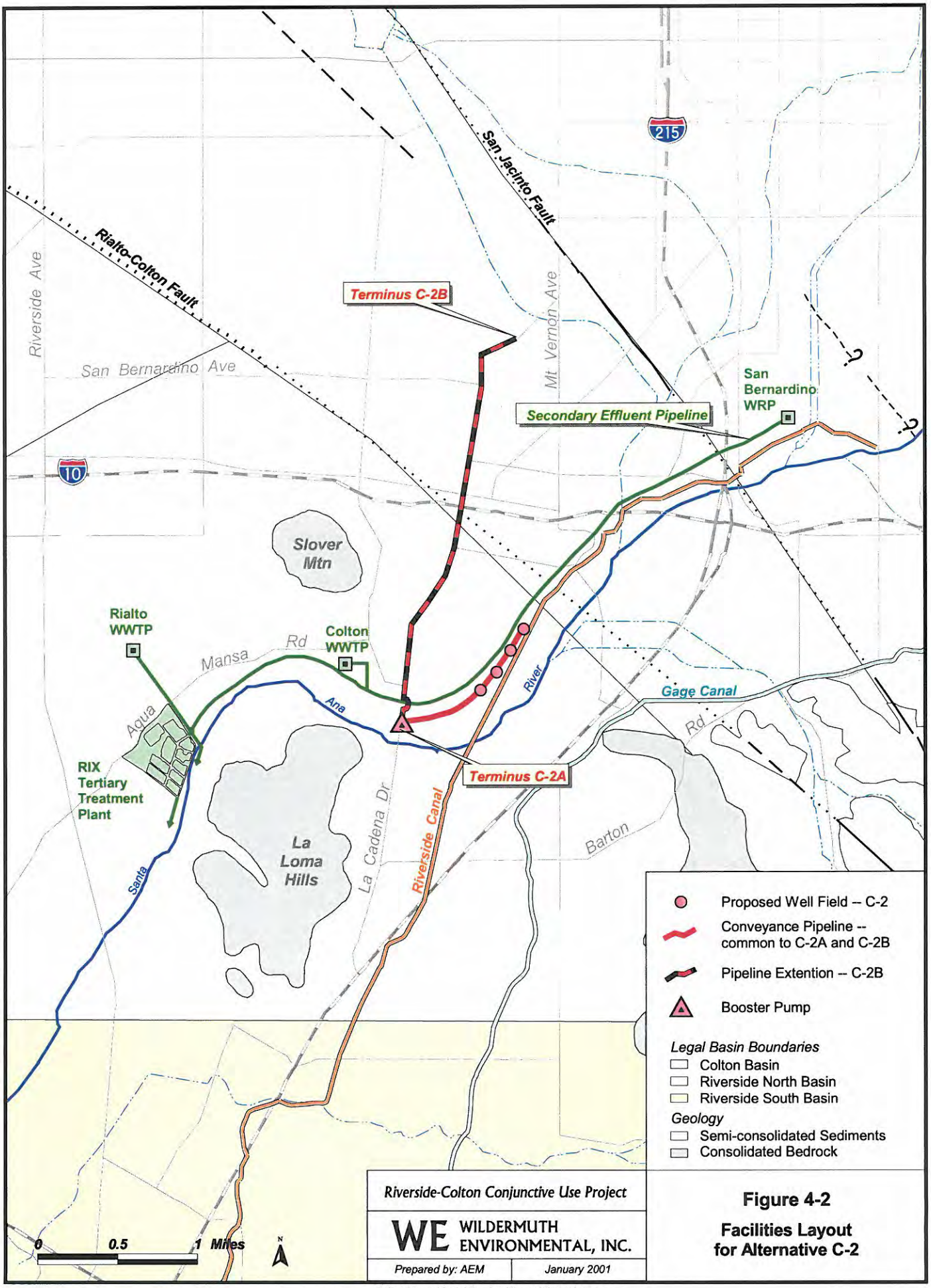

Figure 4-2

Facilities Layout for Alternative C-2

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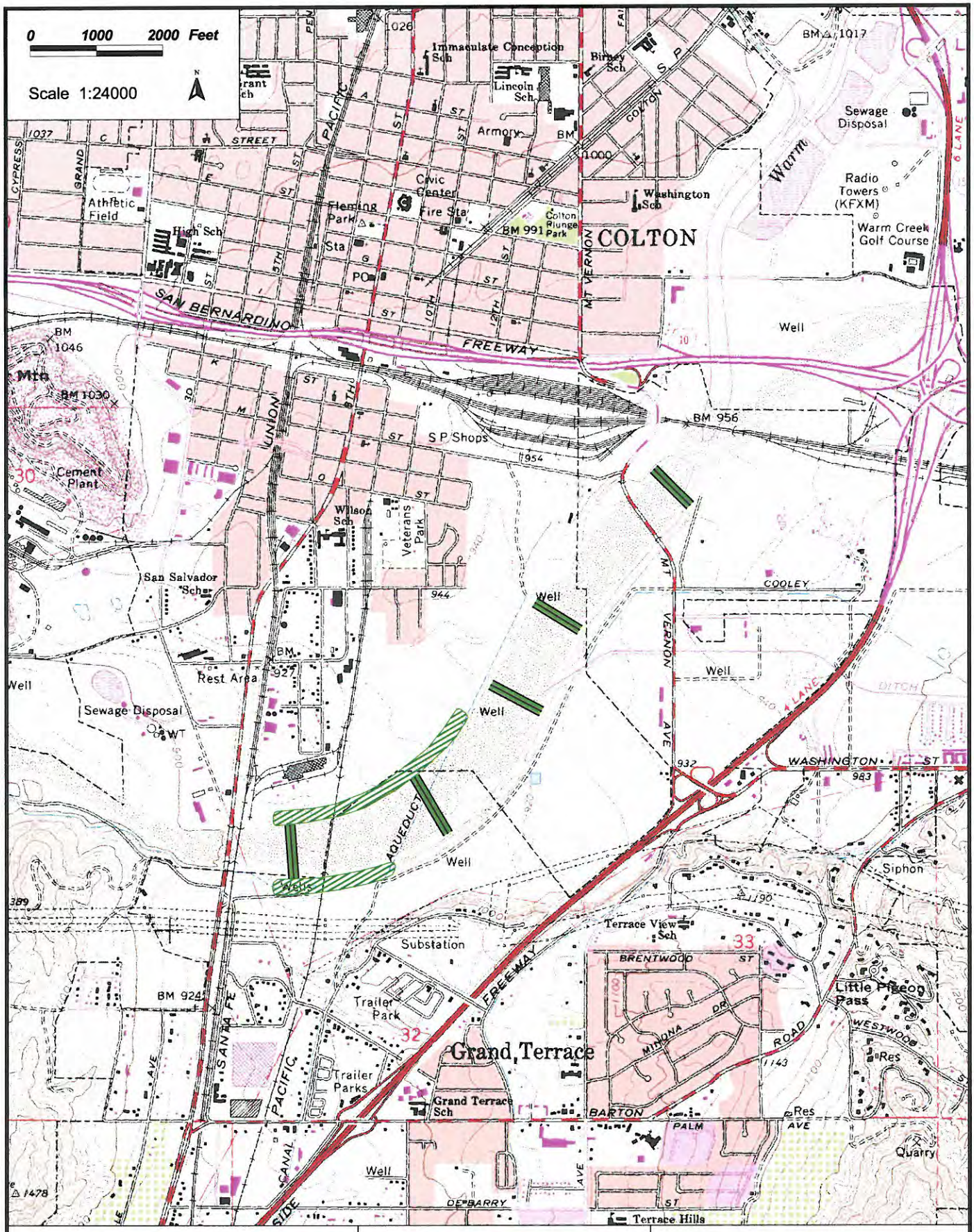

Riverside-Colton Conjunctive Use Project

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Prepared by: AEM | *April 2001*

Figure 4-3

Facilities Layout for Project C3

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